THE PRODUCTION AND DISTRIBUTION OF KNOWLEDGE IN THE UNITED STATES

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THE PRODUCTION AND DISTRIBUTION OF KNOWLEDGE IN THE UNITED STATES

BY FRITZ MACHLUP

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PREFACE

ENDOWED lectures have often been responsible for publications of pamphlets or slim books. This time a heavy tome has grown out of five lectures. The first of these was the John L. Senior Lecture in American Studies which I gave in March 1959 at Cornell University; the other four were the Moorhouse I. X. Millar Lectures which I gave in October 1960 at Fordham University.

Had it not been for the persuasive powers of Father William T. Hogan, S.J., of Fordham University, I doubt that I would have been enterprising enough to embark on the research for this ambitious project. The work was more laborious than I had anticipated, and the product much more voluminous than had been intended. The manuscript had been promised to the Fordham University Press; but when it grew to extraordinary size, comprising no less than 84 statistical tables, it seemed more expedient that the Princeton University Press should undertake the publication. My thanks go to the Directors of both these university presses, to Father Quain for releasing me from my obligations and to Mr. Bailey for taking on the task. My relations with the Princeton University Press have proved particularly pleasant and I wish to pay my respects to Mr. John B. Putnam for his editorial help and to Mr. P. J. Conkwright for his designing skill.

Several research assistants and associates have helped me in the detective work of finding, examining, and cross-examining the statistical data needed for the quantitative story presented in this book. Acknowledgments are due to Dr. Thomas F. Dernburg, Mr. Rudolph G. Penner, Dr. Vladimir Stoikov, Mr. Leon P. Sydor, and Mr. John H. Williamson. Mrs. Mary B. Fernholz did an outstanding job of preparing the manuscript for the printer, keeping track of seemingly endless revisions, and, together with Miss Lillemor Wedholm, checking the galley proofs. In the preparation of the index I was helped by Mr. Hang-Sheng Cheng and Mr. James W. Land. My thanks to all these faithful friends.

The sources of financial support must not go unmentioned in my list of acknowledgments. Grants from the National Science Foundation, from the Ford Foundation, and from a large corporation allowed for release of time from teaching duties and payments of salaries for research assistance. The facilities of the International Finance Section and the Pliny Fisk Library of Princeton University also contributed substantially to the work.

Having acknowledged my indebtedness to many persons and organizations, I may acknowledge the major defect of which I am conscious in the conception and execution of this work. My concepts of knowledge and knowledge-production are unusually wide, particularly because I recognize, and work with, both meanings of knowledge: as *that which is known*, and as the *state of knowing*. Hence, to "produce knowledge" is not only to add to the stock of what is known but also to create a state of knowing in anybody's mind. Producers of knowledge may, however, work on very different levels: they may be transporters, transformers, processors, interpreters, or analyzers of messages as well as original creators. What I have failed to do in this volume, and would do if I had time for it, is to attempt a statistical separation of knowledge-producing activity by these different levels. Perhaps I shall undertake this task as a sequel to the present book; or perhaps someone else will want to do it, especially with reference to the changes in the occupational structure, discussed in the last chapter of this volume.

F. M.

Summer 1962

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CHAPTER I · INTRODUCTION

EVERY branch of learning takes a good many things for granted. If these things *have* to be explained, "Let George do it." George is always someone in another discipline. Hence, the analysis of the production and distribution of knowledge falls into George's field.

George has always been a popular fellow. People were inclined to rely upon him even if they did not know whether he really existed. In recent years, however, Georges have actually appeared on the scene in increasing numbers. Many of them are called "interdisciplinary research workers."

The Economist as a Student of Knowledge Production

Anything that goes under the name of "production and distribution" sounds as if it clearly fell into the economist's domain. An analysis of "knowledge," on the other hand, seems to be the philosopher's task, though some aspects of it are claimed by the sociologist. But if one speaks of the "communication of knowledge in the United States," the specialist in education may feel that this is in his bailiwick; also the mathematician or operations researcher specializing in communication theory and information systems may prick up his ears. In fact, some of the knowledge to be discussed here is technological, and thus the engineer may properly be interested. When I tried out the title of this study on representatives of various disciplines, many were rather surprised that an economist would find himself qualified to undertake this kind of research. Of course, they did not really know what kind of research I was planning under that intriguing title.

KNOWLEDGE AS A DATUM IN ECONOMIC ANALYSIS

Knowledge has always played a part in economic analysis, or at least certain kinds of knowledge have. There has always been the basic assumption that sellers and buyers have *knowledge of the markets*, that is, of their selling and buying opportunities. The theories of supply and demand, of competition and monopoly, of relative prices, interdependence, and all the rest, all have been based on the assumption that sellers know the highest prices at which they can sell and buyers know the lowest prices at which they can buy. In addition, it has always been assumed that producers have *knowledge of the technology of the time*, that is, of their production opportunities. In other words, the assumption has been that they know the lowest cost at which they can produce. The usual supposition has been that all producers in an industry are familiar with the "state of the technical arts."

This does not mean that economic theorists have regarded technological knowledge as unchanging. But to most economists and for most problems of economics the state of knowledge and its distribution in society are among the data assumed as given. There is nothing wrong with this. When an economist analyzes the effects of new taxes, of changes in interest rates or wage rates, it would be unreasonable for him *not* to assume a given state of technology. And even when he analyzes problems of growth and development, he will often find it expedient to assume either a given state of the arts or a given rate of progress, whatever this may mean.

An increasing number of economists these days concern themselves with the prospective growth of the economy during the next twenty or thirty years. Needless to say, they cannot take the state of technical knowledge as given and constant. On the other hand, they do not want to burden their models with more stuff than is absolutely necessary for their task and, therefore, they choose to assume a given rate of advance of productivity, to project the past rate of advance into the future. In other words, the progress of technical knowledge is made an exogenous variable, or a simple trend function, a function of time.

Incidentally, the same practice prevails concerning other important variables in growth economics—for example, population and labor force. There was a time when economists regarded the explanation of population growth as their business. Later they got out of this job and assigned it to George—this time a specialist, the demographer. Only very exceptional economists today concern themselves with the economic determination of population changes, and would include population as a dependent variable in their growth model. The choice between taking a variable as exogenous or making it an endogenous one, a variable determined by the system of functions, is a matter of relevance and convenience. No economist, for example, would refuse to recognize the explanation of capital formation as a part of his job. He constructs elaborate models in which investment functions and saving functions, together with several other equations, are supposed to serve this task. Yet, there are problems—for example, projections of national income figures into the future—for which a rate of accumulation will expediently be assumed as given, and the underlying functions be left aside.

Now, the growth of technical knowledge, and the growth of productivity that may result from it, are certainly important factors in the analysis of economic growth and other economic problems. But with one very minor exception—namely, the theory of patent protection—the stock of knowledge and especially the state of technology have customarily been treated as exogenous variables or as trend functions in economic models. Yet we have implicitly recognized that the stock of knowledge can be increased by special efforts; that the allocation of resources to education and to research and development is an important economic variable which can significantly alter the rate of increase of knowledge, both basic and applied. During the last few years economic statisticians have given a good deal of attention to the appropriations made by society for the creation and communication of knowledge. The economics of education and the economics of research and development are new areas of specialization which are now developing, partly with the generous aid of research foundations.

KNOWLEDGE AS A PRODUCT, A FUNCTION OF RESOURCE ALLOCATION

The "promotion" of knowledge from the rank of an exogenous independent variable to that of an endogenous variable dependent on input, on the allocation of resources, is an important step. Not that this idea is a novel one. Adam Smith in 1776 wrote that "man educated at the expense of much labor and time . . . may be compared to one of those expensive machines,"[1] and the notion of the "capital concept applied to man"[2] has never completely disappeared from the economic treatises. It was especially emphasized by writers, such as Friedrich List, who gave much prominence to the development of the productive powers of man. In connection with several policy issues the differences between the private and social benefits from such investment in knowledge were discussed with great intensity—for example, in the arguments for infant-industry protection. But never before our time was the interest of economic writers so closely concentrated upon the analysis of economic growth and development, and thus it is not surprising that there is now such a burst of activity in studying the productivity of investment in knowledge.

The focus of these studies is upon education, basic research, and applied technical research and development, thus, upon the production

[1] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (Everyman's Library, 1910), Vol. I, pp. 88-89.

[2] R. J. Walsh, "Capital Concept Applied to Man," *Quarterly Journal of Economics*, Vol. XLIX (1935), p. 255ff.

of such types of knowledge as may be regarded as an investment in the sense that it will pay off in the future through increased productivity. A few economists aim their analytical weapons at a somewhat different target: market research. Recognizing that the assumption of full knowledge of selling and buying opportunities cannot be maintained for all problems, and that increased effort in market research may lower the costs and raise the revenues of the firm, economists have started to analyze the marginal efficiency of investment in market research. All these kinds of knowledge have in common that they are instrumental in increasing the efficiency of the economy.

There are, however, several other types of knowledge, besides those designed to pay off in the future; there are, for example, types of knowledge that give immediate pleasure to the recipients, and society is allocating ample resources to the dissemination of such knowledge. While it would, of course, be possible to confine a study of the production and distribution of knowledge to types of knowledge that are expected to yield a future return in terms of increased productivity, such a limitation would not satisfy a transcendent intellectual curiosity. Moreover, whether an investigator's interests be wide or narrow, he could not study "productive" knowledge without paying considerable attention to "unproductive" knowledge because ever so often they are joint products. What is taught at school, printed in books, magazines and newspapers, broadcast over the radio, or produced on television is knowledge of many sorts; and to study one is to analyze all.

An even further expansion of the scope of the study seems promising. As an economy develops and as society becomes more complex, efficient organization of production, trade, and government seems to require an increasing degree of division of labor between knowledge production and physical production. A quite remarkable increase in the division of labor between pure "brain work" and largely physical performance has occurred in all sectors of our economic and social organization. This increase can be observed in the growing role, measured in terms of manpower, of the government of most political bodies as well as of the management of business firms; it can also be observed in the ratios of "nonproductive" to "productive" labor in many industries. The so-called nonproductive workers are those who shuffle papers and give signals, who see to it that others "know" what to do. To include this sort of "knowledge production" may look strange to most readers at first blush but will become more understandable and look more sensible at later stages of the discussion.

Thus, besides the researchers, designers, and planners, quite naturally, the executives, the secretaries, and all the "transmitters" of knowledge in the economy will eventually come into the focus of our analysis of the production and distribution of knowledge.

If society devotes considerable amounts of its resources to any particular activity, economists will want to look into this allocation and get an idea of the magnitude of the activity, its major breakdown, and its relation to other activities.

Terminological Proposals

The economist undertaking this study will have to prepare himself for it by developing a conceptual framework for an analysis for which he does not find ready-made tools. He will have to use terms that have established meanings in other fields of discourse, and may not find these meanings suitable for his task. The problems arising from these needs will be taken up for careful scrutiny in the next chapter. At this point, however, we propose a time-saving terminological agreement.

"PRODUCTION AND DISTRIBUTION"

So far in this introduction we have always referred to pairs of economic activities, such as "production and distribution," "acquisition and transmission," "creation and communication" of knowledge. We can save words and drop the twin phrase as soon as we realize that we may designate as "knowledge" anything that is known by somebody, and as "production of knowledge" any activity by which someone learns of something *he* has not known before even if others have.

In this sense, disclosure, dissemination, transmission, and communication become parts of a wider concept of "production of knowledge." Of course, we shall then have to distinguish a special kind of "socially new knowledge"—that which no one has had before—but since we shall have much more to say about the production of old knowledge in new minds—"subjectively new knowledge," if you like—the proposal will on balance save words.

Thus, if I tell you something that you have not known, or only vaguely known, or had forgotten, I am producing knowledge, although I must have had this knowledge, and probably several others have too. In other words, "producing" knowledge will mean, in this book, not only discovering, inventing, designing, and planning but also disseminating and communicating.

"KNOWLEDGE AND INFORMATION"

By the same token, I propose that we get rid of the duplication "knowledge and information." There are those who insist on distinguishing "information" from "knowledge," for example, by having "information" refer to the act or process by which knowledge (or a signal, a message) is transmitted. But even if the word is not used for the act of communicating but for the contents of the communication, one may want "information" to refer to disconnected events or facts, and "knowledge" to an interrelated system (though others want to confer upon "systematic" or "ordered" knowledge the nobler title, "science"). One author, for example, proposes to contrast "knowledge," or "contextual knowledge," which "illuminates the basic causal structure of some field of operations," with "information," which "provides current data on the variables in that field."[3] The specialist in "information theory" uses the word, as he frankly admits, in a "rather strange way," in "a special sense which . . . must not be confused at all with meaning." To him, "information is a measure of your freedom of choice when you select a message. . . . Thus greater freedom of choice, greater uncertainty and greater information all go hand in hand."[4] This concept serves a significant purpose in an important field, but it is not what is commonly meant by "information." Perhaps the fact that the special use of the word is becoming increasingly current should make it more desirable to use, whenever possible, the word "knowledge" for the ordinary meaning of "information." *Webster's Dictionary* defines "information" as "knowledge communicated by others or obtained by personal study and investigation," or alternatively as "knowledge of a special event, situation or the like." Hence, in these ordinary uses of the word, all information is knowledge. We may occasionally refer to certain kinds of knowledge as "information," but we shall avoid the redundant phrase "knowledge *and* information."

The Task Before Us

Perhaps another word or two about the desirability of this undertaking: an economist's investigating the production of knowledge.

[3] The same author, however, decides later to treat both as "information," yet he continues to oscillate between talking about "bits of knowledge" and "bits of information." Anthony Downs, *An Economic Theory of Democracy* (New York: Harper, 1957), pp. 81, 208, 215, 219.

[4] Warren Weaver, "The Mathematics of Information," in *Automatic Control* (New York: Simon & Schuster, for *The Scientific American*, 1955), pp. 100, 104.

The production of knowledge is an economic activity, an industry, if you like. Economists have analyzed agriculture, mining, iron and steel production, the paper industry, transportation, retailing, the production of all sorts of goods and services, but they have neglected to analyze the production of knowledge. This is surprising because there are a good many reasons why an economic analysis of the production of knowledge seems to be particularly interesting and promising of new insights. Some of the reasons refer to observed facts, others to probable relations to economically significant developments, still others to novel hypotheses that call for investigation.

SOME OF THE REASONS FOR OUR CURIOSITY

(1) It is a fact that increasing shares of the nation's budget have been allocated to the production of knowledge.

(2) It can also be shown that a large portion of the nation's expenditures on knowledge has been financed by government, so that much of the production of knowledge depends on governmental appropriations.

(3) One may strongly support the judgment that the production of knowledge yields social benefits in excess of the private benefits accruing to the recipients of knowledge.

(4) It is probable that the production of certain kinds of knowledge is limited by inelasticities in the supply of qualified labor, which raises questions of policy, especially concerning the allocation of public funds.

(5) The facts that the production of knowledge of several types is paid for by others than the users of the knowledge, and that these types of knowledge have no market prices, raise questions of their valuation for national-income accounting as well as for welfare-economic considerations.

(6) The production of one type of knowledge—namely, technology—results in continuing changes in the conditions of production of many goods and services.

(7) One may advance the hypothesis that new technological knowledge tends to result in shifts of demand from physical labor to "brain workers."

(8) There is evidence of a change in the composition of the labor force employed in the United States, in particular of an increase in the share of "knowledge-producing" labor in total employment.

(9) There is ground for suspicion that some branches of the production of knowledge are quite inefficient, although it is difficult to ascertain input-output ratios and to make valid comparisons, especially since the very wastefulness is held to be productive of psychic incomes and social benefits.

(10) It has been suggested that some of the growth in the production of knowledge may be an instance of "Parkinson's Law," which implies that administrators tend to create more work for more administrators.

(11) There is probably more validity in the hypothesis that the increase in the ratio of knowledge-producing labor to physical labor is strongly associated with the increase in productivity and thus with the rate of economic growth.

These points indicate some of the reasons why it may be said that an economic analysis of the production of knowledge is not only justified but overdue. What I shall have to offer may be only prolegomena to the subject. And, to repeat, it will not be possible for me in this attempt to stay within the confines of economics. Indeed, I shall linger with particular pleasure in some outlying fields, and I trust that the representatives of these fields of learning will be hospitable to the ingressions of a friendly outsider.

PLAN OF THIS STUDY

Our first task, as I have said before, will be to develop the conceptual framework for an analysis of "knowledge-production." This will involve discussions of the meanings of the term "knowledge" and of the various ways in which scholars—philosophers, sociologists, and others—have classified knowledge. It will further require an analysis of the various methods of producing knowledge, with appropriate distinctions between technical and economic points of view. Finally, it will call for the formulation of criteria for deciding under what conditions knowledge is a "final" product, or only an "intermediate" one, and, if it is a final product, whether it is investment or a service to consumers. All this is on the program for Chapter II.

Chapter III is a brief essay on the significant difference between an "industry approach" and an "occupation approach" to the study of knowledge-production. The industry approach will be followed in the subsequent six chapters, and only the last chapter of the book will return to the problem of the secular increase in the share of "knowledge-producing occupations" in the total labor force.

Chapter IV, the longest in the volume, is devoted to "Education," the largest of the knowledge industries. After brief discussions of education outside the schools—in the home, on the job, in the church, in the armed services—historical statistics and expenditure analyses are presented first for elementary and secondary schools and then for institutions of higher education. The problems of the productivity—social rate of return—and of the efficiency of education are examined, and finally a proposal for school reform is submitted. Earnest consideration of this proposal is requested.

Another long chapter, V, deals with "Research and Development" and the enormously rapid growth rate in this activity, largely financed with government funds. The various subdivisions—basic research, applied research, and development—are treated separately as well as jointly; the inventive process and the role of the patent system in the promotion of inventive effort are analyzed. After an examination of the competitiveness between industrial research and secondary and higher education, and the essential complementarity between basic research and education, a warning is sounded against the widely favored expansion of industrial research and development, because it may lead to a fatal curtailment in the training of research scientists. Too rapid growth of applied research and development work threatens to dry up the supply of research personnel and, thus, to force cutbacks of research in the future.

"The Media of Communication" are to be treated in Chapter VI. This will include historical and statistical surveys of printing and publishing—books, periodicals, newspapers—the stage and the cinema, radio and television, telephone and telegraph, the postal service, and a few other media. Though each of these discussions is relatively brief, they add up to a considerable compendium.

Chapter VII is devoted to a survey of "Information Machines." Here the replacement of men by machines in the processing of information and the prompt availability of information needed for more rational decision-making are discussed. Some basic facts about electronic computers and automatic control systems are presented, and the spectacular growth of this industry is shown by means of statistical data furnished by some of the larger firms.

"Information Services" will be discussed in Chapter VIII, in a somewhat groping fashion because of the awkward conceptual and statistical problems involved. Several information services are rendered jointly with other services at joint costs and, in view of the arbitrariness of statistical separation, no satisfactory treatment seems possible.

A summary statement of the expenditures for the products of the various knowledge industries is to be presented in Chapter IX. Although the growth rate of knowledge-production as a whole is naturally less sensational than the growth rates in some of its parts, it still is impressive. An ever-increasing part of the actual and potential Gross National Product has been taken by the production of knowledge. The causal connections are complex, and undoubtedly go in both directions: an increase in the production of certain kinds of knowledge, in the nature of investment, leading to increased productivity in the use of resources and to higher national incomes; the increase in total income, in turn, leading to greater consumption of other kinds of knowledge and also providing ampler funds for investment in more knowledge of the productive types.

The last chapter, X, will treat of the gradual, but distinct, change in the occupational composition of the labor force that has been going on at least since 1900, and has become even more conspicuous in recent years. This change involves a continuous increase in "knowledge-producing" workers and a relative decline in what used to be called "productive labor." The changing employment pattern now shows such a rapid trend toward the use of more brainpower relative to the use of physical strength or physical skills that a serious problem of employability of less-educated members of the labor force arises.

The plan of this book shows, I submit, a unity of conception which sharply distinguishes it from a collection of essays. Yet the author's effort will be apparent to make each chapter as self-contained as possible. This is attempted for the sake of specialists who may be interested in some chapters but not in others. It is quite likely that many "educators" will want to read only Chapter IV, and many "research scientists" only Chapter V. While I cannot say that they would not miss anything if they chose to neglect the rest of the book, at least they would never know that they have.

CHAPTER II · TYPES OF KNOWLEDGE AND OF KNOWLEDGE PRODUCTION

SOME people have firm convictions regarding the virtue or vice of beginning a discussion with definitions. Even nationalistic prejudices have been appealed to in this cause. I have heard references to Teutonic authoritarianism and its propensity at the very outset to impose definitions upon the helpless reader; to English pragmatism and its propensity to defer definitions until it has become clear what is called for in the setting of problems and issues; to French orthology and its propensity to proscribe discourse on undefined subjects. I have no convictions on this question. In the present instance, however, it would be impossible to begin with a definition, because we shall see that "knowledge" does not have just one meaning, which one could delineate and demarcate with a definition. It has several meanings, and two of them will be needed throughout this book. Although they are different, they are logically correlated and neither of them is dispensable in our discussion. The one is knowledge as that which is known; the other is knowledge as the state of knowing.

The Known and the Knowing

The two essential meanings of the word "knowledge" are usually not kept apart. Most philosophers of science, when they distinguish among different kinds of knowledge, mean different kinds of subjects, different kinds of things known. Yet in epistemology different ways of knowing are examined: in order to study the relation between the knower and the known one has to inquire into the ways of knowing, the ways of getting to know, as well as the classes into which to sort that which has been or is becoming known.

THE DOUBLE MEANING

In everyday language we use the word just as often in the one as in the other of its meanings. We speak of having acquired "much knowledge," and we also speak of "having knowledge" of this or that. But if knowledge means both what we know and our state of knowing it, we might have to say that we "have knowledge of much knowledge."

The same kind of equivocation has developed with other words. "Possession" means both that which we possess and the state of our possessing it, from which one might conclude that we have possession of our possessions. "Property" means both that which belongs to me and my right to it, which would imply that I have property of my property.

KNOWLEDGE PRODUCTION

With this double meaning of "knowledge" we shall find the terminological proposal made in Chapter I even more justified. Knowledge as a state of knowing is produced by activities such as talking plus listening, writing plus reading, but also by activities such as discovering, inventing, intuiting. In the first group of activities at least two persons are involved, a transmitter and a receiver, and the state of knowledge produced in the consciousness of the recipient refers to things or thoughts already known, at least to the transmitter. Only one person is engaged in the second group of activities. The state of knowing which he produces may be of things or thoughts not known to anybody else.

Knowledge in the sense of "that which is known" exists as soon as one single person "has" it and, hence, it is first produced by the kind of processes mentioned above with the second group of activities producing a "state of knowing"—discovering, inventing, etc. Of course, if only one person has a particular piece of knowledge and does not share it with anybody, it may be that no one knows "about it." We do not ordinarily take notice of knowledge possessed by only one knower. Only when he discloses what had been a "one-man secret" and thus does his part in the production of a state of knowing, in other minds, what he alone has known, will one usually speak of "socially new knowledge." When does such knowledge stop being socially "new"? How much time must have passed since its first acquisition or since its first disclosure? There is no need to answer this question since little, if anything, depends on how it is answered. But it is important to bear in mind that from several points of view, and particularly from an economic point of view, the transmission of the knowledge from the first knower to at least a few others is essential. This implies that the production of new knowledge—in the sense of that which is known—is not really complete until it has been transmitted to some others, so that it is no longer one man's knowledge only.

INFORMATION AND KNOWLEDGE

In the first chapter we had to touch on the meaning of "information," and decided to prefer the word "knowledge" whenever possible in place of the word "information." It may not be out of place, however, to add here a few words concerning the relation between the two concepts as they are used in everyday speech.

Linguistically, the difference between knowledge and information lies chiefly in the verb form: to *inform* is an activity by which knowledge is conveyed; to *know* may be the result of having been informed. "Information" as the act of informing is designed to produce a state of knowing in someone's mind. "Information" as that which is being communicated becomes identical with "knowledge" in the sense of that which is known. Thus, the difference lies not in the nouns when they refer to *what* one knows or is informed about; it lies in the nouns only when they are to refer to the *act* of informing and the *state* of knowing, respectively. It happens that information is not often used in the latter sense.

In denying that there is a difference between knowledge and information when both refer to what one knows or is informed about, I may have offended against common usage in some respects. If our stock of knowledge includes, say, the multiplication table one may object to calling it "information." Or, if we know the law of supply and demand and also know that certain prices have just gone down, it may be preferable to speak of the price change as a piece of information, and of the usual consequences of a price change as a piece of knowledge. One may object to referring to the law of supply and demand as a piece of information, but there should be no serious difficulty in referring to the report of the price change as having become part of our knowledge. Again we conclude that all information in the ordinary sense of the word is knowledge, though not all knowledge may be called information.

Classifications of Knowledge

We shall argue that attempts to classify knowledge (in the sense of that which is known) are often more enlightening than attempts to define it. Classifications are said to make little sense unless it is stated what purposes they are to serve. Sometimes, however, the purpose may be merely to give an impression of the range and variety of things that are there to think about. An exhaustive classification may suggest a definition; a merely illustrative classification would leave the definition open, but may still suggest most of what is meant by the term in question.

PERSUASIVE DEFINITIONS OF KNOWLEDGE

I have seen a good many "persuasive definitions" of knowledge:

the defining scholar trying by his definition to restrict the designation "knowledge" to what he considers worth knowing. Now if he wants to show his respect or contempt for one kind of knowledge or another, he has every right to do so. But what he needs for this purpose is a set of distinctions of different types of knowledge, not a definition; he need not exclude some of the things some people know (or believe they know) from the concept of "knowledge." It may well be less important to know baseball scores than symphony scores; less important to know all makes of cars than to know how an engine works; less important to know the plots of Hollywood movies than the works of Shakespeare. But these value judgments do not suggest any dividing lines between knowledge and non-knowledge; at best they suggest distinctions and classifications of types of knowledge.

There are those who seem to identify knowledge with the things taught in schools, colleges, and universities, so that their classifications often cover not much more than academic learning. Their customary division of academic learning into natural sciences, social sciences, and humanities, plus various professional disciplines such as medicine and engineering, helps at best to perpetuate a tradition in organizing the faculties of institutions of higher education. But there are other distinctions which we ought to consider more closely.

BASIC AND APPLIED KNOWLEDGE

The distinction of a class called "scientific knowledge" does not seem very useful for our purposes. There is less agreement about the meaning of the words "science" and "scientific" than about most other words that can be used to qualify the word "knowledge." (I have, in fact, strong views about what science "ought" to mean, but what good does this do in a discussion if one rarely knows the meanings others attach to the word?) The extension of the term "scientific knowledge" varies so widely that its usefulness for purposes of classification is quite limited, though some of its connotations may be generally understood.

The widely used distinction between "basic" and "applied" knowledge, though not easy to carry through when it comes to sorting out the things learned or taught, does make sense and serves some good purposes. There are, in the first place, certain functional relations between basic knowledge and applied knowledge: the former may permit us to derive practical knowledge from it, which explains the name "applied" knowledge; but sometimes it is the other way around—that is, the discovery of some pieces of practical knowledge may suggest the need for new basic knowledge and may provide clues for finding it. Secondly, there is the perennial question of the right division of emphasis in our teaching: the liberal arts versus the vocational curriculum, the former stressing basic and general knowledge, the latter stressing the applied and practical. The most distinguished scientists, scholars, and educators try to sell the former, while the majority of parents and students buy the latter. There is, thirdly, the question of the right allocation of funds between basic and applied research: the former oriented toward general knowledge of wide and indirect or of unknown applicability, the latter oriented toward specific knowledge of practical use in particular activities. The scientists cry for more liberal money allocations to basic research, while the dispensers of funds devote ten times as much for applied research and development. All these issues will be examined later in this book.

It should be noted that knowledge regarded as "basic" because of its wide and indirect applicability—"indirect" by way of knowledge deduced from it—is not confined to the natural sciences. There is much practical knowledge based on the theoretical social sciences—just think of tax legislation, monetary policy, labor relations—and on the humanities—think of the practical use of foreign languages or of the teachings of history applied in international relations. Moreover, a great deal of practical knowledge is not based on anything that can be attributed to science or scholarship of any sort; for example, where I can shop at lowest prices, which is the fastest route from my home to my office, how I can tie my shoelaces if they are too short, at what time the last train for Princeton leaves Pennsylvania Station. That is to say, not all practical knowledge needs a particular "base." On the other hand, one may be impressed by the large amounts of resources society allocates to the production of practical knowledge in the form of technology in the narrow sense of the word, and for these efforts surely a stock of knowledge of the natural sciences is basic.

SCIENTIFIC AND HISTORICAL; GENERAL-ABSTRACT AND PARTICULAR-CONCRETE; ANALYTICAL AND EMPIRICAL

Some philosophers of science used to distinguish between "scientific" and "historical" knowledge. The former would be concerned with generalizations (regularities, tendencies, rules, laws) regarded as relevant to the explanation or prediction of recurring phenomena. The latter would be concerned with individual facts and unique events, regarded as significant for the understanding of past developments of importance to states or nations.

This division again focuses largely on school learning and leaves out most of the knowledge, general and particular, that is not taught in schools, and even a good part of what is taught. A lot of knowledge, some of which is taught at school and most of which is not, is neither "scientific" (in any sense of the word) nor historical. Not that the distinction is inappropriate; it simply fails to cover enough ground.

More helpful in this respect is the distinction between "general-systematic" and "particular-concrete" knowledge. By not confining "general-systematic" (or "general-abstract") to "scientific," nor "particular-concrete" knowledge to "historical" knowledge, the proposed classification embraces a much larger universe. Used chiefly for logical and epistemological analyses, it has been regarded by many as insufficiently discriminating. One of the proposed amendments distinguishes three kinds of knowledge: (1) of logically necessary universals, (2) of empirically probable universals, and (3) of particulars (chiefly events in the past, including the immediate past). Others want to stress chiefly the difference between analytical and synthetic propositions, but have some difficulty in deciding the logical nature of theories using abstract constructs designed to be useful in the interpretation of the empirical world. Distinctions of this sort, though indispensable in an introduction to methodology, are not serviceable in studies of the social and economic significance of different types of knowledge.

In order to build bridges between classifications serving logical analysis and classifications designed for other purposes, it is sometimes helpful to make cross-references. They may be utterly "irrelevant" to almost anything and yet aid in orientation: students of one discipline may feel more at home in another if they can see how the categories of the alien field relate to the categories of their own.

KNOWLEDGE OF ENDURING AND OF TRANSITORY INTEREST

A distinction which serves as a helpful bridge-builder between different disciplines is that between knowledge of enduring interest and knowledge of only transitory or ephemeral interest. Schools supposedly teach only what is considered to be of enduring interest; but undoubtedly the mass of things known but only of ephemeral interest bulks large in the total of knowledge.

Knowledge of the battle of Waterloo may be of enduring interest, while knowledge of a fight in a tavern on Main Street may be of transient interest, though there are probably more Americans who know of a recent tavern brawl than who know of the battle of Waterloo. The death of Marat may be more lastingly important than the death of a retired salesman who left his fortune to his widow and his brain to Johns Hopkins; but this does not mean that the one piece of information is "knowledge" and the other is not.

These examples refer to "particular-concrete" facts, to "historical" events. But knowledge of merely transitory interest is by no means always knowledge of particular events. Many generalizations, likewise, are not of enduring but only of transitory and spatially limited interest. Take, for instance, this proposition: "In dialing telephone numbers the first three letters of the exchange are dialed in London, but only the first two letters in New York." In a few years this piece of knowledge may be completely out of date and uninteresting. The knowledge of the present train schedule from New York to Washington will remain of interest to several thousand people until next October or April, when it is changed.

Some of the mass of knowledge, general-systematic or particular-concrete, which is of only transitory relevance has nevertheless great economic value. Certain services of specialists in particular kinds of transitory knowledge have a market value, not because it takes especially scarce qualifications to acquire this knowledge, but because the "division of knowledge" is a great time-saver and thus a highly productive arrangement in the economy.[1] For example, the freight forwarder knows which lines operate between particular places, when their vehicles depart and arrive, what the rates are, etc. The importer knows where to find certain materials, what they cost, to whom to apply for an import license, how to declare the goods in order to get the lowest import duty, how to procure the foreign exchange, etc. Most of this knowledge is picked up by the individual practitioner in the course of his business operations. But some transitory knowledge is acquired through organized research. For example, many millions of dollars are spent every year in market research by business firms exploring the outlets for their products, the preferences of the consumers, the acceptability of alternative quality improvements, the sensitivity to price changes, etc.

This kind of knowledge, of great social and economic importance,

[1] Friedrich A. Hayek, "The Use of Knowledge in Society," *American Economic Review*, Vol. xxxv (1945), pp. 519-530. Reprinted in *Individualism and Economic Order* (Chicago: University of Chicago Press, 1948), pp. 79-91.

finds no place in any of the classes of knowledge distinguished by some philosophers. This remark is not intended as a criticism; few of these thinkers have been concerned with knowledge of transitory value. But we cannot help being concerned with it since society devotes large amounts of resources to the production of such knowledge.

MAX SCHELER'S CLASSIFICATION

To the extent that ephemeral knowledge helps people *do* certain things it would fit into the scheme proposed by Max Scheler: it would be what he called "Herrschaftswissen." Scheler distinguished three classes of knowledge, *Herrschaftswissen, Bildungswissen*, and *Erlösungswissen*[2]—that is, knowledge for the sake of action or control, knowledge for the sake of non-material culture, and knowledge for the sake of salvation; let me call them instrumental knowledge, intellectual knowledge, and spiritual knowledge.

One might be inclined to characterize intellectual knowledge as knowledge for its own sake, but Scheler rejected this explicitly. "There is no such thing as knowledge just for the sake of knowing," he insisted; intellectual knowledge has a purpose too, namely, "the free self-fulfillment of all mental capacities of the individual and the continual growth of his mind."[3]

There is no place in this scheme for knowledge of merely transitory value that is neither instrumental to action nor regarded as intellectual. The scheme is, nevertheless, vastly superior to such simple divisions as that between "basic" and "applied" knowledge. If anybody wishes to regard *all* intellectual knowledge as "basic," I would not quarrel with him, though I believe it can be basic only in the sense in which Darwin regarded poetry and music as required exercises because "the loss of these tastes . . . may possibly be injurious to the intellect and more probably to the moral character. . . ." I doubt that Darwin would have included most of our film and television plays or our books and magazines in this category of valuable taste-builders, or that Scheler's scheme would accommodate them in any of his categories since so few of them convey instrumental, intellectual, or spiritual knowledge. To be sure, some films, TV plays, books, or magazines do qualify for one of these three groups. But we need a class of knowledge for what is neither instrumental nor intellectual nor spiritual. It would be too arbitrary to say that a cookbook conveys instrumental knowledge, a

[2] Max Scheler, *Die Wissensformen und die Gesellschaft* (Leipzig: Der Neue-Geist Verlag, 1926), p. 250.
[3] *Ibid.*, p. 251.

Shakespeare play intellectual knowledge, the Bible spiritual knowledge, and most other books no knowledge at all. They do convey a type of knowledge, however low-brow, and we need a name for it.[4] I shall presently propose one, together with a more comprehensive classification.

FIVE CLASSES OF KNOWLEDGE

With regard to all schemes of classification of knowledge I believe that an objective interpretation according to *what* is known will be less satisfactory than a subjective interpretation according to the meaning which the knower attaches to the known, that is, *who* knows and *why* and *what for*. For example, to stay for the moment with Scheler's classification, what is spiritual knowledge for the religious man may be intellectual knowledge for the man of learning, and instrumental knowledge for the cleric and the therapist. What is instrumental knowledge for the professional man is intellectual knowledge for the man outside the field. Thus, economics is instrumental knowledge for me as economic consultant, but purely intellectual knowledge for the physicist; contrariwise, physics is instrumental for the physicist and the engineer, but purely intellectual for me. (Incidentally, I would prefer to use the words "training" for learning what is needed for one's job, and "education" for learning what is not needed for it. Thus, no amount of knowledge of economics could make me an educated man; I am educated only to the extent that I know Latin, music, literature, physics, geography, etc. In this book, however, I shall not use the word "education" in this restricted sense.)

Using then the subjective meaning of the known to the *knower* as the criterion, I propose to distinguish five types of knowledge:

(1) Practical knowledge: useful in his work, his decisions, and actions; can be subdivided, according to his activities, into

a) Professional knowledge
b) Business knowledge
c) Workman's knowledge

[4] A classification proposed by Anthony Downs, *An Economic Theory of Democracy* (New York: Harper, 1957), p. 215, would put it under "entertainment knowledge," which would include both intellectual and low-brow entertainment. Downs, who is chiefly interested in political information, distinguishes two main classes, (1) information "procured solely for the edification it provides" and (2) information used for decision-making. The former he calls "entertainment information," the latter he subdivides into "production information," "consumption information," and "political information." Whether he would class religious knowledge as entertainment, production, consumption, or politics is not clear; he probably has not thought about it.

d) Political knowledge
e) Household knowledge
f) Other practical knowledge

(2) Intellectual knowledge: satisfying his intellectual curiosity, regarded as part of liberal education, humanistic and scientific learning, general culture; acquired, as a rule, in active concentration with an appreciation of the existence of open problems and cultural values.

(3) Small-talk and pastime knowledge: satisfying the nonintellectual curiosity or his desire for light entertainment and emotional stimulation, including local gossip, news of crimes and accidents, light novels, stories, jokes, games, etc.; acquired, as a rule, in passive relaxation from "serious" pursuits; apt to dull his sensitiveness.

(4) Spiritual knowledge: related to his religious knowledge of God and of the ways to the salvation of the soul.

(5) Unwanted knowledge: outside his interests, usually accidentally acquired, aimlessly retained.

The adequacy of a classification cannot be judged before one knows what is done with it. And, with its subjective point of view, the proposed classification may look as if it could not be used for anything. I submit, however, that many, perhaps most, "meaningful" classifications in the social sciences *begin* with subjective-sense interpretations, for only then are they truly adequate for explanatory purposes.[5] Many of the subjectively meaningful concepts, however, have objectively discernible (operational) counterparts. As to the types of knowledge, we shall of course not ask each knower for his personal evaluation of every piece or bit of information that he has obtained; but there are ways for the social scientist to judge the typical status of various classes of knowledge in the value systems of their typical recipients.

KNOWLEDGE AND TRUTH

Philosophers with a strong positivist bent make a fuss about testability or verifiability. This raises delicate questions about several types of knowledge, especially spiritual knowledge. If, for some philosophers, knowledge is "warranted belief," it would depend on what kinds of warranty are accepted whether belief in God and salvation can be called "knowledge" of God and salvation. For the purposes of our study there is no need to enter deeply into epistemological discussions.

[5] I am referring to Max Weber's postulates of *Sinnadäquanz* and *Kausaladäquanz*.

Sermons and Sunday-school classes have to be included in our study no matter what one holds concerning the truth value of the contents taught. There are ways of making it all knowledge regardless of the strength of belief in it or warranty for it. For example, whether or not I believe what the minister told me from the pulpit, I know that he said it, and thus I have full knowledge, verified by witnesses and documents, of what he and others have said about God and salvation. There may be less sophistical ways of accomplishing our purpose; in any case, the concept of knowledge used here must not be limited by positivistic restrictions.

A requirement that knowledge be "true," tested, verified, would not be much less embarrassing with regard to other classes of knowledge, so-called scientific knowledge not excluded. It is one of the postulates of a scientific attitude that one is willing on good evidence to reject or correct at any time what today is considered verified knowledge. The possibility that our present knowledge, say of mechanical statistics or cytology, might in the future be shown to be largely erroneous does not mean that what we now believe to be true in these fields cannot qualify as "knowledge." Often conflicting hypotheses are equally good explanations of the same set of events, and only one of them, at best, may eventually turn out to be correct. Yet all the competing hypotheses are part of our knowledge. The cosmogonists and the earth-scientists have no tested knowledge of the origin of the universe or the earth; but they have knowledge of what has been written about it and the comparative merits of the competing hypotheses. Similarly, the fact that most of what Copernicus or Newton taught has later proved to be in need of correction, and thus was not "true knowledge," should not mislead anybody to deny that they possessed knowledge. "Knowledge" need not be knowledge of certified events and tested theories; it may be knowledge of statements and pronouncements, conjectures and hypotheses, no matter what their status of verification may be. The history of past errors in science is a highly important part of our knowledge today.

The problem of truth is least bothersome in the case of what I have called "small-talk and pastime knowledge." The knowledge of a rape and murder which the newspapers disseminate in all gory details should, of course, be "possibly" true if it is to be effective, but the eager readers —and there must be many or the papers would not give so much space to such stories—do not care very much whether it is really true. They would read with almost equal interest a fiction story about the same rape and murder if it were equally brief and equally selective with regard to the details described. The main element is probably the possibility of identification with the criminal, the victim, the detective, or someone close to any one of them: "It could have been me!" Since every true story has elements of fiction, and all pure fiction has elements of truth, they both should be regarded as objects of knowledge—not necessarily as knowledge of events that have actually taken place but, nevertheless, knowledge of reports of events.

All this refers, with small or no modifications, to certain kinds of intellectual knowledge. Knowledge of the *Iliad* or of the *Nibelungen Saga* is knowledge of works of art—poetry, fiction—which, in the opinion of almost all who possess it, enriches them. It is partly for this reason that we call it intellectual rather than pastime knowledge. Other great literary works may contain more "historical truth," but this does not necessarily add to the amount of knowledge the knower of these works possesses. The reader of *King Richard the Second* does not acquire more knowledge than the reader of *King Lear* just because the former play is closer to history than the latter.

Perhaps one might say that the questions of truth, accuracy, and verifiability matter only for practical knowledge, not for the other types of knowledge. Inaccuracy may have serious consequences in the application of practical knowledge. For example, misinformation about the time schedule of the railroad may cause me to miss my train; misinformation on the ingredients of a pharmaceutical product may cause my untimely death. There is a reason why "pragmatism," or at least one of the thirteen philosophical systems that go under that name, is understood as a theory of truth: lack of truth has no consequences in the case of nonpragmatic knowledge; if it has, the knowledge in question is pragmatic. If intellectual knowledge or pastime knowledge proves false and causes the misinformed to lose face, he has actually used his knowledge to impress others, and this in a way is a practical use. Intellectual knowledge stops being intellectual when it is exhibited by the show-off.

We have failed to mention ethical knowledge. Should it perhaps be a class or type of its own? To the extent that ethical knowledge serves as a guide to action, it qualifies as practical knowledge. To the extent that it is knowledge of values actually recognized by others, but does not form a basis on which the knower judges his or their actions, it qualifies as intellectual knowledge. A treatise on ethics would be regarded by most of those who read it as conveying intellectual knowledge, though it may have a lasting influence on the value systems of some readers and thus contribute to the production of practical knowledge. We decide against making a separate box labeled "ethical knowledge," although we may be severely criticized for disposing of an important philosophical problem in such cavalier fashion. But we have not stopped to differentiate positive and normative knowledge, especially since most normative propositions can, by reformulation as hypothetical statements, be transformed into positive ones. "Don't do this!" can be translated into "If you do this, you must face such and such consequences."

INTELLECTUAL, PASTIME, AND UNWANTED KNOWLEDGE

Not all knowledge is embodied in language. For example, instrumental music and visual art are objects of knowledge. We "know" Leonardo's *Mona Lisa*, Michelangelo's *Moses*, Bach's *Italian Concerto* no less than we "know" Goethe's *Faust*, Kant's *Critique of Pure Reason*, and Gibbon's *Decline and Fall of the Roman Empire*. All these are objects of intellectual knowledge. The lines between intellectual and pastime knowledge are not hard and fast. The differences which I have proposed as the characteristic ones lie in the attitude of the knower, in the accessibility of the knowledge, and in the effects of the knowledge on the knower. Most decisive for the distinction is perhaps the active questioning and intelligent concentration required in absorbing intellectual knowledge, in contrast to the passive reception of pastime knowledge. In addition, intellectual knowledge usually keeps its "cultural value" for longer periods, perhaps forever, while small-talk and pastime knowledge is only of ephemeral value.

To give an example of the difference, we may point to a comparison between chamber music and rock 'n' roll music. It is a serious strain to listen to and appreciate a difficult chamber-music composition, at least the first few times; even on repeated hearings, the typical listener will try to discover nuances in rhythm, in harmony, in counterpoint, which he has not taken in previously, or differences in interpretation by the performers. In contrast, few rock 'n' roll listeners will concentrate on the aesthetic form and patterns of the composition; the enjoyment they get from listening will not be an intellectual one, and probably not one subject to aesthetic analysis.

The choice of these extremes in musical knowledge has made it easier for us to differentiate between them. Had we chosen an "easy" symphony or a melodious opera and compared it with a popular march or a "cheap" operetta, we might have found it hard or impossible to make the difference stick and draw a clear line between intellectual and non-intellectual knowledge. Here the reference to the "typical" listeners may not help us any longer in classifying the objects of knowledge and, to do it conscientiously, one would have to resort to an analysis of the "particular" listeners and their attitudes to the works presented. For a statistical study designed to show broad orders of magnitude, such resort to individual analysis is quite unnecessary; arbitrary distinctions according to "general opinions" on the aesthetic nature of the artistic offerings would not make much difference.

If we actually attempt to make estimates of the relative amounts of expenditures which society makes to produce the different types of knowledge—and we shall try to do so, for example, when we study the expenditures on books and newspapers, radio and television—we shall rely on "expert opinion" in classifying the contents of the presentations in question. This may look like a deviation from the methodological postulate of subjective interpretation, of "accepting" the knower's own evaluations of the knowledge. That postulate, however, does not mean reliance on empirical survey research; it involves no more than the construction of "ideal types" of knowers. The investigator makes his distinctions, to put it crudely, with the aid of "imagined introspection." He asks himself how he would feel acquiring certain pieces of knowledge if he were the typical person acquiring it. To be sure, the investigator's imagination can hardly be free from the influence of his personal interests and tastes, though he will do his best to study and evaluate "representative" opinions and thus avoid serious biases due to his own background and experience.

Such problems of possibly biased evaluation and classification may arise several times in this study. Thus, when we come to the analysis of the mass media of communication we shall ask ourselves how their offerings are divided among the five types of knowledge which we distinguished, and to what extent the impression gained from "casual observation"—that by far the greatest part is pastime knowledge—is borne out by an examination of the contents. What in official statistics is called "entertainment"—the movies, theatres, operas, concerts, variety shows, etc.—will likewise be divided into intellectual and pastime knowledge, and my decisions may possibly be judged, by my critics, as high-brow or even snobbish. Similar differences in value judgment may show up in connection with education, since schools and other institutions of education produce knowledge of all five types

—not merely practical and intellectual knowledge, as some idealists might prefer.

When I included "unwanted knowledge" in my scheme of classification, I was not thinking of the required subjects taken by unwilling pupils at schools and colleges. What these pupils dislike is not the knowledge but rather the effort of acquiring it. Thus when I described what I think is unwanted knowledge I spoke of knowledge "usually accidentally acquired and aimlessly retained," though outside the interests of the knower. The existence of such unwanted knowledge will hardly be contested by anybody who has his radio or television program rudely interrupted by long-winded commercials, or who has to wade through pages of advertising in his newspaper or magazine in order to find the end of the story that began on an earlier page. Some of the jingles which advertise the wonderful qualities of this or that product on the radio or TV may stick to the musical memory of some unhappy listeners like wads of chewing gum to the shoe soles of unhappy pedestrians and resist all efforts to remove them. The inclusion of this unwanted knowledge in an economic study of the production of knowledge is justified by the very large expenditures incurred in the process. Of course, this knowledge is not unwanted by everybody; there are always a few of the recipients who want it as practical information aiding their decisions about what to purchase and where. It is unwanted knowledge for the majority of listeners because they either have already absorbed it or do not care. Incidentally, that those for whom it is "wanted" knowledge are small minorities is not an argument against its dissemination. Help to a few may well justify a minor inconvenience to many.

RESPONSE TO FREE CONSUMERS' CHOICE AND POLITICAL DECISION

One may object to the classification proposed because the principle on which it is based does not seem to be clear and unambiguous, and in any case seems quite unrelated to economic reasoning. Economists are not usually interested in the various "types" of product supplied by an industry unless certain hypotheses can be formulated about the changing or unchanging composition of product or about some remarkable relationships to other phenomena. One answer to this is that economists of several persuasions have been known to make all sorts of comment, even evaluative ones, regarding the composition of the national product produced for the market by free enterprise reacting to price incentives. And while a relatively small group of economists have consistently refrained from expressing dissenting value judgments in situations in which they recognized the product-mix to be a reflection of consumers' free choice under a regime of "consumer sovereignty," they have not withheld critical comment when the supply was largely politically determined.

The production of knowledge is, for the greater part, not guided by the market mechanism. Most of the knowledge produced is not purchased by the consumer at a price but is offered to him free of charge. The largest item is the expenditure for schools and institutions of higher education, paid for chiefly by government, with smaller portions defrayed by philanthropists and parents; the contents of the teaching is determined in a complicated process by political bodies, lay boards, and professional educators. Another large item is the cost of research and development; the projects are selected chiefly by the government, which pays for more than half of the total. Radio and television are paid for by "commercial sponsors" in the United States, and by government in many other countries; the programs are chosen on the basis of considerations of (1) what the masses of listeners and viewers seem to like best and (2) what is thought to be good for them, the mixture of considerations varying between 2:1 and 1:2, depending on whether advertising agents or government officers do the choosing. To what extent consumers actually influence the knowledge produced by the mentioned branches of the "knowledge industry" is difficult to decide. In any case, there is ample justification for investigators to question the opinions of the suppliers, or of those who give the specifications, concerning what the people want and what they "ought" to want or "would" want if they were better prepared to make their choices.

For discussions of this sort the proposed classification may be helpful. But additional classifications will be needed, and we must proceed to propose them.

SUBJECTIVELY NEW AND SOCIALLY NEW KNOWLEDGE

The distinction between the production of *subjectively* new knowledge—a process resulting in one or more persons knowing what he or they had not known before—and the production of *socially* new knowledge—a process resulting in a person (or persons) knowing what neither he (or they) nor anybody else had known before—is important because society devotes increasing amounts of resources to the latter (although the total spent on socially new knowledge is still much less than the amount spent on communication and dissemination of existing knowledge). Most of the efforts and funds allocated to the production of socially new knowledge—chiefly in the form of scientific and industrial research and development—are designed to obtain generalizations about predictable effects resulting from specified acts under certain conditions. Many of these generalizations are of enduring value. Some new technological knowledge, pertaining to particular industrial products, may be of value only for a relatively short time. The same is true with regard to some socially new knowledge of social phenomena or relations. For example, the findings of market research may be relevant for a few weeks or months only; similarly the results of investment analysis or financial research. It may, nevertheless, be well worth while for people to spend large amounts of money on such activities or for the information obtained.

The reporting of news is a special case in the production of knowledge because it is doubtful whether even the first reporter—who has discovered that the particular event has taken place—is really the first who has obtained knowledge of it, if the event is one in which one or more human beings have taken part. For, evidently, the participants have had knowledge of their actions or sufferings before the first reporter discovered what happened. But the problem involved here is trivial and easily disposed of by resolving that the first who makes a report in communicable form be deemed to be the one who produces the socially new knowledge of the reported event. This first reporter will usually be a detective, a policeman, a "spokesman," an "authoritative source," a "usually reliable source," a newspaper reporter; it may be any sort of observer or analyst. In any case, the overwhelming part of the total cost of news-reporting lies in the phase of dissemination, not in the production of socially new knowledge. Thus, the work performed by the mass media of communication (newspapers, magazines, books, radio, television), as incidentally also the work performed by schools and other institutions of education, is essentially reproduction of knowledge, its production in new minds—that is to say, its transmission by "haves" to "have nots."

KNOWLEDGE AS PRODUCT—CONSUMPTION OR INVESTMENT—OR AS COST

One more classification must be made, one which is essentially based on economic principles. Knowledge can be classified either as a final product or as a necessary requirement—cost element—in the production of other goods and services. The class "knowledge as a final product" is subdivided into two subclasses, consumption and investment. For example, education and scientific research produce knowledge which one may wish to regard as investment, whereas the publication of comic papers and the performance of burlesque shows produce knowledge which one may prefer to regard as consumption. On the other hand, market research and financial analysis produce knowledge which will commonly be regarded as current cost of production, not as a product in its own right.

This classification will occupy us later in this chapter and repeatedly in this volume. Notice of this is given at this point because it must not go unmentioned in a section on classifications of knowledge. But its further discussion had better be postponed until we have found out more about the techniques and activities by which knowledge is produced.

Methods of Producing Knowledge

By production of knowledge we understand any human (or human-induced) activity effectively designed to create, alter, or confirm in a human mind—one's own or anyone else's—a meaningful apperception, awareness, cognizance, or consciousness of whatever it may be. This is, I must admit, a rather broad definition; but it is not, I submit, unduly so. I find comfort in others' having chosen similarly broad concepts—for example, Warren Weaver's using the word "communication . . . to include all of the procedures by which one mind can affect another."[6]

TECHNIQUES AND INTENTS OF KNOWLEDGE PRODUCTION

Where the result of the knowledge-producing activity is upon the actor's own mind, that activity will typically be watching, listening, reading, experimenting, inferring, intuiting, discovering, inventing, or (often also in connection with received messages) interpreting, computing, processing, translating, analyzing, judging, evaluating—to give an illustrative, not an exhaustive, list.

Where the result is upon someone else's mind, the activity by which it is produced will typically be talking, writing, typing, printing, motioning, gesturing, pointing, signalling, but also drawing, painting, sculpturing, singing, playing, or performing in any other visible or audible way.

All these examples have stressed the use of two of our five senses,

[6] Warren Weaver, "The Mathematics of Information," in *Automatic Control* (New York: Simon and Schuster, for *The Scientific American*, 1955), p. 97.

seeing and hearing; knowledge-production through touch is less frequent (except for the blind); and smelling and tasting are confined to a few very specialized occupations.

The same techniques of producing impressions upon another mind may be used for a large variety of purposes. When the communicator talks, he may do so, for example, in order to teach, to insult, to persuade, to impress his audience, or for many other purposes. To compile a list of possible intents of communication—of producing knowledge in another mind—would be like copying many pages of Roget's *Thesaurus*. Merely to give an impression of the variety of the intents let us list a score of verbs signifying "talking for a purpose": conversing, chatting, reporting, confessing, complaining, denouncing, scolding, threatening, warning, requesting, begging, advising, persuading, directing, commanding, convincing, permitting, teaching, entertaining, showing off, edifying, reassuring, consoling, confirming, affirming, denying, misleading, teasing, insulting, harassing, embarrassing. This is only a sample. Among the economically most important of the intents of communicating are reporting, advising, directing (managing), teaching, and entertaining. These constitute the activities of a large number of persons who derive their incomes from the services they render in this fashion: e.g., the reporters of news, research findings, etc.; the consultants, advisers, and staff officers in business and government; the directors, managers, and administrators of all sorts of organizations, especially in business; the teachers at all levels; the entertainers and performers of arts, high-, middle-, and low-brow. Again, these are only illustrations, a small sample from a long list. Incidentally, a much longer list of knowledge-producing occupations will be used in Chapter x.

TYPES OF INDIVIDUAL KNOWLEDGE PRODUCERS

Modern communication theory has given a description of the process between and within two persons or units in a system, one the transmitter, the other the receiver of the message. The transmitter selects the message from his information store, transmits it, usually after encoding it into a "signal," through a "communication channel" to the receiver, who, after decoding the signal, puts the message into his information store. (The use of the personal pronoun in this statement makes it pertinent to human transmitters and receivers, though the application is more frequently to machines.)

If we want to analyze the activities of an *individual* person engaged in the production of knowledge, the sequence of acts usually has to be turned around: he will receive first and transmit afterwards. The "receiving" is of course not confined to messages addressed to him, nor to messages identifiable as the "input" to which the outgoing messages can be attributed. For there may be plenty of "storage" and therefore an inventory of knowledge in the individual's mind. In contrast to most other inventories, his knowledge inventory will as a rule not be reduced when he transmits knowledge to others. On the contrary, the more often he sends out a certain message the more firmly will its contents be retained in his own mind. Only in the simplest forms of forwarding a message will no storage on the part of the forwarder be involved. For example, the mail carrier retains nothing, and the oral-message bearer, the typist and the printer, and even some processors of knowledge who can do the processing "mechanically," in a routine fashion, will retain little or nothing unless they try hard to commit part of the message to memory.

Before we attempt to make distinctions between the various types of knowledge-conveyors, we may note that the transmission or delivery of a message may be "pre-scheduled" or "upon demand" or "spontaneous." The written message, in the form of a postcard or letter, which the mail carrier receives for delivery will reach the addressee at a pre-scheduled time, unless it was marked "general delivery," in which case it will be delivered upon demand. The teacher delivers his lectures according to a fixed schedule, the consultant or medical doctor gives his advice upon demand, the creative artist, scientist, or inventor communicates his message spontaneously.

According to the degree to which the messages delivered by a person differ from the messages he has previously received, we may distinguish several types of communicators, or knowledge-producers, as we have chosen to call them. A *transporter* will deliver exactly what he has received, without changing it in the least; for example, the messenger carrying a written communication. A *transformer* changes the form of the message received, but is not supposed to change its contents; for example, the stenographer receiving a message in sound, changing what she hears to penciled shorthand notes and then to a typed letter, which she dispatches. A *processor* changes both form and contents of what he has received, but only by routine procedures which subject different pieces of knowledge received to certain operations, such as combinations, computations, or other kinds of rearrangements, leading to definite results, independent of the processor's tastes, moods, or intuition, dependent solely on conventions concerning such processing rules; for example, the accountant receiving separate debit and credit advices, which he combines in definite ways to prepare balance sheets and income statements. An *interpreter* changes form and contents of the messages received, but has to use imagination to create in the new form effects equivalent to those he feels were intended by the original message; for example, the translator of a subtle speech or sensitive poetry in a foreign language. An *analyzer* uses so much of his own judgment and intuition in addition to accepted procedures, that the message which he communicates bears little or no resemblance to the messages received. An *original creator*, although drawing on a rich store of information received in messages of all sorts, adds so much of his own inventive genius and creative imagination, that only relatively weak and indirect connections can be found between what he has received from others and what he communicates.

That all these activities are designated here as knowledge-production may be resented by some who wish to reserve such a high-sounding phrase for the upper strata, perhaps the analyzers and original creators. I find it more convenient to use the phrase for the entire spectrum of activities, from the transporter of knowledge up to the original creator. There may be instances in which one may ask whether the communication was the work of an analyzer or of just a processor. At least we need not quarrel about the result: the communication produces knowledge in another mind.

KNOWLEDGE RECEIVING AS KNOWLEDGE PRODUCTION

In the discussion in the preceding section the emphasis was on knowledge-*transmitting* as knowledge-production. All acts of knowledge-transmission were treated as productive. This was perhaps premature, and we may have to take back part of what was said. Some acts of communicating knowledge may be designed chiefly for the pleasure of the transmitter—e.g., when he satisfies his desire to chat or to show off. In these instances the production of knowledge in the other mind may be only a by-product of his activity, and not necessarily one that is at all valued by the recipient. While this is production of knowledge in a technical sense, we must question whether it should be regarded as production from an economic point of view.

In the case of *receiving* knowledge the presumption will even more often be against regarding the required activities as economic production of knowledge in the recipient's mind. Most frequently these activities are listening, watching, and reading. In a technical sense they are undoubtedly part of the process of knowledge production. Indeed, the writers, editors, publishers, demonstrators, and teachers succeed in their functions of communicating and disseminating knowledge to the extent only that there are readers, listeners, watchers, and learners of adequate intelligence, diligence, and interest to receive and absorb the message. Still, this does not imply that the receivers' activities should be accepted as "production" from an economic point of view.

An analogy may be helpful at this juncture. In the production of nourishment, the sequence of activities near the end of the line include wrapping, taking to the kitchen, unwrapping, cooking, cutting, slicing, salting, lifting to the mouth, chewing, swallowing. Although most of these activities are technically necessary parts of the production process, we draw the line at an earlier point, and rule that "economic production" ends when the food passes into the possession of him who eats it. We may be going too far, however, in accepting the "lesson" of this analogy. Taking in food is always viewed as consumption. Taking in knowledge may be, but need not be, consumption.

When the acquisition of knowledge, or the exposition of one's receiving organs to the signals which are convertible into knowledge, serves the purpose of giving immediate or early satisfaction to the recipient, his activity to this end will not be regarded as knowledge-production from an economic point of view. Although his listening, watching, or reading is necessary to produce the impact on his mind which the productive activity of the talker, performer, or writer is designed to produce, his part in this process is consumption, not production, if the chief aim is the pleasure it gives.

When the acquisition of knowledge is designed to increase the productive capacity of the recipient, when his listening, watching, or reading is intended as *learning*, and therefore intended to serve future ends, his activities should be regarded as production from the economic point of view. In these circumstances the receiving and absorbing of messages constitute, economically as well as technically, production of knowledge in the actor's own mind.

There is a third possibility: the recipient of information may use it for other things he is doing; it may serve him as a directive in physical work, in productive or consumptive activities of all sorts. He may watch for signals directing him in the best timing of his movements; he may listen to a foreman telling him what to do, or he may read the instructions for a drug he takes or for a gadget he installs. In almost everything we do as physical workers, as consumers, as passengers, as drivers, as pedestrians, or in any capacity whatever, we are aided directly or indirectly by information received. The activity of the knowledge-recipient in such instances will not be viewed as production of knowledge from an economic point of view. Instead, it will be regarded as an integral part of the productive or consumptive activity in which it is supposed to be of assistance.

In summary, the activities of the knowledge-recipient are technically always, but economically only in certain situations, part of the production of knowledge. They should be recognized as production of knowledge in the economic sense if they are designed to increase the productive capacity of the recipient for future use. They should not be so recognized if they are part of activities in which the recipient is engaged for other purposes; they may even be part of the cost of doing these things. Nor should they be recognized as economic production of knowledge if they are motivated by a desire for immediate or early satisfaction.

One must guard against a misunderstanding on this point regarding "knowledge for consumer's satisfaction." Technically such knowledge is produced by activities on the part of the transmitter and on the part of the receiver. We have ruled that the receiver's activities in this process should not be recognized as production of knowledge, but only as consumption. This does not change the status of the transmitter's activities. He does produce knowledge in the receiver's mind, even if it is pastime knowledge. The entertainer is therefore a knowledge-producer, and his products, the pleasurable impressions on the minds of the receivers, are final output. Production for purposes of consumption by others remains production from every point of view.

Knowledge as Consumption, Investment, or Cost

The decision to call an activity "production," "consumption," or neither, can be reasonably made only on the basis of a conceptual scheme suitable for particular purposes. Different purposes will often call for different conceptual schemes. And even if one scheme is found best for a purpose, some theoretical consistency may have to be sacrificed for the sake of statistical convenience. Let us see what the goals of theoretical consistency and statistical convenience require by way of conceptualizing in the area of knowledge-production.

PRODUCTION: THE USE OF VALUABLE INPUT FOR VALUABLE OUTPUT

Production, in economic theory, implies that "valuable input" is allocated to the bringing forth of "valuable output." The input is valued in terms of foregone opportunities—that is, by the magnitude of the sacrifice of alternative outputs that could be produced in lieu of the output actually obtained. The output is valued in terms of someone's willingness to pay for it. Thus, we do not speak of production if all inputs are "free," that is, if no other output is being "missed" in consequence of the inputs—human energy plus things of any sort—being allocated to the particular activity. Nor do we speak of production if the output is wanted by nobody, neither by those who put it out, nor by those who cause it to be put out, nor by those who are in any way affected by its being put out.

Let us apply these criteria to the transmission of information, say, of a report that the New York Yankees beat the Baltimore Orioles 8-5 in a baseball game. This activity will be regarded as production (in the sense of the conceptual scheme chosen for theoretical consistency) if those who telephone or otherwise transmit the report could have done something else with their time (something they or someone else would appreciate) and if some of those who receive the report would "give something" to hear it (either because their curiosity is thereby satisfied or because they are in any other way "enriched" or "gratified" by receiving or having received the information). The communication of this information would *not* be called production in an economic sense if its transmitters did it for the fun of it without sacrifice of otherwise employable time and effort, and if its receivers were totally uninterested and no third party were interested in the transmitters' giving, and the receivers' getting, the information.

The need for statistically operational concepts forces the exclusion of those knowledge-producing activities which, although they require sacrifices on the part of the communicators and give satisfaction to the recipients, fail to give any clue to the statistician of the amounts of cost and satisfaction involved. A man in love may spend several hours a day describing in letters to his beloved his feelings, thoughts, and activities, and he may neglect his work doing so. The recipient of his affection and of his letters may derive the greatest happiness from these reports, and would give anything for this knowledge were it not received gratis. The costs and the satisfactions connected with this romantic knowledge escape the statistician's eye and remain unrecorded. Where there are no records of money payments or other transactions, the statistician will usually, perhaps with a regretful shrug, pass on to other matters; purely hypothetical opportunity costs and psychic incomes are, as a rule, of no concern to him.

The best-known example of this—from another area—is the classification of cooking in the national-income accounts. Labor employed in the production of meals in restaurants and taverns is entered under national income originating in service industries; labor engaged in the production of meals in private households appears as part of the national income only if it is performed by a hired cook, maid, or housekeeper—domestic service—but is entirely omitted from the statistics if it is performed by the housewife or another unpaid member of the household. That the production of a meal in the household is an effort (disutility) and yields a benefit (utility) is not denied, but it is nevertheless disregarded in the statistics of national product and income. Similar or analogous considerations are valid for the analysis of the production of knowledge.

The production of knowledge will appear in the customary national-product accounts only where it requires the paid services of people or the paid use of installations and materials, so that the costs can be estimated, or where the information services rendered are paid for by somebody—by those served or by a third party, such as the government—so that these payments can be interpreted as an expression of the value of the services rendered.

INVESTMENT IN KNOWLEDGE AND INVESTMENT FOR KNOWLEDGE

When knowledge is produced in order that or in the expectation that, as a result, the productivity of resources—human, natural, or man-made—will increase in the foreseeable future, the production of knowledge can be regarded as an investment. The types of knowledge which chiefly qualify for this designation are those flowing from scientific and technological research and development and from improved or extended schooling, training, and education.

The decision in each particular instance of whether the production of knowledge should be regarded as investment, as consumption, or as intermediate output in the production of other things is rather arbitrary, a matter of judgment. We shall see in subsequent chapters that no reliable objective criteria are available for making this judgment. To anticipate one of the points to be made in interpreting our national-income accounts, we cannot accept all business expenditures for research and development as necessary cost of *current* production, just because our tax laws allow business firms to treat them as such. These expenditures are undertaken in order to improve or secure the competitive position of the firms in the *future*, either through cost reductions or product improvements. Thus, from an economic point of view they are investment expenditures even if they are "expensed" rather than "capitalized." Where research and development expenditures are financed by the government, our national-income statisticians treat them as "final output," without however committing themselves as to whether they are investment or consumption. If one regards the part of these expenditures that is futile or wasted as necessary and inseparable from the apparently successful expenditures, then the entire outlay for research and development should be counted as investment.

The effects of improved and extended schooling will be discussed in Chapter IV. The only point to anticipate here is that it would be certainly wrong to regard the entire cost of schooling as *net* investment, and probably wrong to regard it all as *gross* investment. The decision as to what part of the cost of schooling should be characterized as consumption would, I am afraid, be rather controversial, and one may prefer to avoid making such a decision.

Investment in knowledge should not be confused with investment in durable goods needed in the production of knowledge, no matter whether that knowledge may be investment, consumption, or an intermediate product in the production of current output of other things. If, for example, a firm builds another research laboratory, it invests in a durable asset which, for years to come, will be used in the production of technological knowledge designed to increase its productivity; hence, it makes an investment *for* the production of knowledge, a production which in turn will be also an investment *in* knowledge. If, on the other hand, a TV station builds another studio or transmitting plant, it invests in a durable asset which over the years will be used for the most part in the production of pastime knowledge, that is, for consumption purposes. If, to give an example of the third possibility, a manufacturing company buys an electronic computer for use in its payroll, billing, and accounting departments, it invests in a durable asset which over the years will be used in the production of business knowledge for use in its operations as producer of manufactured goods.

KNOWLEDGE AS INTERMEDIATE PRODUCT

In a statistical analysis, *investment* expenditures for knowledge and *consumer* expenditures for knowledge are relatively easy to ascertain only if the National Income Division of the Commerce Department has regarded the knowledge in question as "final output" and therefore recorded the expenditures in question in Gross National Product and national-income accounts. Considerable reinterpretations and modifications may have to be made even in these cases. Serious complications, however, arise in connection with estimates of knowledge produced as an intermediate service in the production of other output.

The statistical problem of obtaining cost estimates of knowledge used in the production of other output can only be overcome without great trouble where firms are specialized in the production of knowledge for business use and are grouped into special service industries whose total sales are reported. For example, where information services and consultation services are sold by incorporated businesses to incorporated businesses engaged in the production of things, statistical problems arise only to the extent that some sales are made to non-business buyers, to consumers. Thus, the services of investment analysts and securities brokers are sold partly to business firms and partly to consumers.[7] On the other hand, the services of certified public accountants, marketing-research organizations, and consulting engineers are sold almost entirely to business firms. Whether the firms buying these services use them for producing consumer goods or capital goods (durable producer goods) does not matter for our purposes; in either case the production of knowledge serves in the current production of other things, and the cost of the production of knowledge will be part of the cost of these other things, not a separate item in the national product, gross or net. The services of consulting engineers will perhaps be used more often in connection with new construction than with the current production of manufactured goods, and it might be interesting

[7] That consumer expenditures for such services are counted as "consumption," although they do not yield direct satisfaction but instead serve to increase the returns from personal savings, is one of the flaws of the accepted techniques of social accounting. It is analogous to the consumer expenditures for transportation to the place of employment, which are officially counted as "consumption" although they are a cost of earning income.

to see what portions of the investment in new plant are payments for knowledge produced in its planning and design. The services of architects are altogether of this sort; whether for industrial or residential construction, they furnish knowledge to be embodied in durable assets, and the cost of this knowledge becomes part of the investment in fixed plant or dwellings.

Where knowledge for business use as an intermediate product in the production of other things is produced, not in separate knowledge-producing industries, but rather within the firms that use it, the problems of statistical compilation become very difficult. If separate departments serve these functions, and separate cost accounts are published for these departments, the problem could be solved. Assume, for example, that the information services maintained by large firms were organized as separate departments with separate accounts, or that such accounts were available for all public-relations desks or departments; the costs of providing this sort of public information could then be compiled. But in fact we do not have these data.

Even if the cost data for all special information-producing departments of business firms were available, they would comprise only a small part of the relevant total. For under modern techniques of manufacturing a great amount of knowledge is produced and used in one and the same department or even in one and the same operation. In many cases it would be impossible to distinguish the mental, knowledge-producing, from the manual, knowledge-using phase of the operation. The operator tending certain machines or apparatuses may have to watch measuring instruments and react by quick manipulations to the information they convey; he may have to turn valves, press pedals, push buttons in accordance with information-giving signals produced by others in the group, by instruments he has to read, or even by information he himself produces by mental operations on the basis of information read from the instruments. The knowledge produced in these instances is an indistinguishable part of the physical operations performed. It would be impossible to quantify this kind of knowledge-production. Wherever mental and physical labor are combined in the activities of a person, it will be sounder procedure for our purposes not to attempt an analytical separation. The training by which the special skills of the highly qualified worker or operator are acquired is of course an important part of the production of knowledge in society, although even this may defy statistical measurement if the training occurs "on the job" rather than in schools or special courses.

KNOWLEDGE-PRODUCING PERSONNEL IN BUSINESS FIRMS

In every business a considerable percentage of the work force consists of persons specializing in the production of knowledge. This can be said not only of the research, development, planning, and designing personnel but of the entire body of executive, administrative, supervisory, technical, and clerical personnel, from the chairman and president of the firm to the switchboard operator and stock clerk. All the people whose work consists of conferring, negotiating, planning, directing, reading, note-taking, writing, drawing, blueprinting, calculating, dictating, telephoning, card-punching, typing, multigraphing, recording, checking, and many others, are engaged in the production of knowledge in the sense in which we understand these words. If complete sets of numerical data on this division of labor within firms were available, we could examine differences in the relevant ratios among various industries, regions, and countries, as well as changes that have taken place over time. It is a fact that the increase in factor productivity in American industry over the years has been associated with an increase in the ratio of knowledge-producing labor to physical labor. And it is very likely that the association has been a causal one. We have often been shown the secular increase in the amount of capital per worker and the enormous rise of the use of machine-generated energy (horsepower) per worker. It would surely be interesting to see statistical evidence of the increase in the quantity of knowledge-producing labor per manual worker.

Evidence of this sort will be produced in the last chapter. It will not, we may repeat, relate to the problem of the division between the use of intelligence and the use of physical skill or strength in the same worker. This cannot be done. But where there is a division of labor, where some members of the work force specialize in the production of information (reports, advice, directions, orders), statistics can show the numbers and ratios involved. A discussion of some of the theoretical problems involved will be found in Chapter III.

INSTRUMENTS FOR THE PRODUCTION OF KNOWLEDGE

While we shall have only fragmentary data on human knowledge-producers within business firms, we may be able to obtain data on engineering products that serve as knowledge-producers. Every firm has a battery of machines, apparatuses, instruments, and gadgets for this purpose.

There are first of all the various devices for the communication of information, such as bells and light signals, telephones and intercoms, typewriters and multigraphing equipment, and telegraph and teletype systems. There are, furthermore, many devices for the automatic initiation of information, such as thermometers, manometers, speedometers, voltmeters, ammeters, and scores of other measuring instruments. Simple scales, tapes, gauges, calipers, compasses, counters are among nonautomatic measuring devices which aid human knowledge-producers in the acquisition of information on such things as weight, length, thickness, all sorts of numbers. Finally there are the devices for the processing of information, such as adding machines, cash registers, calculating machines, up to the complicated computing machines of recent vintage.

For an estimate of the annual cost of knowledge-producing equipment we should have to know its value, depreciation rates, and maintenance. In lieu of these unavailable data we might do with the annual sales of measuring instruments and office equipment, which can be had from census data. For the most part these sales are to business firms and it is probably not too serious an error if the total (apart from some government purchases of electronic computers) is included in business investment.

Some knowledge-producing instruments are sold to consumers. We all buy watches and clocks which tell us the time of the day; thermometers and barometers, which tell us about the weather; bathroom scales, which tell us whether we have gained too much weight; cameras, which give us pictures preserving the images of our young girl friends or babies; phonographs, records, and tapes, which reinforce our knowledge of musical compositions; and radios and television sets, which provide us with an abundance of pastime knowledge and with some unwanted knowledge to boot. Consumer expenditures for knowledge-producing instruments figure prominently in the national income, and there is a clear upward trend in this outlay and its share in the consumer's budget.

WHO PAYS FOR IT AND HOW?

Whether a particular output is regarded as consumption, investment, or non-final product, is decided, in national-income accounting, not by an analysis of the use made of it, but rather on the basis of who pays for it and how it is treated in private accounting. As a rule, products paid for by consumer expenditures, government expenditures, and those business expenditures which are entered as capital assets in the books of a firm are regarded as final output, while business expenditures which are treated as costs of sales are deemed to be for intermediate products.

These rules would not do for our purposes, as I have mentioned before in connection with expenditures for research and development. Since business may in tax-accounting treat these expenditures as current expenses, the production of new technology would be regarded as intermediate, as cost of current output of manufactured goods. Yet, in the context of our study, it should be regarded as investment. The fact that government expenditures for research and development are regarded as paying for final output points up the conceptual contradiction and the need for correcting it.

Another instance of contradictory treatment in national-income accounting is radio and television broadcasting. There are in principle three ways of paying for this service: the consumer, the government, or business may pay the bill. If business pays for it and treats it as advertising cost, the national-income accountant calls the service an intermediate output in the production of the goods advertised by the sponsors. If government pays for the service, or if the consumer pays for it, then the national-income accountant calls it final output. Just as the national income is statistically reduced when bachelors marry their cooks, the national income is statistically increased when radio and TV are nationalized. Such a contradiction requires correction in our study: broadcasting will here be regarded as final output, as consumption, no matter who pays for it and how.

CHAPTER III · KNOWLEDGE-PRODUCING INDUSTRIES AND OCCUPATIONS

A FEW TIMES in discussing the various types of knowledge and the methods of knowledge-production we used the phrase "knowledge industry." Although we shall soon find that this phrase is not really appropriate, even as an analogy, we shall go on using it, especially when we embark on a discussion of the conceptual and operational difficulties of an analysis of this "industry."

The Knowledge Industry

A statistical analysis of any industry and of its role and performance in the economy involves data of many kinds. Ideally they should include measures of physical output, total sales broken down by major products, total employment, value added and income originating in the industry, changes in the composition of output, changes in selling prices, changes in productivity, and a few more things. Unfortunately, little of this can be had for the "knowledge industry."

WHAT WE DON'T KNOW ABOUT THE KNOWLEDGE INDUSTRY

There are several insurmountable obstacles in a statistical analysis of the knowledge industry. In the first place, there is no physical output. Indeed, for most parts of the production of knowledge no possible measure of output can be conceived that would be logically separate from a measure of input; and those relatively rare kinds of knowledge for which independent indices of output could be concocted cannot in any meaningful way be compared, let alone aggregated, with other kinds of knowledge.

In addition, most of the services of the knowledge industry are not sold in the market but instead distributed below cost or without charge, the cost being paid for in part or in full by government (as in the case of public schools), by philanthropists (as in the case of some private schools), and by commercial advertisers (as in the case of newspapers, magazines, radio, and television). Hence we lack the valuations which for most other industries the consumer puts on the product by paying a price for it. There are no "total sales" and no selling prices.

Because of the nonmeasurability of the product, the consequent lack of productivity data, and the absence of market prices, one cannot even state with assurance that an increase in the expenditures for knowledge, relative to Gross National Product, will result in more knowledge being provided to society. This is a problem to which we may have to return more than once or twice, for it has special importance in the evaluation of data on education and on research and development. Even in the few exceptional instances where we do have consumption expenditures in the form of purchases of products at market prices, the heterogeneity of the product makes a quantification of output most difficult. Book-publishing may serve as an example: "increased sales" may mean that more books ("titles") were published or that more copies (of perhaps fewer titles) were sold, or that more hard-cover rather than paperback editions were sold, or that perhaps more books requiring expensive typesetting or printing were sold, all this quite apart from differences in the types of books and their potential contributions to knowledge.

For the most part, employment data or factor-cost data are the only available sources of information about the production of knowledge. A fundamental question arises here: if inputs are essentially the only thing that can be measured, would it be more appropriate to select for the statistical compilation the inputs according to the type of contribution they make to the production process in which they are engaged or according to the type of product which they help produce? In other words, speaking of labor input alone, should an "occupation" approach be used, or an "industry" ("product") approach?

THE TYPE OF PRODUCT OR THE TYPE OF LABOR

Examples can make clear what is asked here. A chemical engineer employed in the food industry, a designer in the shoe industry, an accountant or a lawyer in the chemical industry, all are engaged in the production of knowledge according to their *occupation*, but not according to the *industry* in which they work. On the other hand, a janitor in a school building, a charwoman in a research laboratory, a mechanic in a television studio, all are engaged in the production of knowledge according to the *industry* in which they work, but not according to their *occupation*. If the phrase "knowledge industry" were to be given an unambiguous meaning, would it be a collection of industries producing knowledge or rather a collection of occupations producing knowledge in whatever industries they are employed? Would it thus include all people employed, and factor cost paid, in education, research and development, book publishing, magazines and newspapers, telephone and telegraph, radio and television? or rather all people employed, and factor cost paid to them, as accountants, actors, architects, artists, auditors, authors? The results may be quite different, at least as far as the relative magnitudes—knowledge-production relative to total production—are concerned. It may be that the results are not too different when one looks at growth rates over time. For it is quite likely that knowledge-production has been increasing on both counts, by occupations and by industries.

Industries and Occupations

Could one possibly conceive of an imaginary economy in which specialization is carried so far that each occupation is organized in special firms selling its particular services and nothing else? If so, could the imaginary statistics of such an imaginary economy be so organized that the occupation approach and the industry approach become one and the same?

"COMPLETE" DIVISION OF LABOR

In such a completely "disintegrated" economy no firm could have an engineer, a typist, an accountant, a cashier, a salesman, a messenger boy; they would have to buy these services from engineering firms, typing bureaus, accounting offices, collection and disbursement firms, sales agencies, message carriers (just as the small firms in our world have no lawyers on their staffs but retain outside legal service). However far this scheme can be pushed, a limit will be reached with management. Decision-making is one activity which the firm must perform internally, or it stops being a firm. There may be professional "management consultants" and there may be "management contracts" between a parent company and its subsidiary, but every independent firm must have its own management and, hence, the occupation "manager" can never be so organized that it becomes available only to specialized "management firms," forming a "management industry."

The economies of the real world are far removed from the scheme just considered: most firms employ members of various occupations, and larger firms, no matter what they produce, employ members of various knowledge-producing occupations. In other words, there is "internally-produced knowledge" which is "used" within the firm. Where it is produced by persons statistically listed as members of some "white-collar" occupation, the occupation approach to our statistical problem may give us clues which the industry approach cannot possibly provide.

PRODUCTION FOR INTER-INDUSTRY TRADE AND INTRA-INDUSTRY USE

A few comments on the division of labor between knowledge-producers and producers of physical goods and services may be helpful in this connection. This (as any other) division of labor may take different forms: entire *industries* specializing in particular types of output; some *firms*, within more broadly defined industries, specializing in particular outputs or including a specialized service among the several which it supplies; *departments* within firms specializing in certain activities that serve other departments in the same firm; *groups or teams* of workers specializing in certain performances required within the same department; *individual workers* specializing in particular tasks needed within a team of collaborating workers.

Where input or output data are broken down only by broadly defined industries, only the first of these five forms of division of labor can be statistically captured. Thus, the industry approach will yield immediate results for our study only where knowledge-transmission is the entire output of the industry, as for example in "newspapers and magazines" or even in "printing and publishing." If industry classes are broad and the firms included produce various goods and services, some of which qualify for our survey while others do not, the industry approach will help us only to the extent that we are able to make educated guesses about the share of the total sales of the industry that the output in which we are interested may constitute. For example, if "electrical appliances" include radio and television receivers (for which we want data) along with vacuum cleaners and dishwashers (which are outside our present interests) we need a separation which the industry breakdown may not provide. In the particular case of radio and TV receivers, fortunately, we are able to obtain relevant information; but in other cases we may have to resort to guesses based on the flimsiest evidence.

Where the division of labor gives rise to *inter-industry trade*, so that knowledge instruments or knowledge services produced by one industry are purchased by another industry, we face problems of double counting in some instances and of lack of information in others. National-product accounts will omit such production entirely because it does not represent "final output." Where the division of labor is of any of the last three forms—namely, within a firm—and knowledge is produced for intra-industry use, the industry approach will yield no data at all. In these cases the occupation approach alone can shed light on our problem.

On the other hand, the occupation approach will leave us in the dark with regard to several essential matters. Thus, some of the most important ways of producing knowledge require as input intermediate products largely made with types of labor from non-knowledge-producing occupations. For example, books, newspapers, and magazines are printed on paper produced by labor not in the knowledge-producing category; the same is true for the equipment for telephone, telegraph, radio, television, all of which are eminently involved in the production of knowledge. There could be large increases in the production and use of all these means of communicating knowledge, without any accompanying increase in the relative number of workers from knowledge-producing occupations. We conclude that both industry analyses and occupation analyses are needed in order to find out about the past development and present role of knowledge-production.

THE MAJOR SUBDIVISIONS OF THE INDUSTRY

Both approaches will be followed in this study, though the major emphasis will be on the industry approach. This allows for more interesting subdivisions. Detailed analyses of the major product classes in the knowledge category will open up vistas that might be missed were we to follow the occupation approach only.

Education is by far the most important product class to be studied. The chapter on education will be of a scope that would have permitted devoting the entire book to this topic. The chapter on research and development will not be of much narrower scope. The author must confess that this subject was his first interest in the field of knowledge-production. The temptation to expand the area of study to cover the entire knowledge industry—to use once again the questionable phrase—came later, and proved irresistible. The results are chapters on media of communication, on information machines, and on information services. Only then shall we present a summary statement on the knowledge industry as a whole, followed by a last chapter devoted to a comprehensive though brief analysis of the knowledge occupations and the changing occupational composition of the labor force.

Firms, Industries, and the Whole Economy

If the occupational structure of the whole economy changes so that the ratio of knowledge-producing occupations to the entire labor force increases, this may or may not be associated with a similar change in the occupational structure of individual firms. It would be possible for the composition of the work force of most existing firms to remain virtually unchanged while new firms employing chiefly members of knowledge-producing occupations appear on the scene.

THE OCCUPATIONAL STRUCTURE OF SINGLE FIRMS

There are strong indications that the change has in fact been taking both forms: many new firms with substantially greater ratios of knowledge-producing labor have been emerging *and* many old firms have been employing increasing shares of white-collar labor. The hypothesis suggests itself that technological progress has forced firms to make such changes in their employment patterns and that firms in the forefront of technological innovation have moved faster in this direction than firms following merely adaptive policies. One may advance an even stronger hypothesis, holding that firms that are more innovation-minded than those representative of their industry will employ substantially higher ratios of white-collar labor because they need research and development laboratories, planning divisions, and market-research departments.

A hypothesis of this sort was advanced in a brief and suggestive pamphlet by Harbison and Hill, and subjected to empirical tests.[1] Several firms in the same industries were studied and their employment patterns and innovative policies were compared. The sample was too small to permit conclusive results, but whatever findings were obtained seemed to be consistent with the hypothesis.

There are at least two grounds, however, on which the hypothesis may be challenged. First, technological change need not always—and least so in the individual firm or particular industry—take the form of a displacement of physical labor. While this may be the way in which technological advance proceeds in the economy as a whole, innovation in some industries and some firms may be of a different nature. It may very well happen, for example, that a novel technique of data-processing is introduced which decimates the clerical work force of the firm. Secondly, a firm leading all the other firms in the industry in the adoption of new technologies need not perform the necessary research and development work within its organization. It may instead retain firms of consulting engineers to do the research and development for it. There is no need for it to maintain a staff of its own for the inventive

[1] Frederick H. Harbison and Samuel E. Hill, *Manpower and Innovation in American Industry* (Princeton: Princeton University, Industrial Relations Section, 1959).

and developmental activities required for its innovative program if it can buy all these services from the outside.

These arguments do not invalidate the hypothesis, but they can explain why empirical tests may turn out negative in a large number of cases. One may hit upon several instances in which the rate of innovation in the firm has been faster than in the rest of the industry, and the proportion of white-collar labor in the work force has nevertheless declined instead of increased. It would not be likely that empirical tests come out this way if the sample of firms investigated is large and the time period over which they are observed is long. But one must not expect all tests to confirm the hypothesis; it could survive negative tests, which presumably contradict it.

On principle, however, this is not a sufficiently significant hypothesis to seek its verification. If it is possible for innovation to proceed without this "expected" change in the employment pattern of the firms concerned, we should not stake much effort on empirical tests proving that the patterns do change. We should put our money on the hypothesis that the employment pattern changes in the economy as a whole as technology advances. This is what really matters. This is the problem to which we shall return in the last chapter of this book.

CHAPTER IV · EDUCATION

This chapter will deal with the knowledge that is produced through education. The words "education" and "training" will not be given different meanings, since most dictionaries, reflecting current usage, treat them as synonyms. To be sure, "training" has the connotation of being oriented toward the development of skills for a particular occupation or practice, and personally I should prefer to see the difference between general (nonvocational, liberal) *education* and special (vocational, practical) *training* given semantic recognition. But in deference to more widespread usage I shall not follow my preference and not differentiate between education and training except where such a differentiation is made in current practice—for example, when one speaks of "higher education" (not "higher training") and "on-the-job training" (not "on-the-job education").

Locus and Modus Operandi

According to the place and technique of such knowledge-acquisition as is called education, we should distinguish (1) education in the home; (2) education in school; (3) training on the job; (4) instruction in church; (5) training in the armed forces; (6) education over television; (7) self-education; and (8) learning from experience. These distinctions, like most distinctions in the social sciences, are "sharp" only in abstract reasoning, while no sharp lines can be drawn in reality. As long as we disregard the borderline cases which reality presents, there is a fundamental difference between the first six and the last two entries in this list. In the first six, knowledge is "taught," transmitted to the learner by a teacher, be it his mother or father, school teacher or professor, foreman or fellow worker, priest or minister, sergeant or officer, studio teacher or other broadcaster. In the case of self-education and learning from experience the learner acquires knowledge by reading or doing—that is, from books and from his practical work. We shall focus on those forms of education where learning is aided by teaching—that is, where there are systematic efforts to disseminate knowledge by way of instruction.

Most discussions of education are confined to "formal" education, which usually means kindergarten, elementary school, secondary school, college, graduate school, and professional and vocational schools. We shall widen the focus of our survey to include education in the home, on the job, in the church, and in the army, though we shall be satisfied with obtaining a general idea of the order of the magnitudes involved in these activities. To deal with all aspects of education, or even all economic aspects, would be beyond our scope; we are engaged here only in a survey of resource allocation to the production of knowledge of all kinds, relative to the entire productive activity of the nation. The chief task of this chapter on education, therefore, is to present estimates of the cost of education of all types (except educational broadcasting, which will be taken up in Chapter VI, together with radio and television broadcasting). Some space, however, will be given to special problems of great importance, such as the productivity and efficiency of formal education.

Education in the Home

From some points of view the "basic training" a child receives from his mother is of paramount importance, and the amount of knowledge systematically produced in the home by parents and siblings is often remarkable in comparison with that produced at school. But there are reasons why education in the home does not receive, in descriptive analyses of education, the same consideration as education at school.

STATISTICS: NO EXPENDITURES, NO PRODUCT

Economic analysis, focusing on the allocation of scarce resources among a multitude of ends and hence asking for the opportunity costs of the goods and services produced, is apt to disregard all presumably "costless" production. A product will, as a rule, be omitted in national-income computations if no payments are made either for it or for the factors of production used in its production. Homemade knowledge produced by voluntary labor—the education mothers give their children in the home—is not a product entered on the national-product account.

The omission of mother's teaching from the account is on a par with the omission of mother's cooking. The work of a hired nurse or governess would be included in the national product just as the work of a hired cook is. The beginning student of national-income statistics learns usually to his amazement and amusement of the reduction of the national income, as conventionally computed, that would follow from changing employment contracts into marriage contracts.

Omission from the national-product accounts does not, however, justify disregard by economic analysis. Even if mothers are not paid for their work, and donate their labor to the children, one should ask whether there is an opportunity cost involved, how it may be estimated, and what the order of its magnitude may be. The first of these questions can be quickly answered affirmatively: the mothers who stay home to "bring up" their children have to forego the income they could earn otherwise. The sacrifice of this alternative use of their time is the cost, social as well as private, of education in the home.

Some might object to the disregard of the psychic income derived from the activity, the disregard of the pleasure mothers get out of being with their children (though the marginal pleasure or satisfaction is apt to be zero or negative in a twelve-hour day of child education). This objection would miss the point: no one denies that there are large benefits derived from education in the home. There are, above all, the benefits to the children in the form of current enjoyment and, even more important, in the form of future capacities to live productive and happy lives. There are, moreover, the benefits to the mothers in the form of anticipations of the fruits of their labor and in the form of the joy of giving love and affection to their offspring. If mothers should, in addition, actually enjoy their work with the children, all the better for them—and perhaps all the worse for us who omit all these benefits and costs from our accounts of the private and social product of the nation. But, be this as it may, the inquiry into the *cost* of an activity is one thing, the question of its *benefits* is another.[1]

People are willing to incur higher costs where the benefits promise to be high. Where all or some of the benefits are to accrue in later years, the costs are viewed as investment. In calculating the rates of return from investment it would be rather confusing if one's estimate of the cost were "adjusted" for some of the expected benefits. Incidentally, attempts to estimate costs need not reflect any desire to show that the costs are either too high or not high enough. Not that there would be anything wrong with such a critical point of view. If one believes, for example, that the marginal productivity of educational investment in "human capital" is higher than that of other forms of investment, it would be most appropriate to adduce evidence supporting this charge

[1] Strictly speaking, there can be some subtle influences of the expected benefits upon the cost of particular services. For example, psychic incomes accruing to those who render the services will affect their supply at given money rates of earning. This comment may qualify the generalization expressed in the text, but does not alter the principle that a cost calculation must not omit any items just because there are benefits—perhaps unpaid satisfactions—derived from them.

of underinvestment in education. Likewise, comparisons of costs and benefits would be required to support a charge of overinvestment in education. However, one may well be interested in estimates of the total cost, without any critical contentions, just wanting to know how much it is, how it compares with other allocations in the economy, and how it has been growing over time. Essentially this will be the attitude of the present account.

INCOME FOREGONE BY CHILD-REARING MOTHERS

It would be quite wrong to assume that every woman foregoes an income when she stays home to take care of a pre-school child. After all, many women who have no children to take care of stay home too. In order to estimate the income loss of mothers of young children, one has first to ascertain the difference in the "participation in the labor force" of women with young children and of women with no children or with older children. If we were to find that 60 out of 100 women with pre-school children are not in the labor force, we could not say that these mothers forego any income, since 40 percent is the approximate labor-force-participation rate of married women with older children. If, however, 82 out of 100 women with children under six years of age are found outside the labor force, 22 of them may be regarded as staying home for the sake of their children, while the other 60 would in any case stay out of the labor force. The average wage or salary earned by women can then be used to estimate the income foregone by each of the 22 mothers staying out of jobs in order to bring up their small children.

In Table IV-1 we produce the relevant data from the available statistics on women in the labor force. We can readily see that there is a considerable difference between the labor-force-participation rates of women with children under six and those with older or no children. It may be surprising, at first blush, to find that the percentage of working women with children between six and seventeen only is greater than the percentage of working women (now or ever married) with no children under eighteen. This is easily explained, however, since the latter group is likely to contain a considerable number of older women, 65 and above, who have left the labor force, if they have ever been in it. The relevant group for comparison is therefore that of women with children between six and seventeen only, because they are more similar in age to the group of women with children under six. The percentage of working women with pre-school children was, during the four years examined, consistently less than half of the percentage of working women with school-age children. It seems safe to infer that this difference can be attributed to the desire or obligation felt by the mothers to take care of their small children.

TABLE IV-1

NUMBER OF WOMEN, TOTAL AND IN LABOR FORCE, BY AGE OF CHILDREN, 1954-1958

	All women age 14 and above	Women ever married			
		Total	No children under 18	Children 6-17 only	Children under 6
1954					
Population (thousand)	59,542	48,499	25,037	10,354	13,109
Labor force (thousand)	19,726	14,314	8,296	3,795	2,223
Per cent of population in labor force	33.1	29.5	33.1	36.7	17.0
1955					
Population (thousand)	60,250	49,288	25,178	10,547	13,564
Labor force (thousand)	20,154	15,066	8,543	4,048	2,474
Per cent of population in labor force	33.4	30.6	33.9	38.4	18.2
1956					
Population (thousand)	60,975	49,849	25,327	10,628	13,894
Labor force (thousand)	20,842	15,675	8,942	4,245	2,488
Per cent of population in labor force	34.2	31.4	35.3	39.9	17.9
1957					
Population (thousand)	61,863	50,376	25,292	11,011	14,073
Labor force (thousand)	21,524	16,146	9,158	4,401	2,587
Per cent of population in labor force	34.8	32.1	36.2	40.0	18.4
1958					
Population (thousand)	62,472	50,962	25,519	11,297	14,146
Labor force (thousand)	22,451	16,636	9,142	4,647	2,847
Per cent of population in labor force	36.0	32.6	35.8	41.4	20.1

SOURCES: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Series P-50; and U.S. Department of Labor, Women's Bureau, *1958 Handbook on Women Workers*, Bulletin 266, Table 25.

The number of women staying out of the labor force in order to bring up their pre-school children can be estimated by calculating the hypothetical number of working women in the group of women with pre-school children—by applying to this group the labor-force-participation rate found for the women with older children—and deducting from it the actual number in the labor force. This is done in Table IV-2. It shows that the number of women educating their children rather than working in jobs increased from 2,288,000 in 1954 to 3,055,000 in 1956, and remained almost unchanged in 1957 and 1958. No reliable figures are available for earlier times but there is little doubt about the fact that at the beginning of this century relatively few women took jobs. During the wars many women joined the labor force, but left it again afterwards. In recent years the percentage of women in the labor force has been increasing steadily, and accordingly the amounts of income foregone by child-rearing mothers has been increasing.

TABLE IV-2

NUMBER OF MOTHERS OF YOUNG CHILDREN STAYING OUT OF THE LABOR FORCE, 1954-1958

	Labor force participation rate of women with children 6-17 only	*Women with children under 6*			
		Total population (000)	Hypothetically in labor force (000)	Actually in labor force (000)	Difference (000)
1954	36.7	13,109	4,511	2,223	2,288
1955	38.4	13,564	5,208	2,474	2,734
1956	39.9	13,894	5,543	2,488	3,055
1957	40.0	14,073	5,629	2,587	3,042
1958	41.4	14,146	5,856	2,847	3,009

SOURCE: Computed from Table IV-1.

The median wage or salary income of working women[2] was $1,421 in 1956 and $1,473 in 1958. (This would be about $28 a week for a 52-week work year, or $30 a week for 48 weeks.) Taking these as the representative incomes, and multiplying them by the number of women staying with their small children,[3] we find that the income foregone by the mothers was $4,341 million in 1956 and $4,432 million in 1958.

[2] U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Series P-60, No. 27, Table 24, and No. 30, Table 27.

[3] The technique used here is subject to some objections: (1) If the women who stay home to bring up their children were suddenly to join the labor force, the increased supply of labor would lower the rates of earning and consequently also the labor-force-participation rate of women with no children. This is neglected if, as we have done, the actual earning rates and the actual labor-force-participation rates are used for estimates of earnings foregone. (2) Median earnings—which are more readily available—are probably below the arithmetic means, and the latter might have been preferable as the basis of estimates of earnings foregone. (3) Women who stay home can do other valuable things in addition to just bringing up their children. Thus, the

Training on the Job

As usual, analysis requires distinctions. With regard to the production and acquisition of knowledge while working on a job, especially in the case of an employee of a business firm, one should distinguish between "on-the-job training" provided by the employer and "learning on the job" on the part of the employee without any training activities arranged by the employer.

LEARNING ON THE JOB

Learning on the job would more properly come under the heading of "learning from experience," which we have excluded from knowledge-production through education. This learning process is not paid for by an employer, not guided by a supervisor, and not designed as training for the job assigned to a new employee. It is either a conscious preparation on the part of the employee for a better job he may aspire to in the future; or it is a conscious effort to acquire greater efficiency and higher earnings in the present occupation of the employed (or self-employed) worker; or, again, it may be the automatic, almost unavoidable, improvement in the worker's efficiency as he gains more experience in his job.

Most younger workers are learning as they work, thus gaining in skill, circumspection, reliability, maturity, and they will eventually become eligible for more responsible tasks or jobs. The growth of their efficiency or productivity ordinarily leads to promotions or transfers to better jobs with higher earnings, sometimes to increased earnings in the same job. This is not what should be understood by the phrase "training on the job," although it is sometimes investigated together with genuine on-the-job training, probably because empirical data affording a separation have not become available.

Learning on the job may be regarded as an investment by the worker if and insofar as he "invests" something in expectation of future benefits. The chief form of this investment is the sacrifice of higher earnings which the worker could make *now* from alternative activities, a sacrifice he accepts in the hope of still higher earnings *later* in the future. He may have a choice between two occupations, one with a low initial

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cost of education in the home is really less than the earnings foregone by the mothers. The weight of the second objection is certainly smaller than the weights of the first and third, both of which point to possible overestimations of the cost of education in the home. On the other hand, there is no way of finding out just what corrections of the figures used should properly be made in order to take adequate account of the points in question.

wage but good raises as his skill improves, the other with a higher initial wage but much slower raises. The second type of job may be one that requires no skill or one in which efficiency does not improve with experience. The initially meagre income stream from the occupation in which skill is a function of experience overtakes after some time the initially bigger income stream from the alternative occupation. (We may think of a young lawyer in his first years in a big law firm, who accepts a much lower salary than he could get in several other occupations.) Individuals who choose the "growth job" and thus forego earnings in earlier years are investors: they invest in their own earning capacity.

Some occupations or jobs afford a chance for improvement, or even an inevitable prospect of improved skill and earning capacity, without requiring a sacrifice of higher earnings in the early years. In this case increased earning capacity is acquired on the job without cost: no income is foregone in the process. Consequently not every increase in earnings through learning on the job can be attributed to an "investment in human capital."

The problem of estimating the investment, and the rates of return on the investment, in on-the-job learning is very intricate. Most ingenious theoretical and empirical analyses have been undertaken by Gary S. Becker and Jacob Mincer, designed to obtain such estimates from statistical age-and-earnings series for persons with given amounts of formal schooling engaged in different occupations. These studies[4] are still unfinished, but preliminary findings have become known. Measuring investment by earnings foregone (plus interest) in alternative activities, Mincer puts the aggregate investment through on-the-job learning (or on-the-job training, as he still prefers to call it) by U.S. males at $11,300 million, and by U.S. females at $1,200 million—together $12,500 million—in 1958. Lest there be confusion, let us note that this figure does not refer to accumulated human capital, but to the amount invested during the year.

There is much that can be questioned regarding the methods of this estimation.[5] More thought will have to be given to this problem before

[4] Gary S. Becker, "Investment in Human Capital"; Jacob Mincer, "On-the-Job Training: Costs, Returns, and Some Implications." Both these studies are being prepared for publication by the National Bureau of Economic Research.

[5] An objection which suggests itself readily relates to the fact that the income foregone by the marginal investor, or the marginal investment, is not always a good basis on which to compute the total investment. For, if more people had chosen the initially better-paying jobs instead of the growth-jobs, the former would have paid less and the latter more, with the result that the earnings foregone might be much less,

the estimate of $12,500 million as the 1958 investment in human skills through on-the-job learning can be accepted. We choose to dodge the issue by excluding the entire category from our account. Our previous decision to keep learning from experience apart from all strictly educational activities, in which an instructor of some sort takes part in a purposive "production of knowledge," can justify our exclusion. The situation is different with respect to genuine on-the-job training.

TRAINING PROGRAMS PROVIDED BY BUSINESS FIRMS

Training on the job is designed to instruct a newly hired, newly promoted, or newly transferred worker in carrying out the requirements of his job with reasonable efficiency. This is done either in a specially designed training course given by an instructing staff, or—more literally "on the job"—in breaking in the new man under the supervision of a foreman or older workers and having him catch on and do his tasks with increasing speed and accuracy.

The distinction between systematic training programs and informal training, both provided by the employer, may be especially relevant for an empirical analysis of the costs involved. Training programs usually operate with fixed budgets, so that the expenditures could be ascertained even where the accounting is not sufficiently detailed to yield the cost data. (On principle, it would be possible to separate in the accounting procedures the wages and salaries paid to the training staff and to the trainees from the regular payrolls of administrative personnel or production workers. But, in any case, budget data would do for purposes of statistical reports.) Formal training courses are offered mainly in big corporations where the number of new employees is ordinarily so large that it pays to institute special programs. Yet no reliable information on total expenditures is available. Surveys have been unsuccessful because few firms replied, and of those who did some said that they could not ascertain the cost while others furnished data that were clearly not comparable.[6]

From information given out by firms responding to inquiries by

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perhaps even nil. If the demand for all relevant kinds of labor services is highly elastic, shifts between occupations need not substantially affect the earnings ratios; but without estimates of the demand elasticities it is exceedingly bold to assume that total investment through foregone incomes can be estimated on the basis of the observed earnings ratios. This objection is especially serious where occupations requiring rather specific qualifications are involved, particularly services for which the market is relatively small.

[6] O. N. Serbein, *Educational Activities of Business* (Washington: American Council on Education, 1961), pp. 9-10.

various researchers estimates of the cost per trainee have been derived. They vary widely according to the type of job for which the training was provided. For the training of ordinary operatives as little as $85 per man was spent, while the cost in some executive training programs exceeded $2000 per trainee. But neither the total number of participants in such training programs nor the composition is known. Mincer seems inclined to rely on a survey in New Jersey, according to which approximately 5 per cent of all employees participated in formal training programs in 1959, one fifth of them in management development programs, the others in sales training, technical training, operative training, safety campaigns, orientation courses, and apprenticeships.[7] Applying the New Jersey percentages to the entire country, Mincer believes that the formal training programs by U.S. business firms may have cost between $2,000 and $3,000 million in 1958.

I doubt that the New Jersey findings are representative for the country, chiefly because the types of industries located in New Jersey are too dissimilar from the national pattern. (The Bell Laboratories and many other industrial research organizations with ambitious professional and managerial development programs are located in New Jersey.) A good many important corporations may maintain extraordinarily expensive training programs for their employees, and the number of such programs has surely increased in the last few years. Still, probably less than 10 per cent of all firms in the country have instituted them, and probably for only a very small percentage of their employees. My first estimate of the 1958 cost of formal training programs by U.S. businesses was only $335 million. This may have been an underestimate, which I am now prepared to correct, but I cannot persuade myself that the cost was more than $1,000 million in 1958. To indicate my judgment that there is a rising trend in this sort of undertaking, I make my 1956 estimate of the cost of formal training programs in business firms $800 million.

INFORMAL TRAINING ON THE JOB

The cost of informal training on the job is much greater, but how much is difficult to say. This cost has been decomposed into (1) the loss of output owing to the low productivity of the new workers, (2) the increased cost of supervision, (3) increased maintenance and depreciation, (4) higher accident rate, and (5) higher inspection cost.

[7] U.S. Department of Labor, Bureau of Apprenticeship and Training, *Employee Training in New Jersey Industry* (Washington, 1960).

"These on-the-job costs may range from $50 for an experienced employee to several thousand for an inexperienced one."[8] Firms in which the turnover of labor plays a very large role have probably made special studies to ascertain the cost of training newly hired personnel. One may assume that the Telephone Company is well aware of the huge cost of the inevitably large turnover of operators and the continual need to train new ones. Many manufacturing firms may likewise have investigated the cost of the on-the-job training necessitated by the turnover of their work force. But such studies cannot give us figures for the economy as a whole. To get total-cost figures we shall have to resort to a courageous estimate.

LABOR TURNOVER AND THE COST OF TRAINING NEWLY HIRED PERSONNEL

For several years the Bureau of Labor Statistics has published monthly rates of new "accessions," reported by a representative sample of firms in manufacturing industry. The average monthly rates were usually between three and four per cent, more often nearer four than three. A monthly accession rate of four per cent means an annual rate of 48 per cent—that is to say, nearly half the total number of employed. This would be an unbelievably high turnover rate, and it is so high only because the "accessions" include workers reemployed after temporary separation. Workers returning to jobs they have previously held do not need much training to re-acquire efficiency. Now, for the most recent years, beginning in 1957, we are also given the rates of "new hires," that is, additions of workers not previously employed and recalled by the same firm. The average monthly rates of "new hires" in manufacturing were 1.8 per cent in 1957 and 1.3 per cent in 1958. Multiplying by 12, we obtain annual new-hire rates of 21.6 per cent for 1957 and 15.6 per cent for 1958. Since the latter year, containing the trough of a recession, was probably exceptional, we shall use 20 per cent as the annual new-hire rate in our further calculations.

The next assumption needed for our estimate concerns the average length of the training period. There are some jobs which any greenhorn can learn in a day or two; for other jobs normal efficiency cannot be attained in less than several months. I propose that a loss of approximately two weeks' work be regarded as a plausible equivalent for the average cost of training a new worker, counting supervision, main-

[8] Frederick J. Gaudet, "Calculating the Cost of Labor Turnover," *Personnel*, September-October 1958, pp. 31-37.

tenance, accidents, and inspection besides the loss of output. The loss of two weeks per newly hired worker can be translated into four per cent of his annual wage income. Hence, we shall take the cost of "on-the-job training" to be four per cent of the annual compensation of 20 per cent of the total number of employees, or 0.8 per cent of the wage bill.

We would not dare to use this rate for years in the distant past—or for the future. Labor turnover may have been very different in the past, and may change in the future. More important, however, is the probable change in the average training period. For unskilled work little training is needed; and the ratio of unskilled labor in the total labor force used to be much higher than it is now, and is likely to decline further in the future. The number of jobs for which special training is needed has been increasing, both absolutely and relatively, and is apt to increase further. We conclude that the cost of on-the-job training was relatively small in earlier times, and has been on the increase over the years.

In view of these changes over time, we must confine ourselves to applying our 0.8 per cent rate to the few years for which our considerations may be pertinent. Employees' compensation[9] was $242,500 million in 1956 and $256,800 million in 1958; at the rate of 0.8 per cent, the cost of training on the job would have been $1,940 and $2,054 million, respectively. I have mustered the courage for proposing these "estimates," on the basis of so much speculation and so little information, believing that there is merit even in poor estimates, for they may provoke others to undertake the research necessary for improving them.[10]

A THEORETICAL CONNECTION BETWEEN TRAINING COST AND LEARNING COST

Becker and Mincer have suggested an interesting theoretical connection between the cost of on-the-job training provided by the employers and the cost of on-the-job learning incurred by the employees in the form of foregone earnings in other jobs. In an abstract model

[9] Compensation of employees includes wages, salaries, and "supplements" (fringe benefits). National Income Supplement, *Survey of Current Business.*

[10] Jacob Mincer again comes to a much higher estimate. He accepts an estimate of the "training costs per worker replacement" of about $230 and uses the 4 per cent monthly accession rate instead of the lower monthly rate of "new hires" (hence a 48 per cent annual rate instead of our 20 per cent rate). This leads him to an estimate of $7,000 million for 1958, or 3½ times my estimate.

of a perfect labor market in which there is pure and perfect competition among firms in buying labor services and likewise pure and perfect competition among workers in selling labor services, both training cost and learning cost would be reflected in the rates of earnings and, hence, be borne entirely by the worker. This would be so because firms, having a choice between trained and untrained workers, would evaluate the marginal productivities of untrained workers net of the cost of on-the-job training; and workers, having a choice between skill-improving jobs and jobs with less chance for improvement, would figure the relative growth prospects among the compensation offered. With learning costs and training costs accounted for in the supply and demand functions for labor services, the equilibrium rates of earning would reflect both. There would be no point in this case in allocating the total investment in skill improvement among costs originally paid by the firms and costs implied in the workers' job preferences.

Let us pay our sincere respect to the analysts who have pointed to these interesting connections, even if we do not accept the view that we can rely on them in measuring the investment in human capital through skill acquisition on the job.

INVESTMENT OR CURRENT COST?

Most of the outlays for education can be regarded as investment in human capital because they are expected to yield returns in future years. This can be said even for the expensive executive-training programs operated by some large corporations. But it cannot be said of the outlays for workers' training on the job. The firms cannot count on keeping the trained workers for any length of time and, indeed, the high turnover rates indicate that the training has to pay off quickly. Thus, the outlays are current expenses incurred for the production of output within a very short time. Needless to say, these costs are not incurred in order to obtain the output that is to come out of the production lines in the very same weeks. But, it should be understood, outlays that are required to obtain output within a year, and would be incurred even if the benefits would not continue beyond one year, are in our conventional terminology not regarded as investment. (To the extent that the skills acquired in one job are transferable to other jobs and other firms, the cost of training, though a current-cost item for the firm, may be regarded as investment from the point of view of society. This would be a case of "external economies." Probably, however, the larger part of the knowledge produced by on-the-job training is useful only for work in the same firm; we shall therefore disregard the incidental social investment.)

This is mentioned because it is peculiar to training on the job. On-the-job training, apart from the training of executive and professional personnel, is the only educational activity that is not a final output but should be regarded as an intermediate good, as "cost of current output." All other costs of education are either investment, yielding future returns, or consumption expenditures, yielding immediate satisfaction.

Education in the Church

To jump from a discussion of training on the job to a discussion of education in the church may look silly and tactless, but is expedient. The excuse for this procedure is that it allows us to dispose of all forms of education which are not ordinarily treated as formal education before we take up this big subject, on which so much more statistical information is available. This procedure also compels us to make the conceptual and statistical separation between church and school which is dictated by the political separation under the official institutional arrangements in the United States.

RELIGIOUS INSTRUCTION VERSUS CHURCH-AFFILIATED SCHOOLS

The conceptual separation is not at all easy. In many parts of the world, and for several centuries, all formal education was in the hands of the church and it would be difficult, if not impossible, to divide the teaching which it provided into spiritual and secular parts. Even today it would be hard to draw a clear line between religious instruction and church-inspired education, at least at some levels and places. In attempting such a differentiation one would not be aided either by the distinction between clergymen and lay teachers, nor by that between religious and nonreligious subject matters. Clerics may teach reading, writing, and arithmetic, while laymen teach Sunday school and bible classes. A college course in philosophy may emphasize certain doctrinal tenets of the church, while a course on religion may be completely a-religious, stressing the history, comparative philosophy, and institutions of Brahmaism, Buddhism, and other "foreign" religions. There are church schools, convent schools, denominational schools of all sorts where religious instruction plays a very minor role, if any. In some countries, on the other hand, where the separation between church and state is not carried out, state schools may require religious instruction as a part of the general curriculum. With at least one group of people even the semantic difference between church and school does not exist: when Orthodox Jews say that they are going to "school" they are actually heading for the synagogue.

Having declared that a distinction can hardly be made, we shall of course proceed to make one. This distinction is perhaps not much harder to make "for all practical purposes" than are most other distinctions in the social sciences. After all, there are laws on the statute books which provide for compulsory education and it was necessary to decide what kind of teaching would be accepted as fulfillment of the requirement. The governments of each state have had to rule on the question of which nonpublic institutions, private or parochial, were to be officially recognized as elementary and secondary schools in the meaning of the law. At the level of higher education it is, in the United States, usually not the state but an accrediting association that decides on the status of an institution. Numerous theological seminaries are included among institutions of "higher education" rather than among "religious activities." We shall not quarrel with such decisions and shall accept the determinations made by those in charge of making them.

STATISTICAL ESTIMATES OF CURRENT EXPENSES

We shall not attempt to distinguish religious instruction in a narrow sense of the word from religious activities in general. Some perfectionists might contend that sermons are educational while prayers and hymns are not. But apart from the fact that it would be hard to split the cost of religious services between sermons and other phases of worship and liturgical proceedings, it would be narrowmindedness to accept singing in the school but reject singing in the church as part of the educational process. Those who prefer to exclude all religious services from the class "education" can do so with no serious inconvenience. They may simply subtract our estimate of the cost of "education in the church" from the total cost of education which we shall figure out at a later point, and transfer it to another account.

It is not easy to estimate the cost of religious activities.[11] The only data available for this purpose are (1) an annual series of current expenditures of "religious and private welfare organizations,"[12] which cannot be broken down (it includes, e.g., private "social-welfare and foreign-relief agencies"); (2) a series of outlays for new construction

[11] I am indebted to Mr. John H. Williamson for research assistance on this section.
[12] U.S. Bureau of Labor Statistics, *Monthly Labor Review*, December 1959. The same series is used in the tabulation of consumption expenditures in the National Income Supplements of the *Survey of Current Business*.

of churches;[13] (3) a series of new construction and total congregational expenditures for 21 large Protestant denominations;[14] (4) a series giving contributions, benevolences (including contributions for home and foreign missions) and congregational outlays (including construction) for 48 to 52 Protestant denominations (plus Eastern Orthodox);[15] and (5) estimates of total contributions to churches and religious organizations up to 1948-1949.[16]

These data provide us with the limits between which the current expenditures for religious activities must lie. The lower limit is given by the "congregational outlays" (expenses plus construction) of the approximately 50 denominations included in the fourth series listed above, minus the total construction outlays listed in the second series. The congregational outlays of the fifty-odd denominations were $1,354 million in 1954, $1,655 million in 1956, and $1,878 million in 1958. The total construction outlays were $593 million in 1954 and $775 million in 1956, but are unavailable as yet for 1958. This leaves the "lower limits" for current expenditures at $761 million in 1954 and $880 million in 1956. The actual total is clearly considerably higher, since (1) the construction outlays deducted are for all denominations and (2) the expenditures of the Roman Catholic Church and the Jewish congregations are not included. The upper limit is given by the expenditures of religious and private welfare organizations stated in the first of the above sources; they were $2,988 million in 1954, $3,465 million in 1956, and $3,939 million in 1958. Since private welfare expenditures are included in these figures, the amount spent for religious activities must evidently be lower.

Attempts to estimate where total current congregational expenses lie between these limits are necessarily conjectural. We may calculate, from the third series listed above, the ratio between new construction and total congregational expenditures for twenty-one Protestant denominations, and then assume that approximately the same ratio—32 per cent—holds for all denominations. This assumption, with total construction outlays for churches and synagogues in 1956 of $775

[13] National Council of the Churches of Christ in the United States of America, *Yearbook of American Churches*, ed. by Benson Y. Landis.

[14] *Ibid.*

[15] National Council of Churches of Christ in the United States of America, *Statistics of Giving* (November 1955 and 1957); *Statistics of Church Finances* (November 1958).

[16] F. E. Andrews, *Philanthropic Giving* (New York: Russell Sage Foundation, 1950); E. C. Jenkins, *Philanthropy in America* (New York: Association Press, 1950).

million, would make total current congregational expenses in 1956 $1,645 million.

Alternatively we may calculate from the fifth source the ratios between estimates of total contributions to churches less those for construction (in 1948 and 1949) to total expenditures of religious and welfare organizations as given in the first source, and then assume that the same ratios hold for other years. The Jenkins estimate for 1948 was $1,378 million; the Andrews estimates were $1,582 million for 1948 and $1,894 million for 1949. Construction outlays were $251 million in 1948 and $360 million in 1949. We therefore obtain three different estimates of the current expenses of the churches—$1,127 and $1,331 million for 1948 and $1,534 million for 1949. These constitute, respectively, 51, 60, and 69 per cent of the religious and welfare expenditures of the year in question. When applied to the 1956 figure for religious and welfare activities these three ratios yield, respectively, $1,741, $2,057, and $2,361 million as total contributions to churches less those for construction. To obtain current congregational expenses we must deduct from these figures the sum devoted to benevolences. From the second series we know that this amounts to about 35 per cent of current expenses for the fifty-odd Protestant denominations. Assuming this figure to be typical, current congregational expenses in 1956 were 65 per cent of the figures estimated above as total current expenses. Current congregational expenses in 1956 were therefore $1,130, $1,336, or $1,532 million on our three estimates. They all are below the estimates based on the first method.

We shall take $1,400 million as the "compromise estimate" of current expenditures for church activities in 1956. Assuming that these expenditures increased from 1956 to 1958 by the same percentage as the congregational outlays of the fifty-odd denominations, namely, 13.4 per cent, the current expenditures for church activities in 1958 will be entered as $1,588 million.

CHURCH PROPERTY AND NEW CONSTRUCTION

We have no figures for implicit interest and depreciation on church property. In a complete cost account the opportunity cost of the use of all buildings and grounds would have to be included. We shall not, however, take the time to derive such estimates. But the annual construction cost of new churches and synagogues must not be omitted, since this is an investment for future education in the church. As already noted, in 1956 the construction outlay was $775 million. Again using the 13.4 per cent as the rate of increase from 1956 to 1958, we shall enter $879 million as the construction outlay for 1958.

Education in the Armed Services

The "academies" operated by the armed services are included among the institutions of higher education. A great deal of training, however, which is given to all men in the Army, Navy, and Air Force does not usually come under the heading "formal education," and thus should be discussed separately. Perhaps there are some who question the value of this training and would want to deny it the designation "education." To answer them, one may either demonstrate that the training provided by the armed services does contribute to the intellectual development and productive capacity of the trainees, or one may argue that we do not stop to examine the effectiveness of any other kind of teaching or training as a condition of its inclusion in this survey. The productivity and efficiency of any kind of education is a separate question, which deserves separate attention.

BASIC TRAINING AND SPECIAL TRAINING PROGRAMS

The armed services provide two kinds of training, "basic" and "special." Basic training has probably changed over the years and I do not know whether the emphasis is still on physical exercise, marching drills, promptness, superficial neatness, and potato peeling. Be this as it may, there are probably hundreds of thousands of young men for whom this kind of training was not bad at all, and who were better prepared for and more efficient in all sorts of jobs than they would have been without the basic training received in military service.

The training provided in special schools or programs run by the armed services may in some instances make only better soldiers out of the trainees, but more often it will make them into specialists who can utilize their acquired skills in civilian occupations after they return to civilian life. There are about 400 "specialties" available for enlisted personnel in the Navy and Marine Corps, and more than 900 in the Army; most of them seem to be quite useful for civilian occupations. According to a recent survey, a classification of "enlisted" jobs into major occupational groups showed that, in 1958, 25.8 per cent were mechanics and repairmen, 20.6 per cent were in administrative and clerical work, 19.4 per cent in crafts and services, 13.5 per cent in electronics, 7.4 per cent in "other technical" work, and only 12.9 per cent in "ground combat."[17] The same study indicates that in 1955 alone 430,000 men in the services received training in civilian-type specialties.

It was probably quite unnecessary to discuss the usefulness of military training for civilian occupations. We do not doubt the desirability of biology courses for future mechanics or secretaries, or of geography courses for future carpenters or accountants; our youngsters learn to play baseball even if they do not plan to become professional ball players, and many girls are trained as telephone operators even if they soon become practicing mothers. The transferability of skills is an interesting topic, but it has little relevance to an analysis of the total cost of education.

THE EXPENDITURES FOR MILITARY TRAINING

The expenditures for special training schools and programs of the armed services were estimated to have been $1,100 million in 1959. For this figure I am indebted to Rudolph C. Blitz, who has done careful research on the cost of education.[18] This estimate represents not only the current cost of instruction but also the costs of feeding and clothing the trainees, of medical care, etc. It is exclusive of an amount of $500 million cash payments to these special trainees. The estimate also excludes both depreciation of plant and equipment and the outlay for the expansion of plant and the procurement of equipment. These costs will be disregarded.

The expenditures for basic training were estimated to have been $1,810 million in 1956. This estimate, by Rudolph G. Penner, is based on an official statement[19] according to which the training cost per new enlisted man was approximately $3,200. There were 566,000 new enlisted men in 1956. In the two years after 1956 there was a slight reduction in new enlistments, but probably a slight increase in training cost. It will not be unreasonable to use the same $1,810 million as the expenditure for basic training in 1958.

In the absence of any systematic statistics, these two isolated estimates will have to suffice. They do no more than give an impression

[17] Harold Wool, "The Armed Services as a Training Institution," in Eli Ginzberg, ed., *The Nation's Children* (New York: Columbia University Press, 1960), Vol. II, p. 166.

[18] Rudolph C. Blitz, "The Nation's Educational Outlay," a paper presented to the Political Economy Seminar at the Johns Hopkins University, April 1960. To be published by the U.S. Office of Education in a volume on the *Economics of Higher Education*, ed. Selma J. Mushkin.

[19] U.S. Department of Defense, *Semi-Annual Report of the Secretary of Defense*, January-June 1956.

of the order of magnitude of the expenditures for military training in recent years.

OTHER KNOWLEDGE PRODUCTION BY THE ARMED SERVICES

The two expenditure items for military training were part of a huge defense budget, in which there are evidently many items connected with the production of knowledge of many sorts. This is not the place to discuss the production of "military intelligence" or the production of all the plans, designs, manuals, directions, and orders which are needed in military procurement and in the operation of the military establishment. But what does deserve mention in this chapter on education is the educational program carried out by the Department of Defense by means of pamphlets, motion pictures, and overseas broadcasting. The following paragraph from an official report will illuminate this kind of activity:

"Emphasis was also placed on world affairs, good citizenship, absentee balloting procedures, and the Code of Conduct for Members of the United States Armed Forces. These themes were publicized in 35 pamphlets prepared during the year, of which 11,000,000 copies were distributed, and in 13 motion pictures, seen by an estimated 30,000,000 viewers. Other materials and services provided by the Department of Defense included 72,000 hours of kinescopes for use by 29 overseas television stations and 507,000 hours of transcriptions distributed to 148 overseas radio outlets."[20]

No data are available that would permit us to make an estimate of the cost of such programs. We must be resigned to the fact that many items will be missed in this survey.

Elementary and Secondary Education

No difficult conceptual or classificatory problems arise in connection with elementary and secondary schools; moreover, statistical information is relatively ample. The data on enrollment and expenditures in public schools go back to 1870. For nonpublic schools, private and parochial, enrollment figures are available back to 1889, and expenditures can be estimated by assuming that the cost per student is, on the average, approximately the same as in public schools. (This is the procedure followed by the U.S. Office of Education, and it is good enough for us.) Table IV-3 presents enrollment figures, and Table IV-4

[20] U.S. Department of Defense, *Semi-Annual Report of the Secretary of Defense*, January-June 1958, p. 35.

expenditure figures, in their relationships to relevant aggregates, such as population totals and Gross National Product.

EXPENDITURES FOR ELEMENTARY AND SECONDARY SCHOOL

A first glance at the expenditures column shows us that the total spent for elementary and secondary education was $18,622 million in 1960, $6,624 million in 1950, $1,117 million in 1920, $160 million in 1890. Thus, the 1960 expenditures were about 16.7 times those of 1920 and about 116 times those of 1890. The population of the country in 1960 was only 1.7 times that of 1920 and 2.9 times that of 1890. Seeing these comparisons, opponents of liberal spending may be shocked and get ready to bewail the huge increase in school expenditures as a terrible extravagance. Their shock may be reduced by explanation. The increase in total school expenditures can be explained as the result of a combination of factors, most of which have operated in the same direction: (1) changes in population; (2) changes in the number of years of compulsory schooling; (3) changes in the ratio of school-age population to total population; (4) changes in the per-

TABLE IV-3

ENROLLMENT IN ELEMENTARY AND SECONDARY SCHOOLS, COMPARED WITH POPULATION, 1870-1960

	POPULATION (RESIDENT)			ENROLLMENT IN ELEMENTARY AND SECONDARY SCHOOL					
	Total	*Age 5-17*		*Total*		*Public schools*		*Non-public school*	
	thousands	thousands	% of (1)	thousands	% of (2)	thousands	% of (2)	thousands	% of (2)
YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1870	39,905	12,055	30.2	n.a.	n.a.	6,872	57.0	n.a.	n.a.
1880	50,262	15,065	30.0	n.a.	n.a.	9,868	65.5	n.a.	n.a.
1890	63,056	18,546	29.4	14,479	78.1	12,723	68.6	1,757	9.5
1900	76,094	21,413	28.1	16,855	78.7	15,503	72.4	1,352	6.3
1910	92,407	24,237	26.2	19,372	79.9	17,814	73.5	1,558	6.4
1920	106,466	27,736	26.1	23,278	83.9	21,578	77.8	1,699	6.1
1930	123,077	31,584	25.6	28,329	89.7	25,678	81.3	2,651	8.4
1940	131,954	29,817	22.6	28,045	94.1	25,434	85.3	2,611	8.8
1950	151,234	30,774	20.3	28,492	92.6	25,111	81.6	3,380	11.0
1952	155,761	31,361	20.1	30,373	96.8	26,563	84.7	3,809	12.1
1954	161,191	34,534	21.4	33,175	96.1	28,836	83.5	4,339	12.6
1956	167,259	37,276	22.3	35,872	96.2	31,163	83.6	4,709	12.6
1958	173,260	41,728	24.1	39,400[a]	94.4	33,800[a]	81.0	5,500[a]	13.2
1960	180,126	44,672	24.8	42,700[a]	95.6	36,200[a]	81.0	6,500[a]	14.6

SOURCES: For Columns (1) and (2): U.S. Bureau of the Census, *Current Population Reports* (the 1960 figures are provisional). For Columns (4), (6), and (8): U.S. Office of Education, *Biennial Survey of Education.*

[a] Estimates of U.S. Department of Health, Education and Welfare, *HEW Trends*, 1960.

TABLE IV-4

EXPENDITURES FOR ELEMENTARY AND SECONDARY SCHOOLS, COMPARED WITH NATIONAL AGGREGATES, 1870-1960

(current expenditures plus capital outlays)

YEAR	GROSS NATIONAL PRODUCT BILLION DOLLARS (10)	EXPENDITURES FOR ELEMENTARY AND SECONDARY SCHOOLS — *Total* million dollars (11)	*Total* per cent of (10) (12)	*Public schools* million dollars (13)	*Public schools* per cent of (10) (14)	*Non-public schools* million dollars (15)	*Non-public schools* per cent of (10) (16)	*Per student* (13)÷(6) dollars (17)	*Per capita* (11)÷(1) dollars (18)
1870	6.7	n.a.	n.a.	63	0.94	n.a.	n.a.	9.17	n.a.
1880	9.2	n.a.	n.a.	78	0.85	n.a.	n.a.	7.90	n.a.
1890	13.5	160	1.19	141	1.04	19	0.14	11.08	2.54
1900	17.3	234	1.35	215	1.24	19	0.11	13.87	3.08
1910	31.6	436	1.47	426	1.35	37	0.12	23.91	5.01
1920	88.9	1,117	1.26	1,036	1.17	81	0.09	48.01	10.49
1930	91.1	2,556	2.81	2,317	2.54	239	0.26	90.23	20.77
1940	100.6	2,585	2.57	2,344	2.33	241	0.24	92.16	19.59
1950	284.6	6,624	2.33	5,838	2.05	786	0.28	232.48	43.80
1952	347.0	8,397	2.42	7,344	2.12	1,053	0.30	276.48	53.91
1954	363.1	10,460	2.88	9,092	2.50	1,368	0.38	315.30	64.89
1956	419.2	12,611	3.01	10,955	2.61	1,656	0.40	351.54	75.40
1958	442.2	15,648	3.54	13,569	3.07	2,079	0.47	401.45	90.31
1960	504.4	18,622	3.69	15,805	3.13	2,817	0.56	436.11	103.38

SOURCES: Column (10): U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, Washington, D.C., 1960. 1930 to present: Official estimates of Department of Commerce. 1890-1910: Kuznets estimates adjusted by Kendrick to Department of Commerce concept. 1870-1890: Kuznets estimates of five-year averages (not adjusted to Department of Commerce concept). Columns (11) and (13): U.S. Office of Education, *Biennial Survey of Education*, and advance releases. Column (15): Estimated on basis of per-pupil expenditures in public elementary and secondary schools.

centage of the school-age population actually attending school; (5) changes in the ratio of teachers to pupils; (6) changes in the teachers' real income (apt to move up, though at a faster or slower pace, with the general standard of living); (7) changes in the teachers' money incomes to adjust for price inflation; (8) changes in school expenditures for things other than instruction.

The first four of these factors can be easily separated from the rest: their effect is upon enrollment. By concentrating on "expenditures per student" (Col. 17, Table IV-4) one can eliminate the effects which the four enrollment-increasing factors have upon expenditures, and will then have to explain the increase in expenditures per student by examining the role of each of the other four factors. Two of these other factors—the increase in teachers' salaries to adjust to the growth in the nation's real income per head as well as to price inflation—can be roughly eliminated by concentrating on "expenditures as a percentage of gross national product" (Col. 12, Table IV-4); the increase in this ratio will then require explanations chiefly in terms of the factors (2) to (5) and (8) listed above.

If factors (5) and (8)—the pupil-teacher ratio and the relative volume of nonteaching activities (food, transportation, etc.)—were unchanged, school expenditures per student would depend entirely on teachers' salaries, which in turn might move more or less closely with per capita national income. Let us look into the changes of these magnitudes over various periods. (In lieu of national income we shall use Gross National Product, for which earlier data are available. We take the "GNP per head" figures from *Historical Statistics of the United States.*) Between 1870 and 1920, school expenditures per student increased from $9.17 to $48.01, i.e., 5.2 times; GNP per head increased from $165 to $835, i.e., 5.1 times. But over the longer period 1870 to 1956, school expenditures per student increased to $351.54, i.e., 38 times, while GNP per head increased to $2,493, only 15 times. During the second phase of this long period either teachers' salaries rose faster than GNP per head or the other cost-increasing factors operated strongly, or both. Let us make similar comparisons for a period for which we have also data on teachers' salaries, say 1890 to 1956. (*Historical Statistics*, pp. 91-97.) In this period the increase of GNP per head (from $210 to $2,493) was less than 12 times, of the average of (public school) teachers' salaries (from $256 to $4,156) more than 16 times, and of school expenditures per student (from $11.08 to $351.54) almost 32 times. We may infer from these differences that teachers' pay increases are surely not the chief factor in the increase in school expenditures per student.

In order to check the impressions conveyed by these comparisons concerning the relation between GNP per head and teachers' salaries we may test two more periods. In 1900, 1930, and 1960, GNP per head was $231, $740, and $2,800; the average of teachers' salaries was $328, $1,420, and $5,160, respectively. Over the entire 60 years GNP per head increased 11.7 times, while salaries increased 15.7 times. Over the second half of the period, 1930 to 1960, GNP per head increased 3.8 times, while salaries increased only 3.6 times.

Since there has sometimes been serious resentment concerning the political pressures for teachers' pay increases, it may not be superfluous to point out a thing or two relevant to this question. One may conceive of an economy in which all increments in productivity are distributed through lower product prices, not through higher money incomes. But the economy in which we live is not of this sort. Money incomes have been rising in all sectors of the economy. If the earnings in other occupations increase, teachers will also have to be paid more, or the other occupations become so much more attractive that there will not be enough teachers. Hence, expenditures for schools will usually rise faster than enrollments. One may contemplate how ridiculous the salaries paid some time in the past would be at the present time: the annual average salary of public-school teachers was \$1,441 in 1940, \$936 in 1920, \$195 in 1880. Although the average salary in 1960 was as high as \$5,160, many teaching positions remained unfilled or were filled only with teachers of questionable qualifications. This implies that the actual increase in teachers' salaries, relative to the earnings of other occupations, had not been sufficient to attract the number of teachers needed. As the nation's living standard rises, teachers' incomes must rise with it.

The effects that increased incomes have had upon school expenditures can be largely neutralized, as we have said, by comparing total expenditures with Gross National Product. We then see—in column 12 of Table IV-4—that as a percentage of GNP the 1960 expenditures for elementary and secondary schools were only 2.9 times those of 1920 and 3.1 times those of 1890. This puts the matter into an entirely different light. No one can reasonably contend that the nation cannot afford to spend 3.69 per cent of its gross product on its elementary and secondary schools. One may be on better ground arguing that a growing nation at our level of "affluence" cannot afford to spend less than that.

THE INCREASE IN ENROLLMENT

The main reason for the increased percentage of national product devoted to elementary and secondary education is the increased and prolonged school attendance. Table IV-3 shows us, besides the increase in population (Col. 1), the changes in the ratio of school-age population to total population (Col. 3), and the increase in the percentage of the school-age population actually enrolled in elementary and secondary schools (Col. 5).

The changes in the vital statistics of the United States have been such, at least for most of the period examined, as to offset to some extent the institutional changes regarding school attendance. The ratio of the population of 5 to 17 years of age to the total population declined from 30.2 per cent in 1870 to 28.1 per cent in 1900, 26.1 per cent in 1920, 20.3 per cent in 1950, and 20.1 per cent in 1952. Only after that year was the trend reversed, and the percentage reached 22.3 in 1956, and 24.1 in 1958. It is interesting to note that, at the 1870 ratio of school-age population, total enrollment in elementary and secondary schools, with the actual attendance rates, would have been 35.5 per cent higher than it actually was in 1956. That is to say, instead of the actual 35.9 million pupils, there would have been 48.6 million pupils enrolled, and with the same cost per student, total expenditures would have been $17,082 million, instead of the actual $12,611 million.

Among the institutional changes leading to increased school enrollment were the enactment in most states of laws raising the age of compulsory school attendance[21] from 12 or 14 to 16 or 18; the establishment of high schools extending the public school systems everywhere to a sequence of 12 grades; the development of social pressures, if not legal requirements, for everybody to complete high school; the establishment of kindergartens at a rapid rate during the last twenty years. The result of these and other developments was a steady increase (except for the Second World War and its aftermath) in the percentage of the 5 to 17 age group that was enrolled in elementary and secondary schools. Enrollment in public schools increased from 57 per cent of the age group in 1870 to 85.3 per cent in 1940 (Col. 7, Table IV-3); enrollment in both public and nonpublic schools increased from 78.1 per cent of the age group in 1890 to 96.2 per cent in 1956 (Col. 5, Table IV-3).

It can be shown that in the earlier parts of the period the increase in the enrollment rates was most conspicuous among youth 14 and 15 years old. As late as between 1920 and 1930 the enrollment rate of 14-year-olds increased from 86.3 to 92.9 per cent, and that of 15-year-olds from 72.9 to 84.7 per cent. The increase for older groups went on even later: the enrollment rate of 16-year-olds increased from 66.3 per cent in 1930 to 76.2 per cent in 1940, and that of 17-year-olds in the same decade from 47.9 to 60.9 per cent. The next decade, from 1940 to

[21] Stigler questions the importance of compulsory school attendance laws: "The influence of legislation is difficult to isolate, but a brief investigation suggests that on the whole compulsory school attendance laws have followed more than led the increase in enrollments of children over 14." George J. Stigler, *Employment and Compensation in Education,* National Bureau of Economic Research Occasional Paper No. 33 (New York: National Bureau of Economic Research, 1950), p. 8.

1950, brought the most remarkable increase in kindergarten attendance: the enrollment rate of the five-year-olds jumped from 18 to 51.7 per cent, and the enrollment rate (for kindergarten and grade school together) of the six-year-olds climbed from 69.1 to 97 per cent. By 1958 the enrollment of the five-year-olds had climbed further to 63.9 per cent.[22]

ANALYSIS OF THE EXPENDITURE INCREASE

Besides the two sets of factors discussed thus far—those increasing school enrollment and those raising teachers' salaries—there are other factors at work raising total expenditures for elementary and secondary schools. The most important of them is the extension of "auxiliary services" by the schools, especially the provision of school lunches, buses, and health care. But in comparison with increasing enrollment and salaries, the auxiliary services alone do not bulk heavily.

A recent analysis by Freeman attempts to show just how much each factor contributed to the expenditure increase.[23] For public schools alone, expenditures—excluding capital outlays and all expenditures not related to regular pupils (e.g., for community services, summer schools, community colleges, and adult education)—increased from $1,844 million in 1930 to $8,193 million in 1956, that is, by $6,349 million. To break this increase down into its component factors, one may make alternative assumptions and reach different results. For example, one may first calculate the cost of salary increases by applying the increases to the teachers employed in the base year, and then calculate the cost of enrollment increases on the basis of the increased salaries. Or one may first calculate the cost of enrollment increases on the basis of the salary level prevailing in the base year, and then calculate the cost of salary increases given to the larger number of teachers. Freeman uses the second method, which makes the enrollment increase appear cheaper and the salary increase more expensive. He allocates 6.2 per cent of the total increase in expenditures to the enrollment increase, 20.6 per cent to that part of the increase in teachers' salaries that would simply compensate for the inflation of consumer prices, 36.2 per cent to the increase in "real" salaries, 5.3 per cent to a reduction in the teacher-pupil ratio (from 1:29.2 to 1:25.6), 10.1 per

[22] All these data come from the U.S. Bureau of the Census, as reproduced in the *Statistical Abstract of the United States.*

[23] Roger A. Freeman, *School Needs in the Decade Ahead* (Washington: Institute for Social Science Research, 1958), especially pp. 237-238.

cent to auxiliary services, 6.3 per cent to fixed charges, 7.6 per cent to plant operation and maintenance, and another 7.6 per cent to other instructional expenses and administration. The last four of these items absorb no less than 31.6 per cent of the total increase in school expenditures.

Higher Education

Higher than what is "higher" education? No matter how low the intellectual level of some "high" schools may be, an institution higher than high school is commonly assumed to furnish "higher" education. Only the very best colleges and universities in the United States maintain standards of admission defined in terms of aptitudes and achievements—not just high-school graduation. It would be well to use a "persuasive" definition of higher education and restrict this designation to institutions which impose high—intellectually selective—admission standards. Yet, since we are not dealing here with an ideal world but rather with the world as we find it, we have to accept as higher education that which is provided by accredited or self-styled institutions of higher education.

ENROLLMENT AND EXPENDITURES

Expenditures for higher education increased from $46 million in 1900 to $6,230 million in 1960, or 135 times. In 1960, population was only 2.4 times that of 1900, and gross national product 29 times that of 1900. As a percentage of GNP, expenditures for higher education increased over these sixty years from 0.26 to 1.23 per cent. The fastest increases occurred in the 1920's and in the 1950's. Within the two years from 1956 to 1958 the increase of expenditures was 34 per cent in terms of dollar outlays and 28 per cent in terms of the portion of gross national product spent on higher education.

The chief factor in the absolute and relative increase in expenditures for higher education was the immense increase in the percentage of the college-age population going to college (See Table IV-5). This percentage was 3.9 in 1900; 7.6 in 1920; 15.2 in 1940; 33.5 in 1960. The rate of increase in the enrollment of graduate students was even faster than that for undergraduates. Enrollment of undergraduates increased from 231,761 in 1900 to 3,235,000 in 1960, or 14-fold; of graduate students from 5,831 to 332,000, or 57-fold. But since graduate enrollment is only less than ten per cent of undergraduate enrollment, it is the college which bulks so heavily in the total cost of higher education.

TABLE IV-5

ENROLLMENT IN INSTITUTIONS OF HIGHER EDUCATION, COMPARED WITH POPULATION, 1870-1960

YEAR	POPULATION (RESIDENT)			ENROLLMENT IN INSTITUTIONS OF HIGHER EDUCATION					
	Total	*Age 18-21*		*Total*		*Public*		*Non-public*	
	thousands	thousands	% of (1)	thousands	% of (2)	thousands	% of (2)	thousands	% of (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1870	39,905	3,116	7.8	52	1.7	n.a.		n.a.	
1880	50,262	4,253	8.5	116	2.7	n.a.		n.a.	
1890	63,056	5,160	8.2	157	3.0	n.a.		n.a.	
1900	76,094	6,131	7.9	238	3.9	91	1.5	147	2.4
1910	92,407	7,254	7.9	355	4.9	167	2.3	189	2.6
1920	106,466	7,869	7.0	598	7.6	315	4.0	282	3.6
1930	123,077	9,369	7.3	1,101	11.8	533	5.7	568	6.1
1940	131,954	9,845	7.4	1,494	15.2	797	8.1	698	7.1
1950	151,234	8,439	5.8	2,297	27.2	1,154	13.7	1,142	13.5
1952	155,761	8,728	5.2	2,148	24.6	1,113	12.8	1,035	11.9
1954	161,191	9,002	5.0	2,500	27.8	1,395	15.5	1,105	12.3
1956	167,259	9,536	5.0	2,947	30.9	1,682	17.6	1,265	13.3
1958	173,260	10,629	5.1	3,259	30.7	1,912	18.0	1,346	12.7
1960	180,126	11,204	5.3	3,750[a]	33.5	2,210[a]	19.7	1,540[a]	12.9

SOURCES: For Columns (1) and (2): U.S. Bureau of the Census, *Current Population Reports* (the 1960 figures are provisional). For Columns (4), (6), and (8): U.S. Office of Education, *Biennial Survey of Education* and *Circular No. 545*.

[a] Estimate by U.S. Office of Education.

Detailed statistical series on expenditures go back only to 1930 (see Table IV-6). The expenditures cannot readily be divided between undergraduate and graduate study, since in most universities the same facilities are used by both groups of students, the same professors teach graduates and undergraduates, and many courses are open to both. Broadly speaking, however, graduate instruction is more expensive per student than undergraduate instruction, chiefly because of the more extensive laboratory and research facilities needed for graduate work, but also because the graduate faculty usually contains more distinguished professors, commanding higher salaries, offering fewer courses, and teaching fewer students.

Expenditures per student, undergraduate plus graduate, increased from $574 in 1930 to $1,747 in 1960. This can be explained by increases in faculty salaries, increases in the ratio of faculty to students, and increases in expenditures for other things than teaching (especially research). These factors will be discussed in turn.

TABLE IV-6

EXPENDITURES FOR INSTITUTIONS OF HIGHER EDUCATION, COMPARED WITH NATIONAL AGGREGATES, 1900-1960
(current expenditures plus capital outlays)

		EXPENDITURES FOR INSTITUTIONS OF HIGHER EDUCATION							
	GROSS NATIONAL PRODUCT	*Total*		*Public*		*Non-public*		*Per student*	*Per capita*
YEAR	(Billion dollars) (10)	Million dollars (11)	% of (10) (12)	Million dollars (13)	% of (10) (14)	Million dollars (15)	% of (10) (16)	(11)÷(4) dollars (17)	(11)÷(1 dollars (18)
1900	17.3	45.8	.26	n.a.	—	n.a.	—	192	.60
1910	31.6	91.9	.29	n.a.	—	n.a.	—	259	.99
1920	88.9	215.9	.24	115.6	.13	100.3	.11	361	2.03
1930	91.1	632.2	.69	288.9	.32	343.3	.37	574	5.14
1940	100.6	758.4	.75	391.6	.39	366.8	.36	508	5.75
1950	284.6	2,662.5	.94	1,429.6	.50	1,232.9	.44	1,159	17.61
1952	347.0	2,874.3	.83	1,565.4	.45	1,308.9	.38	1,338	18.45
1954	363.1	3,435.6	.95	1,932.3	.53	1,503.3	.42	1,374	21.31
1956	419.2	4,210.3	1.00	2,376.0	.57	1,834.3	.44	1,429	25.17
1958	442.2	5,665.2[a]	1.28	3,276.9[a]	.74	2,388.3[a]	.54	1,738	32.70
1960	505.0	6,230.0[b]	1.23	3,596.0[b]	.71	2,634.0[b]	.52	1,747	34.59

SOURCES: Column (10): See Table IV-4. Columns (11), (13), and (15): U.S. Office of Edu cation, *Biennial Survey of Education*. Data for 1930-1952 for Continental United States; 1954 1960 include Hawaii, Alaska, and Territories.

[a] U.S. Department of Health, Education, and Welfare, Office of Education, September 1960 Release.

[b] Advance Release by U.S. Office of Education.

FACULTY SALARIES

Salary increases can be divided into those just sufficient to maintain real incomes (before taxes) in the face of price inflation, and those going beyond such adjustments and thus raising the real incomes. The annual average salary of college teachers (of all ranks) was $3,065 in 1930, $2,906 in 1940, and $6,810 in 1960. Inflation had raised the consumer price index of 1960 approximately 77 per cent above that of 1930 and 111 per cent above that of 1940. Hence, a 1960 salary of the purchasing power of the 1930 salary would have to be $5,424, and one of the purchasing power of the 1940 salary would have to be $6,132. The actual average salary in 1960 of $6,810 was therefore 26 per cent above the 1930 real income and 11 per cent above the 1940 real income. This increase in the real salaries of college faculty compares with an increase in national income per head in constant dollars of 114 per cent above 1930 and of 78 per cent above 1940.

The widespread concern about the inadequate compensation of professors—inadequate because it results in shortages of competent teachers—can be understood even better if their incomes are compared with those of other professions. Table IV-7 presents such comparisons with lawyers, physicians, and dentists.

TABLE IV-7

AVERAGE ANNUAL INCOME OF VARIOUS PROFESSIONS, IN CURRENT DOLLARS, 1930-1960

Year	*College teachers*	Lawyers	*Non-salaried* Physicians	Dentists	*GNP per capita*
1930	3,065	5,194	4,870	4,020	740
1932	3,111	4,156	3,178	2,479	468
1940	2,906	4,507	4,441	3,314	761
1948	4,234	8,003	11,327	7,039	1,769
1950	4,354	8,349	12,324	7,436	1,876
1952	5,106	9,021		7,884[c]	2,210
1954		10,258		8,381[c]	2,236
1959	6,630[a]		16,032[c]	9,340[c]	2,733
1960	6,810[b]				2,800

SOURCE: U.S. Bureau of the Census, *Historical Statistics of the U.S.*, 1930-1954.

[a] U.S. Office of Education, *Higher Education and Management Data 1958-59*, Washington, 1959.

[b] U.S. Office of Education, *Higher Education and Management Data 1959-60*, Washington, 1960.

[c] Robert S. Markley, *Trends in the Supply and Demand of Medical Care*, prepared for the Joint Economic Committee, Study Paper No. 5, 1959.

The implications of these comparisons are threefold: (1) the incomes of nonsalaried professionals adjust themselves much more quickly than professors' salaries to changes in market conditions, particularly to changes in national income; (2) the delay in the adjustment of professors' salaries is apt to result in an allocation of talent that is not in accord with the relative needs of society, particularly in view of its increased desire to provide higher education; (3) the increase in the expenditures per student is to a large extent the reflection of the increase in gross national income per head.

STUDENT-FACULTY RATIO

The student-faculty ratio, shown in Table IV-8, changed considerably between 1930 and 1950, when the number of students per faculty member declined from 12.8 to 9.3, but it has not changed much during the 1950's. The lower student-faculty ratio, relative to earlier years, is probably less a result of *smaller* than of *fewer* classes per teacher, in accordance with the increased emphasis on research which has accompanied the growth of graduate education. Only 4.3 per cent of total enrollment in 1930 was for graduate study; this increased to 7.1 per cent by 1940, and to 8.9 per cent by 1950. Between 1951 and 1960

TABLE IV-8

NUMBERS OF FACULTY AND STUDENTS IN INSTITUTIONS OF HIGHER EDUCATION, 1930-1958

Year	Faculty members	Students	Students per faculty member
1900	86,185	1,100,737	12.8
1940	146,929	1,494,203	10.2
1950	246,722	2,296,592	9.3
1954	265,911	2,499,750	9.4
1956	298,910	2,946,985	9.9
1958	344,525	3,258,556	9.5

SOURCE: National Science Foundation, *Statistical Handbook of Science Education*, Washington, 1960.

the share of graduate students fluctuated between 9.5 and 11 per cent. This shift of faculty time from teaching to research, which is a precondition of graduate work, has probably extended to the better colleges, which could not compete with graduate schools for the most qualified professors if they insisted on higher teaching loads.

OTHER EXPENDITURES

Higher faculty salaries and lower student-faculty ratios do not explain the entire increase in expenditures per student. Expenditures for other things than teaching have increased substantially (see Table IV-9). Administration and general expenses, plant operation and maintenance, and "organized activities related to instructional departments" are all more expensive, both absolutely and relatively, than they used to be. In addition, the institutions of higher education have taken on or expanded numerous activities which are not directly related to academic instruction. There are the expenditure items for "auxiliary enterprises and activities," which should not properly be counted as educational costs. They include expenditures for "enterprises operated primarily for service to students and . . . intended to be self-supporting."[24] In many instances these enterprises offer services even to the noncollege public of their respective communities. Examples of "auxiliary" activities are residence and dining-hall accommodations, student unions, college bookstores, industrial plants (printing, woodworking, etc.), intercollegiate athletics, theatres and concerts.

Incidentally, for many years the accounting systems of most institutions did not enable them to submit data that could be regarded as really comparable. Only in the early 1950's were uniform standards for accounting adopted. One of the more troublesome columns in the financial statistics from 1930 to 1952 is that under the heading "other expenditures," because it combines outlays of quite disparate nature. On the one hand, the figures in question contain unspecified amounts of "student aid expenditures," such as scholarships, prizes, and other stipends. (In the one year for which these outlays were specified, 1952, they amounted to 54 per cent of the total reported as "other expenditures.") From the point of view of social accounting, student aid is no cost item, but a transfer payment helping students to pay tuition (and perhaps also some of their maintenance). Other items in "other expenditures" include expenses for student solicitation campaigns, interest on debts, payments to beneficiaries of annuity funds (but not pension payments), and other activities not of a distinctly educational nature. One may claim, however, that these outlays are part of the cost of running the institution and should not be excluded. What portion of the total of "other expenditures" they were is anybody's guess. Knowing that in 1952 they were 46 per cent, I arbitrarily divide the totals for the preceding years 50:50 between institutional cost and student aid. This is done in Table IV-10, which presents a specification of expenditures of institutions of higher education.

Research expenditures have increased to a remarkable extent, most of them financed by the federal government. In 1930, expenditures for "organized research" were about eight per cent of expenditures for "resident instruction"; by 1956 they were 44 per cent, and by 1958 almost 50 per cent.[25] To the extent that research is carried out by teachers and students it is an integral part of education. Indeed, on advanced levels the principle may hold: "no research, no education." But large portions of the "organized research" of the universities are completely divorced from the regular teaching faculty and student

[24] U.S. Office of Education, *Biennial Survey of Education*.

[25] The increase is probably exaggerated through the inclusion of capital items such as the cost of laboratory equipment, computing facilities, etc.

TABLE IV-9

Expenditures of Institutions of Higher Education, 1930-1958
(millions of dollars)

	1930	1940	1950	1952	1954	1956	1958
1. Administration and general	42.9	62.8	213.1	233.8	290.5	358.4	478.2
2. Resident instruction	221.3	280.2	781.0	823.1	966.8	1,148.5	1,477.3
3. Organized research	18.0	27.3	225.3	317.9	374.9	506.1	733.9
4. Libraries	9.6	19.5	56.1	60.6	73.4	86.1	110.5
5. Plant operation and maintenance	61.1	69.6	225.1	240.4	280.0	326.3	408.9
6. Organized activities relative to instruction	n.a.	27.2	119.1	147.9	187.9	222.3	246.4
7. Extension (adult education, etc.)	25.0	35.3	86.7	97.4	114.7	141.1	178.9
8. Auxiliary enterprises and activities	3.1	124.2	476.4	477.7	539.3	639.7	778.0
9. Student aid (scholarships, prizes)	15.1[a]	14.3[a]	36.3	39.3	74.0	96.2	131.4
10. Other noneducational expenditures	111.0	14.3	26.6	32.9	—	—	—
11. Total current expenditures	507.1	674.7	2,245.7	2,471.0	2,902.5	3,524.7	4,543.5
12. Expenditure for plant expansion	125.1	83.8	416.8	403.3	533.1	685.6	1,121.7
13. Total expenditures	632.2	758.5	2,662.5	2,874.3	3,435.6	4,210.3	5,665.2
14. Not allowed as cost of education [(3), (8), and (9)]	36.2	165.7	738.0	834.9	988.3	1,242.0	1,643.3
15. Total allowed expenditures for education [(13) minus (14)]	596.0	592.8	1,924.5	2,039.4	2,447.3	2,968.3	4,021.9
16. Allowed current expenditures [(11) minus (14)]	470.9	509.0	1,507.7	1,636.1	1,914.2	2,282.7	2,900.3

Source: U.S. Office of Education, *Biennial Survey of Education*. Data for 1930-1952 for Continental United States; 1954-1958 include Hawaii, Alaska, and Territories.
[a] Estimated.

body, located sometimes at considerable distance from the campus and staffed by a separate "research faculty" whose members do not teach at all. These research expenditures are not properly included in the cost of higher education. But in any case, whether university research is or is not linked with teaching, it must not be counted twice. Since all research expenditures which can be accounted for in the official reports will be included under the heading of "research and development," we must exclude them from "education."

Three items are thus "not allowed" as cost of education: organized research, auxiliary enterprises and activities, and student aid. They are totaled as item 14 of Table IV-9 and deducted from total expenditures, and likewise from current expenditures.

FINANCING HIGHER EDUCATION

Table IV-10 shows how the allowed current expenditures for higher education have been financed. To see how much was paid by students or their families, income from tuition and student fees must be reduced by the student-aid payments just discussed. The net payments by students covered 27.4 per cent of the allowed current expenditures of educational services in 1930, 36.7 per cent in 1940, only 23.8 per cent in the postwar year 1950, and 27.9 per cent in 1958. While it may be true that *private* colleges and universities are covering increasing portions of their expenditures for instruction with revenues from tuition, it would not be safe to predict a rising trend of tuition finance of higher education in general, since the share of the private sector in education is rapidly declining and tuitions in public institutions are so much lower.

The contribution from endowment income, though increasing in absolute amounts, is declining relatively. From 14.6 per cent of current allowed expenditures in 1940 it has fallen to 6.3 per cent in 1958. Private gifts and grants are becoming somewhat more important; but, although they have increased since 1930 almost 13 times in absolute amount and have almost doubled as per cent of current allowed expenditures, they covered only a little over 11 per cent in 1958.

Net student payments, appropriations from state and local governments, endowment income, and private gifts and grants have covered between 75 and 93 per cent of the allowed current expenditures. The rest was covered from several other sources. In view of the increasing receipts from the federal government—between 22 and 35 per cent of the allowed current expenditures during the 1950's—it should be recalled that most of these receipts were accounted for by research grants and contracts. Since we have excluded expenditures for organized research from the allowed expenditures for education (in order to avoid double counting), it may be misleading to leave all the income received from the federal government among the sources of funds covering the allowable current expenditures for education. Perhaps it would be more appropriate to cancel the funds received from the federal government against the expenditures for organized research—in which case this source of funds would have contributed almost

TABLE IV-10

INCOME OF INSTITUTIONS OF HIGHER EDUCATION, 1930-1958
(millions of dollars)

	1930	1940	1950	1952	1954	1956	1958
1. Student fees	144.1	200.9	394.6	446.6	554.2	725.9	939.1
2. Endowment earnings	68.6	71.3	96.3	112.9	127.5	145.0	181.6
3. Federal government	20.7	38.9	524.3	451.0	419.5	493.9	712.4
4. State governments	150.8	151.2	492.0	611.3	751.6	891.6	1,156.5
5. Local governments		24.4	61.4	72.0	88.2	106.9	129.4
6. Private gifts and grants	26.2	40.4	118.6	149.8	191.3	245.5	325.0
7. Organized activities relating to instruction	n.c.	32.8	112.0	136.4	165.5	192.4	246.8
8. Miscellaneous	72.7	11.4	34.6	40.8	58.8	80.5	71.7
9. Auxiliary enterprises and activities	60.4	143.9	511.3	509.6	576.8	694.0	841.5
10. Other noneducational income	11.0	n.c.	29.5	32.0	32.9	53.0	71.5
11. Total current income	554.5	715.2	2,374.6	2,562.4	2,966.3	3,628.8	4,675.5
12. Student aid (Table IV-9, item 9)	15.1	14.3	36.3	39.3	74.0	96.2	131.4
13. Net student payments (1) minus (12)	129.0	186.6	358.3	407.3	480.1	629.7	807.7
14. Allowed current expenditures (Table IV-9, item 16)	470.9	509.0	1,507.7	1,636.1	1,914.2	2,278.7	2,900.3
	[per cent of (14)]						
15. Net student payments	27.4	36.7	23.8	24.9	25.1	27.6	27.9
16. State and local governments	32.0	34.5	36.7	41.8	43.9	43.8	44.3
17. Endowment earnings	14.6	14.0	6.4	6.9	6.7	6.4	6.3
18. Private gifts and grants	5.6	7.9	7.9	9.2	10.0	10.8	11.2
19. Sum of (15), (16), (17) and (18)	79.6	93.1	74.8	82.8	85.7	88.6	89.7
20. Federal government	4.4	7.6	34.8	27.6	21.9	21.7	24.6

SOURCE: U.S. Office of Education, *Biennial Survey of Education.* Data for 1930-1952 for Continental United States; 1954-1958 data include Hawaii, Alaska, and Territories.

nothing toward educational expenditures. Indeed, it has been said that federal payments for research at universities have not fully covered the total cost to the institutions, inasmuch as the allowances for overhead have been insufficient.[26]

State and local governments are—and have been since the 1930's—the biggest "single" source of funds for higher education. In absolute

[26] C. C. Furnas and Raymond Ewell, "The Role of Research in the Economics of Universities," in Dexter M. Keezer, ed., *Financing Higher Education, 1960-70* (New York: McGraw-Hill, 1959), p. 85.

amount this contribution has increased more than eight times since 1930. Since enrollment in public institutions is likely to increase in the future considerably faster than in private institutions, one may expect that the share of expenditures covered by these government funds will increase.

An analysis of "other sources" of funds to cover current expenditures is difficult, for this is a rather mixed bag. It includes a large item called "organized activities relating to instruction," which just about matches an item under the same name in the list of current expenditures. These items probably contain receipts from and expenses for football and other athletic pursuits supposedly related to higher education, and various services, such as guidance, testing, and placement. There are also items with the captions "miscellaneous" and "other noneducational income." And if these should not suffice to cover the balance, there is also a modest surplus of receipts over expenditures for "auxiliary enterprises and activities," which we have mentioned before.

Much is being written now on the financing of higher education,[27] mostly with a view to the financing problem raised by the expected "explosion" of enrollment figures. The projections as well as the projects supplied by economists working on solutions of the financial problem of the future would warrant serious consideration, but this is well beyond the scope of the present study.

PUBLIC AND PRIVATE INSTITUTIONS

Tables IV-9 and IV-10 give combined figures for public and nonpublic institutions. For the academic years ending in 1956 and in 1958 separate expenditures data for the two types of institutions are presented in Table IV-11. This separation is called for because at a later point we shall prepare a summary statement in which expenditures are tabulated by sources and uses of funds, which is necessary in view of the different treatment of public and private expenditures in national-income statistics.

In connection with the faster enrollment increase that is foreseen for public as against private institutions of higher education, it is interesting to observe in the statistical series the race that went on between the two enrollment figures (see Table IV-12). The private institutions were ahead in enrollment until after the First World War. By 1920 the

[27] One of the most important reference works will probably be Seymour E. Harris, *The Economics of Higher Education in the United States* (New York: McGraw-Hill, 1962).

TABLE IV-11

EXPENDITURES OF PUBLIC AND PRIVATE INSTITUTIONS OF HIGHER EDUCATION, 1956 AND 1958
(millions of dollars)

	1955-1956			1957-1958		
	Total	Public	Private	Total	Public	Private
1. Administration and general	358.4	152.5	205.9	478.2	218.1	260.1
2. Resident instruction	1,148.5	673.6	474.9	1,477.3	879.0	598.3
3. Organized research	506.1	273.0	233.1	733.9	393.4	340.5
4. Libraries	86.1	46.2	39.9	110.5	61.0	49.5
5. Plant operation and maintenance	326.3	184.8	141.5	408.9	235.2	173.7
6. Organized activities relative to instruction	222.3	136.1	86.2	246.4	152.0	94.4
7. Extension	141.1	130.3	10.8	178.9	166.9	12.0
8. Auxiliary enterprises and activities	639.7	331.2	308.5	778.0	414.0	364.0
9. Student aid (scholarships, prizes)	96.2	32.3	63.9	131.4	46.7	84.7
10. Other noneducational expenditures	—	—	—	—	—	—
11. Total current expenditures	3,524.7	1,960.1	1,564.6	4,543.5	2,566.3	1,977.2
12. Expenditures for plant expansion	685.6	415.9	269.7	1,121.7	710.6	411.1
13. Total expenditures	4,210.3	2,376.0	1,834.3	5,665.2	3,276.9	2,388.3
14. Not allowed as cost of education [(3), (8), (9)]	1,242.0	636.5	605.5	1,643.3	854.1	789.2
15. Total allowed expenditures for education [(13) minus (14)]	2,968.3	1,739.5	1,228.8	4,021.9	2,422.8	1,599.1
16. Current allowed expenditures for education [(11) minus (14)]	2,282.7	1,323.6	959.1	2,900.3	1,712.2	1,188.1

SOURCE: U.S. Office of Education, *Biennial Survey of Education* and a September 1960 release.

public institutions were in the lead, to be overtaken again by the private during the "new era" (the private were ahead in 1930). This changed during the depression years, and by 1940 the public institutions were ahead by 100,000 students. Their lead was reduced, and by 1950 the private institutions had almost caught up with them. Then, after 1952, the public institutions zoomed ahead, and will undoubtedly further increase their lead.

The causes of this trend toward public control of higher education are chiefly financial. To build and expand plant requires huge funds, and taxation can provide what private philanthropy cannot. The possibility of operating private colleges on a paying basis, financed increasingly out of student fees, is not practical when public institutions charge only nominal tuition rates. With the large difference in tuition,

TABLE IV-12

Enrollment in Institutions of Higher Education, Public and Private, 1900-1960

Year	Total thousand (1)	Public thousand (2)	Public % of (1) (3)	Private thousand (4)	Private % of (1) (5)
1900	238	91	38	147	62
1910	355	167	47	189	53
1920	598	315	53	282	47
1930	1,101	533	48	568	52
1940	1,494	797	53	698	47
1950	2,297	1,154	50	1,142	50
1952	2,148	1,113	52	1,035	48
1954	2,500	1,395	56	1,105	44
1956	2,947	1,682	57	1,265	43
1958	3,259	1,912	59	1,346	41
1960	3,750	2,210	59	1,540	41

Source: U.S. Office of Education, *Biennial Survey of Education* and Circular #545.
Note: Figures may not add up because of rounding. 1960 figures are U.S. Office of Education estimates.

the demand for public education will surely gain more strongly than the demand for private education. As far as the quality of education is concerned, the few top-ranking private colleges and universities may keep their present precedence, but the mass of less richly endowed private colleges is quite likely to fall behind the public institutions, which will be able to compete more effectively for the best professors in an increasingly tight market with quickly rising salaries.

The number of private institutions is still almost twice the number of public ones. Table iv-13 gives a breakdown by type of institution and type of control. The traditional designations—universities, liberal-arts colleges, independent professional schools, and junior colleges—have now been given up because the meanings of the terms had become too vague. They were replaced by a classification according to the level of the highest degree offered. The Ph.D.-granting institutions still constitute roughly what was meant traditionally by the term "universities"; and the non-degree institutions are what used to be called junior colleges or community colleges, although some of them now offer four-year courses. Liberal-arts colleges are now divided between two classes depending on whether they grant only bachelor's or also master's degrees. In the latter class are also a few universities which offer no Ph.D. work but only master's work. The largest number of

TABLE IV-13

NUMBER OF INSTITUTIONS OF HIGHER EDUCATION, BY LEVEL OF HIGHEST DEGREE OFFERED AND BY TYPE OF CONTROL, 1960

Highest degree offered	*Total number*	*Public*			*Private*		
		Total	State	Local	Total	Non-denominational	Denominational
Ph.D. or equivalent	205	90	87	3	115	70	45
Master's and/or second professional	462	170	159	11	292	138	154
Bachelor's and/or first professional	718	101	96	5	617	179	438
No degree, 2 to 4 years beyond 12th grade	585	330	39	291	255	111	144
Other	41	7	6	1	34	22	12
Total	2,011	698	387	311	1,313	520	793

SOURCE: U.S. Office of Education, *Educational Directory, 1959-60,* Part 3, p. 12.

private institutions is in the group with curricula leading to the bachelor's degree, the traditional liberal-arts colleges, of which there are six times as many private as there are public.

When one reflects on this large number of institutions of higher education in the United States, and on the enormous enrollment figures, one is tempted to cast a glance at the countries of Europe and compare their situation with ours. Table IV-14 permits such comparisons, though somewhat superficially. Both in numbers of institutions and in enrollment figures the contrast between the United States and the other countries seems perplexing. Not counting teachers colleges ("normal schools"), which in most countries are not considered as institutions of higher education, we see 1,681 institutions in the United States as against 26 in the United Kingdom, and 2,742,250 students as against 97,137.

The explanation is simply that these figures are not comparable because the type of education provided is so very different. Most of the undergraduate course work in American liberal-arts and vocational colleges is more nearly equivalent to what is taught in the upper grades of secondary schools in Europe. To state that 32 per cent of a certain age group in the United States are getting "higher education," as against only three per cent in England and six per cent in France is completely misleading if higher education is understood in terms of subject matter taught and intellectual level required. This is only noted here in passing, but will be discussed further at a later point in this chapter.

TABLE IV-14

Higher Education in Various Countries (Not Including Teacher Training), 1957

Country	Number of institutions	Enrollment (number of students)	Population age 20-24 (thousands)	Enrollment as % of age group 20-24
United States	1,681	2,742,250	11,162[a]	24.6
Canada	33[b]	84,498	1,198[a]	7.1
Belgium	19	37,890	590	6.4
France	22[c]	175,500	3,025[d]	5.8
Western Germany	26[c]	153,923	3,835	4.0
Netherlands	11	32,385	785[d]	4.1
Poland	17[c]	124,094	2,342	5.3
Sweden	15	25,900	432	6.0
Switzerland	9	17,625	360	4.9
United Kingdom	26	97,137	3,310[d]	2.9

Sources: United Nations, *Statistical Yearbook 1959.* United Nations, *Demographic Yearbook 1959.*

[a] Data for the year 1959.

[b] *Commonwealth Universities Yearbook, 1960.*

[c] *International Handbook of Universities, 1959.*

[d] Data for the year 1958.

ACADEMIC DEGREES

The growth of graduate study in the United States was mentioned before, and one might add at this point that in quality it compares favorably with university work almost anywhere in the world. The times when serious students had to go abroad for advanced studies have long since passed. The doctor's degree in the United States certifies a genuine academic achievement.

The statistics of academic degrees awarded by institutions of higher education in the United States from 1870 to 1960—presented in Table IV-15—show clearly the increasing frequency, up to the middle 1950's, of the higher degrees relative to the bachelor's or first professional degrees. The ratio of doctor's to master's degrees has not been very meaningful, because the educational and economic significance of the master's degree has changed much over the period. Thus, the decline of this ratio after 1900, but especially after 1910, reflected chiefly the fast increase in master's degrees. The ratio of master's to bachelor's degrees increased quite consistently up to 1948-1949, when a "bulge" occurred in bachelor's degrees as a lagged consequence of

TABLE IV-15

Earned Degrees Conferred, by Level of Degree, 1870-1960

Year	Bachelor's or first professional	Master's or second professional	Doctor's or equivalent	Master's as per cent of bachelor's	Doctor's as per cent of master's	Doctor's as per cent of bachelor's
1870	9,371	—	1	—	—	.01
1880	12,896	879	54	6.8	6.1	.42
1890	15,539	1,015	149	6.5	14.7	.96
1900	27,410	1,583	382	5.8	24.1	1.39
1910	37,199	2,113	443	5.7	21.0	1.19
1920	48,622	4,279	615	8.8	14.4	1.26
1930	122,484	14,969	2,299	12.2	15.4	1.88
1940	186,500	26,731	3,290	14.3	12.3	1.76
1948	271,186	42,432	3,989	15.6	9.4	1.47
1949	365,492	50,741	5,049	13.9	10.0	1.38
1950	432,058	58,183	6,633	13.5	11.4	1.54
1951	382,546	65,077	7,337	17.0	11.3	1.92
1952	329,986	63,534	7,683	19.3	12.1	2.33
1953	303,049	60,959	8,307	20.1	13.6	2.74
1954	290,825	56,788	8,995	19.5	15.8	3.09
1955	285,138	58,165	8,837	20.4	15.2	3.10
1956	308,812	59,258	8,903	19.2	15.0	2.88
1957	337,663	61,909	8,752	18.3	14.1	2.59
1958	365,748	65,614	8,942	17.9	13.6	2.44
1959	385,151	69,497	9,360	18.0	13.5	2.43
1960	405,000	75,700	9,700	18.7	12.8	2.40

Source: 1870-1957, U.S. Office of Education (for Continental United States). 1958-1960, U.S. Office of Education (for Continental United States plus outlying parts; 1960 is an estimate).

the return of men from the armed forces and the G.I. education program after the war. During most of the 1950's the ratio of master's to bachelor's degrees remained relatively stable, while the ratio of doctor's to bachelor's degrees reached a peak in 1954-1955 and has declined ever since.

This decline was evidently associated with the rise in the percentage of the college-age group that goes to college. As we have seen from Table IV-5, this percentage increased from 24.6 in 1952 to 33.5 in 1960. If the education experts' threat becomes true that the college population will rise to 50 per cent of the college-age population, the relative number of doctorates will decline further, provided the standards for the doctorate are maintained. For one must expect that a decreasing percentage of the future "earners" of bachelor's degrees will be qualified to do postgraduate work. But perhaps the standards for the Ph.D. will fall too—and then we would need a degree beyond the Ph.D.

Neglected Cost Items

In the discussion of expenditures for formal education—elementary, secondary, and higher education—official published cost data only were included. These data are adequate from the point of view of public and private finance, for budgeting and ordinary cost accounting, for analyses of sources and uses of funds. They are incomplete, however, from the point of view of economic analysis concerned with the allocation of the nation's resources and with the opportunity costs of the activities in which the nation engages.

Twice before in this chapter have we dealt with opportunity costs which were not reflected in money expenditures: once when we looked into the cost of education in the home and considered the sacrifice of earnings by mothers taking care of their children; and again when we discussed the costs of on-the-job learning and the sacrifice of present earnings by workers in lower-paying "growth jobs." We shall see that there are imputed, nonexplicit, opportunity costs involved in formal education, which require analysis and estimation.

EARNINGS FOREGONE

Teaching requires the collaboration of at least two people: the teacher and the student. Both spend time and effort, the one on disseminating knowledge, the other on absorbing it. If the time and effort so spent could have been used for other valuable pursuits, the opportunities foregone are costs for the person teaching and for the person taught. An adult who accepts a job as a teacher will usually do so only if he is paid a salary which at least partially compensates him for the loss of the income he could have earned elsewhere. A student old enough to take a job and earn an income, but foregoing this opportunity in order to go to school, will do so, if he has a choice, chiefly because he expects that the future benefits from his schooling will compensate him for the current loss of income. If the student cannot himself exercise such a choice but is compelled, by parents or by the state, to go to school, one may assume that those who chose to compel him have decided that the benefits—to students or society—are worth the cost, including the loss of income he could produce if he went to work.

The expenditure figures for formal education, reproduced in the preceding two sections, did not include the loss of earnings on the part of students who could have gone to work. This is a serious omission because the incomes foregone by students may be more than half of the total cost of education. Just how much they are, and how much they were at certain times past, are questions which several economists have answered somewhat differently. The answers are not uniform because the considerations on which such estimates must be based are complex and allow us to choose among alternative assumptions equally reasonable but yielding different results.

The principle, however, is clear. The cost involved in having potential members of the labor force go to school rather than to work is not only a private cost to the students or their families, but is also a social cost: a potential addition to national product remains unrealized. Needless to say, society incurs this cost because of the benefits expected; that is to say, the cost is an investment in human capital made in the hope of a significant return.[28]

The cost in terms of potential product remaining unproduced is reflected in the statistics of the different proportions in different countries of the age group 15 to 19 who are at work. Table IV-16 shows these proportions for five countries (though unfortunately in different years). The proportion is by far the lowest in the United States, which evidently reflects the higher school attendance in this country.

TABLE IV-16

PROPORTION OF WORKERS IN POPULATION, 15-19 YEARS OLD

Country	Year	Male	Female
Great Britain	1931	88.3%	75.0%
Germany	1933	86.1	63.7
Switzerland	1941	78.0	59.0
France	1946	75.6	58.7
United States	1940	40.1	22.1

SOURCE: United Nations, *Demographic Yearbook 1948*, pp. 232-233; 1949-1950, pp. 252-253.

The decline in the labor-force-participation rate of young people over 14 from 1900 to 1950 in the United States was quite pronounced. For the population in the age group 14 to 19, male and female combined, the participation in the labor force[29] was 45 per cent in 1900, 42 in 1910, 40 in 1920, 32 in 1930, 26 in 1940, and 30 in 1950.

[28] Theodore W. Schultz, "Capital Formation by Education," *Journal of Political Economy*, Vol. LXVIII (December 1960), pp. 571-583.

[29] Clarence D. Long, *The Labor Force Under Changing Income and Employment* (Princeton: Princeton University Press, 1958), Table A-2.

POTENTIAL INCOMES

Some of the assumptions necessary for an estimate of incomes foregone by students relate to the exact age at which one may assume young people to be ready to go to work, the number of weeks per year they might be working, the percentage of them that might remain unemployed, and the amounts per week they could earn.

Concerning the lower age limit for joining the labor force, most authorities agree that 14 years would be the appropriate assumption. Thus, pupils in the first eight grades of school would not forego any labor income by attending school. Whether this assumption is appropriate also for earlier times, say 1910, is an open question, since plenty of twelve-year-olds used to go to work.[30] The opposite argument, that sixteen years would be the better age limit because some states restrict many types of work to people above that age, would not be tenable, because these working restrictions are part and parcel of the state's decision that these young people ought to stay in school. Although the same objection might be raised against the assumption of the fourteen-year limit, the widespread belief that work at an earlier age would be harmful for physiological reasons and that most people would not want their children to go to work before age fourteen even if there were no legal restrictions, may be accepted in support of the assumption.

The assumptions regarding probable unemployment and the number of weeks the youngsters might work if they did not go to school are linked with each other since both depend on what one thinks about job opportunities. It might be held that the "sudden" appearance of some ten million young people on the labor market could not result in anything but wholesale unemployment. Such reasoning, however, would be fallacious since there is no question of actual transfer, either sudden or gradual, from school to the labor market. The comparison is between two hypothetical systems, both long established and well functioning; hence, no transition period, no adjustments with frictions need be taken into account. Another way of going about making appropriate assumptions would be to ascertain the actual unemployment rate and number of work-weeks of those in each particular age group that are in the labor force, and then to assume that those who are in school would have the same work opportunities if they were in the labor force. This is the procedure adopted by Theodore W.

[30] Cf. Rudolph C. Blitz, *op.cit.*, p. 45. Blitz doubts the appropriateness of the 14-year age limit even for 1920 and 1930.

Schultz.[31] Another procedure would be to assume that the youngsters now at school are superior in intelligence, ambition, and dependability to those who have quit school, and would have better employment opportunities.

The assumption with regard to the average weekly incomes which the students would be able to earn if they were working depends on similar considerations. One may take the average weekly earnings of actual workers in the particular age groups and apply them without adjustment to the hypothetical earnings of the potential workers. Or one may argue that the marginal productivity of labor would be lower if the labor force were larger and that therefore the hypothetical earnings would be less than the present earnings. Or one may argue, with Blitz,[32] that the average earnings of the present workers in the school-age groups are exceptionally low because the statistical group includes (1) the low-paid casual labor of school and college students during their summer vacations, (2) the low-paid casual labor of nonstudents who are not vigorously seeking employment and (3) the low-paid labor of those who have left school because of low I.Q. and poor working habits; and that, therefore, the full-time labor-income potential of those who do attend school would be much higher than the earning rates now shown in the statistics.

In order to avoid all these complications, Peter J. D. Wiles uses a flat maintenance allowance for the income foregone by students.[33] This implies the assumption that the young people, if they worked rather than studied, would earn just enough to maintain themselves. As a matter of fact, for high-school students this estimate of potential income would exceed that of Schultz, as one may infer from the fact that one cannot easily live in style for forty weeks on "average weekly earnings" for eleven weeks' work.[34]

THE ESTIMATES

Schultz made estimates of the annual earnings foregone by students attending high school and college or university for the years 1900, 1910, 1920, 1930, 1940, 1950, and 1956. He started with the average weekly earnings in all manufacturing. On the basis of the earnings experience of the relevant age groups in 1949, he assumed that workers

[31] Theodore W. Schultz, *op.cit.*, pp. 573ff.

[32] Rudolph C. Blitz, *op.cit.*, pp. 46-48.

[33] P. J. D. Wiles, "The Nation's Intellectual Investment," *Bulletin of the Oxford University Institute of Statistics*, Vol. 18 (August 1956), p. 285.

[34] The reference to "only eleven weeks' work" will become clear in the next paragraph.

of high-school age would have earned on the average the equivalent of 11 weeks' pay in manufacturing industry, and workers of college and university age would have earned the equivalent of 25 weeks' pay. After multiplying the average weekly earnings in manufacture of each of the seven years examined by eleven for high-school students and by twenty-five for college and university students, he deducted from these "unadjusted" annual-earnings losses per student the percentages of unemployment observed in each of the selected years (8.2 per cent for 1900, 3.9 for 1910, 4.2 for 1920, 12.4 for 1930, 14.7 for 1940, 4.1 for 1950 and 3.0 for 1956). The resulting annual earnings foregone per student in each of the two categories he multiplied by the numbers of students attending high school or an institution of higher education, respectively, to obtain the total earnings foregone. The results are summarized here in Table IV-17.

TABLE IV-17

Annual Earnings Foregone by Students Attending High School, College, or University, 1900-1956

Year	*Average weekly earnings all manufacturing*	*Annual earnings foregone (adjusted for unemployment) per student in*		*Number of students attending*		*Total earnings foregone by all students attending*		
		High school	College or university	High school	College or university	High school	College or university	High schools, colleges & universities
	(dollars)	(dollars)		(millions)		(million dollars)		
1900	8.37	84	192	0.7	0.238	59	46	105
1910	10.74	113	259	1.1	0.355	124	92	216
1920	26.12	275	626	2.5	0.598	688	374	1,062
1930	23.25	224	509	4.8	1.101	1,075	560	1,635
1940	25.20	236	537	7.1	1.494	1,676	802	2,478
1950	59.33	626	1,422	6.4	2.659	4,006	3,781	7,787
1956	80.13	855	1,943	7.7	2.996	6,584	5,821	12,405

Sources: Theodore W. Schultz, "Capital Formation by Education," *Journal of Politica[l] Economy*, Vol. LXVIII (1960), p. 575. Also "Education and Economic Growth," in *Forces In-fluencing American Education*, ed. Herman Richey (Chicago: University of Chicago Press 1960).

The Wiles study was for Britain only, though his method of estimation, based on maintenance costs, could be applied to the United States. We shall not undertake to do this, but shall report on Blitz's findings. He bases his estimates on a number of empirical studies of the actual earnings of school-age children in different periods between 1899 and 1956. While Schultz generalized the earnings experience of a 1949 group, which included school children in part-time casual work, the groups in the studies used by Blitz consist only of actual workers in the relevant age groups who had left school and were in the labor force in the years under examination. The results are 50 per cent and more above Schultz's for workers of high-school age, and exceed by smaller margins Schultz's figures for workers of college age. For 1956, Blitz's estimates of income foregone come to $1,504 per high-school student (71 per cent above the Schultz estimate) and $2,350 per college student (17 per cent above the Schultz estimate). Applying to these estimates the 4.39 per cent increase from 1956 to 1958 in average weekly gross earnings in all manufacturing industries, we come to $1,570 as the income foregone per high-school student and $2,453 per college student in 1958. All these estimates, however, require another correction.

Both Schultz and Blitz had assumed that students could enter the labor market and earn some money during summer vacations and in part-time employment during the school year. But, in the absence of any exact information, they made an insufficient allowance for earnings from such employment when they estimated the earnings foregone by the students. Estimates of students' part-time employment have now become available.[35] These estimates, for October 1959, indicate that 22.6 per cent of the students 14 to 17 years old worked for 11.4 hours per week, and 39.8 per cent of the students 18 to 24 years old worked for 25.7 hours per week, on the average. If October were representative of the entire school year, the Blitz figures of earnings foregone (for 40 hours per week) would have to be reduced by 6.44 per cent for the younger age group and by 25.6 per cent for the older one.[36] Blitz is probably right in holding that October is not a typical month in a student's work-and-study pattern: at the beginning of the year studies seem to require less time, but closer to the mid-term examinations most students find it necessary to reduce the number of hours in part-time jobs. Moreover, the earning rates for part-time work are substantially

[35] U.S. Bureau of Labor Statistics, *Special Labor Force Report No. 6*, "The Employment of Students, October 1959," by Arnold Katz (Washington: July 1960), Tables 3 and E.

[36] The overestimates are calculated as follows: if 22.6 of every 100 students 14-17 years old, work 11.4 hours per week, they earn wages for 257.64 hours; since it had been assumed that they forego weekly earnings for 40 hours each, or 4000 hours, the number of hours not worked must be reduced by 6.44 per cent. The same calculation for the 18-24-year-olds shows a need for correction by 25.6 per cent.

below the rates for full-time work. Finally, some allowance had already been made for part-time and summer employment. Hence, Blitz proposes a downward correction of his original estimates by about one half the percentages derived from the October study, or 3.2 per cent for high-school students and 12.8 per cent for college and university students.[37]

Accepting this proposal and using the same correction factors for the 1956 and the 1958 figures, we arrive at corrected estimates of $1,456 in 1956 and $1,519 in 1958 for earnings foregone per high-school student, and of $2,049 in 1956 and $2,139 in 1958 for earnings foregone per college or university student. The number of high-school students was 7.7 million in 1955-1956 and 8.9 million in 1957-1958; the number of students in institutions of higher education was 2,996 thousand in 1955-1956 and 3,284 thousand in 1957-1958. Multiplication yields the following estimates of total earnings foregone by students: for high-school students $11,211 million in 1956 and $13,519 million in 1958, and for college and university students $6,139 million in 1956 and $7,024 million in 1958. It should be noted that Schultz believes these estimates are too high. Clarification must be left to future research.

Blitz extended his survey to medical interns and residents (excluding graduates of foreign medical schools) and entered $144 million as income foregone by them in 1956 and $165 million in 1958.

IMPLICIT RENTS OF BUILDINGS AND GROUNDS

The expenditure figures for elementary, secondary, and higher education were divided into current and capital outlays. The capital outlays for plant expansion took account of the construction of new school buildings—including administration buildings, libraries, gyms, student unions, dormitories, etc. But no provisions were made, in stating current expenditures, for depreciation and for interest on the capital invested (except where interest was actually paid, as on bond issues).

The question arises which is the soundest procedure, to charge depreciation and interest on the value of the plant but not to add the outlays for new plant into the annual expenditures, to follow the established practice of neglecting implicit interest and depreciation

[37] See Appendix B, Supplement to "The Nation's Educational Outlay" by Rudolph C. Blitz in the forthcoming volume on the *Economics of Higher Education*, ed. Selma J. Mushkin (Washington: Office of Education, 1962).

while recording outlays for plant construction when they are made, or to account for both current depreciation and interest charges on old investment and capital outlays on new investment. The answer, as usual, is that it depends on the point of view and on the purposes one has in mind.

For purposes of fiscal policy the established procedures are quite adequate, and there is no need to bother with merely imputed items. For comparative analysis, however, say for comparing expenditures per student, it would be misleading to include capital outlays in the educational expenses of the year, and thus show low cost figures for years without heavy plant expansion and high cost figures for years when large additions are made to fixed plant. This apparently is the reason why Schultz omits capital outlays but includes implicit interest and depreciation in his calculation of the cost of education. This, by and large, reduces the published expenditure figures for recent years, when capital outlays were heavy, and raises them in earlier years—1900 to 1940—when capital outlays were less than implicit interest and depreciation. For 1956, when outlays for plant expansion in public elementary and secondary schools were $2,387 million, Schultz computes implicit interest and depreciation of public school property to have been only $1,912 million. For colleges and universities, however, the interest and depreciation on their property exceeds capital outlays in 1956, as in any other year since 1900. Capital outlays in 1956 were $686 million, while the implicit interest and depreciation was $712 million, according to Schultz's calculation.

Blitz, interested not only in "gross educational investment in human beings" but also in "gross educational investment in both human beings and equipment," includes in the latter implicit interest and depreciation on the value of existing plant as well as additional investment in new plant. But why should one be interested in such a magnitude? Does it not involve double counting if the entire outlay for plant expansion appears first as part of the educational investment of the year in which the plant is built, and then reappears in subsequent years in the form of depreciation as part of current costs of education (which is regarded as investment in human beings)? Double counting it is, but there is sense in it, and for some purposes it is even necessary.

An analysis of resource allocation requires the consideration of the opportunity cost of every activity. If we refrained from engaging in this or that activity, what could we do with the resources now allocated to it? If we stopped all formal education, or reduced it by a certain portion, what resources would be freed? If we desperately needed resources in an emergency, what resources could be released by a reduction or suspension of school education? The answer is clear regarding manpower: we would release teachers and students, but also all the workers employed in the construction of new plant. As to materials, we would release both what is used for maintenance and what is used for new construction. And as to existing plant, we would release buildings and grounds for whatever use they can serve. Assume a war emergency, in which buildings are needed for barracks, open spaces for drill grounds, and construction workers and materials for putting up shelters, bunkers, and tank factories. Hence, both the old premises and the productive factors used in constructing new ones must be counted in an allocative decision.

In examining the cost of education all the resources must be taken into account: in any one year this will include the existing plant and also the human and material resources going into new plant; and in any subsequent year the completed buildings will be counted with the existing plant and there will again be productive resources going into new plant. The use of the existing plant will be entered with its rental value, which will be approximated by the implicit interest and depreciation of the properties involved. We conclude that Blitz's procedure is sound and serves a legitimate purpose.

The implicit rent of school buildings and grounds is taken by Schultz to be eight per cent of the book value of physical property.[38] The property values in 1956 were $23,900 million for public schools and, by indirect estimation, $3,600 million for nonpublic schools. On this basis the implicit rent in 1956 was $1,912 million for public schools and $288 for nonpublic. Adding the outlays for plant expansions to obtain property values in 1958, and applying the same eight per cent rate, we obtain for that year $2,392 million for implicit rent on public-school property and $352 million on nonpublic-school property.

By similar techniques the implicit rents for colleges and universities were, in 1956, $399 million and $313 million for public and private institutions, respectively, and, in 1958, $464 million and $344 million, respectively.[39] By 1958, incidentally, the outlays for plant expansion in colleges and universities had increased so that they now exceeded the implicit rents.

[38] Schultz explains in detail how the 8 per cent was arrived at. *Op.cit.*, p. 579.
[39] Cf. Blitz, *loc.cit.*

THE COST OF TAX EXEMPTIONS

Schools, colleges, and universities are exempt from property taxes and sales taxes. As a result, a dollar spent for educational investment can buy more than a dollar spent for business investment. Or, to put it differently, educational establishments obtain their share of governmental services—police protection, street cleaning, etc.—free of charge while business establishments must pay for all of it.[40] For an analysis of comparative resource allocation, it will therefore be appropriate to increase the total cost of education by the property taxes and sales taxes which educational establishments would have to pay if they were treated like any other productive enterprise.

Seymour Harris made an estimate of the 1956 cost of the property-tax exemption for colleges and universities.[41] He started from the original cost of their real estate—about $9,000 million—raised it to $20,000 million as its present replacement value, and used 2.5 per cent as the property-tax rate the institutions were exempted from paying; this gives $500 million for the value of the exemption. It has been objected to this procedure that the "inflation factor" employed to adjust original cost to replacement value is larger than the average appreciations made in real property reassessments, and that the effective property-tax rate is more nearly 1.5 than 2.5 per cent. At least the second objection has to be sustained.

Blitz starts from the original cost of the real property of public elementary and secondary schools, which was $23,900 million in 1956, and $29,900 million in 1958, puts the replacement values at $53,000 million and $59,000 million, respectively, and estimates the cost of the property-tax exemption, at a 1.5 per cent rate, as $795 million for 1956 and $885 million in 1958. For nonpublic schools the analogous figures are estimated to be $119 million for 1956 and $131 million for 1958. For colleges and universities the Harris estimate of replacement value with the 1.5 per cent property-tax rate gives $300 million as the cost of the exemption for 1956. Of this amount, $171 million is for public institutions and $129 million for private. Raising the property values by the new plant expansions, one obtains for the property-tax exemptions for 1958 $180 million and $135 million for public and private institutions, respectively.

There remains the trivial item of exemption from sales taxes. Blitz

[40] Both these points are well argued by Blitz, *op.cit.*, pp. 8-12.

[41] Seymour E. Harris, "Broad Issues in Financing," in Dexter M. Keezer, ed., *Financing Higher Education, 1960-70* (New York: McGraw-Hill, 1959), pp. 60-61.

estimates that this amounts to $6 million for elementary and secondary schools and $2 million for institutions of higher education. We use these estimates for both 1956 and 1958 and divide them between public and private institutions roughly proportional to total expenditures (5:1 for elementary and public schools and 1:1 for colleges and universities).

TRANSPORTATION, BOOKS, AND CLOTHING

School buses paid for by public schools are among the items included in current expenditures. But transportation for high-school and college students is paid by them or their families, and should be added to the cost of education.

Books and supplies for high-school and college students should also be included in a survey of education costs. In the context of the present study, which is not confined to education but extends over all branches of the production of knowledge, there is no need to add the cost of books into the "education" account. This is an item that would not be lost sight of, since it would surely get caught in the "publications" account.

There may be some extra need for clothing for high-school and college students—that is, a need that would not arise for those in the age groups who did not attend school.

Schultz takes care of all these expenses by adding an extra five per cent of earnings foregone by high-school students and an extra ten per cent of earnings foregone by college students. For the year 1956 this would, on the basis of Schultz's estimates, amount to $329 million for high-school students and $582 million for college and university students.

Blitz accepts Schultz's percentages, but on the basis of his higher estimates of earnings foregone he arrives at $579 million and $704 million as the respective figures for the students' expenses for travel, books, and clothes. While Blitz had on good grounds raised the estimates for earnings foregone, there are no strong reasons for raising the dollar estimates for the students' incidental expenses. The cost of traveling to and from school, or the cost of school supplies, surely does not depend on what a student could earn if he did not go to school.

Since students' expenditures for books and stationery supplies will be covered by the cost of printing and publishing—see Chapter VI—we propose to use only three per cent of earnings foregone by high-school students and six per cent of earnings foregone by college students as estimates of their expenditures for transportation, supplies, and clothing. The results for 1956 are $336 million and $368 million, respectively; and for 1958, $406 million and $421 million, respectively.

The Total Cost of Education

We are now in a position to consolidate the results of all the analyses of expenditures and implicit costs presented in the various sections of this chapter. Perhaps it is in order to remind the reader that no "exact" figures must be expected. Estimates of this sort are based on much conjecture; they merely serve to convey a better idea of the magnitude of social effort involved in providing for education of all kinds and at all levels.

In making up this comprehensive cost account of education we shall not immediately decide which of the efforts deserve to be regarded as investment, which as consumption, and which as cost of producing current output. There is a presumption for considering education as investment; only in exceptional instances will it be appropriate to rebut the *prima facie* assumption. This will be deferred until the question of the productivity of investment in education is examined.

THE CHOSEN YEARS: 1956 AND 1958

For money expenditures we were able to produce statistical series going back for considerable lengths of time. For some implicit cost items we presented the ingenious estimates by Schultz. It would be a major task, however, to produce "historical statistics" of the comprehensive nature envisaged here. For a comprehensive survey we should be satisfied with estimates for 1956 and 1958. The year 1960 would have given us larger figures, since the recent increases in expenditures for education have been drastic. But most of the statistical data produced in this book will refer to 1958, more recent information being unavailable as yet.

Table IV-18, presenting the summary of the total cost estimates for education in 1956 and 1958, is largely self-explanatory, at least for those who have read the preceding sections. On a few items some reminders or additional comments may be helpful.

As part of the cost of education in the armed services we use trainees' maintenance plus cash payments rather than income foregone by trainees because it is not possible to subtract maintenance from the figures obtained for expenditures on basic and special training. This procedure very likely underestimates somewhat the total cost of education in the armed services.

TABLE IV-18

SUMMARY: TOTAL COST OF EDUCATION, 1956 AND 1958
(millions of dollars)

	1955-1956	1957-1958
EDUCATION IN THE HOME		
Income foregone by mothers staying home to educate their pre-school children	4,341	4,432
TRAINING ON THE JOB		
Formal training programs operated by firms	800	1,000
Production loss and cost of training newly hired workers	1,940	2,054
Total	2,740	3,054
EDUCATION IN THE CHURCH		
Current congregational expenses	1,400	1,588
New construction of churches and synagogues	775	879
Total	2,175	2,467
EDUCATION IN THE ARMED SERVICES		
Expenditures for special training schools and programs (including trainees' maintenance)	1,100	1,100
Expenditures for basic training	1,810	1,810
Cash payments to military special trainees	500	500
Total	3,410	3,410
ELEMENTARY AND SECONDARY EDUCATION		
Current expenditures, public schools	8,568	10,716
" " nonpublic schools	1,295	1,642
Plant expansion, public schools	2,387	2,853
" " nonpublic schools	361	437
Implicit rent, public schools	1,912	2,392
" " nonpublic schools	288	352
Cost of tax exemptions, public schools	800	890
" " " " nonpublic schools	120	132
Earnings foregone by high-school students	11,211	13,519
Transportation, supplies, and clothing	336	406
Total	27,278	33,339
HIGHER EDUCATION		
Current allowable expenditures, public institutions	1,324	1,712
" " " nonpublic institutions	959	1,188
Plant expansion, public institutions	416	711
" " nonpublic institutions	270	411

Table IV-18 (continued)

	1955-1956	1957-1958
Implicit rent, public institutions	399	464
" " nonpublic institutions	313	344
Cost of tax exemptions, public institutions	172	181
" " " " nonpublic institutions	130	136
Earnings foregone by college and university students	6,139	7,024
" " " medical interns and residents	144	165
Transportation, supplies, and clothing	368	421
Total	10,634	12,757
COMMERCIAL VOCATIONAL AND RESIDENTIAL SPECIAL SCHOOLS		
Gross "sales" of commercial vocational schools	196	223
Current costs of residential special schools	23	30
Total	219	253
FEDERAL FUNDS FOR EDUCATION		
Funds not elsewhere included (various training programs, etc.)	241	342
PUBLIC LIBRARIES		
Operating expenses	122	140
Capital outlays	12	n.a.
Total	134	140
Grand Total	$51,172	$60,194

Some of the items have not been previously discussed. The commercial vocational schools deserve special mention as the only entry according to a market value. The general principle of our social accounting is to enter all goods and services produced at their market value, and use factor cost only where market value does not exist. Almost none of the educational services produced in the United States are sold at cost-covering prices; commercial vocational schools are the exceptions.

Under the heading "Federal funds for education" appear expenditures not elsewhere included (that is, those not included in "higher education"—as the military, naval, and other academies—or in "education in the armed services," or in "research and development"). Examples of programs whose costs are taken into account are schools for Indians, surplus-property allocations to educational institutions, schools for dependents of overseas personnel, and apprenticeship training.

The cost of public libraries is incomplete, as entered, in that it contains neither the implicit rent of library building and equipment nor—for 1958—the outlays for plant expansion. Perhaps the inclusion of public libraries under "Education" calls for an explanation, since it was said in the introductory paragraphs of this chapter that "self-education" out of books would not be treated here. We have kept this promise—except for entering the cost of public libraries in the tabulation of all costs of education. It fits there better than any other place in this book.

ADJUSTMENTS OF GNP

The grand totals of approximately $51,000 million for 1956 and $60,000 million for 1958 look impressive, perhaps even colossal, but in an age of changing real value of the monetary unit, a dollar figure standing alone does not mean very much. In order to see such a figure in the right perspective, one should compare it with the gross national product. To see what portion of GNP the nation spends for education makes good sense.

The GNP as computed under the rules adopted by the Department of Commerce would not be the right magnitude with which to compare the full cost of education. The addition of some implicit cost figures to the education account requires corresponding adjustments to the GNP. For example, if the educational services of mothers to their pre-school children are made part of the total educational activities, they must also be counted as part of gross national product. Whether education is regarded as consumption or as investment, in either case it will be national product, and any implicit cost item that is taken into account in determining the value (factor cost) of education must—except the cost of tax exemptions—also be taken into account in totaling the items to obtain GNP.

The necessary adjustments of the GNP figure may also be explained in an alternative way, namely, by employing the concept of a "potential GNP." If the potential incomes earned by mothers, students, buildings, etc., are taken into consideration as opportunity costs when the total cost of education is calculated, this total should be compared with the potential, not actual, GNP. Hence, all incomes foregone, or implicit costs, must be added to the official GNP to obtain the "potential GNP." The difference between this explanation and the one proposed in the preceding paragraph is merely one of language. The adjustments are made in Table IV-19.

Of the adjusted GNP the total cost of education was 11.8 per cent in 1955-1956, and 12.9 per cent in 1957-1958.

TABLE IV-19

ADJUSTMENTS OF GROSS NATIONAL PRODUCT FOR COMPARISON OF COST OF EDUCATION, 1956 AND 1958
(millions of dollars)

	1956-1957	1957-1958
(1) Implicit earnings of mothers educating pre-school children	4,341	4,432
(2) Implicit earnings of high-school students	11,211	13,519
(3) Implicit earnings of college and university students	6,139	7,024
(4) Implicit earnings of medical interns and residents	144	165
(5) Implicit rents for elementary and secondary school buildings	2,200	2,744
(6) Implicit rents for college and university buildings	712	808
Additions to GNP	24,747	28,692
GNP, conventional concept, October-September	408,700	439,500
GNP for comparison with cost of education	433,447	468,192

The Productivity of Education

Discussions of productivity frequently suffer from uncertainty about just what it is that is supposed to be productive, and of what. Sometimes, especially when increased productivity is discussed, the intended reference is to the performance of particular inputs in producing certain outputs; sometimes merely to the quantitative relation between input and output, no matter what may have caused it to change. Again, especially when the output consists of services which are not physically measurable, the reference is sometimes to the effects which this intangible output has upon other things. Thus, discussions of educational productivity may treat either of the *process* by which educational services are produced or of the *effects* which these services may have, say, upon the future productivity of men in doing other things.

The dichotomy just mentioned may be given semantic recognition by distinguishing between productivity *in* education and productivity *of* education. Additional terminological help in avoiding confusion may be found in the use of the word "efficiency" for characterizing the process of education, so that one would say that efficiency in education has increased if the same educational services are produced at lower cost. Efficiency in education will be discussed in the next section; the present section will be devoted to a discussion of the productivity of education.

INVESTMENT OR CONSUMPTION?

If productivity of education is meant to refer to the effects which *present* educational activities are expected to have upon *future* performance of those now being taught and, indirectly, upon the productivity of the economy to which they will contribute, this implies that education is regarded as an investment. If we emphasize the cultural aspects of education and prefer to see it as productive of future joys—for example, the joys of reading good books, of appreciating art and music, of conversing with other educated persons—we should also accept education as an investment, a present cost being incurred for the sake of future satisfaction. But the view of education as investment in human capital need not exclude the position that some part of education may be productive only of current, not future, benefits or pleasures. Emphasis on football, for example, may be interpreted as being oriented toward current satisfaction. In this case, the activities designed to develop a strong football team, vociferous cheerleaders, and enthusiastic spectators, would not be recognized as investment, but only as production for present consumption.

The decision whether certain portions of the educational effort should be regarded as consumption or investment is largely a matter of one's point of view. There are probably many who hold that a heavy dose of nonintellectual "fun" must be mixed in with intellectual "discipline" if a wholesome product is to be achieved; that the current pleasures enjoyed by the students are integral parts of their character development, and thus necessary ingredients in the improvement of their future happiness and productivity. Those who hold such views will want to have *all* the cost of education counted as investment. Others believe that the entertainment provided by the schools at considerable costs does not contribute to the benefits which education may yield in the future, and that these costs should therefore not be added in when the educational investment is determined.

Although I incline toward the "austere" view, and toward the belief that much of the organized entertainment, far from enhancing future productivity, may even reduce it, I do not propose to examine the school and college budgets and decide item by item whether particular parts of the program should be disallowed in determining the portion that can pass as investment and the portion that should go under the heading of consumption. We might find that experts disagree on many items, though perhaps few would insist that *every* single part of the school or college program contributes to *future* benefits and that the total productivity of education would therefore be reduced if any part of the program were dropped.

Some would be inclined to characterize parts of the educational program as consumption, not because it is mere entertainment and unlikely to yield lasting benefits, but because it is "merely cultural" and unlikely to yield *material* benefits in the future. Another possibility would be to accept the popular evaluation of education by parents and students as the criterion, and class all elementary education and half of high-school education as consumption, and the rest of high school and all of higher education as investment. (Theodore W. Schultz reports in "Education and Economic Growth" that this is the popular attitude.) Again another proposal is to exclude from investment all of the education of the population not in the labor force—which would allocate some 37 per cent of the cost of education to consumption. Schultz, who brings up this proposal, rejects it as "too drastic," chiefly because most of the nonmembers of the labor force are women whose role in education is a strategic one for the "effective perpetuation of the stock of education." To that extent, he concludes, the education of those not in the labor force "contributes to this investment process."

While the investment character of primary, secondary, and higher education may be staunchly defended by most professors of education as well as by economists, there may be more reservations with respect to the investment character of military training. If military security, defense against enemy attack, were the only effect of military training—that is, if this training were to make better soldiers but not better workers—one might still regard the cost of military preparedness as an "investment" in national security, though it would be hard to assign any rate of return to the investment. If the training is designed merely to maintain the defensive capacity of the nation, it would be gross investment only, not net investment. The national-income statisticians treat military expenditures as production of final output; thus, if it is not net investment, it would be consumption. It would be consumption of that peculiar type, however, which yields no enjoyment, no satisfaction, but which is necessary, as are the police who stop the speeders, the ride on the crowded bus or subway that takes you to work, or the bitter pills that supposedly cure your cold. There are economists who would prefer not to treat as "consumption" what really are efforts or sacrifices which the nation must make to carry on its business. The effort of training soldiers would, from this point of view, be neither investment nor consumption. It would be a general expense of producing final output, the national product, but not a final output itself.

It has been said, however, that military training does improve the productive capacity of the trainees who return to civilian life. If so, one may, from the point of view of society, regard it as an investment no less (and perhaps more) than high-school education.

The productivity of education in the church is another possible subject of controversy. If religious activity is primarily seen as the cost of salvation, the preparation for a happy after-life, this would imply that it is an investment from the point of view of the individual worshipper. If, instead, it is seen chiefly as a means for securing peace of mind, greater confidence, and higher gratification in life on earth, the activity would have to be regarded as consumption. If, as another alternative, education in the church is given important roles in character development, in the formation of socially desirable attitudes, and perhaps also in the creation of a working morale that contributes to the productive capacity of the nation, then this education will be recognized as an investment from the point of view of society.

Training on the job is, as we said when we discussed it, for the most part neither consumption nor investment, but a cost of producing current output, the goods and services supplied by the firms in question. The time interval between the training and the productive use of the skills produced by it is ordinarily too short, both for the firms and for the economic analysts, to consider the cost of on-the-job training as an investment. Exceptions should probably be recognized in instances in which the present cost is high and an enduring stream of benefits can be expected from it.

THE RETURNS ON INVESTMENT IN EDUCATION

There has lately been much discussion of the rates of return to our investment in formal education, the underlying idea being that high rates of return may be taken as indication of the existence of "underinvestment" and of the desirability of more investment in this field. Some writers have taken the high yield of more investment in education for granted; others have attempted to calculate the rates of return, either for individuals comparing expected private benefits with private costs or for the nation comparing social benefits with social costs. There are many conceptual and statistical difficulties involved in such calculations and, even if they are overcome with great ingenuity, there remain difficulties of interpretation.

One trouble with any discussion of the costs and benefits of education is that people are inclined to interpret any position as a partisan position in favor of or in opposition to an increase in expenditures. Every reference to the social *benefits* of education raises the pulse of some hard-pressed taxpayers who fear that the reference implies a plea for higher expenditures and taxes. And every reference to the *costs* of education arouses the anger of some advocates of progressive action who suspect that the reference implies a plea against greater investments in education. Now let me state with all the emphasis at my command that my observations on costs and benefits of education, and even my criticisms of other writers' views on these issues, are not inspired by any solicitude that we do or do not increase public expenditures. It *is* possible to argue against theories or measurements or computations without arguing a political position. When I eventually do come to policy proposals of my own, the chief objective in my mind will be the *improvement* of education—not the amount of money to be spent.

After this warning we may turn to an appraisal of the calculations of benefits, costs, and rates of return on investment in formal education, elementary, secondary, and higher. Since calculations can be made only where numerical measurements or estimates are obtainable, it is understandable that calculations of rates of return on investment in education omit the immeasurable cultural benefits. An increase in earning capacity is taken as the measurable effect of schooling, and the future benefits from added years of schooling are measured by the higher incomes earned by those with more years of school behind them. Average annual incomes of persons with n years of school are compared with the incomes of persons with $n-d$ years of school, and the difference in income is attributed to the d years at school. Thus, the income differentials earned by college graduates over high-school graduates who did not go to college are regarded as consequences of college education. The fact that differences in native intelligence, ambition, industry, family background, and similar advantages may have much to do with differences in average earnings, is usually disregarded in such comparisons, not by oversight but because there are no satisfactory ways of taking them into account. One can adjust for differences in race, mortality, and perhaps even intelligence,[42] but differences in ambition and industry cannot be measured and isolated—and these are critical.

Assume, for the sake of the argument (about the incremental earnings of college graduates), that the persons who in fact did graduate from college had been barred from going to college, while those who in fact had no college education had been admitted to college with all the financial aid required, so that the two groups had changed places. I would expect that after this exchange of persons the income differential would be small or nil (if not negative), the advantages of the four years of "higher" education being fully offset by the advantages of greater ability, drive, and industry on the part of those barred from college. This does not mean that increased education is not productive of higher earnings;[43] it merely means that higher earnings must not be attributed to increased education without taking full account of differences in working capacity and working habits of the persons concerned.[44] The quantitative studies of the benefits from education have failed to do this—because it cannot be done or at least we do not know how.

THE RATES OF RETURN

The ratio of expected private benefits—in the form of a lifetime of higher earnings—to private costs—chiefly earnings foregone while studying, plus tuition costs, if any—may show high returns to the private investment in education relative to the returns to other forms of investment. If this is the case, one will ask why it is that not more

[42] Gary S. Becker, "Underinvestment in College Education," *American Economic Review*, Vol. L, Papers and Proceedings (May 1960), p. 347.

[43] Becker raises the question whether native intelligence (I.Q.) and college training are substitutes or complements. He concludes they are complements in that education contributes more to the earning capacity of the more intelligent than to that of the less intelligent (*op.cit.*, p. 352). This does not, however, negate the proposition that intelligence and education may, within limits, be substitutes in producing a given amount of earning capacity.

[44] Most comparisons have been of annual incomes without regard to the number of hours worked. A recent study shows that there is a positive correlation between hours worked and educational attainment. Roughly speaking, one more year of school was associated with one more hour per week worked. (See T. Aldrich Finegan, "Hours of Work in the United States: A Cross-Sectional Analysis," to be published in the *Journal of Political Economy*.) Whether this means that college graduates have acquired a taste for more work or rather that those with such taste are more likely to go to college, or whether still other things explain the difference in work load, this difference ought not to go unnoticed.

young people have invested in their education at such favorable terms. Various explanations have suggested themselves at various times: restrictions on enrollment in certain professional schools, such as medical schools; social barriers excluding children from underprivileged homes from higher education even if they have the mental and moral equipment; ignorance about the earnings prospects of the better educated; but, most important, lack of funds and absence of a credit market in which funds for investment in education can be secured. Some of the interpreters of the supposed underinvestment have naïvely used a 4 per cent rate to discount life earnings and have believed that this was "a rather high rate." (For the benefit of non-economists we might mention that very few businesses could risk investments promising to return less than 10 per cent per year. This does not mean that I would recommend charging 10 per cent for student loans. But one must not call an investment that yields this rate an "unusually promising" one.)[45] Incidentally, the earnings differentials in some professions do not even represent a yield of 4 per cent of the required educational investment, counting only the cost incurred by the persons concerned, not the total cost of their education.[46]

For calculations of the rates of return to educational investment one will have to include both private and social cost if light is to be shed on the investment opportunities of the nation rather than on private investment decisions only. In such broader considerations one would like to include all private benefits, pecuniary and nonpecuniary, that accrue to school and college graduates, and also any additional benefits that accrue to society at large. However, while all essential private and social costs can be estimated, numerical estimates of private nonpecuniary benefits and of additional social benefits appear to be im-

[45] Thomas Ribich calls my attention to the low yield of personal savings invested in thrift deposits or savings bonds. In comparison with these uses of funds, a 4 per cent return on educational investment might be regarded as most promising. On the other hand, deposits and bonds provide liquidity to their holders, which accumulated college credits do not. Moreover, most of the families who decide that they cannot afford college education for their children cannot finance it out of their own accumulated or current savings. They are not lenders but would have to be borrowers, competing with industrial uses of funds.

[46] James C. DeHaven, "The Relation of Salary to the Supply of Scientists and Engineers," P-1372-RC (Santa Monica: The RAND Corporation, 1958). DeHaven compared the net present values of the earnings of chemists, chemical engineers, and building-construction workers. At an 8 per cent discount rate, the construction worker, even if he worked only 40 weeks a year, was clearly ahead of the scientist and the engineer. The chemist had no pecuniary advantage over the worker "at any training level or interest rate" (p. 10), and only at a 4 per cent rate did it pay "in dollars to become a chemical engineer instead of a building construction worker."

practicable. Even so, the measurable benefits alone—provided that the earnings differentials can be taken as indicative of them—seem to be high enough, relative to total cost, to show a good return on the investment in formal education.

Primary and secondary education seem to have passed the competitive test as good investments with especially high marks, if one may accept the rates of return which Schultz[47] has calculated for 1939, 1949, 1956, and 1958. Schultz compares the "additional lifetime earnings" of college graduates, of high-school graduates, and of persons who completed eight years of school (the latter are contrasted with those who completed less than eight years) with the "additional cost" of education.[48] The ratio between benefits spread over a lifetime and costs spread over four years is of course not a "rate of return on investment," but is indicative of such a rate. Schultz's ratios for 1956 are 9.77 for college, 11.27 for high school, and 38.4 for elementary school. Compared with 1939 and 1949 these ratios have been slightly increasing for college, have declined for high school (because earnings foregone by students attending high school have increased faster than the additional incomes earned later in their lives), but have much increased for elementary school (the cost of which has increased less drastically because it is assumed that no earnings are foregone by children in the first eight grades of school).

The rate of return which Schultz calculates for investment in college education is less than 10 per cent, hence not higher than for most other forms of investment (although Schultz thinks otherwise). A 10 per cent rate is much less than what some enthusiastic advocates of "college education for all" have been claiming. Moreover, there is a possibility that for some portion of college education the social benefits are lower than the private benefits, rather than the other way around. For, as Blitz has observed, many employers prefer or hire only college graduates, not because the particular jobs require any qualifi-

[47] Theodore W. Schultz, "Education and Economic Growth," in *Social Forces Influencing American Education, 1961*, Sixtieth Yearbook of the National Society for the Study of Education, Part II (Chicago: University of Chicago Press, 1961), pp. 73-79.

[48] The "additional lifetime earnings" make no allowance for any other differentiating factors, such as the native qualities of those who chose, or were chosen, to remain in school and go on to college. With no allowance made for differences in ability, let alone differences in industry, the estimates of the pecuniary benefits may be on the high side. On the other hand, the non-measurable benefits may be large enough to compensate for the overestimate of the earnings attributable to education. Concerning the "additional cost" of education we should recall the previous discussion of Schultz's estimates, where we concluded that some upward adjustments might be justified.

cations to which a college education contributes anything, but only because a college degree serves them as a credential for the diligence and intelligence of the applicant. In these instances society at large may not benefit from the four additional years of education; and the income differential earned by college graduates is not due to the educational effects but only to the selective function of the college. Where it serves only as a test of qualifications, college education may be a downright waste. Needless to repeat, this evaluation leaves the cultural benefits to the graduates and to their contemporaries out of account.

SOCIAL VERSUS PRIVATE BENEFITS

The argument is sufficiently tangled to warrant restatement in a more systematic form, perhaps with brief reminders of the meanings of terms which may be household words to professional economists but not to others.

Education, we have assumed, may serve four purposes: it may increase (1) productivity (capacity to produce) in the (not very near) future, (2) productivity (capacity to produce) in the very near future, (3) pleasures (enjoyment, satisfactions) in the (not very near) future, or (4) pleasures (enjoyment, satisfactions) in the present. As a fifth possibility, though presumably not intended, education may do none of these things, in which case it would be a sheer waste of resources.

As an example of the second of these purposes we have mentioned the largest portion of on-the-job training; we shall make no further reference to it in this context since we are now interested chiefly in the evaluation of formal education, elementary, secondary, and higher.

If education is intended to serve the first or the third purpose (or both), the costs incurred may be regarded as *investment*. This characterization is justified in that present resources are employed to produce desired effects in the (not very near) future. Those who are accustomed to look for capital assets as a result of investment will have to say that "human capital" is created through educational investment—either productive capital in the first case or consumer capital in the third case. To the extent that education is to produce current (present) pleasures (on the part of the students, parents, friends, teachers, alumni, or spectators) it will be characterized as *consumption*.

Productivity refers not only to the working capacity and working habits of the individuals taught but also to the cooperative efficiency of the groups of which they become members and the entire society in which they work. In other words, not only the performance of the graduates themselves counts but also the operation of the society of which they are a part. This broader concept of productivity takes account of the "external" effects of education, including those commonly referred to under the headings of social integration and political stability. The benefits of this increase in productivity achieved by education will accrue not only to the individuals educated, but in part also to other members of the society. Thus, there will be "third-party" or "neighborhood" benefits in addition to the private benefits that go to the school and college graduates in the form of increased earnings.

Similar neighborhood benefits arise from the cultural results of educational investment. The possibility of conversing intelligently about subjects comprehensible only to the educated, and the sharing of experiences in art, music and literature, are enjoyments which go beyond the satisfactions of the individual former students. Moreover, certain cultural services can be produced economically only for large audiences, so that many good books, good plays, operas, and concerts become available only if the number of those educated to appreciate them is large.

Thus, educational investment yields future private benefits (to those who have gone through the educational process) and additional social benefits (accruing to others). Because of these additional benefits to others the total social benefits exceed the private benefits from investment in education.[49] But, likewise, the total social cost exceeds the private cost, since governments have undertaken to pay for a large share of the educational enterprise, chiefly because otherwise there might be a substantial underinvestment in education.

The term "underinvestment" has several meanings, some referring to the amount of aggregate investment in the economy, others to its distribution among competing uses.[50] It is the relative allocation of

[49] In a forthcoming paper on "Education and Investment in Human Capital," to be published by the National Bureau of Economic Research, Burton A. Weisbrod provides a useful survey of the social benefits of education. He distinguishes short-run and long-run benefits to (1) the student (2) external beneficiaries "residence-related" to the student (3) external beneficiaries "employment-related" to the student and (4) society in general. Among the second he lists short-run benefits to the family—relieving mothers of baby-sitting duties—and to neighbors—relieving them of mischievous children in the streets—and long-run benefits to the future family—equipping future parents to provide informal education in the home—and to neighbors—through the development of social consciousness. In the third group he lists, among others, long-run benefits to the co-workers of the (former) student—increasing their marginal productivity as a result of complementarity in production. Weisbrod does not propose any methods of measuring or estimating the "non-market returns" to education.

[50] "Underinvestment" in an aggregative sense may mean that (1) total investment in the economy is too small relative to the thrift or saving propensities of the people,

investment funds which is referred to when one speaks of underinvestment in a particular activity. Thus, underinvestment in education means that relatively too much is invested elsewhere. By contending such an imbalance one means to say that society stands to gain from reallocating its investment funds, switching some of them from other uses to education. In technical terms, the marginal product of education is held to be greater than that of alternative activities, or the marginal rate of return on investment in education to exceed that in other uses of resources.

There may also be imbalances within an educational investment program. For example, where there are serious shortages of particular professional talents—say theoretical physicists, mathematical statisticians, operations researchers, and similar specialists—the social returns to the investment required in producing these scarce professional talents may be exceedingly high. This would not, however, prove the existence of underinvestment in higher education in general. A reshuffling of the investment funds allocated to education might in this case achieve more than an increase would. (Warning: this would not mean a shift from the humanities to the natural sciences in the college curriculum, but rather changes on the elementary and high-school levels.)

MEASURES AGAINST UNDERINVESTMENT IN EDUCATION

One should distinguish between private underinvestment and social underinvestment in education. The first focuses on private benefits and costs, the second on social benefits and costs.

Private underinvestment is explained chiefly by three factors: (1) ignorance of parents or students (who do not know how great the private benefits of education are likely to be), (2) selfishness of parents (who value their own living standard above the improvements of the future earning capacities of their children), and (3) unavailability of credit to finance the private cost of education. If private underinvestment in education is serious, what should society do about it? Should government confine itself to measures reducing the ignorance

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with the result that the economy suffers from deflation or underemployment, or (2) total investment is too small relatively to consumption, with the result that the economy grows more slowly than it could if people were willing to live more frugally. "Underinvestment" in the relativistic sense, explained in the text, may exist simultaneously with aggregative underinvestment. This may sound paradoxical, since underinvestment in the first sense implies oversaving, in the second sense overconsumption, in the third sense overallocation to certain investment outlets. This is not the place, however, to explain how it is conceivable that all three diagnoses be made at the same time. For the purposes of our present study, only the problem of relative allocation is relevant.

about the benefits of education and increasing the availability of credit? Or should government tax everybody, including non-parents and the parents of non-school-age children, to pay for investment outlays which will eventually yield private returns to those whose education was thus financed? Or should government assume responsibility only for a certain part of the educational investment, namely, a part commensurate with those social benefits which do not accrue to the recipients of education?

Our society has long decided not to fuss about paying the cost even where benefits accrue directly to the individuals in question. In a purely academic argument one might attempt a division of benefits and argue that, since 80 per cent (or 70 or 60) of the total will accrue to the individuals in the form of increased earnings and only the rest will accrue to society at large, society should leave 80 per cent (or 70 or 60) of the investment outlay to private responsibility, and assume obligation only for the rest. Practically such a scheme would never do. Since the benefits to society would depend on all private responsibilities being met in full, and since the interest of society in its members being educated at least to a certain level is paramount, governments have assumed full responsibility for elementary education, a large share of the responsibility for secondary education, and a smaller but increasing share of the responsibility for higher education. How great the interest of society, the excess of social over private benefits, really is on the more advanced levels of education is a controversial question.

It is very difficult to formulate, even on purely theoretical grounds, the principles on which government payment of all the cost of higher education could be justified. There are two moral principles on which one attempts to justify robbing (taxing) Peter to pay Paul: one, if Peter is very rich and Paul very poor; the other, if Peter will profit from the scheme and will get back with interest what has been taken from him. How does this apply to Peter's being taxed to pay for the higher education of Paul's children? The average taxpayer is not richer than the average parent of college students. Thus, the principle of redistribution in the name of so-called social justice does not apply. The other principle can apply if it can be convincingly shown that the taxpayer will after some years be repaid in full in the form of an increase in his real income resulting from the advanced education of other people's children to which he was forced to contribute.

One sometimes hears the argument that one single individual among the millions who stop their education after high school might, if he could go on to college, develop into a great scientist and make a discovery worth many billions of dollars to society. This is an excellent argument for seeking out with greater care and efficiency the talented among the school population and luring them into college and graduate school. It is a poor argument, however, for sending many more high-school graduates to college; indeed, by diluting the academic facilities one can easily reduce the efficiency of education and drastically reduce the productivity of the educational investment.

Relatively high rates of return may be indicative of underinvestment in the fields where they are shown to obtain. The rates of return on investment in education, as calculated by Schultz, certainly look attractive enough, but they can be made to look still better if some of the expenses of the schools and colleges are regarded as devoted to the production of current satisfaction—consumption—rather than as investment from which future benefits are to be expected. In his own words, "To allocate all educational costs to investment in human capabilities that increase future earnings, overstates the relevant costs entering into this investment and, therefore, necessarily results in an underestimation of the rate of return to that part of education that is undertaken to increase future earnings."[51] If, as Schultz now assumes, only approximately one half of the total costs of high-school education and three fifths of the total costs of higher education represent investments in future earnings, the rates of return are doubled in one case and increased by two thirds in the other case. But this does not necessarily strengthen the case for increasing total outlays for education, let alone the government contribution to such outlays. Assume, though it may be naughty to assume it even for a moment, that the non-investment portion of the cost of education is entirely for the production of current satisfaction. While one would have a strong argument for increasing educational outlays of the investment type, what argument can one present to justify government aid for the production of unproductive services gratifying the tastes for play and other forms of entertainment? No one will seriously propose that Peter be taxed so that Paul's children can be entertained. (Of course, the assumption was made only to illustrate a point, not to argue a case. The one half of the total cost of high-school education that was not investment in capacities to earn incomes may still have been investment: character building and cultural development. It need not have been cost of entertainment.)

[51] Theodore W. Schultz, "Education as a Source of Economic Growth" (mimeographed Paper No. 61-5, August 14, 1961).

AVERAGE VERSUS MARGINAL RETURNS

One of the pitfalls in applied "productivity analysis" is the widespread confusion of average with marginal rates of return. A high average rate of returns signifies nothing with regard to the marginal rate. If society invests annually 10 billion dollars in high-school education and figures on a rate of return of 12 per cent, an eleventh billion dollars spent on high-school education might very well have a zero return; indeed, the tenth billion might already have a zero return, and the last two billions a return of only 0.5 per cent. (Needless to say, all these figures serve only to make a point, not to state a factual conjecture.)

The failure to think in marginalistic terms may stultify the entire argument. It is not at all difficult to understand this business; almost every housewife does. It she holds that one quart of milk is good for a child, she does not believe that two quarts would necessarily be better; if she finds that a spoonful of baking powder will raise the cake, she knows that a greater dose may spoil it; if she buys oranges because of their vitamin content, she knows that there is a limit, and to spend still more on oranges will not improve the health of her family.

The fallacy of jumping from average returns to marginal returns is compounded by the fallacy of extrapolating historical experience. If the historical statistician finds that the nation's investment in education fifty or eighty years ago has paid off at stupendous rates, he must not conclude that this demonstrates a high productivity of any increase in the education budget at the present time. An investment that makes a literate and disciplined labor force out of illiterates may have a simply colossal productivity; but this says nothing about the returns on an investment which makes it possible for every salesgirl and every ditch-digger to have a college degree.

The last somewhat flippant remark may again arouse the suspicion that the cultural advantages of a college education are not given due recognition. Perhaps it should be said here—it will be discussed and elaborated upon later—that indeed serious doubts may be raised about any advantage whatsoever of overextended periods of school attendance by people below certain levels of intellectual endowment, curiosity, and diligence.

INCREASED VERSUS IMPROVED INVESTMENT

If one finds particularly promising investment opportunities in education, which have not yet or not sufficiently been utilized, this may imply a sudden increase in the marginal productivity of educational investment. But it does so only if all portions of the annual investment budgets have been wisely allocated—so that no reallocation would improve the returns—or if it is impossible to reallocate the financial resources among the various parts of the budget. The marginal-productivity principle ordinarily presupposes that the most important things are done first and additional resources are applied to additional uses in the order of importance (in terms of expected benefits). If this rule is not observed, a new and highly promising use of funds should not be regarded as the one determining the marginal productivity of investment. A 50 per cent return on the next million dollars invested, while there are some millions invested at a zero return, does not raise the marginal rate of return above zero.

Assume, for example, that new programs are proposed for special training of mathematically gifted youngsters, or for training of more or better medical doctors, or for any other purposes highly beneficial to society; the adoption and execution of these programs does not necessarily depend on additional funds to be invested. It would be possible to carry out the most promising programs at the expense of others now in effect but grossly ineffective and therefore wasteful. This brings us to the discussion of the problem of efficiency in education.

Efficiency in Education

In order to spot the gravest instances of inefficiency in education one will do well to note again what the most important items are in the cost accounts of the most costly parts of the educational enterprise of the nation. The most costly parts are the school system—elementary and secondary—and higher education; and the largest items in each are the earnings foregone by high-school students and the earnings foregone by college and university students. It follows that the improvements in our system of education that would matter most would be those which achieve the same or greater benefits with more economy of students' time.

It is widely held, however, that the expansion of school programs to take in larger percentages of the population and to keep them at school for an ever-increasing number of years is inevitable in a growing society with a growing economy and a growing "stock of knowledge"; and hence that there is no possibility of economizing students' time. Perhaps a brief discussion of these issues would not be out of order at this point.

THE STOCK OF KNOWLEDGE

It has been said, and repeated, though without citation of the original author, that whereas "in the eighteenth century knowledge doubled every fifty years, it now doubles in less than ten years."

I suppose that what the author of this statement meant when he said "knowledge" was the number of *books* accumulated in the libraries. This would be a very misleading index of knowledge, or even of book knowledge. The same subject matter is covered in many books with only slight variations in exposition; it is repeated over and over again in varied form for different audiences. And when what was first printed is later found to be false or inaccurate, new propositions *replace* the old ones—which are removed from the accepted body of knowledge—but the books in which the new propositions are published are *added* to those which contain the old ones. We do not destroy the old books, fortunately; but to include them in a count of the "stock of knowledge" is highly misleading.

What sense can be made of the phrase "stock of knowledge"? First of all, and closest to the idea just touched upon, would be the notion of a stock of knowledge as the sum of everything knowable that is embodied in books or preserved in other durable records; many of these things may not actually be known by anybody alive; that is, though once known to the author of the book or document, they may not be present—remembered or reconstructible—in the mind of any "knower." But, with some effort, "recorded knowledge" can at any time again become knowledge actually present in some mind or minds. Bertrand Russell referred to this as "social knowledge," some of which is not individually known to anybody.

In a second meaning, the stock of knowledge may be understood as the sum total of things known to members of our present society, regardless of the number of knowers; some things are known to many, other things to only a few, perhaps only to one living person. Knowledge possessed by many would not be given a greater weight. The inventory of knowledge in this sense would list everything that is known to at least one person.

In a third meaning, the stock of knowledge would be understood as the sum total of all the stocks of knowledge present in individual minds. The separate inventories may contain the same items of knowledge, and the national inventory would thus show a great deal of multiple counting. This is not a defect of this concept, but rather its merit. A society in which only a few people have much knowledge is certainly "less knowledgeable" than a society in which many possess this knowledge, and it makes good sense to say that the "stock of knowledge" is larger if there is a larger number of minds in which the same knowledge is stocked. There is, for example, only one and the same multiplication table for numbers from 1 to 10, but a society in which every adult person knows it possesses more knowledge than one in which only a small percentage can perform multiplications.

A fourth meaning stresses "potential" knowledge in the minds of many, in that it places more emphasis upon general or fundamental knowledge and less on specific information. The basic knowledge which enables persons to read and comprehend quickly gives them easy access to any amount of specific knowledge preserved in written form. Thus the ability to read and grasp written specifications and directions is usually worth much more, and provides more "potential" knowledge, than masses of "actual" knowledge of specific details present in the minds of poor readers or illiterates. The stock of knowledge in this sense would take account of the number of minds that could readily absorb knowledge from printed documents or written communications.

We had better not lengthen the list of meanings that can be attached to the phrase "stock of knowledge," especially since none of the concepts is practically operational, let alone suitable for numerical measurements. But perhaps it should be said that the lack of measurability does not make the concepts "meaningless." Especially when the knowledge, the stock of which is to be sized up, is only of one type, say technological (so that no comparisons between different types of knowledge are involved), then those who speak of a slow or rapid rise in the stock may make good sense. They evidently mean that in a certain period few or many new practical inventions and technical improvements were made which could be introduced to obtain more or better products. Conceptual troubles with statements about a "stock of knowledge" become serious, however, when different "compositions" of knowledge and different "distributions" of knowledge are involved. Even the evaluation of the "flow" of knowledge disseminated by schools becomes highly specious as soon as the emphasis on different subjects is changed—as it is all the time. But before we say more about this, we ought to turn to the problem of the "maintenance of average education."

PRODUCTION AND REPRODUCTION OF KNOWLEDGE BY THE SCHOOLS

In the production of capital equipment a certain part is regarded merely as "reproduction," as replacement for equipment worn out or obsolete, and only the excess of gross production over replacement is called net capital formation. Can the same distinction between gross and net be made in the production of knowledge? Every year a part of the working population is lost through death or retirement; young people must be trained to replace them. The education and training given to as many members of the rising generation as are required to make up for losses in the labor force through death and retirement may be called "reproduction of knowledge." It secures the maintenance of a labor force of given strength both as to the number of trained people and as to the level of their training. Of course, "knowledge" refers here only to that portion that contributes to working skills and capacities.

If the population is increasing in size, mere reproduction of knowledge would not be enough: it is necessary to educate all of the rising generation, or at least an unchanged percentage of it, if "average knowledge" is to be maintained. This is similar to the need for net capital formation when population increases; if the amount of capital per worker were allowed to diminish—without technological improvements—labor productivity would decline. To keep productivity from falling, both average capital equipment and average education must be maintained. Maintenance of average education requires that education and training of the same quality has to be provided for the same percentage of people as had previously been provided for the now "outgoing" generation.

Suppose that a uniform dose of education is given to a fixed percentage of the population; an increase in "average knowledge" could then be achieved by raising either the percentage educated or the level of education, or both. Things are more complicated when the two are changed in opposite directions—for example, when the percentage of children going to school increases but the level of achievement declines. Here arises the problem of measuring "aggregate knowledge," or the total value of knowledge, in terms of its ultimate effect upon productivity. One would want to know what will contribute more toward productivity, a better education—though given only to a smaller percentage of the people—or a larger percentage of the people getting educated—though only to a lower level. Even if the differences in the numbers of people and in the levels of education were specified, the answer would surely depend on the percentages and levels from which any changes were to start.

In reality there is, of course, not one uniform level of education that is raised or lowered, but there is a full spectrum of levels and there are varying percentages of the population attaining different levels of achievement. Changes in the educational program are then usually very complex, with the frequency of some achievement-levels increasing and of others diminishing, so that it becomes still less feasible to arrive at a conclusion as to whether the average knowledgeability of the population is rising or falling.

One might think that some numbers game can be played with the statistics of school attendance and frequency distributions of completion of various numbers of years of schooling. For example, if the percentages of those who have completed 10, 11, and 12 years of school are increasing, and the percentages of those who have only 6, 7, and 8 years of school are falling, one might conclude that the average level is being raised. But this conclusion, unfortunately, would not be warranted, since more years of schooling may mean merely the same amount of knowledge acquired more slowly, and the rise of high-school enrollment often means merely that many elementary materials are now taught in high school instead of in elementary school. We shall come back to this point after a brief reflection on the question of the measurability of educational achievements.

NO MEASUREMENT OF OUTPUT OR EFFECT OF EDUCATION?

Knowledge is heterogeneous beyond compare, and this holds even for the knowledge taught by schools. As far as knowledge of a particular subject is concerned we may attempt numerical estimates. For example, if "high-school algebra" or "first-year French" are defined by some relatively fixed standard, we can say how many pupils each year took such a course and passed the examination. But if the number or percentage of high-school students taking algebra falls while the number or percentage of students taking another course, say "arts and crafts," increases, can we say that the total amount of knowledge produced is increased, reduced, or unchanged?

There are those who deny that a question has meaning if the concepts involved are not operational. We have no operational concept of "amount of knowledge of all sorts." Yet I submit that we do make decisions about such matters—for example, about school programs which involve the substitution of one kind of knowledge for another—and, although we may disagree with the decisions made, the question makes very good sense both to those whose plans are adopted and to those who oppose them. The sense may lie in some sort of aggregation of the various kinds of knowledge to a total of knowledge produced, which implies some sort of valuation given to different kinds of knowledge and summation of the partial values to a total of the value of knowledge produced. The trouble is that the principles of valuation differ and, in the absence of market values, the valuations are quite personal.

The conflict between the humanist and the pragmatist—and here I do not mean the professor of a humanistic subject and the professor in a subject regarded as "useful knowledge," but the humanist in spirit and the pragmatist in spirit—cannot be resolved. The advocate of liberal education and humanistic learning for whom learning and intellectual curiosity are absolute values will rate purely intellectual, noninstrumental knowledge above useful knowledge even if he is told what remarkable increase in material welfare can be had from the latter. However, there is also the position of those who defend liberal education not for any absolute value attached to intellectual pursuits but rather for the contribution it makes indirectly, as a sharpener of intellect and a builder of character, to the eventual social and productive performance of the educated ones, and ultimately to the material welfare of society. Personally I do not like this position, but I admit that it provides the basis for a compromise. If the ultimate results could be measured in terms of material products—goods and services which have market prices—all knowledge would become comparable and measurable in terms of economic productivity. I state this under protest, because I dislike the attitude so very much, but where compromises are needed intransigeance is wicked. Moreover, the believer in learning for the sake of learning and in knowledge for the sake of knowledge usually has such a high opinion also of what learning can do for the learner and what pure knowledge can do for the development of applicable knowledge, that he may without guilt feelings accept the "ultimate-productivity standard" as a compromise in the valuation of knowledge of different types and kinds.

This standard can be helpful only if sound generalizations can be made concerning the contribution which education can make toward the productivity of people by raising the research ability and the inventive skill of the talented, by raising the alertness, diligence, accuracy, and dependability of the mediocre, by raising the employability of the dull-brained, and by improving the working habits and working morale of all. Unfortunately, we are far from safe generalizations on these matters, although some strong convictions, backed by little or no evidence, undoubtedly exist.

THE PRODUCTIVE CONTRIBUTION OF PROLONGED EDUCATION

The absence of accepted generalizations about the ultimate productivity of the knowledge taught is well illustrated by examining the simple question about the contribution which the last two compulsory years of school can make toward the nation's productivity. Suppose a nation considers raising the age of compulsory school attendance from 14 to 16; assume that previously only ten per cent of those of age 14 and 15 have attended school; assume further that the supply of qualified teachers is perfectly elastic so that the teachers needed for the two additional years of high-school work can be provided without encroaching on any other activity in education or research. Can one say without reasonable doubt that the contribution toward productivity will be substantial, or even positive? To raise plenty of doubt we need only list the factors to be taken into account.

There is, first, one clearly negative item: the loss of the potential output produced in other occupations by the additional teachers and the potential output produced by the 90 per cent of students aged 14 and 15 who would have sought employment. There is, second, an undoubtedly positive item: among the 90 per cent, among those who would have stopped their schooling and would have taken jobs, there may be some who in the two added years of school develop talents previously undetected and a taste for learning, and who then continue their education to obtain qualifications that are scarce and valuable to society. The third item is again negative: the 10 per cent who would in any case have continued in school will now have inferior opportunities to learn in the company of less gifted, less interested, involuntary students, whose inclusion cannot help lowering standards.

A fourth item, presumably the most important and the very purpose of the program, is, I am afraid, only slightly positive, if at all: the effect of the prolonged schooling upon the captive 90 per cent. I submit that most of them will learn in ten years of schooling just about what they would have learned in eight years. The chief effect of raising the school age and of adding two years of compulsory school attendance is to spread the same academic curriculum over a longer period, with the result that the 16-year-old of average intelligence will know about as much as the 14-year-old knew before the two years of school were added. If another two years are added and everybody is compelled to go to school until age 18, the standard of achievement in the twelfth grade will probably be about what it used to be in the eighth grade. And, to carry my hypothesis a bit further, if 50 per cent of our youth should go to college, as some educationalists threaten, the standard of college education will soon be what the standard of senior high-school used to be. Most people *can* learn what they will ever learn in school in eight years, and if they are kept there for 10, 12, 14, or 16 years they will merely learn it more slowly. This does not apply to all, but standards are usually adapted to the majority, so that even those who might profit from additional schooling will not really get much out of it. A few, however, may profit a little, and this would account for a small positive effect of the fourth item. Whether this, together with the positive effect of the second item, is enough to offset the two negative items is by no means certain, though many people think so.

Before the professors of education start jumping on me in furious indignation about my heretical views, let me add that I am all in favor of equality of opportunity and do not object to the principle of free or subsidized education for all who want it and can take it. I am critical only of *forced* schooling for those who after age 14 neither want it nor can meet satisfactory standards.

Since this is such a controversial question it may be desirable to summarize the argument concerning the possibly negative effects of prolonged compulsory schooling in a series of brief and provocative propositions. The following consequences may be expected from compelling untalented and uninterested youths to stay in school beyond ages 14, 15, or even 16:

1. Effects upon the *untalented and uninterested* students

(1) They learn no more than they would have learned in less time.

(2) They acquire a stronger distaste for education and an antagonism toward intellectual values.

(3) They acquire poorer habits of work because, with the curriculum spread over more years, they have less to do per year and per week and get accustomed to more loafing than they could otherwise; these habits may lower their productivity for many years, perhaps for their entire working lives.

II. Effects upon the *talented and interested* students

(4) Their motivation and industry is lessened as the competition in the classrooms and for honor rolls of the school is reduced.

(5) Their preparation for colleges and universities suffers because standards of achievement are inevitably lowered if the student body includes the less able and less ambitious.

(6) Their educational opportunities are reduced by the spreading of the curriculum over more years, which becomes unavoidable with the forced inclusion of the weaker students; "skipping" of grades is no substitute for a curriculum designed to "stretch" the mind.

(7) Their prospective productivity in mathematical and scientific subjects is jeopardized by the delay in the completion of their studies beyond the age period in which peak capacity is reached in these subjects and the greatest contributions are likely to be made.

III. Effects upon *all* students

(8) The greater emphasis upon athletics—usually associated with an academically "slow" curriculum—in a group composed of a greater percentage of intellectually poorer students distorts the values system of the community, generally lowering the prestige of academic and intellectual achievement.

IV. Effects upon current output

(9) The reduction in the labor supply effected by keeping unwilling students in the classrooms and away from the labor market causes a current loss of output, an immediate sacrifice of national product quite apart from the long-run effects upon productivity listed in the first eight points above.

(10) The need for additional teachers implies another encroachment upon current output. (If the supply of teachers is highly inelastic and the use of teachers for the added classes encroaches upon the availability of teachers for earlier grades, the resulting deterioration of teaching in all grades is another factor with deleterious effects on all students.)

Lest anybody mistakenly interpret this to be only an argument for lowering the school-leaving age under compulsory-education laws, let it be stated categorically that it is *not* an argument for reducing the amount of education provided. What is now taught in twelve years can just as well, or better, be taught in nine years or ten; and what is now taught in ten years can be taught in eight.

INTERNATIONAL COMPARISONS OF ACHIEVEMENT

The best evidence in support of an assertion that something *can* be done is that it *has* been done and *is* being done. Some of it is done in exceptionally good schools in the United States. But for published evidence one has to go in general to the school systems of foreign countries and to examine the differences in their curricula and in the achievements of their students. Let us discuss achievements first.

Numerous achievement tests have shown that pupils in elementary and secondary schools of some other countries are two or three years ahead of American children of the same ages. The tests have been scattered and unsystematic; perhaps they were not designed with all the care required for scientific experiments. For this reason the United Nations Educational, Scientific and Cultural Organization (UNESCO) is now sponsoring a test to be given to an international cross-section of 13-year-olds in eleven countries: Belgium, England, Finland, France, Israel, Italy, Poland, Scotland, Sweden, Yugoslavia, and the United States. Some 14,000 children will be given the same questions, designed to test their ability "to understand" subject matter rather than to memorize it. Until the results of this project become available we must rest on the findings of the less systematic and less comprehensive evaluations undertaken in the past.

On the basis of "official evaluations," United States colleges and universities have generally given graduates of secondary schools of the "Gymnasium"-type in continental Europe—mostly age 18—credit for the first two years of college; and these foreign transfer students, admitted as juniors, have as a rule done exceedingly well. Their superior achievements can perhaps not be validly compared with the performance of American students, because the immigrant students had extraordinary ambitions "to make good." In view of this difference in motivation one may deny the validity of the comparison, but the high standings which these students achieved in their college classes are not pertinent to our question; what is relevant is that their earlier preparation allowed them to skip two years of college.

A survey of a British parliamentary group, conducted by Philip Goodheart, based on questionnaires completed by British exchange teachers in the United States, concluded that "American school children are two years behind British children in most academic subjects." The "most consistent academic deficiency . . . was in mathematics, particularly in the earlier grades. Shortcomings in English grammar, writing, reading and spelling followed closely."[52]

A recent Canadian study was based on the results of the examinations given by the College Entrance Examination Board to the select group of American high-school seniors seeking admission to the prestige colleges and universities requiring such examinations. The same examination, designed for American students, was given to the entire grade 13 of Ontario high schools and the entire grade 12 of Alberta high schools. (The Ontario students were also a select group in that grade 13 is taken only by those preparing for college; but the Alberta students were fully representative.) The result of the comparison was that "Canadian students are definitely superior on the mathematical tests."[53] Of course, this is only very indirect evidence for the hypothesis in question: not superior achievement of foreign-trained students of equal age, but rather equal achievement of those two or three years younger than our American students is what has to be shown. Though not shown, it may perhaps be inferred from the study.

INTERNATIONAL COMPARISONS OF CURRICULA

An international comparison of the curricula for elementary and secondary schools leaves little doubt that in most European countries considerably more is demanded of the children in school than in the United States. The school systems of Austria, Czechoslovakia, Denmark, France, Western Germany, Norway, Sweden, and USSR, as well as that of Canada, have been examined, chiefly on the basis of the descriptions supplied by the United Nations Economic and Social Council (UNESCO, *World Survey of Education*, 1958). The comparisons were on the basis of (1) hours of class work per year, (2) rigor of the work required, (3) amount of homework required, and (4) relative distribution among subjects required.

In general, the foreign schools schedule more class hours per day, more school days per week, more school weeks per year. As Admiral Rickover stated concerning the Netherlands, a country not included in the comparison presently to be reported on, "the Dutch school day is 10 per cent longer than ours; the school week lasts six days, or 20 per cent longer; the school year 240 days, or 33 per cent longer."[54]

[52] *The New York Times*, May 19, 1960.

[53] R. W. B. Jackson, *The Atkinson Study of Utilization of Student Resources in Ontario*, Department of Educational Research, University of Toronto, 1958, p. 26.

[54] H. G. Rickover, *Education and Freedom* (New York: Dutton, 1959), p. 232.

The Dutch system is more rigorous than the average of the nine systems examined. The number of class hours per year required in these countries (using an unweighted arithmetic mean) exceeds the class hours held in 48 states of the United States (again using an unweighted arithmetic mean) by 4.5 per cent in grades 1 to 4, 20.7 per cent in grades 5 to 8, and 30.6 per cent in grades 9 to 12.[55]

Using these averages, one can calculate that the number of class hours in the first ten years of school in the "average" of the nine foreign countries would correspond to the number of class hours in 11.62 years in the United States. Of the nine countries, Sweden requires the greatest number of class hours, the USSR the least. Nonetheless, it remains true that "during ten years of school attendance a Soviet pupil is expected to spend 2,000 days in school, which does not differ markedly from the number of days required in many of our own schools for a twelve-year period."[56]

There is no good quantitative measure for comparing the rigor of the school work in different countries. The personal testimonies of thousands of students who have attended school both here and abroad may be accepted as a poor substitute for less impressionistic evidence. Perhaps comparative evaluations of the periodic examinations given to the students in the various subjects and grades could be made. For example, the examinations in several continental countries at the end of grades four or five, or the "eleven-plus" examination in England, could be compared with the kind of examinations administered to U.S. pupils at similar ages (eleven or older). The results would undoubtedly show that in terms of materials taught and in terms of the performance required the foreign students are two years or more ahead of ours.

For comparisons of the amount of homework, there may be statistical evidence available, but I have not seen it. Thus I must again rely on personal testimony. The impression that the demands on pupils in terms of required homework are greater in foreign schools than in ours seems incontestable.

Comparisons of the subject-matter requirements are available in quantitative terms. The number of hours devoted to arithmetic in primary schools abroad is up to 20 per cent greater than in our elementary schools. The requirement in mathematics and in the natural sciences in high schools (or their equivalents) in the nine foreign coun-

[55] I am indebted for these computations to Vladimir Stoikov.

[56] Nicholas De Witt, *Soviet Professional Manpower: Its Education, Training, and Supply* (Washington: National Science Foundation, 1955), p. 37.

tries examined exceeds, on the average, the average amount of mathematics and science taken in U.S. high schools by 103 per cent and 126 per cent, respectively. On this score, the USSR seems to lead all other countries, since the portion of time devoted to mathematics and the natural sciences is as high as 28.5 per cent in grades 1 to 4, 36.3 per cent in grades 5 to 7, and 40.8 per cent in grades 8 to 10.[57]

These few observations regarding hours of class work per year, rigor of work required, amount of homework required, and subject-matter requirements indicate clearly that the students abroad have to work harder and in more rigorous disciplines. Admittedly, requirements and achievement are different things. It would be conceivable that despite stiffer requirements the achievements are not superior to those under a more easygoing system. Thus, a comparison of requirements alone would not be convincing. But together with what evidence we have on comparative achievements, the comparisons of school curricula are telling.

ACCELERATION OF INTELLECTUAL GROWTH

The international comparisons of school requirements and achievements have demonstrated, in my opinion, that the learning process in the United States could be accelerated, and the educational objectives now attained in 12 years could be attained in 9 or 10 years of school. Such a speed-up would reduce the social cost of education enormously —that is, it would increase greatly the actual national product.

Needless to say, there would be some loss involved in the acceleration of the school program if it leaves the youngsters less time for play. They would have fewer hours per week free of school and homework, and their summer vacations would be shortened. Given the widespread preference for play and entertainment, which can be more extensively gratified if academic studies are distributed over more years, the compression of the curriculum into a briefer period may spell a reduction in immediate satisfaction. On the other hand, the increase in the time devoted to study may be just at the expense of plain loafing and thus not cut into any worthwhile activities. There was a time, in the United States as elsewhere, when long summer vacations reduced the opportunity cost of education: the youngsters had to work on the farms. This is now nothing but past history.

Several professional schools in cooperation with affiliated colleges of arts and sciences have recently worked out programs to speed up

[57] De Witt, *op.cit.*, p. 37-39.

academic and professional studies. In view of the shortages of high-grade professional and teaching personnel these accelerated programs are desirable and perhaps imperative. But it would be most regrettable if the acceleration were achieved at the expense of general education now offered at college. It should be achieved through compression of elementary and high-school curricula. Colleges should receive fully prepared high-school graduates at ages 14 and 15, rather than at age 18, as is now customary. This is especially important for the mathematically talented students, who should be in graduate school working on their Ph.D. at age 20. It has long been known that many mathematicians have done their most original and pathbreaking work in their early twenties. To keep such people in high school until age 18, and in college until 22, is a reckless waste of talent.

While I submit that a speed-up in elementary and secondary education is possible for practically all levels of intelligence, others propose it only for the academically talented. Dr. Conant, favoring an enriched program over an accelerated one, has stated that "The academically talented student, as a rule, is not being sufficiently challenged, does not work hard enough, and his program of academic subjects is not of sufficient range."[58] Certainly the system should be changed so that the talented students no longer waste several years in elementary and secondary schools which (at present) are designed to permit a youth of average intelligence to learn without strain and with plenty of loafing in twelve years what he could learn with due effort in nine or ten. But the answer, I shall argue, is acceleration for *all* students, not just for the "academically talented."

Incidentally, I am aware of the fact that in Pedaguese, the language of specialists in education, I should speak of the talented as "fortunate deviates." Higher education proper, as it is now offered at a very few colleges only and at graduate schools, is of course only for these "fortunate deviates." The difference in academic standards between our *best* colleges and the *average* American college is so great that the day has come for a restructuring and reclassification of our entire educational system. A proposal for such a reform will now be made.

A Proposal for School Reform

In a society with a stationary or very slowly rising population a school reform involving a reduction of the number of school years

[58] James B. Conant, *The American High School Today* (New York: McGraw-Hill, 1959), p. 40.

required would also involve a reduction in the demand for teachers, classrooms, buildings. Such a reform plan would be politically impossible; the resistance to it could not be overcome. In a society, on the other hand, where the school population is rising so fast that under the existing school programs it would not be possible to secure all the teachers that would be needed, and not easily possible to build all the schools and classrooms that would be needed, the resistance to a reform plan holding down the increase in demand for teachers and buildings should not be too strong.

Of course, fundamental reforms are not welcomed by those who have grown so accustomed to existing institutions that a radical change seems "unthinkable" to them. Anyone proposing a radical change faces a dilemma: either he sets forth his proposal frankly and boldly—and gets branded as a visionary and Utopian—or he hides his proposal behind all the hedges of judiciousness—and gets nowhere. My choice will be in favor of boldness, with all due apologies to the more judicious.

THE EDUCATIONAL GOALS

For the sake of our national security, or even survival, and for the sake of our national welfare and its material and moral prerequisites, we need an educational system that will significantly raise the intellectual capacity of our people. There is at present a great scarcity of brainpower in our labor force. Practically all occupations requiring a solid education have manpower problems; there is virtually no unemployment among the well-trained; but there is severe unemployment among those with no skills or physical skills only. It seems most likely that this trend—the existence of which will be shown in Chapter X—toward increasing job opportunities for the "knowledgeable" and diminishing opportunities for the "non-knowledgeable" will continue. Unless our labor force changes its composition so as to include a much higher share of well-trained brainpower, the economic growth of the nation will be stunted and ever more serious problems of employability will arise.

Hence, we need a school system that turns out not only a much larger elite of top-rate knowledge-producers and knowledge-users but also broad masses of people whose intellectual attainment is well above the present average. This does not presuppose that we raise the average intelligence of the people—which of course we cannot do; it requires only that we use our school system to stretch the minds of the young, to improve their working habits, to increase their learning capacity. This can be achieved by having them learn faster and apply themselves more assiduously to school work than they have in the past.

If the educational goals which we thus set ourselves should call for great sacrifices, if large additional expenditures per student were required to attain them, we would probably find these sacrifices and expenditures well worthwhile. However, it happens that the improved system, the technique of achieving the stated goals, would cost less, not more, than our present system. This is so because the speed-up which stretches the minds of the students saves years of working time by getting them ready for productive employment at a younger age.

THE ECONOMIC ARGUMENT

A year of high school at 1956 prices and incomes (which were much below present prices and incomes) costs approximately $568 for "school inputs"—i.e., teachers, administration, operation, buildings—and $1,456 for "student's time"—i.e., earnings foregone—or together some $2,000 per student. There are now more than five million students attending grades 10, 11, and 12 of high school. Thus, at present enrollment figures and at 1956 prices and incomes, the nation could save over $10,000 million a year by compressing the curriculum and lowering the school-leaving age from 18 to 15. In future years, with a rising population, rising teachers' salaries, and rising income potentials for every member of the labor force, the social cost of high-school education will increase at an exorbitant rate, and the possible economies resulting from a three-year reduction of the school-leaving age would be of increasing importance.

The economies would be even greater, since the cost of college education would also be reduced in the process. This reduction would be due to the fact that students would attend college at ages 15 to 18, when their potential incomes are not as high as they are at ages 18 to 21. The difference per college student would be about $600 per year at 1956 incomes. For three and one-half million college students, this saving would amount to $2,100 million a year and, of course, this too would increase every year as the number of students and the income potentials of workers increase.

There is, thus, no conflict between the economic and the educational objectives. A system of accelerated schooling is at the same time more effective and less costly. This is one of the rare instances where we really can "get more for less." The proposed acceleration of the school program can permit an acceleration of the economic growth of the nation that could not be attained in any other way. For we would not only save several million man-years annually now wasted in semi-idleness at school, but also several million man-years wasted in the unemployment of those unemployable because of inadequate schooling; and in addition we could progress faster if the bottlenecks now existing because of the want of trained specialists are broken as a supply of younger college graduates becomes available.

The argument presented here is in such conspicuous contradiction to the now prevalent thinking about unemployment and school-leaving age that we must not evade confronting the inescapable objections. We have for several years been suffering from chronic unemployment. If the five million students now attending the last three grades of high school were to join the labor force, would they not almost certainly join the ranks of the unemployed? Even now unemployment is heavy among the very young workers. Is it not sheer humbug to promise a great increase in national product to result from the shortening of the school program if in fact nothing but a huge increase in unemployment will result from it?

This objection has been answered once before (see p. 94), where we distinguished between the problem of a comparison of two systems and the problem of a transition from one to the other. But we must face the problem of transition explicitly and show that this "sudden" transformation of five million school boys into five million unemployed members of the labor force is not in the cards. There can be no question of cutting off the education of those now at school and allowing them to terminate their studies with grades 9 or 10 of the present slow curriculum. An accelerated, compressed, and enriched curriculum must begin at the beginning, with the first grade. Hence it would take nine or ten years until the first students under the new program would be ready to graduate from high school. And they would graduate as much better trained candidates either for college or for the labor market. Rather than causing a glut in the labor market they would, by supplying the better qualified complements of less qualified workers, permit an increase in the rate of employment at that time.

THE PREMISES

Lest all these "campaign promises" sound too fantastic, it may be expedient to restate briefly the premises on which they are based.

(1) Normal children can learn all that is now taught in grades 1 to 12, and even much more, within nine or ten years.

(2) Normal children can start to learn reading, writing, and arithmetic at age 5. Hence, if they could go to kindergarten at age 4 and to first grade at age 5, a ten-year curriculum would normally be completed at age 14.

(3) Certain subjects or materials now taught at ages 10, 12, or even higher can be acquired much more easily by younger children. This is especially true with regard to foreign languages.

(4) To teach, as we now do, in twelve years what could be acquired within nine or ten years implies that we fail to develop satisfactory working habits, adequate powers of concentration, and proper reasoning capacity.

A word or two should be said on each of these four points. The first one was, I believe, adequately discussed and supported by evidence presented in a previous section, when it was shown that many foreign countries do in fact teach a richer program in nine or ten years. (And some schools in this country do it too.) On the second point it may be said that psychological tests have demonstrated that most children are ready for the "three R's" even earlier than at age five. I am not referring to the experiment James Mill carried out on young John Stuart Mill, who started learning Greek at age three and was able to read Greek fables at four. I do refer to the experiments of O. K. Moore, of Yale University, who recently proved with 35 children of Hamden Hall School, Connecticut, that all of them could learn to read, to type, and to print at ages less than three, without any strain, in a spirit of "fun," with enthusiasm and a sense of accomplishment.[59] I also refer to the Gestalt psychologist Max Wertheimer, who showed that a class of seven-year-olds could learn differential calculus (and understand it better than many college graduates). Compared with such achievements, it is most moderate to propose that five-year-olds may go to first grade. To withhold education in the three R's from children below six is a waste of human energy, implies a serious underestimation of their preparedness and capacity to learn, and directs their interests into wrong channels.

In support of the third point one need only call attention to the experience of the hundreds of thousands who have gone abroad, or have come from abroad, with their young children and watched them

[59] *Time*, November 7, 1960. One girl, not quite four, had attained third-grade level of reading, according to this report.

pick up a foreign language without effort and within the shortest time. There are now several elementary schools in the United States experimenting with foreign-language teaching in early grades. (Of course, the teachers should be natives of the country whose tongue they teach, or at least should have lived there for some time.) The results will probably confirm the hypothesis that foreign-language teaching at earlier ages has several advantages: the learning is easier, the incidental effects on general comprehension of concepts may be very wholesome, and much of the "learning time" at ages between 10 and 14, one of the most valuable resources of mankind, is freed for other subjects. (How much would we not be willing to give up for a chance of having an extra four years' of learning time with the learning capacity we had at age ten!) What has been said here about foreign languages probably holds also for various parts of mathematics.

Concerning the fourth point, regarding the loafing the child learns at school because not enough is demanded of him, we might recall the judgment of James Mill, who refused to send his children to school "lest the habit of work should be broken and a taste for idleness acquired."[60] Most teachers and most parents will probably agree that not the idle but the busiest children are the happiest. A sense of accomplishment is the deepest of all satisfactions. A school program which allows the children to loaf deprives them of the lifelong pleasure of having learnt to tackle difficult problems, to work hard at them, and finally solve them satisfactorily.

Why should the school-leaving age be reduced to 14 or 15? What magic is there in these numbers, what makes them preferable to 12, or to 16? The answer is that experience has shown this to be the age at which, on the average, children can have acquired what in this country is called secondary education; and that whenever we have raised the school-leaving age we have simply spread over more years what had been taught in less time. Of course, one *can* learn more in additional years of schooling, especially when "learning" is confused with "absorbing more information." The goal of schooling is not to funnel given amounts of "facts" into the children's brains; it is, instead, to develop their capacity to read, write, calculate, and reason so that they are able to use information intelligently. This goal can be achieved by age 14 or 15 with practically all children who can achieve it at all.

To guard against misunderstanding it should be repeated with all

[60] John Stuart Mill, *Autobiography* (New York: Henry Holt and Company, 1873), p. 36.

the emphasis at my disposal that the proposed acceleration or compression of the learning process does not mean "to cut out the last two or three years of high-school work." Nothing is to be cut out; on the contrary, more is to be put into the curriculum. But the students have to get a faster start and a continuous stretch of their minds.

THREE ALTERNATIVE REFORM PLANS

Those who agree that the present school system is unsatisfactory propose to reform it chiefly along three different lines. Plan A would separate the fast learners from the rest and offer them an *enriched* program. They would, however, stay at school for twelve years, like the rest. Plan B would separate the fast learners and offer them an *accelerated* program. They would be through high school, and ready for college, at earlier ages than the rest. Plan C, and this is what I propose, would require an *accelerated* program *for all students.*

All three systems are superior to the present one. But Plans A and B have certain disadvantages compared with Plan C. If, under Plan B, we allow only the most capable and ambitious to accelerate their school program, we reach a very limited objective, where perhaps ten per cent of the high-school students will graduate earlier and enter college two or three years younger than the rest. They will probably be superior students at college too, better on the average than their older classmates. Precisely this was the experience of the colleges participating in a Ford Foundation experiment of admitting students with only two years of high school. The disadvantage of having such a pluralistic college community, a younger and abler group together with an older and less able one, may not be serious, and to allow a larger number of students than at present to graduate from college at age twenty or younger would be all to the good. But this "reform," limited to perhaps 10 per cent of all high-school students, would not be very far-reaching.

If, under Plan A, we keep the fast learners at school for twelve years, with an enriched program, they would learn at secondary school what they now learn at college. To be consistent, colleges would have to adopt higher standards and thus become *genuine* institutions of higher education. Perhaps this would be the "honest" thing to do, but it would shatter the dreams of half of all American parents. For, if the standards of the college are raised, not 32 per cent (as at present) and certainly not 50 per cent (as the hopes for the future go) of all high-school graduates will be able to qualify for a college education. It would imply the adoption of the European system of limiting higher education to the top 10 per cent or less of the high-school graduates.

Under Plan C, all or most students would leave or complete high school at age 14 or 15. Perhaps half of them could go on to colleges, which would receive students better prepared in English, foreign languages, and mathematics than at present, but which otherwise need not raise standards much above those maintained now. (The prestige colleges, of course, may raise standards and thereby become universities, granting master's and doctor's degrees.) Plan C has the great advantage that it would meet a public demand which has become very strong in recent years. Going to college—or sending one's children to college—has become such an important element of "U.S. democracy," "American equality of opportunity," and the "American standard of living" that we perhaps cannot afford much longer to disappoint so many who believe that those without college education are second-class citizens. This proposal would make it possible for almost every student who is willing to work hard and has an I.Q. of not less than 100 to go to college. I submit Plan C for your serious consideration.

A FEW DETAILS

It would be impolitic to encumber the proposal with too much detail. Perhaps though, to make clear exactly what it implies, we should offer a brief illustrative sketch of the proposed system and a comparison with the present one. The present programs of elementary school, junior high school, and high school, are, in the customary code, either of the 6:2:4 or the 6:3:3 type. The compression of the first twelve years of school into nine or ten years would eliminate junior high school and the new system might be of a 4:5, 5:4, or 5:5 type, beginning preferably at age 5.

The curriculum would have to be stronger than it is now in English, foreign languages, mathematics, and natural sciences. Wherever possible, two or more different ability groups should be established at each grade level, all groups covering the same subject matter but at different depths. Each student should be assigned to his appropriate group according to his performance in the previous semester.[61]

It would, of course, be more than visionary to hope that such a

[61] See *Report of the San Francisco Curriculum Survey Committee*, April 1960, p. 9. This report contains many important recommendations, but does not propose a general acceleration of elementary and high-school education.

radical school reform would be generally adopted immediately and everywhere. But perhaps it is not too much to hope that it be tried out in some school districts. If given a fair trial, the system may prove itself, and thus sell itself to the American people.

AN ENGLISH REPORT: "15 TO 18"

Having put forth a proposal to lower the school-leaving age from 18 to 15, we must face the fact that a group of educators in England have just reported their deliberations on extending secondary school to include the ages 15 to 18.[62] On what grounds do they argue for the extension? Do their arguments apply to the situation in the United States, and do they therefore weaken or destroy our case for a shortening of school life?

According to the Crowther Report—Sir Geoffrey Crowther was Chairman of the Advisory Council—"it is both necessary and practicable greatly to extend . . . the provision made for the education of boys and girls in their later teens."[63]

"Secondary education is . . . essentially the education of the adolescent. . . . Until they are 16, boys and girls need an environment designed for their needs."[64]

"A boy or girl of 15 is not sufficiently mature to be exposed to the pressures of the world of industry or commerce."[65]

"The strongest part of the case is the general need for secondary education for all to 16 extending through the difficult and important period of adolescence."[66]

What is the situation in England which the Crowther Report sets out to improve? By the Education Act of 1944 the minimum school-leaving age was raised from 14 to 15. Two further provisions were written into the Act to be brought into force at some indefinite future: one, extending compulsory full-time education to age 16, the other, extending compulsory part-time education to age 18. The Report recommends that the first of these provisions should come into effect some time between 1965 and 1969; and that soon thereafter "county colleges" should be established for part-time education of the 15- to 18-year-olds who have left school and for whom "part-time day release" from their employment (enabling them to attend county college) should be secured.

[62] Ministry of Education, *15 to 18: A Report of the Central Advisory Council for Education (England)*, Vol. I (London: Her Majesty's Stationery Office, 1959).
[63] *Ibid.*, p. 3. [64] *Ibid.*, p. 116. [65] *Ibid.*, p. 108. [66] *Ibid.*, p. 132.

The Report is emphatic on these points: "We have no thought of recommending the raising of the school-leaving age—that is, the age to which all boys and girls are kept compulsorily at school—beyond 16 or thereabouts. But we are equally convinced that full-time education to 17 or 18 is right for many more boys and girls than now get it."[67]

We must realize that there is an essential difference between England and the United States which explains the recommendations for England's secondary education. Only 10 per cent of all 17-year-olds were in school, in England and Wales, in 1958, and even this was a remarkable progress over 1947, when the percentage was 5.5. Almost 74 per cent of all 17-year-olds were in school in the United States[68] in the period 1957 to 1959, and even back in 1950 the percentage was over 68. Only 25 per cent of the age group 15-17 were in school in England and Wales in 1958; in the same year 90 per cent of the age group 14-17 were in school in the United States.

This difference is so great that from an identical point of view one may find it appropriate that the percentage of 17-year-olds in school be much increased in England and reduced in the United States. As a matter of fact, the proposal outlined above for this country did include the provision that perhaps as many as 50 per cent of those graduating from a much improved secondary school at age 15 (or less) could go on to college. Thus, there would be in the United States a much larger percentage of 17-year-olds in full-time education than in England, where county colleges would provide mainly part-time education while full-time students in the "sixth form" would number at best—that is, after a 100 per cent increase—20 per cent of the age group. Thus, the "Machlup Plan" would have a much greater percentage—two and a half times as great—of the 17-year-olds in full-time education than the "Crowther Report" visualizes for a fast-progressing educational system in England.

Both plans, extended education in England and compressed education in the United States, have the same objective: improved education. Both countries need more better-educated people than are now being produced by their school systems. The way to achieve this in England may well be the one proposed, because there the first ten years of school, from age 5 to 15, are already "compressed" and more intensive

[67] *Ibid.*, p. 124.

[68] Approximately one fourth of the 26 per cent not enrolled in school or college had already graduated from high school and thus had completed the equivalent of 12 years of school. U.S. Department of Commerce, *Current Population Reports*, Series P-20, No. 101, May 22, 1960.

than elementary and secondary education in the United States. The way to get better-educated people in the United States is to make them learn faster, study more intensively, so that a greater percentage of those whose minds will have been stretched through intensive work in earlier years can benefit from a likewise somewhat improved college education.

CHAPTER V · RESEARCH AND DEVELOPMENT

THIS chapter is perhaps the only one in this book intended to deal with knowledge-production in the narrow sense: the production of socially new knowledge. Even in this case, however, disclosure, transmission to others, is essential. Indeed, if socially new knowledge were not transmitted to others we would ordinarily not know that it had come into existence. Thus, research and development combines two knowledge-producing activities: first, new knowledge about how things are, or how things could be made, is originated in the mind of the researcher, discoverer, inventor, or developer; and secondly, this knowledge is produced also in the minds of others.

University professors sometimes think that the word "research" belongs to them, so to speak, because research is a large part of their day's work and often of their nightmares too. They are wrong in their proprietary aspirations, because the word denotes the activities of very many more people outside the campus. College and university research is only a small fraction of what the statisticians put under the heading of "research and development"—about a thirteenth of the total. Of the total R & D (as research and development is commonly abbreviated) in this country, 76 per cent is done by industry, 15 per cent by government agencies, 7 per cent by colleges and universities, and 2 per cent by other nonprofit organizations. This, at least, was the distribution of the R & D expenditures in 1956-1957.

Types of Research and Development Work

Research by scholars in the humanities and in the social sciences is not usually followed by "development work." The dyad—research *and* development—refers more typically to technological creation, because it is here that the scientific findings and technical inventions require technological development for practical, chiefly industrial, application.

Further subdivisions have been found useful, and it has become customary to distinguish basic and applied research. Proposals to subdivide development, for example, into exploratory and specific development, have not been widely accepted, because distinctions that fit the situation of one industry do not fit others. In different industries the relative roles of the refinement of rough ideas, synthesis and combination of research findings, design for manufacture, testing, specifications, systems engineering, evaluations, and other necessary phases of "development" are too different to permit a uniform classification to be used for all. The statistical experts of the National Science Foundation, charged with the task of tracing the flow of R & D money, have long been satisfied with a tripartition: basic research, applied research, development. Very recently they have added "tests and evaluation" as a distinguishable part of development.

BASIC RESEARCH

The general idea behind the distinction between basic and applied research is that basic research creates basic knowledge, on which practical, applicable knowledge may rest but which itself is too general, too broad or too deep, to have direct applications; whereas applied research creates directly applicable knowledge. Vannevar Bush has expressed this as follows: "Basic research results in general knowledge and an understanding of nature by its laws. This general knowledge provides the means of answering a large number of practical problems. The scientist doing basic research may not be at all interested in the practical applications of his work. . . . New products and new processes . . . are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realm of science."[1]

This idea, however, can lead to contradictions, because the end product of basic research cannot be known in advance; the intention and the result may be quite different. There are, therefore, two different and often contradictory groups of definitions: on the one hand, those which "define research in terms of investigators' motives and intent and the conditions under which they work" and, on the other hand, those which relate "not to investigators but to the work itself."[2]

If the statistician has to decide whether a particular sum of money spent by a particular research team should be entered in the column "basic" or in the column "applied" research, he cannot in advance evaluate the nature of the findings which this team may eventually produce. He can at best evaluate what the director of the team says they *intend* to find. For this reason the National Science Foundation has formulated the following definitions: "*Research* is systematic, intensive study directed toward fuller knowledge of the subject studied. Research may be either basic or applied. *Basic research* is directed toward increase of knowledge; it is research where the primary aim of

[1] Vannevar Bush, *Science, the Endless Frontier: A Report to the President* (Washington: 1945), p. 13.

[2] Charles V. Kidd, "Basic Research—Description versus Definition," *Science*, Vol. 129 (13 February 1959), p. 368.

the investigator is a fuller understanding of the subject under study rather than a practical application thereof. *Applied research* is directed toward practical applications of knowledge."[3] But in order to permit inclusion of the small amount of basic research that is performed by industry, the National Science Foundation found it expedient to modify its definition, only for the reports by industrial firms, to indicate that basic research projects represent "original investigation for the advancement of scientific knowledge . . . which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company."[4]

In view of the fact that many experts continue to use definitions in terms of the nature of the research *findings* almost interchangeably with definitions in terms of the *motivation* of the researchers, Dr. Kidd looked for a reconciliation of the apparent contradictions. He found one in the "probability" of success if the appropriate motivations prevail, for "the probability of producing a fundamental finding is greater among those whose thinking is not restricted by a search for application."[5]

APPLIED RESEARCH

While in basic research the investigator looks for general laws, with no regard to practical use, in applied research he looks for results which promise to be of ultimate use in practice. Better understanding of the physical or organic world is the goal of basic research, better products or better ways of making them are the goals of applied research. This sounds like a rather clear contrast between the two, but in reality the borderline cases are very numerous and the classifiers have a hard time filling out the report forms. The difficulties are especially great where "intentionally basic" research has resulted in new substances or devices, and where "intentionally applied" research has resulted in a better understanding of physical or organic phenomena. Examples of the first sort are fundamental chemical investigations which, as an unintended, sweet by-product, yielded saccharine, or the studies in solid-state physics which, not quite unintentionally, produced the transistor.

With regard to research in university laboratories it is often possible

[3] National Science Foundation, *Reviews of Data on Research and Development*, No. 17, NSF-60-10 (January 1960), p. 5.

[4] National Science Foundation, *Reviews of Data on Research and Development*, No. 22, NSF-60-43 (August 1960), pp. 1-2.

[5] Charles V. Kidd, *op.cit.*, p. 370.

to accept the divisional lines in university administration as the lines between the two types of research. The physics and chemistry departments in the division of arts and sciences are usually engaged in basic research, while the electrical and chemical engineering departments in the engineering school perform applied research. But there are important exceptions to this rule. I recall, for example, very pure and fundamental research in turbulence undertaken by an aeronautical engineering department. And many other researchers in engineering schools have strong claims on having their projects recognized as basic research.

Research undertaken by industrial firms should be presumed to be applied research. The National Science Foundation has found that "respondents often appear to be guided by their own interpretations because of the abstract nature of basic research and because of an element of arbitrariness in identification of the borderline in the 'gray' area between basic and applied research."[6] Only a very few of the largest corporations maintain basic-research departments, where scientists work on problems of their choice, free from executive restrictions and free from pressures to produce results useful to their company. It has been said that the atmosphere of industrial research laboratories changes the attitudes of even the "purest" scientists and makes within a few years patent-minded materialists out of the most idealistic ex-inhabitants of academic ivory towers. If a firm, therefore, is really interested in maintaining basic research, it must either recreate in its own laboratories the atmosphere of a self-governing university faculty or let its scientists spend much of their time on university campuses.[7]

To describe the difference between basic and applied research, it has been suggested that the former is after discoveries, the latter after inventions. There is much to be said for this suggestion; as I see it, the concepts of "inventive activity" and "applied research" overlap to a large extent. But neither the official definitions nor the private ones favored by industrial research laboratories accept the suggestion. The National Science Foundation in its instructions for the 1957 survey restricted *applied* research to "research projects which represent investigation directed to discovery of new scientific knowledge and which

[6] National Science Foundation, *Reviews of Data on Research and Development*, No. 22, NSF-60-43 (August 1960), p. 2.

[7] A minimum requirement for successful performance of basic research in industry is a blending of "colleague authority" with "executive authority." See Simon Marcson, *The Scientist in American Industry* (Princeton University, Industrial Relations Section, 1960), pp. 121ff.

have specific commercial objectives with respect to either products or processes." In addition, the logical nature of discovery is not so clear as many have assumed, and we shall find it worthwhile later to examine the underlying ideas.

DEVELOPMENT

Even more difficult than the distinction between basic and applied research is the separation between the latter and development. Yet, not only the question where development begins is hard to answer; the question where it ends is equally troublesome.

The official definition until 1958 was as follows: "*Development* is the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, methods, or processes, exclusive of design and production engineering." This was changed to include "design and development of prototypes" and to exclude only "quality control or routine product testing." In any case, in contrast to applied research, which is still designated as "investigation," development is called "technical activity." Specifically it is described as "technical activity concerned with nonroutine problems which are encountered in translating research findings or other general scientific knowledge into products or processes." With regard to the question "when does development end and production begin?" it is stated that "If the primary objective is to make further improvements on the product or process, then the work comes within the definition of research-development. If, on the other hand, the product or process is substantially 'set,' and the primary objective is to develop markets or to do production planning, or to get the production process going smoothly, then the work is no longer research-development."[8]

The term "research-development" is a poor one, for it is not the research that is developed; instead, the *findings* of research, together with old ideas, technological possibilities and inventions, are developed for use in production. Indeed, the term "development" was used much earlier in connection with inventions than with research. It had been found that few inventions can ever be "reduced to practice" just as they are described in patents or other publications. Raw inventions have to be further developed before they can be used. This is not just a matter of incomplete disclosure—which would invalidate a patent—but a matter of practical technology. There is a long way from the

[8] National Science Foundation, *Methodology of Statistics on Research and Development*, NSF-59-36 (Washington, 1959), pp. 75, 124, 126.

sketch, schematizing how the invention is supposed to work, to the blueprints and specifications for the construction of the productive facilities. This long way includes experimentation, design and development of prototypes, scale models, testing, the construction of pilot plants, studies for the use of pilot-plant experience in large-scale production, and a great many new problems, new solutions, redesigning, retesting, etc., at every step of the process. When development designates the sum total of all the steps taken between invention and production, it becomes a little easier to determine where it begins—especially if the invention is patented, so that the patent application marks the end of the inventive work and the beginning of the development work.

The line between research and development is much harder to draw than the line between inventive work and development work. Nor does any such line fit the situation of all industries. Take, for example, the complications concerning research and development in the telephone industry. The Bell Laboratories find it necessary to distinguish several types of investigative activities between research and development. Research is followed by "exploratory development," defined as "the refinement, synthesis, and combination of the results of research," carrying the investigation to the point where the fundamental behavior of all "components, devices, and systems" is sufficiently understood that their technical feasibility can be evaluated. Separate from these explorations is "systems engineering," designed to aid in the selection of the most worthwhile projects for development. Its functions are to study the compatibility of new components and devices with existing ones, to set up specific requirements for this purpose, to evaluate alternative plans, and to forecast development costs and the economic results of the eventual system. Only after all these steps can "specific development and design for manufacture" begin.[9] That these intermediate steps between research and development are by no means of minor importance can be seen from the fact that "research" is only a relatively small part of the Bell Laboratories and "development" is left to the Western Electric Company. Hence, the bulk of the work of the laboratories is in the area between research and development. Of course, for the statistical reports these activities have to be put under one of the two headings even if this is against the conceptual convictions of those in charge of completing the report forms.

[9] Milton L. Almquist, *Systems Engineering at Bell Telephone Laboratories*, American Management Association, Special Report, No. 24.

TESTS AND EVALUATIONS

The relative importance of tests and evaluations in R & D can be seen from the difference which their inclusion made to total expenditures. The figures for government expenditures for tests and evaluations were first obtained in 1958, and for the first two years total government expenditures for R & D were published both with and without the addition. Expenditures including those for tests and evaluations exceeded expenditures without them by 33 per cent in 1958 and by 51 per cent in 1959.

There is no question about the justification of the inclusion of this item. Surely, tests and evaluations must be made before one may undertake to introduce any of the technological novelties in the actual production program. These tests are not routine checks within the production process; they are the "final examination" which the "candidates for innovation," for introduction to production, must pass in order to demonstrate that the development process has been successfully completed. Hence, these tests and evaluations are the final steps within, and thus integral parts of, development, and their costs are a legitimate part of R & D expenditures.

Expenditures for Research and Development

In presenting the story of the enormous growth of R & D, from "early" times—twenty or thirty years ago—to the present, one has the choice of beginning with time series of aggregate expenditures or with separate accounts of the constituent parts. Having just spoken about the major divisions of R & D—basic research, applied research, and development—it seems more appropriate to begin with the parts rather than the whole.

BASIC RESEARCH

Although expenditures for basic research almost doubled in the five-year period from 1953-1954 to 1957-1958, their share in total R & D budget remained stable during these years: 8 per cent. This stability was the result of a relative increase in government performance and a relative decline in industry performance of basic research. In 1953-1954 (which is chiefly the calendar year 1953), basic research amounted to 5 per cent of the total R & D performed by the federal government and 4.1 per cent of that performed by industry. In the year 1957-1958 (chiefly 1957), the government performance was 8 per cent and industry performance 3.6 per cent of the respective totals.

Chief performers of basic research were neither the government nor industry. Colleges and universities, as one would expect, did most of the basic research, largely with government money, of course; they did 48 per cent of all basic research in 1953, and 47 per cent in 1957.

TABLE V-1

EXPENDITURES FOR BASIC RESEARCH, 1953-1954 AND 1957-1958

	Sources of funds					*Uses of funds*			
Year	Federal govern-ment	Indus-try	Univer-sities	Other non-profit	*Total*	Federal govern-ment	Indus-try	Univer-sities	Other non-profit
					(in millions of dollars)				
1953-1954	195	147	62	28	432	47	151	208	26
1957-1958	423	249	111	52	835	111	272	392	60
					(per cent of total)				
1953-1954	45	34	14	7	100	11	35	48	6
1957-1958	51	30	13	6	100	13	33	47	7

SOURCE: National Science Foundation.

Table v-1 presents a breakdown of all expenditures for basic research according to sources and uses of funds, for the years 1953 and 1957, the two years on which good information is available. Who *did* the basic research is shown on the right side, who *paid* for it is shown on the left side. The first two lines give the amounts in millions of dollars, the next two lines in percentages of the total. In both years, government agencies were the biggest source of funds, colleges and universities the largest users of funds for basic research.

Not all the R & D expenditures of colleges and universities are for basic research; in 1957, only 51 per cent were. Lest one wonders why even institutions of higher education were doing so much applied research, we should explain that several of them administer large research centers, most of them off campus, under contracts with federal agencies, chiefly the Atomic Energy Commission and the Defense Department, and that about three fourths of the work in these centers is applied research and development. In 1957-1958, 18 universities maintained 28 federal-contract-research centers. This research, it should be noted, is not connected with graduate training, and indeed competes with it by draining the teaching faculties of some of their personnel. Less than

5 per cent of the scientists employed in these centers were active members of the teaching faculty of the parent universities.[10] They were potential teachers, engaged in full-time research, not in close proximity to students.

In 1958-1959 the expenditures for basic research were $1,016 million, and in 1959-1960 they were $1,150 million—9 per cent of total R & D expenditures in both years. The funds, in 1958-1959, came from the following sources: $565 million from the federal government, $275 million from industry, $118 million from colleges and universities, and $58 million from other nonprofit institutions.

The smallness of the share of basic research in the total R & D budget of the nation should be noted again. Many scientists have raised their voices about the misallocation of scarce resources, involved in this poor 8 or 9 per cent ratio of basic research to total R & D.

APPLIED RESEARCH

The expenditures for applied research, although much larger than those for basic research, are modest compared with those for development; they vary between one tenth and one fourth of the development costs in different industries. For all industries together, 19.2 per cent of the total R & D budget in 1956 went to applied research, as against 3.9 per cent for basic research and 76.9 per cent for development. In 1957 about 21 per cent of the total went to applied research.

The share of applied research in the national R & D effort—not just the industrial—was not too dissimilar. In 1959-1960, 22.6 per cent of total expenditures were for applied research (as against 9.1 per cent for basic research and 68.3 per cent for development).

An analogous breakdown of federal government obligations for R & D shows an even lower appropriation for applied research: between 12 and 14 per cent of the total. The difference may be surprising at first blush, since most government obligations for R & D are for performance by industry. The explanation becomes clear when one examines the breakdown by particular industries. There one may observe that the industry using the greatest portion of government funds for R & D, the aircraft industry, spent in 1956 and 1957 only between 8 and 13 per cent for applied research, but between 85 and 90 per cent for development. On the other hand, the chemical industry, which finances almost all of its R & D without government funds, spent 42

[10] National Science Foundation, *Reviews of Data on Research and Development*, No. 23, NSF-60-61 (October 1960).

per cent and more for applied research and approximately 48 per cent for development.

DEVELOPMENT

The high cost of development in the aircraft industry becomes understandable as soon as one realizes that this includes missiles, rockets, and space capsules. The aircraft industry is far and away the largest performer of R & D, with expenditures amounting to $2,125 million in 1956 and $2,540 million in 1957—almost one third of all industrial R & D and one fourth of national R & D expenditures.[11] But also in several other industries development absorbs between 74 and 79 per cent of the respective R & D budgets. In this bracket are electrical equipment, machinery, and the mixed group "other manufacturing industries." For all industries together, development costs amounted to 77 per cent of total R & D expenditures.

The share of development costs in national (rather than purely industrial) R & D expenditures is a little smaller, as we have noted. In 1959-1960 it was, with total development expenditures of $8,620 million, 68.3 per cent. On the other hand, we see again the higher percentage figure for development cost appearing in the breakdown of government obligations for R & D during 1958-1960. Table v-2 contains two additional items, not allocated to any of the three categories of R & D: the "pay and allowances of military personnel engaged in research and development" and the outlays for new R & D plant. The latter outlays are stated separately from the expenditures for "conduct" of R & D, in order to permit capital outlays for construction to be kept apart from current expenses. (The data for capital outlays, we are warned, are seriously underestimated.)

In connection with the presentation of these data on government expenditures for R & D it may be stated that the numerous inconsistencies between different statistics for the same years hold many frustrations for the user of this information. The reasons for the inconsistent reports lie in the differences between (1) "obligations" to spend, which are incurred when contracts are let and budgets are made, (2) actual "expenditures," which include funds transferred to others for performance of R & D, but often do not include R & D expenditures financed from production and procurement funds, and (3) expenditures re-

[11] By 1960 the expenditures for R & D in the aircraft industry had increased to $3,482 million, again about one third of all industrial and one fourth of all national R & D expenditures.

ported by the recipients of such government funds used for the conduct of R & D, who include under R & D amounts which the government has reported as procurement cost rather than R & D expenditure.

TABLE V-2

FEDERAL GOVERNMENT OBLIGATIONS FOR RESEARCH AND DEVELOPMENT, BY CHARACTER OF WORK, 1958-1960

	1958		1959[a]		1960[a]	
Character of work	Expenditure (million dollars)	% of expenditure on "total conduct"	Expenditure (million dollars)	% of expenditure on "total conduct"	Expenditure (million dollars)	% of expenditure on "total conduct"
Basic research	331	6.0	488	6.7	494	6.4
Applied research	703	12.7	956	13.2	1,109	14.4
Development	4,320	78.0	5,592	77.3	5,903	76.7
Military personnel[b]	188	3.4	197	2.7	195	2.5
Total conduct of R&D	5,542	100.0	7,233	100.0	7,701	100.0
Expansion of R&D plant	336	6.1	662	9.2	447	5.8
Total obligations for R&D	5,878	106.1	7,895	109.2	8,148	105.8

SOURCE: National Science Foundation, *Federal Funds for Science.*

[a] Estimated.

[b] The pay and allowances of military personnel engaged in research and development are not broken down by the character of work.

THE GROWTH OF TOTAL EXPENDITURES

Even if it may not be true that no other industry or economic activity has ever grown as fast as R & D, this growth has certainly been phenomenal. Early estimates of R & D expenditures[12] are rather unreliable, but may indicate sufficiently well the order of magnitude for comparison with recent, more reliable estimates:[13] \$80 million in 1920, \$130 million in 1930, \$377 million in 1940, \$2,870 million in 1950, \$14,000 million in 1960.[14] If the 1920 figure is correct, R & D expenditures have increased 175 times over a period of 40 years. If the 1940 figure is correct, the growth in the 20 years to 1960 was 3,714 per cent, which corresponds to an annual growth rate of 19.8 per cent. Even relative to the gross national product the increase has been remarkable: the

[12] Vannevar Bush, *Science the Endless Frontier* (Washington, 1945), p. 80.

[13] National Science Foundation.

[14] The 1960 estimate is for the "hyphenated year" 1960-1961, i.e., for an aggregate of data for 12-month periods beginning in 1960. In other words, what in some NSF reports is called 1960—see, for example, No. 30 (September 1961)—would by other reporters be called "fiscal year ending 1961." The data are for the calendar year 1960 or for a fiscal year beginning in 1960.

expenditures were 0.09 per cent of GNP in 1920, 0.14 per cent in 1930, 0.37 per cent in 1940, 1.01 per cent in 1950, and 2.78 per cent in 1960. In other words, the relative portion of our gross product that we devote to research and development has risen to almost 7½ times what it was 20 years ago, and to almost 20 times what it was 30 years ago. Such a huge increase can be explained mainly by the fact that organized research and development has been a very recent "development," gathering momentum only in the Second World War with the crash programs for the development of weapons and other defense materiel. This new research-mindedness was then carried over from defense production to industry in general.

The role of the government in promoting this growth is too conspicuous to be overlooked. Even as far back as 1920, if the data for that time can at all be used as approximations to actual facts, the government paid for not much less than half the R & D; it paid for more than half in 1930, and also in every year from 1943 to 1955. While the statistical series reproduced in Table v-3 gives lower percentages for the government contribution after 1955, the data published by the National Science Foundation—see Table v-4—show further increases, reaching almost 66 per cent in 1959-1960.

The series of R & D expenditures by sources and uses of funds from 1941 to 1958 which is presented in Table v-3 suffers from several defects, but it gives a general impression of the growth that could not be seriously false even if every figure in the first ten years were 20 or 30 per cent off. Such inaccuracies would be quite possible, the way the data are derived, for they are the product of two guesses: a crude estimate of the number of scientists and engineers employed in R & D was multiplied by a crude estimate of average salaries and incidental expenses to obtain total expenditures. With this warning we feel no serious compunction in reproducing the table, but the user should never forget the questionable origin of the data.

The data published by the National Science Foundation for the years since 1953 are based largely on surveys with carefully checked and cross-checked reports from both the performers of R & D and the agencies supplying funds for it. Even so, comparability of the figures is imperfect because the definitions were changed in the course of the years. For 1954, 1955, and 1956 no "sector surveys" were made, so that the data had to be derived from related information. Table v-4 presents the complete series for the eight years.

Industry remains the chief performer of R & D and indeed even

TABLE V-3

EXPENDITURES FOR RESEARCH AND DEVELOPMENT, 1941-1958

Year	*Sources of funds* Govern-ment	Industry	Univer-sity	*Total*	*Uses of funds* Govern-ment	Industry	Univer-sity
			(millions of dollars)				
1941	370	510	20	900	200	660	40
1942	490	560	20	1,070	240	780	50
1943	780	410	20	1,210	300	850	60
1944	940	420	20	1,380	390	910	80
1945	1,070	430	20	1,520	430	990	100
1946	910	840	30	1,780	470	1,190	120
1947	1,160	1,050	50	2,260	520	1,570	170
1948	1,390	1,150	70	2,610	570	1,820	220
1949	1,550	990	70	2,610	550	1,790	270
1950	1,610	1,180	80	2,870	570	1,980	320
1951	1,980	1,300	80	3,360	700	2,300	360
1952	2,240	1,430	80	3,750	800	2,530	420
1953	2,490	1,430	80	4,000	770	2,810	420
1954	2,460	1,600	80	4,140	700	3,020	420
1955	2,720	2,600	80	5,400	1,000	3,950	450
1956	3,170	3,250	80	6,500	1,110	4,920	470
1957	3,750	4,300	150	8,200	1,370	6,280	550
1958	4,430	5,600	200	10,230	1,380	8,100	750
			(per cent of total)				
1941	41	57	2	100	22	73	5
1942	46	52	2	100	22	73	5
1943	64	34	2	100	25	70	5
1944	68	30	2	100	28	66	6
1945	70	28	2	100	28	65	7
1946	51	47	2	100	26	67	7
1947	51	47	2	100	23	69	8
1948	53	44	3	100	22	70	8
1949	59	38	3	100	21	69	10
1950	56	41	3	100	20	69	11
1951	59	39	2	100	21	68	11
1952	60	38	2	100	21	68	11
1953	62	36	2	100	19	70	11
1954	59	39	2	100	17	73	10
1955	50	48	2	100	19	73	8
1956	49	50	1	100	17	76	7
1957	46	52	2	100	17	76	7
1958	43	55	2	100	14	79	7

SOURCE: Department of Defense, Office of the Secretary. See *Statistical Abstract of the United States 1960* (Washington, 1960), p. 538.

TABLE V-4

FUNDS FOR RESEARCH AND DEVELOPMENT, 1953-1960
(millions of dollars)

Year	Sources of funds				Total	Uses of funds			
	Govern-ment	Industry	Univer-sities	Other nonprofit		Govern-ment	Industry	Univer-sities	Other nonprofit
1953-54	2,740	2,240	130	40	5,150	970	3,630	450	100
1954-55	3,070	2,365	140	45	5,620	950	4,070	480	120
1955-56	3,670	2,510	155	55	6,390	1,090	4,640	530	130
1956-57	5,095	3,265	180	70	8,610	1.280	6,540	650	140
1957-58	6,380	3,390	190	70	10,030	1,440	7,660	780	150
1958-59	7,170	3,620	190	90	11,070	1,730	8,300	840	200
1959-60[a]	8,290	4,030	200	100	12,620	1,830	9,550	1,000	240
1960-61[a]	9,220	4,490	210	120	14,040	2,060	10,500	1,200	280

SOURCE: National Science Foundation, November 1961 and April 1962.
[a] Preliminary.

increased its share from 70 per cent of the total in 1953 to 76 per cent in 1957, and about the same in 1960. Industry's financial contribution to total R & D expenditures is differently estimated by the two sources. It increased from 36 per cent in 1953, to 39 per cent in 1954, 52 per cent in 1957, and 55 per cent in 1958, according to the estimates of the Department of Defense; it decreased from 44 per cent in 1954 to 38 per cent in 1957, and 37 per cent in 1958, according to the estimates of the National Science Foundation. Hence, one could surely not say that a trend has been established one way or the other.

In absolute terms, however, the amounts of dollars appropriated by industry to R & D have been going up year after year. Indeed, research by industry has become so popular that its allocations to R & D serve almost as public-relations techniques. Consumers seem to be more favorably impressed by reports on research activities of particular firms than by the quality of TV programs sponsored by them. Stock-market analysts seem to use the research budgets of corporations as a sort of index of future performance of profits and they refer to the growth of R & D appropriations as a criterion when they designate the shares of these firms as "growth stock." But regardless of the sincerity of the belief in the profitability of R & D, there is no doubt that management gives it extensive treatment and publicity in the annual reports of the corporations. In some instances, the sincerity of the belief cannot be doubted, especially when large research expenditures of past years have paid off rather well. The DuPont Company is a case in point. According to their annual reports, DuPont's research expenditures increased from less than one million dollars per year during World War I (1915-1918) to six million in 1930, to $38 million in 1950 and to $96 million in 1960. In a few other instances the increase has been even steeper, especially where specialized research corporations were newly established and achieved remarkable success within a few years.

SCIENTISTS AND ENGINEERS IN RESEARCH AND DEVELOPMENT

Growth rates relating to current dollar expenditures are deceptive in a period of inflation. If the real performance of R & D had not changed at all, the dollar expenditures would have more than doubled in the periods under examination. Since the actual dollar figures have increased exponentially, corrections for the price and income inflation cannot change the growth picture too drastically. But it would be desirable to see how the labor input in R & D has behaved over the years.

Statistics of the number of research employees have been compiled for various periods by different agencies. Unfortunately, the data are not easily comparable and are deficient in several respects. The figures for certain years between 1920 and 1938, published by the National Research Project of the Works Progress Administration in 1940, are notoriously incomplete. But merely to give an impression of the early growth, we may state that 7,367 research workers were reported as having been employed by industrial laboratories in 1920, and 44,292 in 1938. The National Research Council, using improved report forms, adjusted the 1938 figure to 49,467 and obtained a figure of 70,033 for 1940—nearly ten times the 1920 figure. All these figures include technical, clerical, and administrative personnel besides professional staff. Continuing this all-inclusive series, estimated by other agencies, the research personnel increased to 138,500 in 1946, to 187,000 in 1951, to 440,000 in 1954, and to 618,600 in 1957. It is safe to say that the figure for 1960 would be about 100 times that of 1920.

More interesting than the data on such a mixed bag of people are those for professional personnel only. A series prepared by the Department of Defense on "research and development scientists and engineers in government, industry, and universities and other nonprofit organizations" presents annual figures beginning in 1941. The number of scientists and engineers in R & D is given as 87,000 in 1941, 122,000 in 1946, 151,000 in 1950, and 192,000 in 1953. Comparing these figures with the expenditures figures estimated by the same agency, we find that the amount spent per professional worker was assumed to be approximately $10,340 in 1941 and approximately $20,830 in 1953. These amounts would include the scientist's or engineer's salary, the salaries of the technical, clerical, and administrative workers who assist him, the materials and supplies, and the annual cost of all instruments, apparatuses, and plant.

For the number of scientists and engineers in research and development work conducted by industry other estimates are available for individual years. They probably are not comparable, but if, forgetting all caution, we use them nevertheless, we find a figure of 37,000 persons in 1940, 70,577 in 1950, 157,300 in 1954, 222,800 in 1957, and 277,000 in 1959. Although the last three figures were published by the National Science Foundation, they do not seem to be consistent with the expenditure estimates. The amounts spent per scientist or engineer would have been $23,080 in 1954, $28,900 in 1957, and $30,690 in 1959. Since it is well known that salaries increased considerably after 1954, and certainly more than the above amounts would indicate between 1957 and 1959, one must conclude that the number of scientists and engineers in industrial R & D cannot have increased as much as the employment figures indicate. Since the 1959 figure is probably the most reliable, the 1954 and 1957 figures were evidently understated.[15] This is admittedly the case for 1954, when very small companies were not included, but the understatement for 1957 must have been even worse. Another explanation may possibly, though not likely, be found in an upgrading of research personnel from technical to professional staff. This can happen under given definitions, since scientists and engineers are defined as "all persons engaged in scientific or engineering work at a level which requires a knowledge of engineering, physical, natural or mathematical sciences equivalent at least to that acquired through completion of a 4-year professional college course." Work experience is sometimes regarded as "equivalent" to college education and thus it *may* happen that research employees after several years of experience as technicians are upgraded as professional research workers.

The ratio of supporting personnel per professional staff member is remarkably stable. Although the distribution of R & D personnel among technicians, craftsmen, and other supporting personnel (including clerical) changed in particular industries, it was the same—or assumed

[15] The National Science Foundation has just published new estimates. The number of R & D scientists and engineers in industry is now given as 164,100 for 1954 and 239,500 for 1958. See Table v-5 below. I acknowledge the assistance of the Office of Special Studies, National Science Foundation, headed by Jacob Perlman, and the cooperative spirit in which my requests for data were answered.

to be the same—for all industries in 1954 and 1957. In both years there were 70 technicians, 50 craftsmen, and 60 other employees, together 180 persons in the category of "supporting personnel," employed per 100 R & D scientists and engineers. The totals in 1957 were 157,400 technicians, 100,400 craftsmen, and 136,900 other personnel supporting 222,800 scientists and engineers, or a total R & D personnel of 618,600.

If the estimates for 1954 and 1957 are accurate, or underestimated by the same percentage, they show an increase of 41.6 per cent over the three years. The increase for particular professional occupations among the scientists was even greater. Physicists in the industrial R & D laboratories increased by 50 per cent, and mathematicians by over 70 per cent. That this increase must have increased the shortage of science and mathematics teachers in schools, colleges, and universities is another matter, to which we shall return later in this chapter.

TABLE V-5

SCIENTISTS AND ENGINEERS IN RESEARCH AND DEVELOPMENT, 1954 AND 1958

	Fields of Specialization				*Sectors of Employment*			
Year	Engineering	Physical sciences	Life sciences	*Total*	Federal govern-ment	Industry	Colleges and uni-versities	Other nonprofit
1954	138,600	63,700	20,900	223,200	29,500	164,100	25,200	4,400
1958	207,500	86,100	33,500	327,100	40,200	239,500	42,000	5,400

SOURCE: National Science Foundation, *Reviews of Data on Research and Development*, No. 29, NSF-61-49 (August 1961); No. 33, NSF-62-9 (April 1962); and revisions as yet unpublished.

The most recent estimates of civilian scientists and engineers engaged in R & D—not only in industry, but also in government, colleges and universities, and other nonprofit institutions—are reproduced in Table v-5. The total increase from 1954 to 1958 was from 223,200 to 327,100 scientists and engineers—i.e., 47 per cent. The largest increase, 67 per cent, occurred in colleges and universities, but it must be remembered that this sector includes the research centers which are, separated from teaching campuses, administered under contract with federal agencies. The number of R & D scientists and engineers in industry increased by 46 per cent over the four years.

Inventive Effort and Patent Protection

More than half of the research and development work is being paid for by the federal government, according to the National Science Foundation. Private industry paid for less than 32 per cent of total R & D in 1959. Since private enterprise is run for profit, one may assume that most of the R & D cost by industry was incurred in the hope that this outlay would pay off, by yielding results which would increase profits, or avoid the reduction of profits, in the future. In some of the considerations concerning industrial R & D and company profits the patent system may play a role, though this is by no means certain. In any case, since a connection between patent protection for inventions and industry finance of research and development has often been asserted, a discussion of inventive effort and patents is in order. Some preliminary reflections on invention will facilitate the exposition.

DISCOVERY AND INVENTION

All research and development activities are motivated by the desire to produce new knowledge, scientific or technological.[16] The production of new scientific knowledge is often called "discovery" and the production of new technical knowledge "invention"—though both these terms are sometimes reserved only for radically new knowledge, not for slight modifications or improvements. But the distinction is not always observed, and those who do not abide by it can claim that this contrast between discovery and invention is not well supported either by tradition or on methodological grounds.

The word "invention" is used in at least three different fields of knowledge: the useful arts, the fine arts, and the pure sciences. It always means, as the Latin word suggests, to "come upon" or "find" something. In the useful arts it means the finding of solutions to technological problems; in the fine arts the finding of aesthetically interesting possibilities; and in the sciences the finding of logically consistent theories which are interesting possibilities for explanatory purposes. In all cases inventing does not mean "coming upon something that has existed" but rather "making something with the mind."[17] It means creation of important ideas hitherto not known to be known by anybody.

In contrast to this "mental finding" of something not previously existing, "discovery" is to find something that has existed. One can discover only what has been existing, though hidden or for other reasons unseen. This contrasting use of the two terms is not traditional, how-

[16] The author uses, as readers of earlier chapters may remember, the word "knowledge" in an unusually wide sense—for anything that is known, general or particular, abstract or concrete, enduring or ephemeral, useful or useless.

[17] William Calvert Kneale, "The Idea of Invention," *Proceedings of the British Academy*, Vol. 41 (London, 1955), p. 101.

ever. For example, Cicero's book *De Inventione* deals with the finding of arguments, new or old, and Leibniz meant by *logica inventiva* the logic of discovery.

Even those who wanted to stress the difference between discovery and invention have used sometimes rather poor differentiating criteria. Thus the categories "idea" and "matter" have been thought to underlie the difference. Some have assumed that invention must always be embodied in material objects, and discovery confined to an abstract idea, such as a "law of nature." Others, paradoxically and yet more logically, have held that discovery, since it refers to the finding of something existing, must relate to something one can perceive by use of the senses, and invention, by contrast, to a creative idea. This differentiating principle, therefore, leads to contradictory conclusions.

Another difference that has been proposed relates to the types of person who would be apt to make discoveries, on the one hand, or inventions, on the other. Scientists would make discoveries, engineers would make inventions. Again this does not hold even approximately. The continent America was discovered, not by scientists, but by seafaring explorers and adventurers. The infinitesimal calculus was invented, but not by an engineer. Even the widely held opinion that "laws of nature" are discovered, not invented, is rejected nowadays by most philosophers of science. Scientific theories are proposed, tentatively accepted, and later replaced by better theories; how could one reasonably say that a law was "discovered" if some time later one finds that this law is not verified and, hence, has not "existed"? Theory formation is the creation of mental models and therefore essentially the result of invention, not of discovery.

We mentioned earlier in this chapter that many have assumed basic research to be directed toward discovery, applied work toward invention. This notion has sometimes been used to support the juridical distinction between finding laws of nature, which are not patentable, and finding technological recipes for production, which are patentable. The distinction is legally and economically important, but its methodological justification is not tenable. Modern logicians speak of the discovery of empirical regularities, but of the invention and construction of theoretical models. We discover by using our sense organs, we invent by using our imagination and reasoning power. In slightly different words, we discover, by means of our faculty of perception, what has been there before, though unnoticed; we invent, by means of our faculty of mental construction, something new and of importance, scientific, artistic, or technological.

Artistic invention, in music and in the visual arts, is outside the scope of this chapter, except to the extent that aesthetic sense and artistic vision guide scientific creation. Scientific invention in theory formation is part of the subject of this chapter inasmuch as basic research aids in and is aided by the construction of explanatory theoretical models. But the focus of our interest is upon technological invention, not that we put engineering above scientific investigation, but because society allocates to technical inventive activity many times the resources that it devotes to scientific work.

TECHNOLOGICAL INVENTIONS AND IMPROVEMENTS

A technological invention is a big step forward in the useful arts. Small steps forward are not given this designation; they are just "minor improvements" in technology. But a succession of many minor improvements add up to a big advance in technology. It is natural that we hail the big, single step forward, while leaving the many small steps all but unnoticed. It is understandable, therefore, that we eulogize the great inventor, while overlooking the small improvers. Looking backward, however, it is by no means certain that the increase in productivity over a longer period of time is chiefly due to the great inventors and their inventions. It may well be that the sum total of all minor improvements, each too small to be called an invention, has contributed to the increase in productivity more than the great inventions have. I do not know of any systematic study of the technological progress of an industry, except Gilfillan's book on shipbuilding.[18] In this industry, he shows, progress has been the result of gradual evolution by innumerable small improvements, rather than of any revolutionary changes or even specific "cardinal" inventions clearly attributable to particular inventors.

One can probably point to some industries in which the development was different and most technological changes can be attributed to inventions by individual men or particular teams. It has been asserted, however, that technological progress on the whole might not have been much slower if the great inventive geniuses to whom the important inventions are credited had never lived. The same inventions, so it is said, would have been made by others without serious delays. The only

[18] Seabury Colum Gilfillan, *Inventing the Ship* (Chicago: Follett Publishing Company, 1935).

proof offered for this hypothesis is the large number of "multiple" inventions made almost simultaneously by two or three men, working independently from one another. The sociologist Ogburn reported his count of 148 such cases, all relating to great, revolutionary inventions.[19] The implication is that for more ordinary inventions one may assume such a high degree of "substitutability" between inventors that none of them is indispensable. In other words, if one inventor did not make a certain invention today, another would make it tomorrow. To be sure, there have been great inventive geniuses, but the real difference between them and the lesser lights may be chiefly this: the genius either is so far ahead of his time that his invention cannot be used until much later, when others might have come upon it too, or he invents single-handed, or single-minded, what otherwise might have been the joint work of a group of less outstanding men.[20] This view of the inventive process and the history of inventions is analogous to the view held by a school of thought in general history, which wants to play down the role of "great men" in shaping the political history of nations and place much more emphasis on "social forces" of anonymous composition.

On the side of the school that explains the progress of technology as a result of social institutions and social forces, without much credit being given to great men and their great inventions, are several scientists and social theorists who point to the fact that usually the supply of inventions has readily responded to demand. Whenever there was a notorious need for a particular novel technique, say, because of shortages of some means of production previously indispensable or because of rapid increases in the demand for some product, inventions taking care of that need were forthcoming before long. Justus von Liebig, founding father of organic chemistry, and William Edward Hearn, a once well-known but now forgotten 19th-century economist, were two among many authors particularly eloquent on this point.[21] A rather obvious objection to this view may be that the emergence of an invention in response to a strong demand for the technology in question is duly recorded and commented upon, whereas the instances, however

[19] William F. Ogburn and Dorothy Thomas, "Are Inventions Inevitable?" *Political Science Quarterly*, Vol. XXXVII (1922), pp. 83-98.

[20] S. C. Gilfillan, *The Sociology of Invention* (Chicago: Follett Publishing Company, 1935), pp. 72-78.

[21] Justus von Liebig, *Letters on Chemistry*, cited by William Edward Hearn, *Plutology: Or the Theory of the Efforts to Satisfy Human Wants* (London: Macmillan, 1864), pp. 187ff.

numerous, in which no inventions are forthcoming to satisfy the demand remain unheralded.

The side which stresses the individual contributions of creative geniuses can point to one of the greatest, Leonardo da Vinci, who made hundreds of inventions, many however too far ahead of his time to be of practical usefulness in his period. But there have been prolific inventors in more recent periods who obtained patents that proved eminently successful in commercial use. F. W. Lanchester had over 400 patents, chiefly in aerodynamics and mechanical engineering; Carleton Ellis had over 800 patents on chemical inventions; and Thomas Alva Edison, whose invention of the electric incandescent lamp in 1878 was followed by inventions in several other fields—phonograph, talking motion pictures, etc.—had obtained 1180 patents by the time of his death in 1931.[22] One may note, however, that the same Edison was said to have defined "genius" as 99 per cent perspiration and 1 per cent inspiration.

PATENTS OF INVENTION AND PROPERTY IN IDEAS

The proportions between inspiration and hard work in the inventive process have probably varied widely. The question of these coefficients of production became crucial in the judicial history of the patent monopoly, since it was held by some judges that for a novel technological recipe to be an invention it had to be the product of a "flash of genius," not just a product of hard work which anybody could have done who had adequate training in the art. For a time the courts held that no patents should be granted where no flash of genius had been in evidence in the creation of the technological development. This legal interpretation was in strange contradiction to the legal, even constitutional, theory that the patent system was devised to promote the "Progress of Science and Useful Arts." For one way to demonstrate that the patent system promoted such progress is to assume that the promise of a monopoly in the exploitation of an invention serves as an incentive to put in hard work on the production of inventions. Hard work needs incentives, flashes of genius do not.

Of course, this is not the only justification that has been given for the patent system. Instead of an incentive for investment in inventive work, patent protection could create an incentive for investment in the further development and plant construction that is necessary before an

[22] John Jewkes, David Sawyers, and Richard Stillerman, *The Sources of Invention* (London: Macmillan, 1958), pp. 100, 102, 112.

invention can actually be used. This theory has become increasingly plausible because developmental work has become more expensive than the inventive work itself; but it is not fully consistent with the purpose given in the constitutional provision. A third justification represents the monopoly grant as a fair exchange for the disclosure of a secret. It assumes that the user of a secret recipe enjoys a monopoly position; he could be induced to divulge his secret in exchange for monopoly protection in its utilization for some limited time, say, 17 years. The trouble with this theory is that it would apply only to those instances where the inventor and his confidants do not think they could keep the invention secret for more than 17 years. Anybody who thinks that others might find out about his secret recipe, or might come upon it independently, within less than 17 years would be glad to trade the secret for the patent monopoly. But he who thinks he can keep his invention secret longer will prefer not to patent it. Hence, the promise of a patent will induce disclosure of secret information only where the possibility of maintaining secrecy is doubtful, and where therefore disclosure by the inventor or first user of the invention is of less value to society.

The incentive to disclose newly invented technology may, however, be valued on different scores. Instead of emphasizing the value of disclosure for a much delayed use of the patented technology by competing producers—after 17 years—one may point to early publication under the patent incentive as a stimulus for alternative and derived inventions and as dissemination of the most up-to-date information on technical advances promoting further advances in related fields. Many scientists and engineers engaged in research and development have stated that this aspect of patent-induced disclosure is of great importance for the progress of the useful arts.

Besides the various incentive theories of patent protection there has been a legal and moral theory which claimed that an inventor has, by "natural law," a "property right" in his idea and that a patent is merely a practical way of confirming this property right. This theory, which had its origin in France, was put forth for a political reason: the word "property" aroused favorable sentiments, the word "monopoly" unfavorable ones. Thus, it was dangerous to justify the patent as a monopoly grant, even though it was to serve good purposes. By contrast, private property in ideas might be made one of the "human rights," respected by all. British lawyers rejected this theory, and many American lawyers did too. But there has been some degree of acceptance by some American patent lawyers, especially after a simply incredible confusion developed between the untenable notion of a "property right in the invention" and the harmless notion of a "property right in the patent." A property right in an idea is not even thinkable. What a patent right does is to exclude others from making and selling goods in the production of which the patented invention is used; it excludes them even if they have developed this technological recipe entirely independently, without knowledge of the prior invention. Thus, they are excluded from using the results of their genius and fruits of their own labor, because someone else has been granted monopoly rights in the use of this invention. There is no logical way of expressing this kind of "exclusive right to make and to sell" as a "property in ideas."

LARGE CORPORATIONS AND EMPLOYED INVENTORS

Patent protection is supposed to serve as an incentive to invest in inventive work or to invest in development and plant construction or to disclose the inventions that have been made. No matter which of these purposes is served, it is sometimes suggested that patents are not really important as incentives for large corporations, but only for independent inventors or for small firms competing with large ones. This view, strangely enough, has been most emphatically stated by representatives of large corporations. Evidence of expressions of this view can be found in several Congressional hearings on the patent law.[23] (Perhaps it should be mentioned that several of these witnesses came from the automotive industry and that representatives of other industries, such as chemical and especially pharmaceutical, have later stated their disagreement.)

If the contention is true, we are faced with the odd situation that patents as incentives for socially desirable activities are considered unnecessary for those who own the bulk of all patents. In the United States about 60 per cent of all patents are assigned to corporations before issuance, which ordinarily indicates that the patented inventions were made by inventors employed by these corporations. Of all patents owned by corporations conducting research and development in 1953, 51 per cent were owned by firms with more than 5000 employees, 30 per cent by firms with between 1000 and 5000 employees, and only

[23] See especially *Investigation of Concentration of Economic Power*, Hearings before the Temporary National Economic Committee, Part 2, 75th Congress, 3rd Session (Washington, 1940), pp. 262, 308, 332, 344. Also Part 30, p. 16311.

19 per cent by firms with less than 1000 employees. Thus, it appears that from among those who hold most of the patents we have testimony to the effect that the patent system is not necessary for them, but only for those who hold the smallest number of patents.

In reply to the question whether patents are essential to the continuance of large expenditures for research and development, an officer of a large company stated that he might cut down these expenditures to perhaps one half of the amount spent at that time if patent protection were removed. It happened, however, that approximately one half of the R & D budget of that company was then devoted to the tasks of securing patents and enforcing the exclusive rights which they were supposed to confer. Hence, if the company were suddenly relieved of the necessity of spending money on obtaining patent rights and litigating about them, the remaining half of its budget would still buy the same amount of genuine research and development work. Many officers of large patent-holding corporations do not think that their research expenditures are dependent on patent protection.[24] An officer of the DuPont Company stated the opposite opinion.[25] But a great friend of strong patent protection, Robert E. Wilson, petroleum researcher and oil company executive (later Atomic Energy Commissioner), speculating about the adverse consequences of a "weakening of the patent system," contended that this—though most harmful for the "progress of both science and industry"—would *least* affect the research policies of large companies.[26]

This judgment can be supported by deduction from the theory of oligopolistic competition: no firm in competition with a few others can afford to let its rivals steal a march upon it as far as the technological base of its competitive position is concerned. The research and development work is essential for the maintenance of its position. It cannot allow itself to fall seriously behind in the technological race, regardless of whether inventions promise it a 17-year patent protection, which in fact as a result of obsolescence means usually no more than a few years, or whether inventions promise it only a head start of two

[24] *Patents and the Corporation*, by a group at the Harvard Business School, copyright Frederick M. Scherer, 2nd edition (Boston, 1959), pp. 116-118.

[25] "Without the patent system it is highly unlikely that any commercial organization could justify a research program of any scope or magnitude." Samuel Lenher, *Patents and Progress* (Wilmington: DuPont Company, November 14, 1961), pp. 6-7.

[26] Robert E. Wilson, "Research and Patents," Address before the Society of Chemical Industry, January 1943, *Industrial and Engineering Chemistry*, Vol. 35 (February 1943), pp. 177ff. Reprinted as appendix in Otto Raymond Barnett, *Patent Property and the Anti-Monopoly Laws* (Indianapolis: Bobbs-Merrill, 1943), p. 556.

or three years or even only a means of catching up with the rivals. Hence, it seems not very likely that the patent system makes much difference regarding the R & D expenditures of large firms.

SMALL FIRMS AND INDEPENDENT INVENTORS

Whether or not it is true that the patent system makes a serious difference regarding the competitive position of the small firm can hardly be decided on the basis of our present knowledge. There are strong arguments on both sides of the question. For example, the patent position of the big firms makes it almost impossible for new firms to enter the industry; patent litigation carried on by big firms makes it difficult for small firms to defend their own patents successfully. On the other hand, there are cases of small firms having succeeded, on the basis of strong patents on inventions of radically new processes or products, in gaining a position in markets previously dominated by a few giants. But this is a question of industrial organization, not a question of the effects of the patent system upon the production of new technological knowledge.

There still remains the problem of the individual inventor. The majority of writers have contended that the days of the free-lance inventor are gone, that invention has become the business of organized large-scale research and development in specialized departments of large corporations. John Jewkes is almost alone in denying this verdict, and he has adduced massive evidence to show that the individual inventors are still having a sizeable share in the production of *important* inventions, even if their share in the production of commercially useful routine inventions has seriously declined. Jewkes believes that the individual inventor needs protection: "So long as the survival of the individual inventor is not utterly despaired of . . . and so long as nothing better can be suggested for the purpose, there is a very strong case for the retention of the patent system."[27]

END OF GROWTH IN PATENTED INVENTIONS?

In amazing contrast to the phenomenal growth in R & D expenditures and personnel since 1920, the number of inventions for which patents are sought has not increased since that time. The number of applications filed for patents on inventions was greater in 1920 than in any year during the 1950's, or indeed any year since 1930. The number of patents actually issued happened to be relatively small in

[27] John Jewkes *et al.*, *op.cit.*, p. 251.

1920, because applications had dropped during the years of World War I, and it is partly for this reason that the number of patents issued in the late 1950's did exceed that of 1920. The annual average of patents issued in the ten years, 1950 to 1959, was 42,599, or only 2½ per cent above the annual average of patents issued from 1920 to 1929, which was 41,492.

Examining the historical statistics of the patent system in the United States,[28] we find that the peak in patent applications occurred in 1929, with 89,752 applications filed. The largest number of applications filed in any year during the 1950's was 78,594, in 1959. The peak year for numbers of patents issued was 1932—note the customary three-year lag behind applications—with 53,458 patents. During the 1950's the low was 30,432 patents in 1955, and the high mark was 52,408 in 1959. (The 1960 figure was only 50,332.)

The ratio of patent applications filed to patents issued in the same year would show considerable variations because changes in the number of applications cannot be reflected in the number of patents issued until after some time. The average time lag has mostly been about three and a half years. If a three-year lag is chosen to compute the ratio of total to successful applications, there appear odd variations during periods when the time lag was actually shorter. For example, the ratio calculated with the three-year lag was below 1—which would imply that the total number of applications was smaller than the number of successful ones—in the years 1865-67, because there was a large increase in applications leading to patents within one year. Nonetheless, the three-year lag gives, by and large, the most reasonable results and on this basis the number of applications filed per patent issued was between 1.55 and 1.85 in 40 out of the 70 years from 1890 to 1959; it was below 1.55 in 14 years, and above 1.85 in 16 years during that period. There has been a slight but not significant increase in the ratio in recent years.

The absence of growth, since 1920, in the absolute numbers of patents applied for or granted implies a decline in patenting relative to such magnitudes as population, the number of technological workers, of scientists and engineers, of R & D professional personnel, or the amounts of R & D expenditures. Some of these data are not available for all years; different tables, therefore, will be used to show the relevant relationships. Table v-6 compares the number of domestic

[28] *Historical Statistics of the United States; Colonial Times to 1957* (Washington, 1960), p. 607.

patent applications with total population and with the number of technological workers in census years from 1870 to 1950. The number of technological workers, compiled by Jacob Schmookler, includes all occupations listed in the population census whose members are skilled

TABLE V-6

NUMBER OF DOMESTIC PATENT APPLICATIONS COMPARED WITH POPULATION AND NUMBER OF TECHNOLOGICAL WORKERS, 1870-1950

Year	Domestic patent applications 5-year averages (thousands)	Resident population (millions)	Techno-logical workers (millions)	Patent applications per 100,000 population	Patent applications per 100 technical workers
	(1)	(2)	(3)	(4)	(5)
1870	18,600	39.91	1.51	46.60	1.24
1880	22,200	50.26	2.01	44.17	1.10
1890	35,800	63.06	3.13	56.77	1.15
1900	36,600	76.09	3.75	48.10	0.97
1910	59,400	92.41	5.39	64.29	1.10
1920	71,900	106.47	6.29	67.53	1.14
1930	73,700	123.08	7.10	59.88	1.04
1940	52,200	131.95	6.59	39.57	0.80
1950	60,100	151.23	8.59	39.74	0.70

SOURCE: Columns (1), (3), and (5): Jacob Schmookler, "The Level of Inventive Activity," *Review of Economics and Statistics*, Vol. XXXVI (May 1954), p. 186. The 1950 figures were supplied in an unpublished paper. Column (2): *Historical Statistics of the United States.*

TABLE V-7

NUMBER OF SCIENTISTS AND ENGINEERS COMPARED WITH NUMBER OF PATENTS ISSUED, 1900-1954

Year	Scientists and engineers	Index of growth of scientists and engineers	Patents granted for inventions	Index of growth of patents granted for inventions	Index of relative growth of patenting in relation to scientists and engineers (4) ÷ (2) × 100
	(1)	(2)	(3)	(4)	(5)
1900	42,000	100	24,660	100	100
1910	86,000	220	35,168	142	65
1920	135,000	320	37,164	150	47
1930	227,000	540	45,243	183	34
1940	310,000	740	42,333	171	23
1950	573,000	1,360	43,072	175	13
1954	691,000	1,640	33,872	137	8

SOURCES: Column (1): National Science Foundation, *Scientific Personnel Resources* (1955), p. 9. Column (3): Department of Commerce, *Historical Statistics of the United States* and *Statistical Abstract of the United States.*

in a technical art or whose training includes some field of technology.[29] Following Schmookler, we shall not use the number of patent applications filed in just the census years—which would reflect the working capacity of the patent lawyers rather than that of the inventors—but take five-year averages centered on each census year, for example, the average of 1938-1942 for 1940.

We see from these data that between 1870 and 1920 patenting grew along with population and with the size of that group within the population which is likely to make inventions. The growth of patenting apparently stopped after the 1920's, and patent applications relative to population and to the number of technological workers declined rapidly.

TABLE V-8

PATENT APPLICATIONS FILED FOR INVENTIONS COMPARED WITH R & D SCIENTISTS AND ENGINEERS AND R & D EXPENDITURES, 1941-1958

Patent applications filed			*Research and development*		*Patent applications*	
Period	Average per year	*Year*	Scientists and engineers (in thousands)	Expenditures (in millions of $)	per 100 R&D scientists and engineers (2) ÷ (4)	per million $ R&D expenditures (2) ÷ (5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1941-1943	47,794	1941	87	900	54.94	53.10
1942-1944	48,411	1942	90	1,070	53.79	45.24
1943-1945	55,843	1943	97	1,210	51.57	46.15
1944-1946	67,697	1944	111	1,380	60.99	49.06
1945-1947	74,815	1945	119	1,520	62.87	49.22
1946-1948	75,113	1946	122	1,780	61.57	42.20
1947-1949	70,625	1947	125	2,260	56.50	31.25
1948-1950	67,865	1948	133	2,610	51.03	26.00
1949-1951	65,098	1949	144	2,610	45.21	24.94
1950-1952	64,085	1950	151	2,870	42.44	22.33
1951-1953	65,759	1951	158	3,360	41.62	19.57
1952-1954	71,341	1952	180	3,750	39.63	19.02
1953-1955	75,552	1953	192	4,000	39.35	18.89
1954-1956	76,426	1954	223	4,140	34.27	18.46
1955-1957	75,430	1955		5,400		13.97
1956-1958	75,533	1956		6,500		11.62
1957-1959	76,762	1957		8,200		9.36
1958-1960	78,560	1958	327	10,230	24.02	7.68

SOURCES: Column (2): *Historical Statistics of the United States; Statistical Abstract of the United States.* Column (4): National Science Foundation, *Scientific Research Personnel Resources*, 1955, Table B-9, *Reviews of Data on Research and Development*, No. 29, NSF-61-49 (August 1961) and No. 33, NSF-62-9 (April 1962). Column (5): *Statistical Abstract of the United States.*

[29] Jacob Schmookler, "The Level of Inventive Activity," *Review of Economics and Statistics*, Vol. XXXVI (May 1954), p. 186. See also his article on "Inventors Past and Present," Vol. XXXIX (August 1957), pp. 321-333.

Table v-7 reproduces a table prepared by Seymour Melman to show the contrast between the growth of the number of scientists and engineers and that of patents issued, for the period 1900 to 1954. Table v-8 is confined to a more recent period, beginning in 1941, for which R & D data, however unreliable, are available; it compares the number of R & D scientists and engineers and the amounts of R & D expenditures with the average annual number of patent applications filed during consecutive three-year periods. The results are rather striking. The moving average number of patent applications per 100 R & D scientists and engineers declined from approximately 63 in 1945—the highest in the 20-year series—to 42 in 1950, 34 in 1954, and 24 in 1958. The patent applications per million dollar R & D expenditures declined from 53 in 1941 to 22 in 1950, 18 in 1954, and less than 8 in 1958.

WHY THE RELATIVE DECLINE?

These comparisons show a conspicuous decline in patenting relative to the presumably relevant variables. This decline has aroused a big debate: does the decline in patenting indicate a similar decline in the relative number of inventions or only in the relative number of patentable inventions? Or perhaps merely a decline in the "propensity to patent"? Of course, these are not disjunctive alternatives; all three things may have happened, and there are good reasons for believing that this is actually the case.

Easiest to explain is the decline in the number of patent applications per million dollars spent on R & D. The general increase in prices and salaries over the years accounts for a part of the decline in the ratio, though not a big part. For a more important cause we may look at the enormous portion of R & D funds that has gone lately into aircraft development (missiles, rockets, space ships, and so forth). It seems rather unlikely that patentable inventions will grow out of the extensive and expensive experimentation in this area. No matter whether the solutions of the many technical problems which we try to get in a hurry are regarded as inventions, combinations of inventions, improvements, or anything else, they are not likely to meet the requirements of patentability. The same explanation would hold for the decline in patent applications per 1000 research and development scientists and engineers. Just as the R & D expenditures, so the R & D professional staff has been concentrated in the aircraft industry, in attempts to find out as quickly as possible what combination of fuels, metals, devices, and all the rest, would make certain types of missiles, etc., operational. The implications of the comparisons in question have not always been fairly presented. While it is fair to conclude that patents play a relatively small role in the present R & D activity, in the sense that they are neither a necessary incentive for, nor a likely result of, the R & D effort, it would not be fair to conclude from the data that patents no longer play a role in any part of the nation's inventive effort.

PATENTS AND RESEARCH EXPENDITURES

The chemical industry suggests itself as an example of an industry in which patents may play a large role. While it ranks behind three or four other industries as far as total R & D expenditures are concerned, it rises to rank number one if the industry's own contributions of funds for R & D are compared. At the same time the chemical industry holds first place in the number of patents pending. This "rank correlation" between patent applications and self-financed R & D expenditures does not prove anything, but at least it conforms to the traditional theory of the patent incentive. Incidentally, if for all industries the government funds are disregarded and only the industry's own funds for R & D are taken into account, the rank correlation between these R & D expenditures and the number of patent applications pending is very high. The data for this statistical test were taken from the National Science Foundation's 1953-1954 survey, *Science and Engineering in American Industry.* (The same test for more recent years is less encouraging. In 1960 the chemical industry fell to second place in company-financed R & D expenditures chiefly because the "electrical equipment industry" and the "communications industry" were combined statistically and now rank number one.)

A high correlation between self-financed R & D expenditures and applications for patents strongly suggests that industry tends to spend its own money on inventive efforts where these efforts are most likely to lead to inventions. It does not establish that these expenditures would not be made without the promise of patent protection. Undoubtedly, if there is a chance to obtain patents on inventions, industry will not pass up this chance. But it cannot be demonstrated from any statistical relationships that only the patents rather than the inventions were wanted, or that inventions without patents would not have been considered worth the money spent on research. As I have said earlier in this section, to have a head start on new processes or products, even if competitors are not barred from imitation, or to catch up with competitors who are leading in the race for new technology, may be sufficiently desirable in a world of oligopolistic competition to bring forth all the inventive efforts that are now attributed to the patent incentive.

The absence of any empirical evidence for either the claim or its denial that the patent system is an effective promoter of inventive research—and thus of the production of socially new technological knowledge—is most frustrating. The doubting Thomases are usually timid and reserved lest they invite the wrath of the faithful. (A recent denial of the claim, by Seymour Melman, is quite exceptional in its directness.[30]) Advocates of patent protection have for centuries propounded the faith in this institution, and their statements admit of not an iota of doubt. They may well have the truth—but faith alone, not evidence, supports it.[31]

Research, Company Size, and Competition

If research and development work is a socially desirable activity, and if a particular type of business firm is more likely than any other type to provide funds to conduct R & D, does it not follow that we should look most favorably at business firms which correspond to this type? R & D cannot be efficiently done on a very small scale, and it is very expensive to maintain a sizeable R & D organization, too expensive for a small firm. Hence, it takes a large firm to undertake R & D. It takes, moreover, a firm which can afford to pay for it out of profits. Firms under heavy pressure from competition have no profits. Hence, it takes a firm not exposed to unrestricted competition. Conclusion: Stop expostulating against big business monopolies, and realize that bigness and some relaxation of the rigors of competition are necessary conditions for large industrial appropriations to R & D. Is this argument sound?

[30] *The Impact of the Patent System on Research*, Study No. 11 of the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, U.S. Senate, 85th Congress, 2nd Session (Washington, 1958).

[31] Fritz Machlup, *An Economic Review of the Patent System*, Study No. 15 of the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, U.S. Senate, 85th Congress, 2nd Session (Washington, 1958).—I have been criticized for my lack of faith and suspected of being a foe of the patent system. Yet, all I contended was that neither the theoretical nor the empirical evidence thus far presented can support the claims frequently made for the patent system as an important, or even the chief, factor in technological and economic progress.

RESEARCH AND COMPANY SIZE

One can hardly deny that a firm with annual sales of $50,000 will not be likely to maintain a large research laboratory; on the other hand, a firm with annual sales of $100 million may find it possible and perhaps desirable to have an R & D outfit. But neither of these insights is relevant to the evaluation of the popular attitude regarding "big business." What is usually meant when this term is invoked are the giant concerns which have grown chiefly by merger, by gobbling up several of their competitors, and which are now running large numbers of establishments under unified control. If an industry includes such "giants by merger" as well as other firms, the non-giants surely do not have to be "tiny tots"; they may be large enough to afford research departments. As a matter of fact, in several industries with both corporate giants and medium-sized firms, the latter spend a larger percentage of their sales for R & D than the former.

Statistical correlations between company size and research expenditures in all manufacturing industry are apt to be misleading. The correlation will be high, to be sure. But if particular industries are examined and particular firms compared, the results will no longer confirm the hypothesis that R & D expenditures are predominantly a function of company size. And even if, in several industries, the largest firms are in fact the largest spenders for R & D, this need not provide a sufficient reason for favoring company growth by merger and the disappearance of smaller firms.

RESEARCH AND RESTRICTED COMPETITION

It seems evident that profits are needed for firms if they are to finance research and development. Profits may be needed on two counts: past and present profits to provide the money with which to finance R & D, and future profits to provide an incentive for doing so. If the economic theorist declares that under "perfect competition" profits will be zero, does it not clearly follow that perfect competition is incompatible with industry financing of R & D?

This would indeed follow if what the economic theorist means by "profit" and by "perfect competition" were what the businessman means by it. Assume a corporation with an equity capital of $50 million; if its profits in the accounting sense of the word are only $5 million, this may not exceed the normal rate of return on business capital, and profits in the economic theorist's sense would then be zero. This corporation, however, could hardly be said to be unable to finance a research laboratory, could it?

The second language difficulty concerns the proposition that perfect competition reduces profits to zero. The competition which is supposed to do the profit-squeezing job is "perfect ease of entry," or "newcomers' competition." Whenever super-normal profits are made in an industry in which entry is easy, newcomers will emerge on the scene before long and no gravy will be left after a while—provided nothing else changes, either in the cost of production or in the quality of products or in the consumers' demand. Assume that a company comes up with new processes and new products every few years; and that eager competitors try to get into the new business whenever it looks as if it has caught on and is making money for the progressive firm. "Perfect competition" would in this case begin to squeeze the profits from the latest venture while the firm is getting ready to come out with some new product. The firm can always be making super-normal profits while competition operates to mop up the profits from the previous undertakings. In the technical jargon of the economist, the "zero-profit-condition of the static equilibrium under perfect newcomers' competition" does not prevent firms from making super-normal profits from innovative investments. No "restrictive practices," no measures to alleviate competition are necessary for running a business with profit. A firm can pay for R & D in the expectation of profit even if it has no monopoly, no shelter against competition.

We conclude that a plug for R & D need not be a plug for "bigness" or "monopoly."

The Flow of Ideas in the Inventive Process

The conceptual and statistical separation of basic research, applied research, and development has been shown to hold many difficulties, chiefly because of the discrepancies between the intended and the actual results of these activities, but also because of the trouble of placing "inventive work" in this framework. Where is the locus of invention in this tripartite scheme? One way of simplifying the scheme, and of modifying it in such a way as to make it more compatible with customary thinking about invention and innovation, is to provide for a stage of explicitly inventive work and to reapportion all applied research among basic research and inventive work, according as the intended results are scientific findings or technological recipes. A flow chart—a schematic representation of the inventive process as a flow of ideas from research through inventive work and development to the ultimate "innovation" in production—will facilitate the discussion.

THE TERM "INNOVATION"

Ought we perhaps to avoid the term "innovation," since it is so promiscuously used for a variety of meanings? A great economist, Joseph Schumpeter, wanted it reserved for a very particular notion: for the entrepreneurial *decision* by which a novel idea, relating to technology or to any other aspect of doing business (hence including procurement, marketing, etc.), is for the first time introduced, enlarging the horizon of productive possibilities open to those who allocate resources to alternative uses. Innovation in this sense is *not* the work of a scientist or engineer, but rather the decision of an entrepreneur risking investment funds on a new venture; it is *not* invention, although it may make use of an invention; it is *not* the adoption of relatively new methods of production, for this would be "imitation." Since not all economists are well read, and would in any case not be bound to accept the word meanings chosen by the masters, the term "innovation" has now been appropriated for several other meanings. Some writers have made it an equivalent of invention, others have merged early imitation with innovation, others have used the term for a more inclusive concept comprising new research findings, inventions, improvements, first application, as well as early imitation.

Under these circumstances we shall do better without the word "innovation" whenever a less ambiguous word is available. Where we do use it, we shall make clear that an entrepreneurial decision is involved, usually an investment decision, and that it excludes imitation of anything done before.

FEEDBACKS

In the chart schematizing the inventive process as a flow of ideas through various stages, we shall have to bring out clearly that this is not a simple unidirectional flow from one stage to the next, from inception to development to eventual adoption, but that there are usually cross-currents, eddies, and whirlpools, if we may use such metaphors. If the "output" of any stage may become again an input of the same stage or even an earlier stage, one speaks nowadays of a "feedback." Several such feedbacks exist in the flow of ideas in the inventive process.

The flow chart will distinguish four major stages: (I) Basic research, (II) Inventive work, (III) Development work, and (IV) New-type plant

THE FLOW OF IDEAS THROUGH THE STAGES OF RESEARCH, INVENTION, AND DEVELOPMENT TO APPLICATION

STAGE	INPUT: Intangible	INPUT: Tangible	INPUT: Measurable	OUTPUT: Intangible	OUTPUT: Measurable
I "Basic Research" [Intended output: "Formulas"]	1. Scientific knowledge (old stock and output from I-A)	Scientists Technical aides Clerical aides	Men, man-hours Payrolls, current and deflated	A. New scientific knowledge: hypotheses and theories	Research papers and memoranda; formulas
	2. Scientific problems and hunches (old stock and output from I-B, II-B, and III-B)	Laboratories Materials, fuel, power	Outlays, current and deflated Outlay per man	B. New scientific problems and hunches	—
				C. New practical problems and ideas	—
II "Inventive Work" (Including minor improvements but excluding further development of inventions) [Intended output: "Sketches"]	1. Scientific knowledge (old stock and output from I-A)	Scientists Non-scientist inventors Engineers Technical aides Clerical aides	Men, man-hours Payrolls, current and deflated	A. Raw inventions: technological recipes a. Patented inventions	a. Patent applications and patents
	2. Technology (old stock and output from II-A and III-A)			b. Patentable inventions, not patented but published	b. Technological papers and memoranda
		Laboratories Materials, fuel, power	Outlays, current and deflated Outlay per man	c. Patentable inventions, neither patented nor published	c. —
	3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A)			d. Non-patentable inventions, published	d. Papers and memoranda
				e. Non-patentable inventions, not published	e. —
				f. Minor improvements	f. —
				B. New scientific problems and hunches	—
				C. New practical problems and ideas	—

III "Development Work" [Intended output: "Blueprints and Specifications"]	1. Scientific knowledge (old stock and output from I-A) 2. Technology (old stock and output from III-A) 3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A) 4. Raw inventions and improvements (old stock and output from II-A)	Scientists Engineers Technical aides Clerical aides Laboratories Materials, fuel, power Pilot plants	Men, man-hours Payrolls, current and deflated Outlays, current and deflated Outlay per man Investment	A. Developed inventions: blueprints, specifications, samples B. New scientific problems and hunches C. New practical problems and ideas	Blueprints and specifications — —
IV "New-type Plant Construction" [Intended output: "New-type plant"]	1. Developed inventions (output from III-A) 2. Business acumen and market forecasts 3. Financial resources 4. Enterprise (venturing)	Entrepreneurs Managers Financiers and bankers Builders and contractors Engineers Building materials Machines and tools	$ investment in new-type plant	A. New practical problems and ideas	New-type plant producing a. novel products b. better products c. cheaper products

construction. (The last would have been called "innovation" had not so many of my colleagues run away with the word.) The intended outputs of these stages are (I) "formulas" (standing for scientific hypotheses and theories), (II) "sketches" (standing for "raw inventions" and proposed technological improvements), (III) "blueprints and specifications" (standing for the fully developed inventions incorporated into plans for plant or machine construction), and (IV) "new-type plant" (standing for the plant and equipment to produce the novel products or use the novel processes). But each of these stages produces by-products which may be used as inputs in the same or in earlier stages. Thus, "new scientific problems and hunches" may come out of Stages I, II, and III, to become possible feedbacks for Stage I. "New practical problems and ideas" may come out of any of the four stages, to become inputs for Stages II and III. The inventions and improvements resulting from Stages II and III may become feedbacks for Stage II; indeed, it will frequently happen that "raw inventions" coming out of Stage II will not be regarded as eligible for "development" but, despite this rejection as input for Stage III, will be valuable feedback-input for further Stage II work.

THE FLOW CHART

The flow chart should be largely self-explanatory. A few ground-rules may be helpful: Roman numerals refer to the four stages; arabic numerals are used in the lists of intangible inputs in each stage; capital letters are used in the lists of intangible outputs of each stage, with small letters used for subclassifications of these. Tangible inputs and outputs are not marked by numerals or letters; their enumeration is merely illustrative, not complete. The columns for "measurable" inputs and outputs serve as suggestion boxes for use in empirical research work on the input and output of scientific and technological R & D activities.

It is not easy to find approximate operational counterparts for the mental constructs of inputs and outputs employed in this model of the inventive process. Some of the suggestions will be regarded with undisguised disdain by managers of R & D laboratories; e.g., they will find it ridiculous that "research papers and memoranda" are listed as a measurable counterpart of the intangible output of basic research. Yet, this output *is* measured, in a vague and informal way, when the achievements of research scientists are evaluated. To be sure, some research papers are quite poor while others are brilliant; but one may assume that the managers of the research laboratory will not keep the authors of consistently poor papers on their staff. Some members of the staff may be notoriously unproductive of written papers, but will be retained because of the original ideas which they spout in oral conversation with their fellow scientists. This means that "orally conveyed scientific hunches" should also be counted, but it is not likely that written records are kept of this sort of output, which therefore will escape the statistical notice of the outside investigators trying to "measure" the output of basic-research scientists.

Most of the important inputs and outputs in the inventive process are definitely nonmeasurable. This is regrettable, but it does not reduce an attempt to list these intangibles to the status of childish play. It is submitted that schematic representations of this sort help in understanding the processes in question, even if the concepts cannot be given operational definitions.

Research as National Product

Some casual remarks in Chapter II may have alerted the reader to the fact that some procedural conventions in social accounting cause the treatment of research and development expenditures to be somewhat unequal, depending on who performs the activities, who pays for it, and in what form. When we summarize R & D performance and list this type of knowledge-production as one among many items under the heading "production of knowledge in the United States," we shall treat R & D as a social investment no matter who did it, who paid for it, and how. We must explain our decision and why it fails to conform with the procedures adopted for our National Income statistics.

RESOURCE ALLOCATION

If scientists and engineers are assigned to R & D work, it does not matter from the point of view of resource allocation whether they are employed by a government agency, a business firm, or a private university; they may even be self-employed. In all cases they are engaged in the production of new scientific or technological knowledge. With whom they have a contract of employment and who provides them with the means of sustenance is interesting for several problems, but not for the general characterization of the work they are performing. Their work does not contribute to the current output of consumer goods; there must be either a stock of consumer goods on which they can live or there must be other people, working in consumer goods industries, who let them have some of their consumable output. Using the concepts "saving" and "investment" for the description of this kind of division of labor, we shall have to say that past or present saving is needed to make it possible; and that it constitutes investment if it is supposed to aid in the production of goods and services in the future.

It is possible, of course, that scientific and inventive work is performed, not to aid in the production of future physical or psychic income, but only for present enjoyment. Assume that all the scientific and technological knowledge is hopelessly "useless" and is produced only for the "fun" of it; that either those who do the work or those who see the results, or both, get a great "kick" out of it but nothing else. In these circumstances, R & D would not be investment but current output of consumer services, just like any other form of entertainment —say, the performance of circus clowns, singers, boxers, or ski jumpers. Let us admit that some scientific and inventive work may be of this nature and that it does give current enjoyment. But we surely must realize that for the most part the nation's expenditures for R & D are not made for this purpose. They are made in the hope that they will contribute to the future improvement of the nation's welfare.

We conclude that the production of new scientific and technological knowledge requires an act of saving and constitutes an act of investment. The R & D activity will therefore be treated here as part of the nation's product, not embodied in the current output of consumer goods, but rather as part of the nation's investment. It is investment in new knowledge.

NATIONAL-INCOME STATISTICS

For reasons not relevant to our discussion, the statisticians preparing the national-income and -product accounts follow very different principles from ours. They distinguish four sectors of the economy—government, consumers, business, and international—and the treatment of any economic activity depends on which sector purchases the goods or services in question. If a service, say R & D, is purchased by the government, it will be entered as an item in the national-product account, no matter what purposes that service is supposed to serve. If the service is bought by a nonprofit organization, it will be regarded as having been bought by consumers as part of their consumption expenditures. If it is bought by a business firm, the treatment depends on how the firm treats it on its own books: if the service is "embodied" in a fixed asset that is capitalized in the books of the firm, it will appear as investment, but if it is "expensed" as a cost of the current output of whatever the firm sells, it will appear neither as investment nor as consumption but as a current cost of production.

The use of these rules in national-income analysis leads to results which are at variance with our decision to treat all R & D as national investment and, thus, as national product.

It may not be of general interest, but will probably be interesting to the student of economics, to follow the different routes of social accounting under different forms of organizing and financing R & D activities in the United States. Let us assume that electronic research of a particular type is performed by (1) a government agency, (2) a business corporation, or (3) a private university, and paid for, to the tune of one million dollars, (a) by the government agency, (b) by the business corporation, or (c) by private individuals (making donations to the university). For the sake of simplicity, let us assume that the entire outlay is for salaries to scientists.

Case 1a. This case, where the research is both performed and financed by the government, is the easiest of all. The government expenditure would be included in government purchases of services; the research would therefore be treated as a final product, part of GNP.

Case 2a. The research performed by industry but financed by government, say in the form of a research contract, would, as in the previous case, be shown as a government purchase of a service, a final product, part of GNP. But there is a possibility of an unusual accounting procedure leading to a different result, if the national-income statisticians do not "catch" it. Normally, the purchase by the government is matched by a sale on the part of the firm, and this is actually shown on the books of the firm if the receipt from the government is entered among the sales. The accountant of the company could, however, adopt a different procedure. He might not want to confuse his sales figure by mixing sales of the manufactured hardware—electronic instruments—with what he regards as a reimbursement for salaries paid for work extraneous to the firm's business. Instead of entering the receipt from the government as "sale" he may enter it as a deduction from salaries paid, thus keeping both his labor cost and his sales clearly confined to his manufacturing business, unadulterated by transactions not related to his regular production. In this case his sales and his "value added by manufacture" will not include the million dollars spent and received (as reimbursement of nonregular salary outlays) for research undertaken on behalf of the government. Total GNP—unless the deficiency is caught—will be less than it would be if the receipts from government had been reported as sales.

Case 3a. Since a private university is a nonprofit institution, its accounts are consolidated with consumer accounts. Hence the government payment for research performed by the university is treated as a transfer payment to individuals, and the individuals, in turn, are assumed to have purchased the research services. These services will be shown, in the national-income accounts, as personal-consumption expenditures. Of course, the research in this case is regarded as final product, an item in GNP.

Case 2b. The business corporation, paying for its own research, will not capitalize this outlay (as an asset on its books) but will expense it (as a cost of production). In other words, the research will now be regarded as a current cost of producing electronic instruments, no longer as a separate product, as an item in GNP. Thus, when the research was performed by the government (Case 1a) and also when it was performed by business and "sold" to the government (Case 2a), the research was a final product separate from the manufactured goods produced by the firm. Now that the research is paid for by the firm, it is no longer a final product, but a part of the cost of manufacturing. The GNP is a million dollars less than in the other cases. Lest someone argue that the firm will charge a higher price for its hardware if it has to pay for its research than it would if it did the research on government account, let us note that research expenditures do not affect marginal cost and hence (assuming rational business conduct) do not affect selling prices; and if they did affect prices (assuming irrational business conduct) the effects upon *real* GNP (corrected for price changes) would still be the same. The point remains that in all three cases when the government paid for the research the research was a final product apart from the manufactured goods; but when business pays for the research, it is not regarded as a final product, but as a cost incurred in the production of the manufactured goods.

Case 3b. In this case, where research is performed by a private university with funds received from industry, the statistical results will depend on whether the funds come as payments under a research contract or as a gift from the corporation. In the first instance, the corporation purchases research, and the payment for it is treated as cost of manufacturing the electronic instruments. In the second instance, the gift is a transfer payment from business to "persons," who, in turn, purchase the research, which thus will appear in personal-consumption expenditures. Hence, in the first instance, the research is not a final product, not an item in GNP, while in the second instance it is. GNP will be one million dollars less in the first instance.

Case 3c. If the private university gets the research funds as a gift from a private philanthropist, the research is simply a personal-consumption expenditure, a final product, an item in GNP.

CONCLUSION

The variety of possibilities may perplex the uninitiated; it may strike him as a case of "now you see it, now you don't." He may object to procedures under which legalities and formal methods of financing play such a role in deciding whether research is a product bought by consumers, a product bought by government, or no product at all. Let him be reassured, however, that the procedures and conventions of national-income accounting have been adopted for reasons of operational convenience, and that no one is bound by them if they do not fit his purposes. They do not fit ours, and we shall stick to our decision to treat all R & D expenditures as investment in new knowledge. This investment, as we have seen, was $5,150 million in 1953-1954, $10,030 million in 1957-1958, $11,070 million in 1958-1959, and an estimated $14,000 million in 1960-1961.

These figures do not include outlays for R & D plant expansion. These investments in tangible assets for the future production of new knowledge were estimated for only one of the R & D performing sectors, where they amounted to $274 million and $452 million in 1956 and 1957, respectively.

The Productivity of Research

Research and development work produces new knowledge—findings, theories, problem solutions, recipes—reported in talks, memoranda, sketches, papers, articles, books, patents. Some of this knowledge is technological and may be useful in production, increasing the capacity of productive resources to produce goods and services.

If the new knowledge, the direct product of R & D, were something tangible and measurable, "productivity" of R & D would naturally refer to the ratio of R & D input, chiefly professional labor, to R & D output—that is, new knowledge. But since this output of R & D is not measurable (apart from the paper on which it is written or printed and the number of words in which it is formulated), one is led to skip to the next stage, where the new knowledge is an input and where increments in goods and services are the output. These increments in goods and services produced are then imputed to the R & D work which produced the new knowledge. "Productivity of R & D" thus comes to refer to the ultimate output increments (or input economies) in the areas in which the new knowledge, the direct output of R & D, is applied.

R & D AS AN INVESTMENT

As in all instances in which considerable time elapses between input and output, between disbursement and receipt, R & D expenditures are *investment*, and the incremental outputs (or economies) attributable to the application of the R & D findings are *return*. Thus the rate of return on investment in R & D can be computed.

The social rate of return on R & D is likely to be higher than the private rate of return on this investment. (That R & D expenditures are usually treated as current expense rather than as capital outlays in the books of the firms is not relevant for either private or social considerations.) This discrepancy between social and private benefits of R & D is due, among other things, to two consequences of the introduction of improved technologies: (1) The prices of the products concerned are usually reduced, which will benefit the consumers, not the innovating producer. (2) The new technology is adopted sooner or later by his competitors, which may help them as well as the consumers but not the innovator. This does not mean that the investor in R & D and first user of the new technology will not benefit from his investment; it merely means that the benefits to society as a whole are not limited to the benefits accruing to the investor, and will often exceed them substantially.

Calculations of social returns on investment in agricultural research have been made by T. W. Schultz[32] and Zvi Griliches.[33] Their estimates show that these investments have been enormously lucrative. The method of estimation, by and large, was to find out how much more input it would have taken to produce, say, the 1950 output with 1940 techniques; or, alternatively, how much less output would have been obtained in 1950 with 1950 inputs but 1940 techniques. The valuation of the differential inputs or outputs involve, of course, questions of

[32] Theodore W. Schultz, *The Economic Organization of Agriculture* (New York: McGraw-Hill, 1953), pp. 114-122.

[33] Zvi Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovations," *Journal of Political Economy*, Vol. LXVI (October 1958), pp. 419-431.

elasticities of supply and demand, which explains why the estimates of benefits in terms of dollars may have to be made for "upper limits" and "lower limits." The estimated benefits are then compared with the cumulated costs of research, to derive the social rate of return. For agricultural research as a whole a lower-limit estimate was 35 per cent and an upper limit 171 per cent per annum. For an especially successful venture, the research on hybrid corn, the rate of return was estimated to have been 700 per cent per annum.

It is, of course, a somewhat questionable procedure to estimate separately the productivity of a successful research project and to disregard the zero productivity of unsuccessful ones. (This would be like calculating the rates of return on the investment in those lottery tickets that have won the highest prizes, and forgetting the blanks.) In order to judge the returns society gets on its investment in R & D, one has to take the entire package, not the choice pieces it contains. R. H. Ewell[34] estimated—and we shall accept the estimate for the sake of the argument—that, for the economy as a whole, the net yield was between 100 and 200 per cent per year on its R & D expenditures. Although 100 per cent, or even 200 per cent, is less than 700 per cent (the return on the hybrid-corn research), it is still enormous; indeed, it is a spectacular rate as far as rates of return on investment go.

The nation has probably no other field of investment that yields returns of this order. We know of water projects, coming from the "pork barrel" approved by our legislators year after year in their playful attempt to get a maximum of federal money for their own states, which yield as little as 1 per cent per annum, if that much. We know that business investment opportunities yielding 15 or 20 per cent are utilized with eagerness. In view of these comparative rates of return, we must ask two questions: first, why does business not put more of its own money into R & D, and secondly, should one not urge the government to go even more heavily than it has done into R & D finance?

AVERAGE VERSUS MARGINAL RETURN

Both these questions require that we first consider the possibility of marginal returns being far below average returns. Is it conceivable that an annual investment of $14,000 million—taking the 1960 estimate of R & D expenditures—should return 100 per cent per year on the

[34] R. H. Ewell, "The Role of Research in Economic Growth," *Chemical and Engineering News*, Vol. XXXIII (1955), pp. 298-304.

average, but nothing on the last millions? Yes, this could easily be the case. One can imagine without strain that annual R & D expenditures of only, say, \$10,000 million would yield annual benefits of \$14,000 million, while a further increase in expenditures would not add anything to these benefits. If \$14,000 million is spent, and total benefits are not higher than \$14,000 million, the average yield is 100 per cent per annum, although the marginal yield is nil. Obviously, marginal, not average, productivity must be considered if economic decisions are to be rational.

Now the question why business does not put more of its own money into R & D allows of two possible answers. Either, business men do not know what's good for them, or they do but have figured out that the "private," as opposed to social, marginal returns on R & D expenditures are down to the normal rate of return on other types of investment. Without entirely excluding the possibility intimated by the first answer, I incline to the second. A few years ago, firms maintaining R & D laboratories were asked, in a government survey, why they did not spend more for R & D than they had been spending. The most frequent reply was that they could not find more scientists to enlarge their staff. They did not say what salary increases they had offered to get the scientists who were unavailable at present salaries; but one may interpret their pessimistic replies to mean that the business officers were afraid that mutual raiding of research laboratories for competent scientists and engineers would merely drive up the cost without adding to R & D capacity.

The "shortage" of competent scientists and engineers, of which we have heard so much in recent years, may mean (1) that salaries for professional personnel have been rising faster than other incomes, (2) that at the salary level of the moment there are more vacancies than applicants, with many vacancies remaining unfilled, and/or (3) that attempts to fill the vacancies would drive up the salary level very substantially. These are really three different things, though all may be part of the same picture. The first would indicate that salaries have been reacting to an increased demand and a relatively less elastic supply in the market for research personnel (less elastic than the supply of other types of labor); the second would indicate that employers of research personnel are unwilling to pay what it takes to get all they want, probably because they are afraid to push these salaries too far "out of line"; the third expresses the small elasticity of supply of qualified research workers which evidently was a fact underlying the first, and a fear underlying the second, of the three phenomena called "shortage." The elasticity of supply is what really matters in the problem at hand.

If the supply of scientists and engineers available for industrial research and development is not very elastic, and hence an increased demand will raise their salaries much more than it can enlarge the research-work force, the marginal cost of R & D may become extremely high. For example, if the elasticity of supply were 0.4, a 4 per cent increase in staff would require a 10 per cent raise in salary, and a 10 per cent increase in staff a 25 per cent raise in salary; the total salary bill for a staff increased by only 10 per cent would be raised by 37.5 per cent ($1.10 \times 1.25 = 1.375$). If, in addition, the quality of the larger staff should on the average be lower, the salaries of highly qualified research men would go up even more.[35] The marginal cost of research work might become forbidding under the circumstances. Since the marginal productivity of the research dollar is the combined result of the marginal benefits and the marginal cost of the research work, we must realize that a scarcity of qualified labor may account for very low or zero marginal returns even when average returns are extraordinarily high.

THE SOCIAL COST OF ADDITIONAL RESEARCH

Increases in salaries of scientists and engineers are of great importance in the calculations of the private marginal productivity of investment in R & D. But they do not figure largely when social productivity is considered. Just as, in a computation of the social benefits of increased production, adjustments are made for product-price reductions which may wipe out the private benefits (or reduce them drastically), in a computation of social costs adjustments are made for factor-price increases which may lift private costs sky-high. To the extent that increases in factor prices merely change relative incomes, they are not regarded as social costs. Only to the extent that productive resources are withdrawn from other uses will the social costs of any activity be increased.

[35] In a recent article I gave an arithmetical example combining the assumption of a supply elasticity of 0.5 with the assumption that "new" research staff members have a working efficiency of three fourths of the old staff. A 10 per cent increase in the total capacity of the research staff would under these conditions require a 90.7 per cent increase in the salary bill. If the average salary was $10,000 before the increase, the marginal cost of research labor would be $90,700. See Fritz Machlup, "The Supply of Inventors and Inventions," *Weltwirtschaftliches Archiv*, Vol. 85 (1960), pp. 221-222.

Thus, we must not admit that the high private marginal cost of R & D indicates a high social marginal cost. Mere transfers of income among members of the community do not count as social costs. The gain to the scientists and engineers would be a loss to the rest of the community, but all groups together neither gain nor lose when the incomes of the research personnel are boosted. But there will be a social cost if R & D takes resources away from alternative activities. The human resources employable in R & D are of a rather special type and cannot be recruited from all sorts of occupations and industries. Indeed, there are really only three competing uses for the type of labor in question: industrial research and development, basic research, and education.

In other words, the same people can either teach or produce new scientific knowledge or produce new technology. Any of these activities can be expanded only at the expense of possible expansions of the others. The social cost of using a scientist in producing new technology consists of the loss of what he might have produced otherwise: either new scientific knowledge, if he were employed in basic research, or new trained minds capable of doing scientific and technological work in the future, if he were employed in teaching.

All the computations of the social productivity of industrial R & D are defective if they are based on the actual dollar expenditures rather than on the output foregone in the alternative uses of the researchers' time. Though previously inclined to suspect that the dollar expenditures exaggerate the social cost, we have now come to surmise the opposite. It may very well be that the salaries paid to R & D personnel do not reflect the full social cost of using them in this capacity. An examination of this possibility is imperative.

Industrial Research Versus Teaching Future Researchers

There can be little doubt that the expansion of industrial research and development has for the most part been a splendid thing. Industrial research and development can be among the most productive activities society may engage in. Looking at the meagre or hardly existing appropriations to R & D in the years before the Second World War, one can only say that it was high time the nation found out about the enormous benefits that can be derived from these activities.

Some enthusiasts, however, are just about going overboard in eulogizing and plugging for R & D. Spokesmen of "national security at all cost" point to the sputniks and to Soviet Russia's technological successes, and want us to step up our R & D expenditures immediately and drastically. Some economic theorists, concerned about discrepancies between private and social marginal product and cost, urge us at least to double our applied research and development work because it contributes so much and costs so little.[36]

As we have just seen, there is something basically wrong in these arguments. They take it for granted that we can have more research without having less of anything else or, at least, that the things which we must sacrifice if we devote more resources to industrial research are not so valuable as the new technological knowledge which we might get from additional research work in industry. This supposition would be tenable only if it were possible to shift manpower of all kind and quality into research, transferring workers from the men's garment industry, from the bakery goods industry, from the farms, from trade or banking, from the entertainment industry, from anywhere that manpower could be spared. Such an assumption would be utterly naïve. While among the research personnel there are many who are simply college graduates and routine engineers, any serious research and development work deserving this name requires people with qualifications not easy to come by. After all, the people guiding the work must have had graduate training in mathematics, natural science, or engineering, and the number of such people at any time is given and cannot be increased very fast.

THE SUPPLY OF SCIENTISTS AND ENGINEERS

To be sure, the number of scientists and engineers is not fixed for all time. The United States has been able to increase its contingent of research scientists at a good rate. The number of Ph.D.'s in scientific subjects, living in the United States and under 70 years of age, has increased from 13 per one million of the U.S. population in 1900, to 182 in 1940, and to 257 per one million in 1950.[37] But it takes several years to train a Ph.D., and to train Ph.D.'s we need qualified teachers at the schools, colleges, and universities. Assume that one half of the existing scientists are in industrial research and the other half are engaged in university teaching. If you want to double immediately the number of scientists guiding industrial research, you have to transfer them out of the universities and you thereby stop immediately the new production and reproduction of scientists; consequently, with a certain time lag, you reduce and eventually stop research itself.

[36] Cf. Henry H. Villard, "Competition, Oligopoly, and Research," *Journal of Political Economy*, Vol. LXVI (December 1958), pp. 483-497, especially p. 489.

[37] National Science Foundation, *Scientific Personnel Resources*, 1955, p. 9.

If an overenthusiast proposes that we double our industrial research and development work, he may mean either doubling the money outlay or doubling the manpower allocation. What would be the "real" effects of doubling the money outlay? It might be relatively modest, since a large part of the increased outlay would pay merely for inflated money costs of human resources already employed in research and development. This was shown in the preceding pages. The illustrations used were based on some arbitrary assumptions, to be sure. But however they may be varied, the result will always be an inflation of research costs as long as the supply elasticity is not infinite and research qualifications of new personnel are below previous standards.

Now think of the other meaning of doubling industrial research and development work: doubling the manpower allocation, not eventually, over many years, but quickly. If it could be done at all, money expenditures would have to be increased by an incredible amount, on the basis of the reasoning just presented. But the doubling of the manpower allocation to industrial research is *not* practically possible and, if it were, it would not be desirable. Let us look at the figures. A recent report states that our industry employed, in January 1959, 277,000 "research and development scientists and engineers."[38] This figure includes everybody who has completed "a four-year professional college course" in engineering, mathematics, or the natural sciences. If we talk about real research scientists, we should look at researchers with a Ph.D. degree. There are perhaps 77,000 Ph.D. scientists in the United States;[39] approximately 27,000 of them may be in teaching, that is, they produce the teachers and researchers of tomorrow. They are the only people available in the country who could be used to fill vacancies in industrial research and development. Take them out of teaching and within a few years you will have fewer men in research and development than you would if you drop the ambitious plan and allow technological research to grow at the rate at which new scientists and engineers can be trained by those in teaching and can be spared for non-teaching assignments.

Table v-9 shows that the number of Ph.D. degrees annually awarded in the physical sciences and mathematics, though increased over the

[38] National Science Foundation, *Science and Engineering in American Industry* (Washington, 1959).

[39] There were 49,000 in 1953, as reported by Dael Wolfle (ed.), *America's Resources of Specialized Talents* (New York: Harpers, 1954), pp. 300-301. Roughly 30,000 new Ph.D. degrees in scientific subjects were granted since 1953. The difference allows for deaths and retirements.

prewar, war, and immediate postwar years, has not significantly increased since 1951. This is surprising in view of the large increase in total college and university enrollment. True, the percentage of those taking their first degree in the physical sciences or engineering declined from 16.8 per cent in 1950 to 11.7 per cent in 1954, but this would still leave an absolutely increasing number of annual bachelor degrees in these fields. The failure of doctorates to increase apace is possibly due to the lure of industrial employment: industry has been picking up graduate students before they had completed their Ph.D. work. If this has happened to a large extent, the competitive strength of industry in this labor market has had two effects: by offering immediate employment at higher salaries than the students could expect to earn several years later in academic employment, industry has reduced the potential number of Ph.D. scientists, and then, in addition, has taken increasing shares of the actual crops of Ph.D.'s.

TABLE V-9

NUMBER OF DOCTOR'S DEGREES AWARDED IN MATHEMATICS AND THE PHYSICAL, BIOLOGICAL, AND ENGINEERING SCIENCES, 1936-1958

Calendar Year	Total	Physical sciences[a]	Mathematics	Engineering	Life sciences[b]
1936	1,465	698	78	68	621
1937	1,524	750	73	90	611
1938	1,476	653	61	65	697
1939	1,571	717	90	61	703
1940	1,814	783	102	97	832
1941	1,978	947	96	110	825
1942	1,856	850	75	83	848
1943	1,435	706	41	49	639
1944	1,118	574	40	61	443
1945	842	372	38	65	367
1946	1,018	466	53	101	398
1947	1,545	676	116	116	637
1948	2,153	931	117	252	853
1949	3,227	1,438	144	446	1,199
1950	3,787	1,686	174	469	1,458
1951	4,249	1,778	204	586	1,681
1952	4,502	1,804	204	569	1,925
1953	4,800	1,781	226	565	2,228
1954	4,920	1,804	247	560	2,309
1955	5,063	1,798	243	648	2,374
1956	4,646	1,729	226	576	2,115
1957	5,101	1,836	260	603	2,402
1958	5,043	1,797	236	655	2,355

SOURCE: National Academy of Sciences, National Research Council.

[a] Excludes mathematics and engineering; includes physical anthropology, archeology, and geography.

[b] Includes psychology.

Before the war approximately 95 per cent of all mathematicians, 75 per cent of all physicists, and 45 per cent of all chemists receiving the Ph.D. degree went into teaching. These figures have declined drastically owing chiefly to the competition of industrial research. The share obtained by academic institutions is down to 56 per cent of the mathematicians, 27 per cent of physicists, and 16 per cent of chemists. Taking all recipients of doctors' degrees in the physical and engineering sciences, only 27 per cent of them entered teaching careers in 1955 and 1956, and only 25 per cent in 1957 and 1958.[40] This attrition of science teaching must be halted—or the supply of well-trained scientists for teaching as well as for industrial careers will dry up.

In order to staff the colleges and universities adequately, at least 58 per cent of the annual crop of Ph.D. scientists and engineers must enter academic careers.[41] We see from Table v-9 that the total number of recipients of doctors' degrees in the natural sciences, mathematics, and engineering has lately been between 4500 and 5000 per year. If only 42 per cent can be spared for nonteaching assignments, this means an annual availability of between 1890 and 2100 for industry. This surely does not permit a "doubling" of industrial R & D, measured in qualified manpower, either immediately or in the near future.[42]

The argument has so far been formulated in terms of Ph.D.'s and academic teaching and research guidance. We have mentioned before, however, that the number of persons counted as "research and development scientists and engineers" now employed by industry is almost six times the number of Ph.D.'s so employed. Does this reveal a flaw in our reasoning? I do not believe it does. For the same argument that was made concerning Ph.D.'s who are in industry instead of in college and university teaching, holds for scientists with M.A.'s and B.A.'s who are in industry instead of in high-school teaching. Nearly every

[40] National Education Association, *Teacher Supply and Demand in Colleges and Universities* (Washington, 1957 and 1959).

[41] Vladimir Stoikov, *The Allocation of Scientists and Engineers*, A Dissertation submitted for the Ph.D. Degree in Political Economy, The Johns Hopkins University, 1960, p. 198.

[42] Not only economists have been unrealistic in their demands for more and more industrial research. Industry is equally unrealistic. Cf. the following statement: "General Electric operating departments estimate that doctorate-level men in their organization will increase 58% in 5 years and 92% in 10 years over the numbers present this year [1958]. The corresponding estimates for the bachelor-master's levels are 33% in 5 years and 52% in 10." Clarence H. Linder, "Trends in Industrial Requirements for Scientists and Engineers," in National Science Foundation, *Scientific Manpower 1958* (Washington, 1959), p. 27.

college graduate with a major in mathematics or the natural sciences is a potential high-school teacher; if he is attracted into industrial employment, the high school has lost a teacher. The lack of qualified high-school teachers is just as bad as the lack of qualified college teachers. To double in a short time the number of scientists in industrial research would deplete the ranks of science and mathematics teachers in high schools.

THE SHORT AND THE LONG RUN

The shortage of scientific personnel, which makes it impossible to increase industrial research without jeopardizing the teaching of scientific subjects, is a short-run phenomenon only. One might think otherwise; one might suspect that the shortage is one of mental endowment of the population, that there are not enough people with sufficiently high intelligence quotients. This is not the case. The percentage of people with adequate I.Q. is large enough for the nation eventually to train all the scientists it may want for industrial research, basic research, and teaching at all levels. That we have not "found" or "attracted" sufficient numbers of trained scientists is chiefly the effect of our school system with its delayed mathematics teaching, its "freedom to loaf," and its freedom to choose easy curricula and avoid the more demanding courses. If we reform our school system, we shall be able to give a much larger percentage of the young an academic education and thus to train the scientists that are wanted. (Is it necessary to repeat that the "larger percentage" given an academic education does not mean raising the percentage going to college from 32 to 50 but rather raising the percentage of those who now would really deserve to go on to genuinely higher education from 4 to 10?)

It is conceivable that the "bottleneck" will eventually disappear even if we fail to reform the school system. The better employment opportunities, the increasing salary levels, and the improved social status for those in scientific careers may attract larger numbers of young people into these fields, or may persuade more parents to steer or push their youngsters into academic preparation. One way to double the percentage of physics and mathematics students would be to drop discrimination against women. We have completely neglected to develop our "womanpower resources"; the prejudice against women in mathematics and science is purely traditional and not justified on any reasonable grounds. The disappearance of this prejudice could solve much of our problem. It is reported that more than half of the medical doctors in Soviet Russia are women. If someone has doubts concerning the capacity of women as imaginative research scientists, he may propose to guide young women into medical education and direct many of the young men who now wish to study medicine to go into mathematics and science instead. In any case, what should be stressed is that the shortage of scientific manpower is not necessarily permanent, that it is not a lack of native intelligence, but only a lack of adequate schooling.

The conclusion that the bottleneck is not a long-run problem does not imply that it will be solved automatically. If nothing is done about it, if the prejudice against women in scientific, medical, or academic careers continues, if parents continue to abstain from pressuring their children into the "tough" courses at school, if the schools continue to delay mathematics teaching and to preserve the present freedom to loaf, then the problem will stay with us. It is a short-run problem only in the sense that it is *possible* to solve it in the long run.

How long is the "short run" during which the problem *cannot* be solved and must be dealt with by denying to industrial research the manpower it wants? An authoritative answer to this question presupposes more factual information than we have at the moment. But one may probably assume that it takes about ten years to turn out a scientist: if serious training begins at age ten, we should—in a reformed school system—have adequately trained scientists at age twenty. On the basis of this assumption one may venture to estimate the short run to be a matter of approximately ten years.

This does not mean that the problem may not be gradually alleviated within a shorter period. The more niggardly we treat industrial R & D in the early years, and thus get more teachers for high schools, colleges, and universities, the more researchers shall we have a few years later. The choice is between different "maturities," so to speak. The more manpower we allocate for industrial R & D now, the less we shall have later, and vice versa. If, for reasons of national defense, some crash programs have to be carried out because the survival of the nation depends on quick results, we may decide on a priority of R & D in full knowledge that it will mean that there will be neither adequate teaching nor adequate R & D a few years from now. In other words, the decision to give priority to R & D requirements now implies a conviction that the nation will no longer need R & D in a few years. If one is not certain that the needs for R & D will soon pass, if one admits a possibility that important R & D work will need to be done several years from now, then manpower priorities given to present industrial R & D activities may be suicidal.

One may compare alternative ways of meeting certain R & D objectives in the shortest period of time or of attaining a maximum of R & D projects in a given period of time. For all such alternatives, except for the case of a nonrecurring crash program that can be completed within two or three years, the optimal allocation of scientists and engineers will be one which "assigns" more of them to teaching and fewer to industrial R & D, relative to the distribution we have permitted or promoted during the last six or ten years. The "assigning" of manpower in our society takes the form of appropriating funds. Let us note again that the federal government in 1956-1957 gave $3,230 million for R & D in industry and $380 million for R & D in universities (with a goodly portion of the latter going to nonteaching research centers), and that these relative distributions have not changed in the subsequent years.

There have been many voices crying for ever more and more industrial R & D. Very few voices have been raised to warn that the present emphasis on R & D may starve our teaching institutions and later lead to an atrophy of R & D.[43] One group of experts saw the danger clearly and described it eloquently:

"The most critical bottleneck to the expansion and improvement of education in the United States is the mounting shortage of excellent teachers. Unless enough of the Nation's ablest manpower is reinvested in the educational enterprise, its human resources will remain underdeveloped and specialized manpower shortages in every field will compound. Unwittingly the United States right now is pursuing precisely the opposite course. Demands for high quality manpower have everywhere been mounting, but colleges and universities have found themselves at a growing competitive disadvantage in the professional manpower market.

"Our Nation, like the prodigal farmer, is consuming the seed corn needed for future harvests. The ultimate result could be disaster."[44]

Basic Research and Higher Education

The rivalry, the scramble for scarce manpower, between teaching and industrial research and development work has been shown to

[43] Fritz Machlup, "Can There Be Too Much Research?" *Science*, Vol. 128 (November 28, 1958), pp. 1320-1325.

[44] The President's Committee on Education Beyond the High School, *Second Report to the President* (Washington, 1957), p. 5.

present a serious danger for both. Does the same rivalry exist between teaching and basic research? The 92 per cent of R & D which is applied research and development has been charged with and convicted of taking teachers and potential teachers away from schools, colleges, and universities, and curtailing the future supply of teachers as well as researchers. One might unwittingly extend the indictment and conviction to the other 8 per cent of R & D which is basic research. This would, however, be a grievous error.

BASIC RESEARCH AND HIGHER EDUCATION ARE COMPLEMENTARY

The allocation of funds to basic research has been much too niggardly. If generous increases are demanded for appropriations to basic research, these demands are fully justified, not only because of the greater importance and regrettable neglect of basic research but also because basic research and advanced teaching and learning are complementary rather than competitive activities.

I stressed this complementarity between basic research and higher education on an earlier occasion, and may be permitted to quote from my own writing:

"The essential complementarity between teaching (especially postgraduate) and basic research has always been recognized by institutions of higher education. The performance of university professors is judged, as a rule, by their research work, and it is from the great research scholars that advanced students have received their most lasting inspirations. The respected teachers in the best universities devote much less than one half of their time to teaching and much more to basic research. By and large, the more research they do, the better they will be as teachers. Of course, teaching and research cannot be complementary where heavy teaching loads make it impossible for college teachers to carry on any significant research. Perhaps, if the amount of teaching is measured by the hours of classroom work, all research must be considered an alternative to teaching; only when the amount of teaching is measured by the results achieved—in terms of the intellectual capacities developed—will basic research be recognized as complementary to teaching on the highest levels."[45]

Full support for this view has recently been expressed in a report by the President's Science Advisory Committee, which states:

"It is a fundamental contention of this report that the process of

[45] Fritz Machlup, "Can There Be Too Much Research?" *Science*, Vol. 128 (November 28, 1958), p. 1323.

graduate education and the process of basic research *belong together* at every possible level. We believe that the two kinds of activity reinforce each other in a great variety of ways, and that each is weakened when carried on without the other. . . . The apprentice scientist learns best when he learns in an atmosphere of active research work. . . . The process of graduate education depends on 'research' just as much as upon 'teaching'—indeed the two are essentially inseparable—and there is a radical error in trying to think of them as different or opposite forms of activity."[46]

The complementarity between basic research and higher education is not confined to graduate work. It extends to undergraduate teaching, although many college administrators and professors will not recognize it. The allegedly "excellent teacher" who is not interested in research or has no time to do research is often only a good lecturer or entertainer. The excellence of college teaching cannot be judged by the students taking courses, and their testimony is worth little; it can be judged by former students now in graduate school who were inspired by their "college prof" to go on to graduate work and find that they had been well prepared for it. If this test is applied to the performance of college teachers, one will discover a very high correlation between their teaching effectiveness and their active research.

Despite recent disparagement of research emphasis in undergraduate colleges, the report from which we have just quoted has this to say about the quality of collegiate instruction:

"The first and greatest need is to extend to the college the connected concern with teaching and investigation which we have emphasized throughout. This does not mean that every college must be a university, or that every college teacher must be a dedicated research man, but it does mean that the opportunity and practice of scientific inquiry should be a part of the life of the college laboratory."

PAST NEGLECT OF BASIC RESEARCH

Scientific research is sometimes de-emphasized in the name of the "liberal arts" tradition and of "good teaching" of the humanities, an attitude which amounts to a very "illiberal" and nonhumanistic misunderstanding. Still more frequent is the disrespect in which pure research is held by advocates of "practical" vocational training. American preference for practical knowledge over theoretical, abstract knowl-

[46] "Scientific Progress, the Universities, and the Federal Government," Statement by the President's Science Advisory Committee (Washington: November 15, 1960).

edge is a very old story. Students of intellectual history have often commented on the American's aversion to abstract thought and his genius for technological invention. The pioneer spirit of the settlers and the absence of an old leisure class have been mentioned as explanations for these American traits. Alfred Marshall attributed the inventive and organizing skill to the "effectiveness of the money test" in determining social acceptance. According to him "the able young American is almost as sure to become an inventor or an organizer or both, as the able barbarian was to become a leader in battle, or as the able Florentine in the Middle Ages was to seek distinction in art or politics."[47]

The American idiosyncrasy in favor of the immediately practical and against the general-theoretical has not always helped in the production even of technological knowledge. Thus we read that during the period between 1850 and 1870 "America had little to contribute to technology."[48] And the same writer said this about more recent times:

"In the years after 1870, we were to show the same energy in application of new ideas that we had shown in railroad development. Somewhat like the Japanese, we have commercialized the inventions of other nationals. Unlike the Japanese, we have added almost immeasurably to these inventions to make them peculiarly our own. Development has involved invention, often of high order, but when I speak of capital invention I refer to the basic ideas on which new industries are founded. A few instances of such basic ideas that have originated abroad are the steam turbine, the generator of electric power, the automobile, the diesel engine, wireless communication, X-rays, radioactivity, the electron, nuclear transmutation, isotopes, the quantum theory, mass-energy relationship, catalysis. Even catalytic cracking was brought to an unenthusiastic petroleum industry from France. With these and other borrowed scientific tools we have fashioned immense industries."[49]

The story of the reliance upon imported knowledge of basic science has been told with particular pathos in connection with the development of the nuclear bomb. For a quick check one may count the references to scientists which Smyth makes in the first chapter of his official report on the development of the nuclear bomb.[50] Of the total of 48

[47] Alfred Marshall, *Industry and Trade* (London: Macmillan, 1927), pp. 155-156.

[48] Eugene Ayres, "Social Attitude Toward Invention," *American Scientist*, Vol. 43 (October 1955), p. 533.

[49] *Ibid.*, pp. 534-535.

[50] Henry DeWolf Smyth, *Atomic Energy for Military Purposes; The Official Report*

references to 29 different scientists, only 10 references are to 8 different Americans—and some of them may have studied abroad. The situation has enormously improved in the last twenty or thirty years. The United States has developed its own production of scientific knowledge and has done so with great success. Although it may be poor taste to claim first place for America in all sorts of activities, it is probably true that in pure science the United States is no longer behind any other country in the world, and is actually ahead of most.

This is true in spite of the meagre allocations of funds to basic research. It is true even in spite of the plentiful allocations of funds to applied research and development, which have diverted many actual and potential investigators away from basic research. Given the scarcity of trained scientists, every additional dollar going to industrial R & D makes it harder for basic research to hold its own. It is somewhat embarrassing to say it, but the phenomenal growth of R & D in the United States has on balance probably harmed the development of basic research. This was, of course, neither intended nor anticipated. It was the unavoidable result of honest efforts to get certain projects done in a hurry and to contract for the necessary services—without considering that these services could be rendered only by taking scientists away from basic research. Now that we know that the funds for different R & D projects chase after the same "human resources," should we propose that the appropriations for applied R & D be cut? It would probably cause frictional difficulties if one attempted to correct the present misallocation of manpower resources by seriously cutting the funds for applied R & D. Thus one must propose that the reallocation be brought about through increased appropriations for basic research.

The disproportionate support of applied work and comparative neglect of basic research makes it relatively easy to correct the situation. If the federal government provides approximately 66 per cent of all the funds for R & D, and if basic research receives only 8 per cent of all the funds, a diversion of only 2 percentage points from applied to basic would increase the funds for basic research by about 25 per cent. In other words, an enormous lift could be given to basic research by a relatively small reapportionment of funds. Since the aggregate appropriations are increasing from year to year, the increase in the share going to basic research could be achieved while the dollar amounts provided for applied R & D are still getting bigger.

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on the Development of the Atomic Bomb under the Auspices of the United States Government, 1940-1945 (Princeton: Princeton University Press, 1948).

THE PRODUCTIVITY OF BASIC RESEARCH

There is no way of calculating the benefits society can derive from increased investment in basic research. Since we have seen the enormous benefits which have been attributed to technological research, and since we know that applied research builds upon the findings of basic research, we can only say that the benefits must be very high indeed.[51]

In the case of industrial R & D we have refused to recognize the estimates of the social rates of return because the social costs of the investment did not include the full opportunity cost of the human resources. In taking only the dollar expenditures of R & D as the total cost, the investment analysts overlooked that the professional personnel performing the R & D work had been taken away from teaching; that the scientists and engineers who were assigned the task of producing new technological knowledge had been diverted from the task of producing new scientists and engineers, new producers of knowledge; and that therefore the performance of this R & D work was at the expense of *future* R & D work.

All this is different in the case of basic research. The performer of basic research and the university teacher are one and the same man, and the research grant he receives may be the very thing that keeps him from quitting his university post, and at the same time enables him to keep his best students who would otherwise succumb to the temptation of more lucrative jobs in industry. The danger that there will be less teaching, or less competent teaching, when more funds are made available for basic research is slight. Indeed, the opposite is likely to happen: the professors who receive grants for research may become more useful as teachers, and the students working as research apprentices will learn more, for, in the words of the report from which we have quoted before, "the would-be scientist must learn what it is like to *do* science, and this, which is research, is the most important thing he can be 'taught.' "

The "opportunity cost" of basic research is applied research. Of the three possible uses of the scientist—to produce new scientific knowledge, to produce new technological knowledge, and to produce new scientists—two are complementary with each other, and one is competitive with these two. But if society foregoes some new technological

[51] See Richard P. Nelson, "The Simple Economics of Basic Scientific Research," *Journal of Political Economy*, Vol. LXVII (June 1959), pp. 297-306.

developments at the moment, for the sake of more scientific training and scientific research, the immediate sacrifice is likely to be small compared with the future benefits.

COMPETING FIELDS OF KNOWLEDGE

Almost the entire discussion in this chapter has been concerned with the natural sciences and engineering. This one-sidedness, this disregard of the social sciences and the humanities, is easy to explain but hard to justify. The explanation, of course, is that the nation has been pouring billions and billions into scientific and technological research and development, but has had only encouraging words and an occasional pat on the back for the humanities, and some small change, more pennies than dimes, for the social sciences.

With all the unsolved social, economic, political, racial, and international problems, one should think that research in the social sciences might be enormously important and perhaps immensely "productive." Why then are the pockets of the nation so tightly buttoned up whenever the question of support for the social sciences is raised? Perhaps a fear of social change can explain the reserved attitude toward investigation on subjects in the social sciences. New knowledge in the natural sciences is always welcomed as "discovery" and "progress"; new knowledge in technology is hailed as "invention" and "advance"; but new knowledge in the social sciences is suspected, if not decried, as either "subversive" or "reactionary" or "trivial." The very word "social" seems to remind some people of "socialism" and brings forth a sour reaction to any proposal of support for research in the social sciences.

The nation's stinginess with regard to research in the humanities has different origins. It probably goes back to a deep-rooted anti-intellectualism and disdain for "culture." Concern with the fine arts, with literature, let alone poetry, has often been regarded as snobbish, decadent, undemocratic, unmanly, effeminate. The humanities are something for the ladies, not for a "regular fellow." A true-blooded American should be a farmer, a businessman, or an engineer, and he should not care for that namby-pamby stuff brought in by some foreigners. Natural science, once also esoteric and impractical, proved itself, showed that it was after all practical, when the atomic bomb and the missiles were developed. Natural science, moreover, has become a sort of spectator sport, where one may watch American teams "beat" Russian teams. Humanistic studies, on the other hand, do not help beat the Russians either in peaceful competition or in cold or hot wars. Why spend money on such pure luxury?

These attitudes must be fought. A nation cannot live merely on victuals, comforts, games, and weapons; a concern with ideas and values is essential, for without them life becomes meaningless. Fortunately, the best of the scientists recognize the need for more support of the humanities. And even more fortunately, they do not confine themselves to friendly gestures and assurances of sympathy, but are taking the leadership in a campaign to secure financial help for the humanities and social sciences. This help will probably not come directly through governmental grants in support of humanistic and social research. But it may come indirectly through grants to universities in support of scientific research and graduate education. As the needs of the natural sciences are taken care of by more adequate government funds, general funds of the universities are released and become available for the humanities and social sciences.

CHAPTER VI · THE MEDIA OF COMMUNICATION

IN THIS chapter we shall talk about books and pamphlets, periodicals and newspapers, the stage and the cinema, radio and television, telephone and telegraph, the postal service, and a few other industries engaged in the distribution of knowledge. All these are ordinarily included under the heading "communication industries," or simply "communications," meaning the conveying of knowledge from person to person, or to masses of persons in the case of "mass media."

Of course, the preceding two chapters also dealt with communication, as indeed does almost the entire book. Education is communication for a certain purpose; research and development involves communication in the disclosure of its findings. The chief media for these disclosures are publications of various kinds. And in education almost all media of communication are used: textbooks, learned journals, student newspapers; the auditorium stage, educational films; educational radio and TV; correspondence courses. What distinguishes the present chapter from the others is that it does not confine itself to communication for *one purpose*—e.g., to educate—or to communication of *one type* of knowledge—e.g., scientific and technological—but deals with the *media* used in the communication of knowledge of all types for any purpose whatever.

Our primary objective in this survey of the media of communication will be to estimate the annual expenditures made for each of them. In most instances the focus will be on the year 1958, because the most recent Census of Manufactures was taken for that year. Whenever possible, however, we shall look into historical statistics in order to get impressions of the comparative growth that has occurred in the various activities. In connection with some of the media we shall also attempt classifications of the types of knowledge they distribute. Occasional observations on the social significance of the performance in question will not be suppressed—even if they represent value judgments not supported by objective evidence.

Printed Matter

We begin with "printed matter," or "printing and publishing," to use the terminology of the census classification of industries. When it comes to an examination of "total sales" of printed matter we shall face several complications: Everything that is published has been printed, but there are things printed that are not published, such as labels, ledgers, forms, or greeting cards. Consequently, in a statistical analysis we may take either total sales of "printing" plus the value added by "publishing," or total sales of "publishing" plus the sales of that portion of "printed matter" that is not published. Both sums would still be exclusive of the net product of retail distribution, the value added by stationers, booksellers, and other distributors. Finally, to mention another complication, sellers' receipts for newspapers and periodicals exceed buyers' expenditures for these publications by the cost of advertisements. Thus we must be prepared to meet a number of difficulties in the statistical analysis of the printed media of communication.

BOOKS AND PAMPHLETS

There are some truly amazing facts regarding book publication in the United States. The number of books published was greater in 1914 than in any year thereafter until 1953. In 1959 the number was not more than 24 per cent above that of 1914 (whereas population had increased by 78 per cent and GNP by 988 per cent). The number of books printed and copyrighted in the United States in any year during the 1950's was below the 15,221 published in 1930. Consumer expenditures for books and maps were less, in per cent of national income, during the 1950's than they had been in either the prosperity year 1929 or the depression year 1931.

Perhaps it should be said that statistical jugglery is sometimes possible if "books proper" and "pamphlets" are not distinguished. But even such juggling would not change the trend of book publication in this country. The number of pamphlets (and similar items) annually printed and copyrighted in the United States has not increased. Indeed, the high figure for 1958 is still 3 per cent below the record number copyrighted in 1930. (Some readers may want to know that a pamphlet is defined as "any collection, to be offered for sale, of at least eight but less than sixty-four paperbound pages.")

The historical statistics of book publishing, this important branch of knowledge production, look especially poor when international statistics are adduced for purposes of comparison. It appears that as publisher of books the United States ranks behind Japan, the United Kingdom, and West Germany, and seems to be ahead of France perhaps only because the available statistics of French publications are confined to works originally published in French—that is, excluding translations. In the year 1954, 19,837 books were published in Japan, 19,188 in the United Kingdom, 16,240 in West Germany (including Berlin), 11,901 in the United States, and 10,662 in France. The same order prevailed in 1958, with 24,983 books published in Japan, 22,143 in the United Kingdom, 19,618 in West Germany, 13,462 in the United States, and 11,725 in France.[1] If the number of books were compared with population, let alone national income, the performance of the United States would look even worse. This judgment presupposes that it is a "good thing" to offer variety in book publication. It disregards comparison of the number of books sold and of the percentage of GNP spent on books.

Some of the pertinent data on commercial book production in the United States are presented in Table VI-1. In comparing the sales by publishers with the purchases by consumers one must remember that the former include sales to others than "consumers," and the latter include more than what is received by publishers. Included in "personal-consumption expenditures for books and maps" are small amounts for imported books and large amounts for distribution costs. Included in publishers' receipts are sales to government, business and professional people, churches, libraries, and foreign countries. For the year 1954, for example, publishers' receipts were reported as $665 million, and personal-consumption expenditures as $806 million. Estimates of total expenditures for books and pamphlets, with a breakdown by class of purchasers, were prepared for me by Thomas Dernburg, and are summarized in the following paragraphs.

Of the publishers' receipts in 1954, $628 million were for books, $37 million for pamphlets and unspecified receipts. (See Table VI-3.) According to the Census of Manufactures, the publishers reported sales of books to government in an amount of $108 million, to libraries (including college libraries) $11 million, exports $20 million, direct sales to consumers $208 million, and to distributors $224 million. This gives a sum of $571 million and leaves $57 million not allocated to any customer class. According to information furnished by the U.S. Department of Commerce, one may assume that the following items were not included in personal consumption expenditures: 30 per cent ($19 million) of all technical, scientific, and professional books, pur-

[1] UNESCO, *Basic Facts and Figures: International Statistics Relating to Education, Culture, and Mass Communication* (1956 and 1959).

TABLE VI-1

BOOKS AND PAMPHLETS: NUMBERS PUBLISHED, SALES RECEIPTS, AND CONSUMER EXPENDITURES, 1914-1959

Year	Number of books published in U.S. (1)	Number of pamphlets, etc. printed and copyrighted in U.S. (2)	Sales receipts of publishers for books & pamphlets in millions of dollars (3)	*Consumer expenditures for books and maps* in millions of dollars (4)	dollars per capita (5)	% of GNP (6)
1914	12,010	17,021*	n.a.	n.a.	n.a.	n.a.
1919	8,594	28,261*	n.a.	n.a.	n.a.	n.a.
1929	10,187	40,245	n.a.	309	2.53	0.296
1939	10,640	44,046	155	226	1.73	0.248
1949	10,892	38,664	587	630	4.23	0.244
1950	11,022	39,861	619	677	4.48	0.238
1952	11,840	34,398	730	790	5.06	0.228
1954	11,901	39,460*	665	806	5.01	0.222
1956	12,538	41,779*	n.a.	1,006	6.01	0.240
1958	13,462	44,198*	998	1,181	6.83	0.266
1959	14,876	40,584*	n.a.	1,353	7.67	0.281

SOURCES: Column (1): R. R. Bowker Co., New York, *Publishers' Weekly*. Column (2): Library of Congress, *Annual Report of the Librarian of Congress* and *Annual Report of the Register of Copyrights*. (Note: * For the years in which no separate figures are given for books and pamphlets, the total number of copyrights is reduced by those for books and pamphlets printed abroad in a foreign language; from this the number of books published in the United States is deducted.) Column (3): U.S. Bureau of the Census, *Census of Manufactures*, 1954, Series 27A; *Census of Manufactures*, 1958, Series 27A. Column (4): U.S. *Survey of Current Business*, National Income Supplement, 1953; U.S. Income and Output, 1958. Columns (5) and (6): computed from (4) and Department of Commerce figures.

chased, presumably, by business and professional people; and 100 per cent ($3 million) of all hymnals, and 10 per cent ($3 million) of Bibles and other religious books, purchased, presumably, by church groups, etc. From foreign-trade statistics we find that exports in 1954 were $29 million. Adding all these sales to governments, libraries, business, churches, and exports, we have thus far earmarked $173 million as sales to other than personal consumers. If $10 million of the purchases by business were made through distributors, we may assume that $214 million of the sales to distributors went to consumers, in addition to the $208 million sold directly to consumers. With $422 million sales of books to consumers and $173 million to others than consumers, there are $70 million still unaccounted for, if the total was $665 million for books and pamphlets. Distributing the $70 million among consumption and nonconsumption categories in approximately the same proportions as the items already allocated, we put down $472 million as having gone to consumers and $193 million to others.

Turning now from publishers' sales to consumers' purchases, we deduct from the reported consumption expenditures of $806 million an amount of $3 million for imported books, and obtain $803 million as having been spent on domestic books and maps. This compares with the $472 million of publishers' receipts, the difference ($331 million) constituting the cost of distribution, which is reasonable in view of the customary retail margin of 40 per cent of the list price. If a similar markup is applied to the portion of books purchased by business through bookstores, we may add another $4 million to the $193 million previously computed, and end up with a round $1,000 million as the final estimate of the retail value of books and pamphlets published in 1954—apart from government publications.

To make analogous estimates for 1958 is more difficult because in this year the Census of Manufactures did not allocate sales by customer class. However, since the Census Bureau is reasonably confident that the percentage distribution of sales by customer class is slow to change, we have taken the percentages obtained from the 1954 Census and made 1958 estimates on this basis. For 1958 personal-consumption expenditures were $1,177 million, imports were $4 million, exports were $44 million, and publishers' receipts came to $955 million. We estimate that the market value of government purchases came to $175 million, business purchases to $36 million, and libraries and churches $28 million. Thus, the total retail value of books and pamphlets produced in 1958 came to $1,456 million—without government publications.

An assessment of the total value of government publications requires consideration of four items. First, there is the value of the work done by the Government Printing Office in its main plant and in its five field plants. For 1958 the value of this work comes to $59 million. Secondly, there are approximately 320 printing plants in the executive and judicial branches of the federal government—183 operated by the armed services, 27 by the Atomic Energy Commission, and the remainder by other agencies—that undertake printing independently of the Government Printing Office. The value of the work done by these plants was $73 million in 1958. Thirdly, the cost of the services performed by the Superintendent of Documents—sales distribution, distribution for other agencies and for members of Congress, distribution to depository libraries, and cataloguing and indexing—must be included. These obligations of the Superintendent of Documents amounted to $3 million in 1958.[2] Fourthly, the Government Printing Office as well as the various executive and judicial departments have a considerable amount of their printing done by commercial printers. In 1958 there was $44 million worth of such work. The four items together amount to $179 million.

A large portion of government publications was distributed but not sold. Yet, in 1958 the Superintendent of Documents did sell almost 46,000 different publications, yielding proceeds of $7 million. This is not a large enough amount to fuss about its allocation and we shall therefore assume that the sales were to business firms, an assumption which saves us the work of reallocating the personal consumption expenditures once again. We conclude that the total national production of books and pamphlets in 1958 was ($1,456 million + $179 million) $1,635 million, of which $1,173 million was included in personal consumption expenditures and $43 million was purchased by business as part of the cost of producing other goods and services. Government was a purchaser to the tune of $175 million, and a producer for its own use to the tune of $172 million. The rest was $28 million for libraries and churches, and $44 million for exports.

The ways in which these estimates were obtained probably involve some statistical misdeeds such as double counting; for example, government purchases of books evidently included elementary textbooks for public schools and all sorts of books for the libraries of public universities; these book purchases, as also those by religious groups, were part of the expenditures for education; some of the book purchases by business were probably for their research departments and therefore included in the expenditures for research and development. These items, however, are relatively small and are probably more than offset by underestimates or omissions of other items.

Inasmuch as we have deducted imports and included exports, the result was in the nature of a "national-product" account, with the United States producing some knowledge for foreign use. If "domestic intake" is wanted instead—knowledge produced here and abroad for United States use—the imports must be included and the exports deducted.

[2] Government Printing Office data were furnished by the Comptroller and the Assistant Comptroller. By value of work is meant the total billings of the Government Printing Office minus payments to commercial printers. Data for printing done by governmental agencies separate from the GPO were obtained from *Staff Report to the Joint Committee on Printing*. Obligations of the Superintendent of Documents were obtained from the *Budget of the Government of the United States*.

THE TYPES OF KNOWLEDGE CONVEYED BY BOOKS

As every user of a library knows, books are classified according to subject; even if the classification is not always correct, in a large sample the statistic of the relative numbers of books in different subject classes is not vitiated by the normal extent of misclassification. Such statistical information on new books published, classified by subject matter, has been compiled for many years by R. R. Bowker Company, of New York, though because of a change in the definition of a "book" the series is comparable only from 1950 on. There are 23 subject classes, including one for "miscellaneous." We may reorganize the 22 specific classes by sorting them into the five—so far empty—boxes prepared in Chapter II to distinguish the major types of knowledge conveyed by the books published in a year. Practical, intellectual, pastime, and spiritual knowledge will all be represented, but unwanted knowledge will not, since books conveying unwanted knowledge could not be sold and would not be read. Government publications are not included in this survey.

Table VI-2 presents this classification of new books published, with the figures recomputed as per cent of the totals, for several years since 1950. My subdivision of the subject-matter classes into the four major types of knowledge is, of course, rather arbitrary. One may quarrel with my decision to assign one half of the "juvenile" books to intellectual and one half to pastime knowledge, but it would not make much difference for the outcome how this class is treated. We might have made the same decision for "fiction," except for the fact that Bowker's classification is sufficiently detailed and allowed us to assign "general literature," "history," and "poetry and drama" to the intellectual category; so we left all of fiction under the heading of pastime knowledge.

The stability in the per cent distribution from year to year is quite remarkable, both among specific subject-matter classes and among the broad types of knowledge, where variations are only between one and two percentage points. This distribution relates only to the number of different books published, not to the number of copies sold or the dollar volume of sales. It is conceivable that there are considerable differences between these three distributions. For example, practical books may sell in much larger editions than intellectual books and may be more expensive per copy. Thus, it would be interesting to compare titles published, copies sold, and dollars received.

Unfortunately, comparable statistical breakdowns of all three magnitudes are not available. There are statistics of sales receipts and copies

TABLE VI-2

BOOKS: NEW BOOKS PUBLISHED, BY SUBJECT MATTER CLASSES AND TYPES OF KNOWLEDGE, AS PER CENT OF TOTAL, 1950-1959

Subject matter classes and types of knowledge	1950	1954	1955	1956	1957	1958	1959
Practical	*16.7*	*15.7*	*16.2*	*15.2*	*14.5*	*15.6*	*15.8*
Agriculture, gardening	1.4	1.2	1.3	1.2	1.1	1.2	.9
Business	2.3	2.2	2.5	2.3	2.7	2.8	2.8
Home economics	1.8	2.0	2.0	1.5	1.2	1.2	1.2
Law	2.7	2.5	2.4	2.3	2.4	2.4	2.0
Medicine and hygiene	4.0	4.1	4.2	3.7	3.9	3.9	4.0
Technical and military	4.5	3.7	3.8	4.2	3.2	4.1	4.9
Intellectual	*49.8*	*48.1*	*49.9*	*49.3*	*51.1*	*50.6*	*50.2*
Biography	5.5	6.2	6.6	6.2	6.1	5.2	5.2
Education	2.3	2.2	2.2	2.1	2.4	2.5	2.8
Fine Arts	3.2	2.6	2.8	2.6	2.7	3.4	2.7
General literature and criticism	5.4	4.7	5.2	5.7	4.5	4.6	5.6
Geography and travel	2.6	2.6	2.9	3.1	2.8	2.5	2.6
History	4.7	5.1	5.3	4.8	6.9	6.7	6.1
Music	1.0	.7	.8	.8	.6	.7	.8
Philology	1.3	1.5	1.3	1.5	1.4	1.1	1.3
Philosophy, ethics	3.1	2.6	2.5	3.1	3.4	3.3	3.1
Poetry and drama	4.8	3.9	3.9	3.4	3.7	3.3	3.4
Science	6.4	5.9	6.4	5.8	6.9	7.4	6.9
Sociology and economics	4.7	4.3	4.1	4.2	3.8	4.2	4.2
Juvenile (one-half)	4.8	5.7	5.9	6.0	5.9	5.6	5.5
Pastime	*23.8*	*25.2*	*24.0*	*25.2*	*23.7*	*24.1*	*23.7*
Fiction	17.3	17.6	16.5	17.8	16.1	16.7	16.4
Games and sports	1.7	1.9	1.6	1.5	1.7	1.7	1.7
Juvenile (one-half)	4.8	5.7	5.9	5.9	5.9	5.7	5.6
Spiritual Religion	*6.6*	*7.5*	*6.7*	*7.2*	*7.6*	*7.8*	*7.6*
Miscellaneous	*3.1*	*3.5*	*3.2*	*3.0*	*3.2*	*1.9*	*2.7*
Total per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total publications (thousands)	11,022	11,901	12,589	12,538	13,142	13,462	14,876

SOURCE: R. R. Bowker Co., New York, Reproduced in *Statistical Abstract of the United States.* The subdivisions into four major groupings have been added to the list.

sold, but not for the subject classes that were used for the number of titles published. The classification indeed is a very different one: instead of subject matter, rather broad categories of books are distinguished, so that perhaps ten or twelve subjects would be thrown together as "general books, adult," and the size of the item "all other books" is unduly large. We have these sales statistics for three census years, 1947, 1954, and 1958, as presented in Table VI-3. Only with very questionable manipulations can these data be used for the intended comparisons. Allocations to the types of knowledge conveyed by the books may appear almost whimsical in view of the broad classes used by the census. Nevertheless, just to see what happens, we shall attempt such allocations by making a few 50:50 splits: textbooks and reference works shall be regarded as one half practical, one half intellectual, and general books, adult and juvenile, as one half intellectual, one half pastime. Workbooks, and technical and professional books will all be put into the box labeled "practical." The entries under "all other books," "pamphlets," and "unspecified receipts" will be disregarded, so that the percentage figures will relate to the sums of the first eight rows of the table.

Disregarding the results for 1947 because of the excessive size of the item "all other books" (and the apparent distribution of much of this group over the other categories in 1954 and 1958), we present the

TABLE VI-3

BOOKS AND PAMPHLETS: QUANTITY AND VALUE OF SALES BY PUBLISHERS, 1947, 1954, AND 1958

Product	1947 Copies sold (thousands)	1947 Receipts (thousands of dollars)	1954 Copies sold (thousands)	1954 Receipts (thousands of dollars)	1958 Copies sold (thousands)	1958 Receipts (thousands of dollars)
Textbooks, elementary and high-school	74,254	55,068	81,792	101,652	99,486	148,083
Textbooks, college	23,821	52,513	15,824	51,725	22,649	84,144
Workbooks	41,010	13,227	59,373	26,902	82,572	43,293
Reference books	14,626	63,851	25,860	89,825	30,620	152,677
Religious books	42,543	28,893	30,288[a]	36,006[a]	70,807	58,650
Technical, scientific, and professional books	17,467	45,837	19,217	63,635	23,679	114,133
General books, adult	140,414	69,963	274,553	169,166	340,853	214,284
General books, juvenile	53,752	20,289	220,114	50,835	172,932	61,640
All other books	79,329	85,493	43,819	38,805	56,648	64,885
Total books	487,216	435,134	770,840	628,551	900,246	941,789
Pamphlets	402,290	20,656	267,088	25,094	435,719[b]	31,105[b]
Unspecified receipts		——		11,774		25,534
Total receipts		455,790		665,419		998,428

SOURCE: U.S. Department of Commerce, *Census of Manufactures, 1954*, Series MC-27A, Table 6A, and 1958. Reproduced in *Statistical Abstract of the United States, 1960*, p. 523.

[a] For some categories of religious books no data are available for 1954. The figures in the table include the residue taken from the official tabulation.

[b] "Standardized tests," which the 1958 Census lists among books, are here merged with pamphlets, as in the earlier census tabulations.

results for 1954 and 1958 in Table VI-4. Let us recall that the breakdown of titles published comes from the detailed subject classification of Table VI-2, while the breakdown of copies sold and sales receipts comes from the broad classification of Table VI-3, so that we are comparing figures not strictly comparable. Perhaps it is still legitimate to note that the general hypothesis is borne out that practical books sell more copies per title and for more money per copy than intellectual books. As a result, the share of books of the practical category is higher in the total of copies sold than in the total of titles published, and higher still in the total dollar volume of sales. The opposite relationship prevails with regard to books of the intellectual category: their share in the total of copies sold is lower than their share in the total of titles published, and lower still in total sales receipts. As far as books in the pastime category are concerned, the relationship is different again: their share in the total of copies sold exceeds by far their share in the total of titles published, but their share in total sales receipts is relatively low. Evidently, the editions are large and prices per copy are low. The suggestion is strong that the pastime category contains many books of the pocketbook variety, cheap volumes with paper covers. Since we divided "general books" among the pastime and intellectual categories, one would expect a similar result in the latter, were it not for half the textbooks which we also allocated to the intellectual category. Again, all these results, derived with so much juggling of inadequate data, must be taken with a grain of salt.

TABLE VI-4

BOOKS: PER CENT DISTRIBUTION OF TITLES PUBLISHED, COPIES SOLD, AND DOLLARS RECEIVED AMONG TYPES OF KNOWLEDGE, 1954 AND 1958

	Titles published		*Copies sold*		*Sales receipts*	
	1954	1958	1954	1958	1954	1958
Practical	15.7	15.6	19.3	21.7	36.0	39.9
Intellectual	48.1	50.6	42.5	39.5	39.3	37.7
Pastime	25.2	24.1	34.0	30.4	18.6	15.7
Spiritual	7.5	7.8	4.2	8.4	6.1	6.7
Not allocated	3.5	1.9	...	...	...	...
	100.0	100.0	100.0	100.0	100.0	100.0

The recent development of "paperbacks" deserves special notice. American book production had long stayed away from making cheaper books with paper covers. This was rather strange, since in Europe, especially France and Germany, for several decades many more books had been sold in paper covers than in hard covers. (Ordinarily the buyer had a choice between the cheaper and the more expensive binding.) Speculating about the reasons for the long neglect of the paperback in the United States, we can think of two possibly relevant factors: (1) The American publisher, rightly or wrongly, may have believed that most of the people interested in buying books were rich enough not to be affected by the small difference in price between hard and soft covers. And (2) this difference was so small because in this country the cost of labor usually counts more heavily, in comparison with Europe, than the cost of material. A few years ago, the production and sale of paperbacks began to gain momentum in the United States. What could have changed that would account for this sudden take-off? Technological improvements in the bindery may have reduced the labor cost for mass-produced paperbacks; the market for books may have widened to include more people in income brackets more responsive to small price differences; or changes may have occurred chiefly in the minds of publishers, who belatedly woke up to the fact that the elasticity of demand for books was great enough to warrant the reduction in book prices made possible by the use of the cheaper binding.

Whatever may have been the reason, the number of titles published in paperback editions started to rise in 1958 and has risen consistently ever since: it increased from 1469 titles in 1957 to 2387 titles in 1960, an increase of 63 per cent over three years. The research department of *Publisher's Weekly* classifies the paperbacks in "mass-market" and "other" items, the former distributed through the "magazine and newspaper wholesale system," the latter through the "book trade."[3] The number of the former increased by only 24 per cent (from 1114 titles in 1947 to 1382 in 1960), while the latter increased by 183 per cent (from 355 titles in 1957 to 1005 in 1960). About three fourths of the titles published for the mass market are "fiction." The statistics of mystery stories, westerns, science fiction, and cookbooks, also produced for the mass market, show no increase during these three years. In the relatively higher-priced category, distributed through the normal trade channels, fiction represents only a small and declining part of the total: between 20 and 10 per cent of the titles published. The number of titles of nonfiction published for the non-mass market increased

[3] It seems clear that the mass market includes sales through newsstands. Whether sales through drug stores and supermarkets are regarded as mass-market or trade sales depends on whether these retailers order from the magazine wholesaler, on the one hand, or from the book wholesaler or publisher, on the other.

from 281 in 1957 to 910 in 1960, an increase of 224 per cent.[4] These nonfiction publications are mainly of works in philosophy, mathematics, physics, cosmogony, biology, art, and so forth. This increase in the production of intellectual knowledge is remarkable, although it is confined to a very small sector of knowledge production as a whole.

The growth of the paperback trade is of course reflected in the publishers' sales receipts. The figures published annually by Bowker[5] do not include the sales of all publishers, but they are comparable from year to year and thus allow comparisons of growth rates for various kinds of books. While total net sales (of books and by publishers included in the sample) increased by 72 per cent over the seven-year period from 1952 to 1959, and sales of paperbound books of the type distributed by newsstands—the mass market—increased by 69 per cent, sales of paperbound "adult trade books" increased by 568 per cent. Hardbound "adult trade books" increased over the same seven years by only 48 per cent. Despite the different growth rates—the soaring of the paperback sales and the relative stagnation of the hardcover sales in this category—the former were still only 10 per cent of the latter in 1959. They had been a little over 2 per cent in 1952.

PERIODICALS

Periodicals are magazines, journals, or bulletins, appearing at more or less regular intervals. In contents they range from "general interest" weeklies or monthlies, to comics, sports and club news, trade journals, church gazettes, and learned quarterlies. The statistics are not easy to interpret, because the number of periodicals is one thing, the number of issues per year is another, the circulation per issue is a third, the number of copies per year is a fourth, and the number of readers a fifth. The dollar-volume statistics are encumbered by the fact that receipts from sales and subscriptions evidently do not cover the cost; many periodicals derive most of their income from advertising, others are subsidized or completely paid for out of such sources as club dues or philanthropic donations.

The "growth trends" of periodicals as media of communication are difficult to judge, since the number of periodicals has declined, the number of issues somewhat increased, and total circulation increased more decidedly. Table VI-5 presents some of the statistical time series.

[4] The source of the numerical information is *Publisher's Weekly*, January 19, 1959 and January 16, 1961.

[5] *American Library and Book Trade Annual, 1961* (New York: R. R. Bowker Company, 1960), p. 53.

It may appear from the ratios between the number of periodicals and the number of issues that in earlier times there must have been relatively more monthlies and quarterlies, and fewer weeklies, than there are now. In 1919 the ratio of periodicals to issues was 1 : 5.2, while it was 1 : 17.7 in 1954. An alternative and probably more realistic explanation would be that editors in earlier times neglected to copyright their journals. From the ratios between the number of periodicals published and the circulation per issue it appears that some of those with small circulation have disappeared, while others have built up mass circulations. In 1929 the average circulation was 39,200; by 1939 it had increased to 48,100, by 1947 to 83,500, and in 1954 it was 130,100.

Since both the number of issues per journal and number of copies per issue increased, it is obvious that the average annual number of

TABLE VI-5

PERIODICALS: NUMBERS OF TITLES, ISSUES, AND COPIES DISTRIBUTED, AND RECEIPTS FROM SALES, SUBSCRIPTIONS, AND ADVERTISING, 1910-1959

			Circulation (millions)		*Receipts (millions of dollars)*		
Year	*Number of periodicals published* (1)	*Number of issues copyrighted* (2)	Sum of averages per issue (3)	Average circulation times number of issues per year (4)	Total (5)	Sales and subscriptions (6)	Advertising (7)
1910	n.a.	21,608	n.a.	n.a.	n.a.	n.a.	n.a.
1914	n.a.	24,134	n.a.	n.a.	136	64	72
1919	4,796	25,083	n.a.	n.a.	240	85	155
1929	5,157	44,161	202	4,196	507	185	323
1939	4,985	38,307	240	5,865	409	185	224
1947	4,610	58,340	385	6,848	1,019	407	612
1950	n.a.	55,436	n.a.	n.a.	1,119	470	648
1954	3,427	60,667	449	7,767	1,413	531	882[a]
1956	n.a.	58,576	n.a.	n.a.	n.a.	n.a.	n.a.
1958	n.a.	60,691	n.a.	n.a.	1,588	557	1,031[a]
1959	n.a.	62,246	n.a.	n.a.	n.a.	n.a.	n.a.

SOURCES: Column (1): U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Manufactures: 1958*, Series MC-27A. (*Statistical Abstract of the United States 1960*, No. 680.) Column (2): Library of Congress, *Annual Report of the Librarian of Congress* and *Annual Report of the Register of Copyrights*. (Since each issue of a periodical is copyrighted, the number of copyrights for periodicals is taken for the number of issues.) Column (3): U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Manufactures: 1958*, Series MC-27A. (This figure represents the "*Totals of average circulation per issue* for individual publications from publishers' reporting receipts separately for each frequency of issue.") Column (4): U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Manufactures*, Series MC-27A. (Computed by multiplying aggregate circulation per issue by the frequency of issue per year.) Columns (5), (6), (7): U.S. Department of Commerce, Bureau of the Census, *Census of Manufactures: 1954* and *1958*, Series MC-27A.

[a] Small amounts of miscellaneous receipts in 1954 and 1958 have been added to advertising receipts.

copies per journal must have increased even more; it increased from 813,600 in 1929 to 2,266,000 in 1954. Yet, all in all, the growth in the distribution of periodicals, though better than for books, has been poor compared with that of some other products of "knowledge industries."

It would be wrong to take the circulation figure of a periodical for the number of readers. The circulation figure exceeds the number of readers when many subscribers fail to read the journal, which may occur especially in the case of "controlled circulation," i.e. guaranteed circulation. (Periodicals guarantee a certain minimum circulation to their advertisers, since advertising rates vary according to circulation. Owing to such guarantees many "subscribers" receive the magazine even if they have not paid for it. It is hard to find out to what extent this free literature is actually read.) On the other hand, the number of readers may be a multiple of its circulation figure if several members of the family read it, if families share subscriptions, or if friends, guests, or clients find the periodicals in living rooms or waiting rooms. Several "leading" magazines are engaged in a battle of conflicting claims, evidently in competition for advertisements, one claiming more subscribers, another claiming more readers. (The latter claims are supported by sample-survey research undertaken by organizations such as Alfred Politz, Inc.)

The growth of publishers' receipts from the publication of periodicals has not been commensurate with other growth rates in the economy. The receipts from sales and subscriptions have done especially poorly; in recent years they have fallen in terms of constant dollars; and as percentages of GNP they have declined most of the time. Receipts from advertising increased absolutely and sometimes also relatively to GNP. Advertising revenues amounted to 52.9 per cent of total receipts in 1914; they increased to 64.6 per cent in 1919 and 63.7 per cent in 1929; the percentages were lower in 1939 and 1947, but increased again in the 1950's to reach 62.3 per cent in 1958. The implications of the large share of advertising receipts in the case of periodicals and other media of communication will be discussed later in this chapter.

THE TYPES OF KNOWLEDGE CONVEYED BY PERIODICALS

A classification by subject matter of all periodicals published in 1947 and 1954, with the receipts collected from sales and subscriptions of these periodicals, was presented by the Census Bureau. It is repro-

TABLE VI-6

PERIODICALS: RECEIPTS FROM SALES AND SUBSCRIPTIONS, BY MAJOR SUBJECTS AND TYPES OF KNOWLEDGE CONVEYED, 1947 AND 1954

(thousands of dollars)

	Receipts 1947					*Receipts 1954*				
Major Subject Matter	Total	Practical	Intellectual	Pastime	Spiritual	Total	Practical	Intellectual	Pastime	Spiritual
Agriculture and farm	7,755	7,755				8,575	8,575			
Art, music, drama	2,364		2,364			11,782		11,782		
Business and finance	14,032	14,032				12,615	12,615			
Comics	35,873			35,873		35,360			35,360	
Educational	17,050		17,050			14,926		14,926		
Fashions	8,494			8,494		13,375			13,375	
Fiction	31,158		15,579	15,579		17,840		8,920	8,920	
Fraternal and club	5,904			5,904		868			868	
General interest	120,268	40,089	40,089	40,089		122,285	40,762	40,762	40,761	
Geography and travel	2,683	1,342	1,341			13,253	6,626	6,627		
Home and garden	12,259	12,259				29,144	29,144			
Juvenile	3,266		1,633	1,633		6,668		3,334	3,334	
Labor	3,511	3,511				1,057	1,057			
Legal	1,831	1,831				2,487	2,487			
Medical and dental	4,668	4,668				6,424	6,424			
Military and naval	1,206	1,206				2,983	2,983			
Motion picture	7,695			7,695		9,111			9,111	
News and current events	(combined with General Interest)					48,816	16,272	16,272	16,272	
Religious	36,050				36,050	27,713				27,713
Science and technology	7,593	3,797	3,796			7,627	3,814	3,813		
Sports, outdoor, hobbies	21,610			21,610		31,179			31,179	
Trade	22,598	22,598				23,051	23,051			
University, college, school	106		106			533		533		
Women's service	33,686	16,843		16,843		29,439	14,720		14,719	
All other and unspecified	5,356					53,469				
Total	*407,016*					*530,580*				
Total without unclassified	401,660	129,931	81,959	153,720	36,050	477,111	168,530	106,969	173,899	27,713
Per cent distribution	100.0	32.3	20.4	38.3	9.0	100.0	35.3	22.4	36.5	5.8

SOURCE: U.S. Department of Commerce, Bureau of the Census, *Census of Manufactures, 1954*, Series MC-27A, Table 6F.

duced in Table VI-6, together with my arbitrary allocations of the receipts for each subject-matter class into the various boxes of the now familiar "types of knowledge." In most instances the allocations will not be controversial: hardly anyone will contest the assignment of religious periodicals to the box labeled "spiritual," and not many will question the assignment of trade journals to "practical," of art, music, and drama magazines to "intellectual," and of comic papers and sports sheets to "pastime" knowledge. Several "split decisions," however, are necessary, partly because of the mixed composition of the contents of most periodicals, partly because of the mixed attitudes with which different readers approach the published materials. As I have shown in Chapter II, the type of knowledge produced in the mind of the reader depends on his purposes and mental make-up. What is practical for one reader may be intellectual knowledge for another and shallow pastime knowledge for a third. In view of these possibilities, the dollar figures stating the receipts from sales and subscriptions are subdivided in several instances and apportioned to different "boxes."

"General-interest" journals, and "news-and-current-events" magazines, are subjected to a three-way division among practical, intellectual, and pastime knowledge. Half-and-half divisions between practical and intellectual knowledge are made for "geography and travel" and "science and technology." Similar half-and-half divisions between intellectual and pastime knowledge are made for "fiction" and "juvenile" magazines; and between practical and pastime knowledge for women's journals.

Disregarding the journals which could not be classified by the census, the percentage distributions were not too different in the two years: between 32 and 35 per cent of the readers' dollars purchased practical knowledge, between 20 and 22 per cent purchased intellectual knowledge, between 36 and 38 per cent pastime knowledge, and between 6 and 9 per cent religious knowledge. But while the relative apportionment between the big boxes did not change substantially, there were impressive changes in specific subject-matter classes. News and current-event magazines won the largest increment in consumer interest, measured by their expenditures. Home and garden, and art, music, and drama magazines also made good progress.

NEWSPAPERS

The difference between a newspaper and a magazine need not be seen in the frequency with which it appears, or in the contents it publishes, or in the paper on which it is printed. Both may be printed on the same "newsprint"; both may publish the same news, feature stories, editorials, or advertisements; both may appear at the same intervals, though the interval should not be more than a week for newspapers. One may stress, instead, that a magazine is stitched, sewn, or stapled together, while a newspaper is loosely folded. This distinguishing criterion is not, however, generally accepted. The result is that statistics from different sources are sometimes irreconcilable. Another difficulty in counting the number of newspapers exists when morning and evening editions have the same name, or several editions appear during the day. For historical trends these differences in counting method will not matter much.

The story of the economic development of the newspaper in the United States during the last forty years is not very different from that of the periodical: absence of growth, indeed, generally a decline, in the number of separate papers, moderate growth in average and total circulation and in total receipts. (See Table VI-7.) The part that advertising has had in total receipts was greater than for periodicals: it was 64.8 per cent in 1914, reached a peak of 74.3 per cent in 1929, a low of 63.7 in 1939, and was around 70 per cent during most of the 1950's.

TABLE VI-7

NEWSPAPERS: NUMBER, CIRCULATION, AND RECEIPTS FROM SALES, SUBSCRIPTIONS, AND ADVERTISING, 1914-1959

Year	*Number of papers*	*Sum of average circulation* (millions)	*Receipts (millions of dollars)* Total	Sales and subscriptions	Advertising
1914	16,944	67	284	96	188
1919	15,697	73	566	192	374
1929	10,176	92	1,073	276	797
1933	6,884	76	668	239	429
1939	9,173	96	846	306	540
1947	10,282	120	1,792	600	1,192
1950	n.a.	n.a.	2,375	734	1,641
1954	9,022	136	2,926	841	2,085[a]
1958	n.a.	n.a.	3,491	988	2,503[a]

SOURCE: U.S. Department of Commerce, Bureau of the Census, *Census of Manufactures*.

[a] Small unclassified receipts have been added to advertising revenue.

Personal-consumption expenditures for newspapers, as reflected in receipts from sales and subscriptions, have sometimes increased and sometimes declined relative to national income; in per cent of national income they were highest during the depression, reaching a peak in

1933 with 0.595 per cent, and became lower when national income increased. In 1958, the sales and subscriptions were 0.229 per cent of national income. This is a clear instance of a small income-elasticity of demand.

Table VI-8 compares the total circulation of daily and Sunday papers with the number of households, from 1920 to 1958. The circulation of daily papers was consistently greater than the number of households; in 1920 it exceeded it by 13 per cent, in 1930 by 32 per cent, in 1945 by 29 per cent, in 1958 by only 14 per cent. The circulation of Sunday papers was most of the time below the number of households, except from 1945 to 1950. The increase in Sunday paper circulation from 1940 to 1945—the war years—and from 1945 to 1950—the postwar years—was remarkable. (The largest jump occurred in 1946.) After 1950 the circulation of Sunday papers not only stopped rising, but fell absolutely for a number of years.

The sharp increase in the circulation of Sunday papers in and after

TABLE VI-8

NEWSPAPERS: CIRCULATION OF DAILY AND SUNDAY PAPERS, COMPARED WITH NUMBER OF HOUSEHOLDS, 1920-1958

Year	*Total circulation* Dailies (millions) (1)	Sundays (millions) (2)	*Number of households* (millions) (3)	*Per household* Dailies (4)	Sundays (5)
1920	27.8	17.1	24.5	1.13	0.70
1925	33.7	23.4	27.5	1.23	0.85
1930	39.6	26.4	30.0	1.32	0.88
1935	38.2	28.1	31.9	1.20	0.88
1940	41.1	32.4	35.2	1.17	0.92
1945	48.4	39.9	37.5	1.29	1.06
1950	53.8	46.6	43.6	1.23	1.07
1955	56.1	46.4	47.8	1.17	0.97
1958	57.6	47.0	50.4	1.14	0.93

SOURCES: Columns (1) and (2): *Editor and Publisher, International Year Book Number*, 1960. Column (3): Bureau of the Census, *Current Population Reports.*

1946 was probably connected with the end of the war—with the return of soldiers and war workers to their homes and the drastic increase in the number of households. The relative decline in circulation after 1950 may be connected with the price increases between 1950 and 1958—the prices of Sunday editions were raised as much as 33⅓ to

100 per cent[6]—and, much more likely, with the rise of television. In many households, apparently, the colored comics, rotogravure, and magazine sections of the Sunday papers lost out to the Sunday programs on television. After all, it is not the news contents that accounts for the greater bulk[7] and higher price of the Sunday paper compared with the weekday edition; the entertainment sections are the main cause of the higher cost, and it is chiefly on this score that TV competes with the Sunday paper.

The number of newspapers in the United States has declined from almost 17,000 in 1914 to less than 7,000 in 1933, and then again from over 10,000 in 1947 to 9,000 in 1954. Lest these figures give a false impression, let us note that they include daily as well as Sunday, weekly, semiweekly, and other papers; indeed, over four fifths of these papers were *not* daily newspapers. The number of daily papers declined less drastically: from 1888 in 1939, to 1780 in 1949, and 1755 in 1959. But the disappearance of newspapers is significant even if numerically it does not look alarming. The causes of the disappearance are largely economic, the relative increase in printing costs probably being the chief factor in the development. The consequences, however, are chiefly political and cultural. Competition between daily newspapers in a city can be most wholesome culturally, because of the greater choice of ideas presented to the reading public, and politically, because of the greater chance of journalistic exposures of local corruption and political machinations. The disappearance of alternative local newspapers creates monopolies in the presentation and evaluation of local news, and this has been occurring in two or more cities every year. In 1961, there were only 60 cities in the United States that had more than one daily newspaper.

THE TYPES OF KNOWLEDGE CONVEYED BY NEWSPAPERS

Whereas books and periodicals were classified according to the subject matter to which they were chiefly devoted, a newspaper cannot be assigned, either as a whole or in two or three parts, to particular subject-matter classes. The knowledge it conveys may be of any kind or type whatsoever. Any statistical breakdown must therefore be based on an

[6] The Sunday edition of the *New York Times* cost 15 cents in 1950, 25 cents in 1958; of the *Chicago Tribune*, 15 cents in 1950, 20 cents in 1958; of the *Washington Post* and *Baltimore Sun*, 10 cents in 1950, 20 cents in 1958.

[7] The size of the Sunday paper has increased remarkably: the average number of pages was 86 in 1940, 70 in 1945, 112 in 1950, 132 in 1955, and 141 in 1959.

analysis of the allocation of space to different subjects in representative newspapers.

Such an analysis of the contents of newspapers was made by Charles E. Swanson for 130 daily papers in the year 1954.[8] The space that was not given to advertising was apportioned among 40 topical classes. Compressing the 40 into 18 somewhat wider classes plus one "unclassified," Table VI-9 presents a summary of Swanson's space distribution, with my arbitrary grouping according to the general type of knowledge each subject is judged to represent. At least one "split decision" has to be made: economic reports should be divided between practical and intellectual knowledge, on the ground that they include financial news and analyses, e.g., stock-market transactions, which are practical knowledge for most who read them. Political news and analyses are put under the heading of intellectual knowledge, although it could be argued that they may aid, especially during election campaigns, in readers' "decision-making," and to that extent are practical.

Should total dollar figures be apportioned in proportion to newspaper space? Before this could be attempted, one would have to answer the question as to just what should be so apportioned: total receipts, receipts from sales and subscriptions only, or the portion of the cost that can be allocated to the nonadvertising portion of the paper? Objections could be raised to any of these alternatives. Since advertising space is costly too, it would be wrong to apportion total receipts, including those for advertising, among the various parts of nonadvertising space. Since receipts from sales and subscriptions do not cover the cost of gathering and printing the news, etc.—some of the advertising receipts being needed to subsidize the rest of the newspaper—it would not be right to limit the apportioned amount to what the readers pay for their newspapers. And to attempt an allocation of the newspapers' cost would be hopeless, not only because of the inadequate accounting data available for such a task, but also because of the impossibility of economically meaningful allocations of overhead costs.

Apart from these questions, the principle of apportioning a total receipt or cost among the various subject-matter classes or knowledge types in proportion to the space they are given in the papers would be defensible only under rather unlikely conditions. If the cost of a printed line, column, or square inch, including the cost of gathering and editing

[8] Charles E. Swanson, "What They Read in 130 Daily Newspapers," *Journalism Quarterly*, Vol. 32 (Fall 1955), pp. 411-421.

TABLE VI-9

NEWSPAPERS: DISTRIBUTION OF SPACE, EXCLUSIVE OF ADVERTISING, AMONG VARIOUS SUBJECT MATTER CLASSES AND TYPES OF KNOWLEDGE, IN 130 DAILY PAPERS, 1954

Subject matter and type	Per cent of total	
Practical		7.9
Home and garden	3.8	
Economics, finance (one half)	4.1	
Intellectual		33.4
Politics	2.0	
Government	11.5	
Foreign	5.4	
Economics, finance (one half)	4.1	
Education, science, philanthropy	7.3	
Serious arts	0.9	
Information features	2.2	
Pastime		51.4
Crime and vice	4.0	
Accidents and disaster	3.6	
Popular entertainment	3.6	
Comics	8.4	
Personalities	1.8	
Society	12.7	
Sports	13.0	
Human interest	4.3	
Spiritual		2.0
Churches, religion	2.0	
Unclassified	5.3	5.3
	100.0	100.0

SOURCE: Charles E. Swanson, *Journalism Quarterly*, Fall 1955. The major groupings of the subject classes were added.

the news, were the same for crime and accident reports, society news, government releases, foreign correspondents' reports, book reviews, sports news, comics, stock-market prices, and all the rest, one could reasonably use the distribution of space as the basis of the distribution of the total cost of the newspapers. Or, if the readers' interests in the contents of the newspaper were distributed among all subjects in the same way as the space given to them, so that the desire to purchase a paper is explained by the satisfaction the readers derive from each printed line, column, or square inch, one could argue that the distribution of space is an accurate basis for the distribution of the total consumers' expenditures for the newspapers. One may safely assume that neither of these conditions prevails in reality. It stands to reason that foreign news is more expensive than local society news, and comics are more expensive than government releases. It is also quite likely that many more readers buy the newspaper for the comic strips than for reports from the Congo; more for sports news than for reports on education or art. The editor's decision to include in his paper very expensive materials, and materials with less-than-average reader appeal, is economically sound on marginalistic principles—that is, if it is hoped that additional sales will cover additional costs. But this is exactly why it would be unsound to apply a proportionality rule in the allocation of costs or revenues to the amounts of space given to different subjects.

The problems just discussed do not apply with equal force to the apportionment of expenditures for books or periodicals, because books or periodicals can usually be classified without much trouble into one or two subject-matter groups, and hence the expenditure incurred in buying the book or subscribing to the periodical may be regarded as a purchase of the particular kind or type of knowledge which it conveys.

A few additional remarks on newspaper advertisements may be in order, since advertising space was excluded from the space distribution shown in Table VI-9. An analysis of the distribution of total newspaper space between advertising and nonadvertising shows that on the average the share of advertising has been consistently above 50 per cent and has been increasing over the years. It was 57.7 per cent in 1947, 59.3 per cent in 1951, 61.7 per cent in 1955.[9] Receipts from advertising relative to total receipts were even larger: 66.5 per cent in 1947, 69.9 per cent in 1951, 70.4 per cent in 1954. (The receipts for 1955 are not available.) This indicates that advertising is paying not only for the practical knowledge—concerning buying opportunities—which it is designed to convey but also for a part of the other types of knowledge communicated by the newspapers. Though much of the advertising may give unwanted knowledge to annoyed readers who have to turn pages to find the continuation of a news or feature story they started to read on an earlier page, it also subsidizes some of the production of wanted knowledge, be it intellectual, practical, or pastime. A more comprehensive discussion of advertising had better be postponed until after the section on radio and television.

ALL THE NEWS THAT'S FIT TO PRINT?

A brief comment on the performance of the newspaper as a distributor of news may not be out of place here. The well-known slogan "all

[9] Source: U.S. Department of Commerce, Business and Defense Services Administration.

the news that's fit to print," reproduced daily in the masthead of the *New York Times*, may give an exaggerated impression of the news-gathering efforts of our newspapers. That they cannot print *all* the news is obvious; but it is seldom realized that the selection of the news that is printed is not so much from what could be obtained by a corps of ubiquitous expert reporters than it is from a mass of press releases distributed by interested parties. For national and international news most papers rely on the large news agencies, and these agencies in turn rely to a large extent on handouts received from the public-relations officers of government departments, private corporations, and public and private organizations of all sorts. The effort of the newspaper, apart from that of selecting the items for publication, is often confined to some "copyediting"—mostly cutting, and sometimes distorting in the process—the release written by those who want to get their stories into the papers. I must admit that I have not the evidence to support this statement; but I challenge the newspaper publishers or editors to produce the evidence showing what percentage of the contents of their papers was originally written by their own reporters and staff writers, and how much came, directly or indirectly, from the handouts of interested parties. Perhaps it would be too expensive to attempt more independent work on the part of the newspaper men; the results, moreover, might be less rather than more reliable in many instances; and, surely, the amount of news available to the press could not possibly be as large as it is thanks to the "collaboration" of the public-relations officers or agents. On the other hand, would it not be fair to the reader if he were told which news items originated from unsolicited press releases?

If I may deliver myself of another observation of a critical nature, I want to refer to the repetitiveness of the usual news reports. Perhaps four or five times as many news items could be printed if unnecessary repetitions were avoided. Repetitions occur (1) within the same story, when a lead paragraph contains what an inch or two later is spelled out again in the same words or with only slight variations, (2) over two or three days, when the same news is reported several times by the same newspaper, (3) in a succession of reports over several days, when earlier developments are warmed up (evidently on the assumption that readers cannot remember what they read the day before, or that readers have not seen yesterday's paper, or that readers, like children listening to fairy stories, want to get the same story all over again), and (4) in reports using technical terms (which uneducated readers may not understand), when simple (and often incorrect) definitions are added whenever the terms re-occur.

Repetitions of the second and third types are particularly frequent in the case of sex crimes, evidently the most precious news items from the point of view of some editors. Details of a rape (if "fit to print") may be repeated as often as four or five times. Repetitions of the fourth type may occur as often as 50 times a year, for example, in the periodic reports about the state of the "balance of payments," a term always found in need of a definition (which, incidentally, no one can possibly grasp who does not know it anyway).

But now, even if my readers should share my propensity to indulge in digressions, we must get on with our statistical survey.

EXPENDITURES FOR PERIODICALS AND NEWSPAPERS

The final account for expenditures on periodicals and newspapers has to be prepared from a joint beginning because the national-income statisticians give us only a single figure for personal consumption expenditures on "magazines, newspapers, and sheet music," and leave to us the task of unscrambling. We shall neglect "sheet music," which cannot be a significant portion of the total, and do some calculations with the two main parts.

We shall begin with personal-consumption expenditures, and deduct imports to obtain what consumers paid for the domestic product. Then we shall take the publishers' receipts from sales of and subscriptions to periodicals and newspapers, each separately, and deduct the value of their exports, to obtain their revenues from domestic distribution. The difference between the consumers' expenditures and the publishers' revenues must be distribution cost. Assuming that this cost is percentagewise the same, we shall be able to separate the consumers' expenditures between periodicals and newspapers. There is a defect in this method in that some periodicals and newspapers are sold to businesses, such as hotels, dentists, physicians, banks, industrial and commercial firms; but the error of neglecting these business subscriptions cannot be very serious. Computations for 1954 and 1958 are made in Table VI-10.

Confining ourselves to the results for 1958, we see that the cost of domestic production for domestic use was $1,804 million for periodicals and $3,952 million for newspapers, of which consumers paid $773 million for periodicals and $1,449 million for newspapers, while business paid $1,031 million and $2,503 million, respectively, for adver-

TABLE VI-10

PERIODICALS AND NEWSPAPERS: CONSUMPTION EXPENDITURES, PUBLISHERS' RECEIPTS, EXPORTS, IMPORTS, DISTRIBUTION COST, AND TOTAL COST, 1954 AND 1958
(millions of dollars)

	1954	1958
Personal consumption expenditures for periodicals and newspapers (neglecting sheet music)	1,825	2,233
Imports (neglecting stamps and Bibles)	6	11
Personal consumption expenditures for domestic periodicals and newspapers	1,819	2,222
Publishers' receipts from sales and subscriptions		
Periodicals, total	531	557
exports	29	32
domestic sales and subscriptions	502	525
Newspapers, total	841	988
exports	3	4
domestic sales and subscriptions	838	984
Periodicals and newspapers, domestic sales and subscriptions	1,340	1,509
Distribution cost (retailers' margin, etc.)	479	713
Periodicals	178	248
Newspapers	301	465
Periodicals		
Distribution cost	178	248
Publishers' receipts from domestic sales	502	525
Publishers' receipts from advertising	882	1,031
Cost of domestic production for domestic use	1,562	1,804
Newspapers		
Distribution cost	301	465
Publishers' receipts from domestic sales	838	984
Publishers' receipts from advertising	2,085	2,503
Cost of domestic production for domestic use	3,224	3,952

SOURCES: Personal-consumption expenditures from *Survey of Current Business.* Publishers' receipts from *U.S. Census of Manufactures.* Distribution cost is the difference between consumers' expenditures and publishers' receipts, allocated in proportion to publishers' receipts.

tising. It we want the "national output" we shall have to add exports —$32 million and $4 million respectively—and if we want "domestic intake" we shall have to add imports—$11 million for periodicals and newspapers together.

OTHER PRINTED MATTER

Books, pamphlets, maps, periodicals, and newspapers do not exhaust the entire production of the "printing and publishing" industry. Although nonpublished printed matter is usually not treated among the media of communication, a wider concept of communication will include all printed matter, and indeed all instruments of transmitting messages, which includes stationery and other writing supplies.

The census lists the following "industry groups" within the printing and publishing industry: newspapers, periodicals, book publishing and printing, book printing, miscellaneous publishing, commercial printing, lithographing, greeting cards, bookbinding and related industries, and printing trade services. The last of these groups sells all its services—typesetting, engraving and plate printing, photoengraving, and electrotyping and stereotyping—to the other groups within the industry. Likewise, book printers sell only to publishers, and their receipts are included in publishers' sales. The largest of the non-publishing groups is commercial printing. Its sales include receipts for printing newspapers and periodicals, which are of course included in the cost of these publications. After deducting them, the sales of commercial printers were $1,245 million in 1947, $1,746 million in 1954, and $1,753 million in 1958. Lithography sales include only smaller receipts from newspapers and periodicals; after deducting these receipts, the product of this industry group was $475 million in 1947, $962 million in 1954, and $1,182 million in 1958.

In contrast to commercial printing and lithography, which chiefly serve business and thus produce intermediate products becoming part of the cost of producing other goods and services, the greeting cards industry group produces final products, sold through the retail trade; this makes it necessary for us to consider adding the retailers' margin. Another category of printed products sold to buyers outside the printing and publishing industry is "blank books and paper ruling." This includes ledgers and account books, sales books, memo books, check books, appointment books, diaries, albums, and scrap books. Most of these are sold to businesses, some may be included in the stationery supplies bought by final consumers. Finally there is the product group "loose-leaf binders and devices," sold partly to business buyers, partly via retailers to personal consumers.

One might think that total sales of stationery stores might somehow match personal consumption expenditures for "stationery and writing supplies." This is not the case, since consumers buy much more stationery than stationers sell; this is so because drug stores, dime stores, and department stores handle these products too. A more promising way of getting at retail values is to start from manufacturers' sales and try to find out what portion of them went to personal consumers. Table VI-11 lists the industry groups and subgroups that produce stationery and office supplies; they belong to three industries: paper and paper products, printing and publishing, and miscellaneous manufactures. We obtain from the compilations in this table the total sales by manufacturers. From national-income statistics we know the personal-consumption expenditures for stationery and writing supplies. Assum-

TABLE VI-11

STATIONERY: PAPER PRODUCTS, CARDS, BLANK BOOKS, AND OTHER OFFICE SUPPLIES, 1947, 1954, AND 1958

(millions of dollars)

	1947	1954	1958
Printed products			
Greeting cards	129	217	275
Other cards (including picture postcards)	4	5	6
Blank books and paper ruling	76	92	118
Loose-leaf binders and devices	52	70	95
Business services, indexes, etc.	27	56	72
Paper products			
Die-cut office supplies	31	37	58
Die-cut cards, including machine tabulation cards	21	62	88
Stationery, tablets and related products	65	106	155
Business-machine paper supplies	13	24	46
Office supplies			
Pens, mechanical pencils, and parts	138	118	136
Lead pencils, leads, and crayons	45	51	65
Hand stamps and stencils	27	48	58
Carbon paper, stencil paper, inked ribbons	49	91	119
Total manufacturers' sales	677	977	1,291
Personal consumption expenditures for "stationery and writing supplies"	440	698	952
Retailers' mark-up, 40 per cent	176	279	381
Manufacturers' sales for consumers' use	264	419	571
Manufacturers' sales for business and government use	413	558	720
Total manufacturers' sales	677	977	1,291

SOURCES: Manufacturers' sales from *Census of Manufactures*, MC-27 and 39; consumption expenditures from *Survey of Current Business.*

ing that the retailers' markup is 40 per cent of the retail prices, we conclude that 60 per cent of consumers' expenditures must have been the manufacturers' receipts from sales to personal consumers. Deducting these from total sales, we may regard the balance as sales to government and business. This time we assume that one half is sold without middlemen, one quarter through wholesale distributors, and only one quarter through retailers; and hence that the distribution cost of this portion of manufacturers' sales is, on the average, only 25 per cent of the manufacturers' price. In Table VI-12 we calculate the total expenditures incurred, according to these assumptions, by consumers, business, and government for stationery and office supplies. The totals were $956 million in 1947, $1,385 million in 1954, and $1,852 in 1958.

These estimates are probably on the low side. It seems rather unlikely that government and business offices should spend no more on stationery and other office supplies than households do. The only consolation for this apparent underestimate is that a correct estimate would involve some double counting in that it would comprise businesses engaged in the production of knowledge, and therefore resources already included in our statement. The expenditures for printed matter and office supplies used in schools, research organizations, publishing firms, advertising agencies, and all the rest, are part and parcel of the total expenditures for education, research, publications, advertisements, and all other knowledge-producing activities. On the strength of this consideration we shall let the underestimate stand. We divide the expenditures between government and business in the ratio 20:80, which is approximately the ratio of clerical workers employed in government and business in 1958. Thus we take $180 million as government expenditure and $720 million as business expenditure for stationery and office supplies not elsewhere accounted for in 1958.

We have not so far had any indication of the growth of expenditures on printed matter, stationery, and office supplies. The only historical series at our disposal is that of personal-consumption expenditures for stationery and writing supplies.[10] These expenditures were estimated at $143 million in 1929, $69 million in 1933, $149 million in 1939, $496 million in 1949, $819 million in 1956, $952 million in 1958, and $1,052 million in 1959. The increase has been considerably faster than that of population, national income, or GNP. The amount of

[10] National Income Supplement, *Survey of Current Business*, 1954; U.S. Income and Output, 1958, *Survey of Current Business*, 1959.

TABLE VI-12

STATIONERY AND OTHER OFFICE SUPPLIES: TOTAL EXPENDITURES, INCLUDING DISTRIBUTION COST, 1947, 1954, AND 1958
(millions of dollars)

	1947	1954	1958
Manufacturers' sales for government and business use	413	558	720
Add 25 per cent for distribution cost	103	139	180
Expenditures by government and business	516	697	900
Personal consumption expenditures	440	688	952
Total expenditures for stationery and office supplies	956	1,385	1,852

SOURCE: Table VI-11.

paper work per man and per dollar earned has been increasing substantially.

ALL PRINTING AND PUBLISHING

We are now prepared to compile a final statement for the expenditures for "printed knowledge" in the United States in 1958. Since foreign trade plays a role in this field, we shall distinguish the expenditures for "national product"—which includes exports and excludes imports—from the expenditures for "domestic intake"—which excludes exports and includes imports.

Table VI-13 presents this summary. The columns are "books and pamphlets," "periodicals," "newspapers," "commercial printing and lithography," and "stationery and office supplies." The breakdown by paying sectors serves chiefly to reconcile the figures with the national-income account. The important difference to note is, of course, that the expenditures by business are regarded as cost of production, not just of the printed matter they create, but of the goods and services the firms make and sell. Thus, if half a magazine is paid for by the advertisements of soap and automobile manufacturers, only the other half—that paid for directly by consumers—is regarded as a final product in the national-income accounts. The one half that is paid out of business receipts is regarded as an intermediate product needed in the production of soap and automobiles. If for our present purposes we do not exclude the business-paid portions of publications from our survey, and if we eventually compare the expenditures for various media of communication with total GNP, we shall have to make an upward adjustment of the GNP by adding in those products that were denied full status in national-income computations.

The data in Table VI-13 come from previous tables and from computations, most of which were explained in the discussion of the expenditures under the various headings. Thus far, only the following entries are unexplained: the imports of magazines and newspapers are separated on the basis of an educated guess; the total output of commercial printing and lithography, which had already been net of sales to commercial book publishers and publishers of periodicals and newspapers, is now further reduced by the $44 million purchased by government agencies (which is included in the government expenditures for books and pamphlets); the export and import figures for printed products are obtained from U.S. foreign-trade statistics, and the division of the domestic purchases between government, business, etc., is arbitrary, using approximately the ratios of clerical personnel employed by the various sectors.

TABLE VI-13

TOTAL EXPENDITURES FOR ALL PRINTED MATTER AND WRITING SUPPLIES, 1958

(millions of dollars)

	Books and pamphlets	Periodicals	Newspapers	Commercial printing and lithography	Stationery and office supplies	Total
National Production (Output)	1,635	1,836	3,956	2,891	1,852	12,170
deduct Exports	44	32	4	31	—	111
add Imports	4	7	4	19	—	34
Domestic Use (Intake)	1,595	1,811	3,956	2,879	1,852	12,093
paid for by						
Personal consumption expenditures	1,177	780	1,453	—	952	4,362
Government expenditures	347	—	—	570	180	1,097
Business expenses	43	1,031	2,503	2,280	720	6,577
Private nonprofit organizations	28	—	—	29	—	57

SOURCES: See previous tables and discussions in text.

Photography and Phonography

Among all the media of communication, the closest to the printed page and the published pamphlet are probably the photographic picture and the phonographic record. Yet, photography and phonography are usually not even mentioned among the media of communication. Photography, the recording of images through the action of *light* on sensitized surfaces, and phonography, the recording of *sound* on disks, cylinders, or tapes, are surely means of communicating visual or auditory messages or impressions.[11]

PHOTOGRAPHY

For a statistical story about the role of photography in our economy we would need data on total expenditures for (1) photographic equipment, (2) photographic supplies, (3) developing and printing, and (4) services of photographic studios (portraits, passport photos, etc.), broken down by economic sectors making the expenditures, such as (a) personal consumers, (b) the government, (c) business for purposes elsewhere included in this survey (e.g., publishing, advertising), (d) business for purposes not elsewhere included in this survey, and (e) exporters.

These data are not available. The statistics of personal consumption expenditures contain purchases of photographic equipment inseparably merged with purchases of sport equipment, including "boats and pleasure aircraft"; purchases of photo supplies mingled with purchases of sport supplies and "nondurable toys"; payments for photo developing and printing, and for the work of professional studios, mixed with other "recreational" services. Statistical series on retail sales of "camera and photographic supply stores" are available, but it is well known that photographic equipment and supplies are also sold in drugstores, sporting goods stores, gift shops, discount houses, department stores, and mail-order houses. Production statistics, corrected for export and import data, might be helpful were it not so difficult to obtain the "value added" by wholesale and retail distribution, and information about the extent to which the products—equipment and supplies—were ultimately purchased by consumers, by businesses in one of the knowledge industries, and by other businesses.

In these circumstances much improvisation is needed to arrive at any estimates of expenditures for photography. Let us begin with the only series that is directly usable, the receipts of photographic studios.[12] We see them rise from $32 million in 1933 to $64 million in 1939, $212 million in 1948, $334 million in 1954, and $423 million in 1958. This is quite a substantial growth—about 1300 per cent from 1933 to 1958—but nothing phenomenal.

[11] Note the linguistic difference: a "phonograph" is the instrument on which a phonographic record is reproduced, but a "photograph" is the record produced with a photographic camera. The word phonography has sometimes been used for other things, but I see no objection to its use analogous to that of photography.

[12] *Historical Statistics*, p. 526; *Statistical Abstract, 1960*, p. 852.

Retail sales of camera and photographic supply stores[13] were $278 million in 1954 and $382 million in 1958. In view of the many other stores that sell photo equipment and supplies, an estimate to the effect that consumers purchased twice as much would be highly conservative; an estimate of sales three times as high would still be safely within the mixed bags of personal-consumption expenditures mentioned above. In 1958 the expenditures for goods in the group containing photo equipment were $1,883 million; and for goods in the group containing photo supplies, $2,162 million. The total of $4,045 million could comfortably comprise an amount of, say, $1,000 million as consumers' purchases of photo equipment and supplies. Perhaps for all four categories together—equipment, supplies, developing and printing, and professional photographers' services—we may put down $1,600 million as a reasonable figure for the year 1958.

We shall not attempt an estimate of government and business expenditures for photography. We assume that the largest part of such expenditures is incurred by businesses in printing and publishing, in advertising, and in research and development. All these expenditures are counted among the cost of these activities and thus are "captured" in one item or another of this survey. Expenditures for photography by other businesses will have to be allowed to escape our statistical vigilance.

PHONOGRAPHY

Among the expenditures for "phonography" we include purchases of phonographs, record players and attachments, magnetic recorders, and phonographic records in the form of disks or tapes. There should be added the receipts from "juke boxes," on which, however, no data seem to be available.

Historical statistics, from 1921 on, are available only for the retail sales of phonograph records. These data are obtained by the Record Market Research Division of *Billboard Music Week*, trade publication of the music industry, from a variety of sources, such as U.S. excise tax figures, but chiefly on the basis of reports on actual cash-register sales, received from a rotating sample of dealers across the nation. The series, reproduced in Table VI-14, shows a rather unique career of record sales: a decline from 1921 to 1925, a modest recovery until 1929, a precipitous fall—resembling the stock-market crash—until 1933 (when sales were down to about 5 per cent of the 1921 volume), then

[13] *Statistical Abstract, 1960*, pp. 840-841.

a recovery and steady increase until 1947 (when sales were 37 times the 1933 volume and almost twice the 1921 volume), a recession down to 1949, and then again an upward surge to 1960, with a continuing upward trend. The 1960 sales volume of $521 million was 494 per cent of the 1921 volume, 9480 per cent of the 1933 volume, and 302 per cent of the 1950 volume.

Three figures in this series can be checked against data obtained through the Census of Manufactures, 1947, 1954, and 1958. The census figures for manufacturers' sales of phonographic records, on disk and tape, were $105.8 million in 1947, $80.2 million in 1954, and

TABLE VI-14

Phonograph Records: Retail Sales, 1921-1960

(millions of dollars)

Year	Sales	Year	Sales	Year	Sales	Year	Sales
1921	105.6	1931	17.6	1941	50.6	1951	178.5
1922	92.4	1932	11.0	1942	55.0	1952	189.0
1923	79.2	1933	5.5	1943	66.0	1953	191.1
1924	68.2	1934	6.6	1944	66.0	1954	182.7
1925	59.4	1935	8.8	1945	99.0	1955	235.2
1926	70.4	1936	11.0	1946	198.0	1956	312.6
1927	70.4	1937	13.2	1947	203.7	1957	400.0
1928	72.6	1938	26.4	1948	172.2	1958	390.0
1929	74.8	1939	44.0	1949	157.5	1959	462.0
1930	46.2	1940	48.4	1950	172.2	1960	521.0

Source: *Billboard Music Week.*

$139.3 million in 1958. One cannot expect a constant ratio to prevail between manufacturers' and retail sales, chiefly because (1) some variable portion of the former may have been sold through other than domestic retail outlets, (2) a variable portion of retail sales may have been of imported records, and (3) the retailers' margins vary greatly, as one would gather from the frequent announcements of bargain sales and advertisements of discount houses. If all manufacturers' sales had been to retailers and all retailers' sales had been of domestic records, the average markup would have been 48 per cent of retail prices in 1947, 56 per cent in 1954, and 64 per cent in 1958. If one holds that retailers' margins could not have increased so much, and if one assumes that manufacturers' sales of the more recent years were not underestimated nor retail sales overestimated, then one will conclude that retailers have sold an increasing quantity of imported records.

According to the Billboard research staff, records are sold through four channels. Approximately 50 per cent of the total volume is sold through regular stores—specialized record shops, chain and variety stores, phonograph equipment stores, and other types of stores with record departments. Between 20 and 25 per cent of the total is via "racks" in supermarkets and drugstores. About 17 per cent is sold through record clubs, such as the Columbia Record Club, the Reader's Digest Record Club (which sells RCA-Victor records), and the Capital Record Club. The remaining 10 per cent is accounted for by sales to juke-box operators. Incidentally, juke boxes use 7 inch 45 rpm records, rather than customary long-playing 12 inch 33⅓ rpm disks. About 80 per cent of total sales are in these LP records, and only 20 per cent in smaller and faster disks.

Statistical information on phonographic equipment has been compiled and released by *Electrical Merchandising*. Single record players constitute the largest item, and phono-radio combinations the second largest, in the sales statistic. Concerning the sales of magnetic recorders, we cannot be quite sure whether dictating machines were duly separated out. To include this item as a whole seems safer than to omit it entirely. Table VI-15 furnishes the sales figures for all phonographic equipment in 1954, 1958, and 1959.

TABLE VI-15

PHONOGRAPHS, PHONO-RADIO COMBINATIONS, AND MAGNETIC RECORDERS: RETAIL VALUES, 1954, 1958, AND 1959

	1954		*1958*		*1959*	
	Numbers sold (thousands)	Retail value (millions of dollars)	Numbers sold (thousands)	Retail value (millions of dollars)	Numbers sold (thousands)	Retail value (millions of dollars)
Single players	2,234	154	3,212	319	3,355	292
Phono-radio combinations	393	102	760	251	845	232
Record-player attachments	379	13	124	5	75	3
Magnetic recorders	360	54	400	70	500	80
Total		323		645		607

SOURCE: *Electrical Merchandising*, January 1960.

Adding the sales of phonographic equipment and records, we record that expenditures for phonography were $506 million in 1954 and $1,035 million in 1958.

THE TYPES OF KNOWLEDGE CONVEYED BY PHONOGRAPH

Detailed classifications of phonograph records produced and offered for sale could easily be made on the basis of catalogues published by manufacturers and record shops, but would tell us only about the availability of the recorded knowledge, not of the degree to which the consuming public avails itself of such opportunities. Classifications of records sold are made by only four broad types: "popular," "classical," "jazz," and "other." In the breakdown furnished by *Billboard*, the subclass "semiclassical" is merged with "popular," which is described as an "all-inclusive term taking in regular popular singers, groups, bands, Broadway casts, movie and TV soundtrack LP's, comedy, percussion, etc." In 1961, an estimated 65 per cent of all record sales fell in this class. "Jazz," although it contains frequent best-sellers, accounted for only 12 per cent of total record sales.

While the number of releases in the "classical" category has been increasing at a remarkable rate and sales of classical records have been rising fast, the share in total record sales is still only a modest 18 per cent. "Other" records, accounting for the remaining 5 per cent, include the music of non-Western civilizations, "spoken word" records, educational, documentary, and foreign-language records.

In terms of our own classification, we conclude that 77 per cent of all records bought convey pastime knowledge and only 23 per cent convey intellectual knowledge.

Stage and Cinema

Media of communication, in a narrow sense, are needed if the person who intends to communicate—thoughts, sentiments, or whatever it be—is separated in time or space or both from the person or persons receiving the message. Thus, the printed page, the phonograph, the motion picture, radio, television, and all the means of telecommunication are media in this sense. In a wider sense the word is also used for the methods of presentation employed for communication between persons present at the same time in the same place: the lecture, the seminar, the round-table discussion, the stage performance, theatrical presentations, and all the rest, are sometimes referred to as media of communication. A few words on communication between collocated persons, with the "sender" on the stage or podium, will be appropriate before we proceed to the discussion of the motion picture.

STAGE AND PODIUM, PLAYS AND CONCERTS

Oratory from the rostrum and other presentations from podium and stage were the chief forms of mass communication for thousands of years. Song, pantomime, dance, choruses, choirs, tragedies, and comedies were the major art forms for the communication of ideas, impressions, and feelings from authors and performers to spectators and listeners. If authors and performers are different persons, the latter can be regarded as personal media of communication. In addition, the visual arts—sculpture, painting, drawing, etching—should not be omitted from a list of media of communication.

The theatre—the "legitimate theatre," to distinguish it from the motion-picture theatre—had probably been the most expensive of the media for hundreds of years, until it was overtaken by the symphony orchestra. Plays and concerts were often subsidized by wealthy patrons of the arts, by princes and sovereigns. Even today the consumer ordinarily does not pay the full cost when he purchases his admission ticket for orchestra concerts.

Information on expenditures for theatres and concerts is very poor. The statistics of personal consumption expenditures contain series for "admissions to specified spectator amusement," but the relevant caption reads in one place "Theater entertainment (plays, operas, etc.) of nonprofit institutions, except athletics,"[14] but in another place, "Legitimate theaters and opera, and entertainments of nonprofit institutions (except athletics)."[15] If the first caption is correct, plays produced by profit-seeking companies are excluded; but they are probably included, if the comma in the second caption is correct. In any case, the time series is quite disappointing. It begins in 1921 with total expenditures of $81 million, rises to $195 million in 1927, falls to $41 million in 1933, recovers to $71 million in 1940 and $185 million in 1950, and then rises to $225 million, $251 million, $276 million, $296 million, and $313 million, in 1954, 1955, 1956, 1957, and 1958, respectively.

Statistical information on the "number of theaters and theatrical producers" in the United States, given by the census as 2,179 for 1954, is quite meaningless because it includes theatres and producers that have not produced any plays during the year, and also concert bureaus, ticket agencies, theatrical employment agencies and equipment-renting businesses, etc. The Census for 1958 is more helpful. It reports that there were 392 "producers of New York or road shows," of which 308 met payrolls, and 197 "stock or repertory companies," 161 of which had payrolls. Information obtained from the American National

[14] *Historical Statistics of the United States: Colonial Times to 1957*, Washington, 1960, p. 224.

[15] *Statistical Abstract of the United States, 1960*, Washington, 1960, p. 197.

Theatre Academy in New York permits us to add that there are between 2,000 and 3,000 community theatres and over 400 university theatres, but only between 67 and 80 professional theatres in the country. This compares with about 200 professional theatres in the United Kingdom.[16] With the U.S. population of 180 millions and the U.K. population of 52 millions, the number of professional theatres per million population is 0.4 in the United States and 4.0 in the United Kingdom. Evidently, the legitimate theatre is not a well-developed branch of knowledge production in the United States.

The Decennial Census of Population[17] reports the number of actors and actresses in the United States as 21,000 in 1940 and 20,000 in 1950, a decline from 0.041 to 0.034 per cent of the "economically active population." These numbers include unemployed, which is not a small portion of the members of this fascinating profession. (More than 25 per cent of the actors and actresses were out of jobs in 1950.) While we are concerned with the number of persons in the performing arts we may note a curious increase in the number of dancers and dancing teachers: from 14,000 in 1940 to 18,000 in 1950, or from 0.027 to 0.031 per cent of the economically active population. The statistic of musicians and music teachers goes back to much earlier times and yields the following time series: 92,000 in 1900, 139,000 in 1910, 130,000 in 1920, 165,000 in 1930, 167,000 in 1940, and 166,000 in 1950. As a percentage of the total economically active population this profession has declined from 0.37 per cent in 1910 to 0.31 per cent in 1920, 0.34 per cent in 1930, 0.32 per cent in 1940, and 0.28 per cent in 1950.

There has been, however, in recent years a considerable development of concert music in the United States. New symphony orchestras have been formed in several cities, the interest in chamber music has increased, and recitals of instrumental and vocal music are drawing larger audiences. Unfortunately, we have no statistical evidence for these statements, but even if they are true, concert activity in this country is still notably below that of most countries of Europe. According to the 1958 U.S. Census of Business, total receipts for "symphony orchestras, opera, and ballet companies" were $24 million, to which another $5 million may be added for "other classical music

[16] *Britain: An Official Handbook*, 1960 ed., p. 230.

[17] See U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, Washington, 1960, p. 75. To bring in at this point some data pertaining to the occupations approach is really inconsistent, but excusable since industry data are so inadequate.

groups." These $29 million for serious concert music, opera, and ballet compare with $82 million for dance bands and orchestras, in the same year.

Figures are available for admissions paid to "spectator sports."[18] The objection that watching baseball or boxing should not be recognized as something that produced "knowledge" can be overruled. It would be ridiculous to exclude from our survey a ball game seen in personal attendance, but to include it when it is seen on television or read about in newspapers. It is interesting to follow in the statistical series the race between the legitimate theatre and spectator sports, the receipts of which are of the same order of magnitude. The theatre was leading during the 1920's, sports during the 1930's, the theatre again during the war years, sports from 1946 to 1954, and the theatre again since 1955. The admissions paid for spectator sports were $240 million in 1956 and $255 million in 1958. There is no real growth in this business: consumer expenditures have declined in constant dollars since 1946.

GOVERNMENT SUBSIDIES FOR THE ARTS?

The arts cannot live on what the market can offer. This can be explained in terms of the good old law of supply and demand. The demand is relatively small because the number of buyers is severely limited since, as a rule, the taste for the higher arts is acquired only with considerable intellectual effort and the amount each buyer can take is not elastic. One must learn to appreciate pictorial art, sculpture, chamber and symphonic music, artistic dance, opera, and drama—and the learning is not easy. The number of sellers of artistic services is relatively large because active performance in the arts by those who have completed the learning process is an even greater pleasure than watching and listening. The psychic income of the artist is so large that he continues to supply his services at earnings rates far below what persons of similar qualifications could obtain in other occupations. But even at these substandard earnings some of the arts, especially those which require considerable team effort—symphonic music, opera, ballet, repertory theatre—could not be sustained at market prices paid by consumers; subsidies by patrons, foundations, philanthropists, or governments are needed. The question whether and to what extent government subsidies for the arts can be justified is most controversial.

[18] *Historical Statistics of the United States*, p. 224.

In the old developed countries the kings and princes covered the deficits of the opera companies, and the city, state, or national governments have provided large subsidies out of tax revenues. In the United States private donations have covered the difference between box-office receipts and cost, but this has been confined to only a very few cities. Modest municipal or state support has been provided for a few symphony orchestras. Proposals for a federal subsidy for opera or other performing arts have been rejected, usually with indignant invocations of the principles of a free, unregimented society. For, as a general rule, in a free market economy everybody has to pay the cost of the products and services he consumes. If there are a few people who like to go to the opera or a symphony concert, they ought to pay what it costs to produce such performances. If there are not enough of those who want to listen to operas and concerts and pay what it costs to produce them, then operas and concerts need not be produced. This point of view is poignantly expressed by an irate writer of a letter to the editor: "As a taxpayer I am not enthusiastic about having my money used to pay salaries to stagehands, musicians and singers. . . . If the Met [Metropolitan Opera] cannot operate within its income from contributions and ticket sales why not let it die like any other money-losing operation? . . . Is there a need for government help to an art form which I would guess reaches or appeals to less than one per cent of the population?"[19]

It is the "less than one per cent" argument in this letter which supplies the key to the problem. After all, it is precisely the smallness of the appreciative audience which makes it necessary to turn to the government for financial support. The question is very similar to that of government aid for education in "nonpractical" subjects which have a natural appeal to only small numbers of people. How many are greatly interested in Assyrian history, in Sanskrit literature, in Germanic philology? How many would pay remunerative prices to hear lectures on topology, spectroscopy, cytology, crystallography? But even in the subjects accessible to almost everybody, instruction is not sufficiently in demand to be supplied without government aid. In recognition of the social benefits of the production of knowledge in the form of general education a majority of the voters have accepted the principle of government aid for it. The few dissenters, who hold that education should be left to the free market without the supporting intervention of the government, will of course even more vehemently oppose govern-

[19] Letter to the Music Editor, *The New York Times*, Sunday, November 26, 1961, p. 20 X.

ment aid to the performing arts. But to accept public support of education and reject public support of the arts is inconsistent.

MOTION PICTURES

As far as the cinema is concerned, the story is one of growth and decline. Average weekly attendance[20] was 40 million in 1922, 90 million in 1930, 80 million in 1940, again 90 million from 1946 to 1948, but only 60 million in 1950, 46 million in 1955, and 40 million in 1958. The decline during the 1950's was clearly associated with the rise of television.

The statistic of admissions paid to motion-picture theatres[21] does not show exactly the same growth and decline, apparently because the prices for admission changed over the years. Total payments were $301 million in 1922, $732 million in 1930, $1,692 million in 1946 (the peak year), $1,367 million in 1950, $1,217 million in 1955, $1,116 million in 1956, and $1,172 million in 1958.

There is no reflection of these trends in the number of motion pictures copyrighted. The peak in this series was in 1916 with 3,240 films, followed by many years with less than 2,000 films per year, and a new rise from 1950 on, reaching again 3,199 films in 1958 and climbing to 3,724 in 1959. The explanation apparently lies in the fact that the length of films varies greatly. Most 1916 films were probably quite short; and many films since 1950 may have been of the shorter variety for television rather than cinema. This seems to be borne out by the statistics of "releases" of motion pictures for exhibition in picture theatres: the number of releases was 622 in 1950, and 507 in 1958.[22]

Since the connection between the decline of cinema attendance and the rise of television-set ownership is so clearly apparent, some people wondered at newspaper stories of a report—by Sindlinger & Co.—which showed "a television owner to be a more frequent movie-goer than someone who does not own a set." This is no paradox at all. People who do not care for movies surely do not care for most TV programs either. On the other hand, avid movie-goers have found a good and cheaper substitute in the usual TV fare. They have not

[20] *Historical Statistics of the United States*, p. 225. The Film Daily, *Yearbook of Motion Pictures, 1960*.

[21] *Historical Statistics*, p. 224. The 1958 figure comes from the *Statistical Abstract of the United States, 1960*, p. 853.

[22] The Film Daily, *Yearbook of Motion Pictures, 1959*, p. 99.

completely substituted TV-watching for movie-going, but they have done so to some extent. That owners of TV sets are better customers of the movie theatres than non-TV-owners merely shows the real competitiveness of the two media: their appeal is essentially to the same audience.

Incidentally, still another change has taken place in the habits of this audience: a shift from indoor to outdoor picture theatres. The growth of the "drive-in movie theatre" has been significant. In 1947 there were 550 "drive-ins" in the country; by 1960 there were almost 4500.

Series of production costs of motion pictures are not available. The Census of Business produced some data for 1954 and 1958, which are reproduced in Table VI-16. We dare not add the various items, since this would involve double counting to an unknown extent. If the receipts of "motion-picture production" are derived from the receipts of "motion-picture distribution," which in turn are derived from the receipts of "motion-picture theatres," we would count some expenditures three times. Of course, it seems likely that some motion-picture production was for television, but in this case it was paid for as advertising cost by the TV sponsors. We may conclude that receipts from motion-picture production and distribution need not be counted as separate items, because production and distribution cost are paid either by the picture theatres or by TV sponsors.

TABLE VI-16

MOTION PICTURES: RECEIPTS FOR PRODUCTION, DISTRIBUTION, SERVICES, AND THEATRES, 1954 AND 1958
(millions of dollars)

	1954	1958
Motion picture production	136.9	252.8
Motion picture distribution	673.9	832.5
Motion picture service industries	133.8	163.7
Motion picture theatres	1,407.2	1,171.8

SOURCE: *U.S. Census of Business*, 1958.

It may be interesting to see how the consumer's dollar paid for admission is distributed among the various sectors of the motion-picture industry. Table VI-17 presents a schematic account of this sort, which however is not of recent vintage and may not reflect the present situation.

TABLE VI-17

MOTION PICTURES: DISTRIBUTION OF GROSS RECEIPTS, 1941
(per cent of total)

Gross box-office receipts		100
Local theatre payroll	16	
Real estate (including depreciation)	20	
Local advertising, publicity	8	
Light, heat, cooling	8	
Other expenses	13	
Value added by exhibitor		65
Wholesale distributor	10	
Studio for producing film	25	35

SOURCE: *Information Please Almanac 1947.*

EXPORTS AND IMPORTS OF FILMS

Motion pictures are media of communication across national borders. American films are shown abroad and foreign films are shown here. The share of foreign movies in total releases for exhibition in this country fluctuates considerably, as Table VI-18 shows. Perhaps it should be said that the number of imports looks unbelievably large compared with the number of foreign films included in the listings of cinema programs in the daily papers. The explanation is simple: even if there are only a few picture theatres in only a few large cities that specialize in showing foreign pictures, a relatively large number of imports will be required, while the overwhelming majority of theatres all over the country can do with a relatively small number of U.S.-produced pictures. In other words, the ratio between U.S.-produced and imported pictures released has nothing to do with the ratio of American and foreign pictures in the programs of the American cinemas.

The figures shown in Table VI-18 indicate that the decline in the annual number of features released since the peak years 1950 and 1951 was more strongly reflected in domestic production than in imports. The number of U.S.-produced features released for exhibition in U.S. picture theatres exceeded the number of foreign features in every single year until 1957. In 1958 and 1959 imports exceeded U.S. releases.

The same sources that report on the foreign features released in this country are silent on the export of American pictures. We do, however, know the receipts from such exports. Estimates of dollar remittances received from abroad by American motion-picture producers are pub-

TABLE VI-18

MOTION PICTURES: RELEASES OF U.S.-PRODUCED AND IMPORTED FEATURES, 1939-1959

Year	Total Releases	U.S.-Produced	Imported
1939	761	483	278
1949	479	356	123
1950	622	383	239
1951	654	391	263
1952	463	324	139
1953	534	344	190
1954	427	253	174
1955	392	254	138
1956	479	272	207
1957	533	300	233
1958	507	241	266
1959	439	187	252

SOURCE: The Film Daily, *Yearbook of Motion Pictures, 1959*, p. 101, and *1960*, p. 103.

lished in the balance of payments of the United States. Since 1946 these receipts have been between $120 million and $215 million, the latter figure being the estimate for 1958.

NONTHEATRICAL MOTION PICTURES

Reference was made to motion pictures produced for television. In addition, there is also a considerable production of "nontheatrical motion pictures." These are 16 mm. films made available to the public, sometimes sold or rented but mostly free of charge, for private showing. There were 8,440 pictures of this sort produced in 1959, 7,210 of them freely available upon request, 1,230 available for rental or sale.[24]

The kind of knowledge distributed in this form can perhaps be deduced from the kinds of organizations which distribute these films: 5,400 came from business (chiefly industrial firms), 1,500 from government agencies, and the remaining 1,540 from various groups promoting education, medicine and health, religion, civic, social, recreational, or artistic activities. The total expenditures for these nontheatrical motion pictures were $287 million in 1959. No figure is available for 1958. It may be assumed that the cost of these films is included in several items reported elsewhere: for films distributed by business, among advertising expenditures (discussed later in this chapter); films distributed by the government, among information

[24] The Film Daily, *Yearbook of Motion Pictures, 1960*, p. 113.

services (dealt with in Chapter VIII); educational and religious films, among expenditures for education (Chapter IV). What remains is negligible.

Broadcasting

Here are some striking facts about broadcasting: radio came into civilian use in the early 1920's; television, with a first start in 1941 and the real take-off after the war, grew so rapidly that its revenues overtook those from radio broadcasting in 1954, and by 1958 were almost twice those from radio; while only about 8,000 households had TV sets in 1946, over 54.5 million households had TV sets in January 1960; in 1957, expenditures on new radio and TV sets were $1,491 million,[25] the radio and television repair bill was $652 million,[26] and the receipts of radio and television broadcasting stations were $1,461 million, making for an annual current expenditure for broadcasting transmission and reception of $3,604 million, to which one may wish to add the capital outlays of another $806 million for the expansion of studios and transmission plants.

RADIO AND TELEVISION

A statistical picture of the development of the broadcasting industry is given in Tables VI-19 and VI-20. It is interesting to look at radio and television in juxtaposition because this affords us a better comparison of the growth rates.

The period of fast growth of radio transmission and reception was from 1921 to 1948, when the number of stations grew from 1 to 1,900 and the number of households owning one or more radio sets grew from 1 to almost 38 million. The period of fast growth of television transmission and reception was from 1947 to 1955, when the number of stations grew from 15 to 437 and the number of households owning TV sets grew from 14,000 to almost 30,700,000.

During the eight years, 1947 to 1955, the revenues of TV stations increased from $1.9 million to $744.7 million. Expressed in percentages, the growth in this period was 2,913 per cent for the number of stations, 219,286 per cent for the number of households with TV sets,

[25] Actual figures on domestic expenditures by consumers and business on new radio and TV sets were not available. The above figure is the retail value of production of radio and TV sets minus exports. If it can be assumed that changes in inventories were not large, the latter figure should be a satisfactory estimate of the expenditures on new radio and television sets.

[26] This figure underestimates the total repair bill because it includes only consumers' expenditures. Business expenditures, e.g., of restaurants and hotels, were not available.

TABLE VI-19

GROWTH OF RADIO AND TELEVISION BROADCASTING, 1921-1959

Year	*Number of households with* Radio sets (thousands) (1)	*with* TV sets (thousands) (2)	*Number of Stations* Radio (3)	TV (4)	*Revenues of stations* Total (millions of dollars) (5)	Radio (6)	TV (7)	*Gross investment in broadcasting stations* Total (millions of dollars) (8)	Radio (9)	TV (10)
1921	n.a.		1							
1922	60		30							
1923	400		556							
1929	10,250		606							
1930	13,750		618							
1932	18,450		604							
1935	21,456		585		86.5	86.5				
1940	28,500		765		147.1	147.1		70.9	70.9	
1942	30,600	....	856	6	178.8	178.8	......			
1943	30,800	....	846	6	215.4	215.3	0.1			
1945	33,100	....	906	6	299.6	299.3	0.3	88.1	88.1	
1946	33,998	8	1033	10	323.3	322.6	0.7	107.8	107.8	
1947	35,900	14	1516	15	365.6	363.7	1.9	150.0	150.0	
1948	37,623	172	1927	47	415.7	407.0	8.7	201.8	201.8	
1949	39,300	940	2125	98	449.5	415.2	34.3	286.5	230.6	55.9
1950	40,700	3,875	2229	107	550.4	444.5	105.9	314.7	244.4	70.3
1951	41,900	10,320	2266	108	686.1	450.4	235.7	347.7	254.7	93.0
1952	42,800	15,300	2380	122	793.9	469.7	324.2	391.5	267.4	124.1
1953	44,800	20,400	2479	334	908.0	475.3	432.6	509.3	276.2	233.1
1954	45,100	26,000	2598	410	1,042.5	449.5	592.9	593.8	278.8	315.0
1955	45,900	30,700	2742	437	1,198.1	453.4	744.7	649.4	284.7	364.7
1956	46,800	34,900	2966	474	1,377.5	480.6	896.9	727.2	297.5	429.7
1957	47,700	41,834	3164	501	1,460.5	517.2	943.3	805.8	328.2	477.6
1958	48,500	42,607	3290	514	1,553.1	523.1	1,030.0			
1959	49,950	45,500	3528	519	1,723.9	560.0	1,163.9			

SOURCES: U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, Washington, D.C., 1960. For 1958 and 1959: *Statistical Abstract of the United States*, and Federal Communications Commission.

and 39,195 per cent for the revenues of TV stations. The growth rates per year were 52, 162, and 111 per cent for the three respective magnitudes—probably some of the largest growth rates encountered in this study.

Adding to the expenditures on *new* radio and TV sets the consumers' expenditures for radio and TV *repair* and the stations' revenues for radio and TV *broadcasting*, we obtain a first approximation of a series of current expenditures—see Table VI-21—which paradoxically does not show an impressive growth over the years. In absolute figures, these current expenditures increased almost six-fold between 1940 and 1950,

TABLE VI-20

EXPENDITURES FOR RADIO AND TELEVISION RECEIVERS, 1940-1959

Year	Production of radios (thousands) (1)	Retail value (millions of dollars) (2)	Production of television sets (thousands) (3)	Retail value (millions of dollars) (4)	Retail value of radio & TV sets (millions of dollars) (2) + (4) (5)	Export of radio & TV sets (millions of dollars) (6)	Production for domestic sales at retail price (millions of dollars) (5) — (6) (7)	Private households' annual repair bill for radio & TV sets (millions of dollars) (8)	Current expenditures on radio and TV receivers[a] (millions of dollars) (7) + (8) (9)
1940	11,860	335.5	......	......	336	10.2	326	32	358
1941	13,700	469.6	......	......	470	13.5	456	36	492
1946	14,031	701.6	7	2	704	23.2	681	115	796
1947	16,961	926.1	179	84	1,010	53.5	956	140	1,096
1948	13,108	691.6	975	383	1,075	28.1	1,047	174	1,221
1949	7,972	345.5	3,000	970	1,316	17.1	1,299	201	1,500
1950	9,849	433.6	7,464	2,235	2,669	15.8	2,653	281	2,934
1951	8,084	276.6	5,385	1,572	1,849	22.9	1,826	350	2,176
1952	7,692	261.4	6,096	1,719	1,980	27.0	1,553	389	1,942
1953	8,186	268.8	7,216	2,020	2,289	18.1	2,271	428	2,699
1954	6,276	188.8	7,347	1,690	1,879	25.7	1,853	475	2,328
1955	7,269	233.2	7,757	1,745	1,978	20.2	1,958	522	2,480
1956	8,461	275.9	7,387	1,404	1,680	27.9	1,652	585	2,237
1957	9,009	303.4	6,399	1,216	1,519	27.6	1,491	652	2,143
1958	8,032	286.6	4,920	1,009	1,296	34.3	1,262	720	1,982
1959	10,245	325.4	6,270	1,336	1,661	28.3	1,633	784	2,417

SOURCES: Columns (1)-(4): *Electrical Merchandising Week*, Annual Statistical and Marketing Issues, 1954 and 1960. Column (6): for 1940-53 above source; for 1954-59 U.S. Bureau of the Census, *Quarterly Summary of Foreign Commerce of the United States*. Column (8): *Statistical Abstract of the United States.*

[a] The expenditures on repair of receiving sets owned by businesses, such as hotels, restaurants, etc., are not included.

but have hardly grown at all since then. Relative to the Gross National Product these expenditures were 0.50 per cent in 1940, 1.22 per cent in 1950, and 0.82 per cent in 1957. The paradox can be explained, apart from the increase in GNP, by the great cost reductions in this industry due to the rapid rate of technological improvement. For example, the average retail price of television sets came down from $393 in 1948 to $190 in 1956. Likewise, the average retail price of radio sets was $136 in 1929, $52 in 1948, and $32 in 1956.

TABLE VI-21

Expenditures for Radio and Television Services, Current and Capital Outlays, 1940-1957
(millions of dollars)

Year	Total revenues of radio & TV stations (1)	Expenditures on radio & TV receivers (2)	Current expenditures (1) + (2) (3)	Current expenditures as % of GNP (4)	Gross investment of radio & TV broadcasting stations (5)	Current plus capital expenditures (6)	Current plus capital expenditures as % of GNP (7)
1940	147	358	505	.50	71	576	.57
1946	323	796	1,119	.53	108	1,227	.58
1947	366	1,096	1,462	.62	150	1,612	.69
1948	416	1,121	1,537	.59	202	1,739	.67
1949	450	1,500	1,950	.76	287	2,237	.87
1950	550	2,934	3,484	1.22	315	3,799	1.33
1952	794	1,942	2,736	.80	392	3,128	.90
1954	1,043	2,328	3,371	.93	594	3,965	1.09
1956	1,378	2,237	3,615	.86	727	4,342	1.04
1957	1,461	2,143	3,604	.82	806	4,410	1.00

Source: Tables vi-19 and vi-20.

THE TYPES OF KNOWLEDGE CONVEYED BY RADIO

An analysis of the radio programs of representative samples of all stations would show great differences between rural and urban communities, between cities and towns of different size, between different parts of the country, and most of all between AM and FM stations. No ready-made analysis of this sort seems to exist.

Among the available studies is a recent survey by the Federal Communications Commission, showing the average allocation of broadcasting time among different types of programs at 14 different radio stations. This is too small a sample to be accepted as more than suggestive. In addition, the classification of the programs is too broad. For example, the class "entertainment" evidently includes all kinds of music, classical as well as popular. From personal experience we know that only FM stations devote considerable portions of time to serious music. Though such personal-experience sampling cannot pass as "analysis," there is hardly anything else to do but regard the whole entertainment class as falling under the heading of pastime. To compensate for this gross decision we shall put the entire classes of "talks" and "discussions" under intellectual knowledge, which is surely a complimentary evaluation. Our division of "news," giving one third to intellectual and two thirds to pastime knowledge, is probably fair in the light of the way radio newscasters customarily divide their time between reports on crimes, accidents, and similar local events, on the one hand, and national and international affairs, on the other.

TABLE VI-22

RADIO: ALLOCATION OF TIME TO VARIOUS TYPES OF PROGRAMS, AVERAGE OF 14 STATIONS, 1957

Type of program	*Per cent of non-advertising time*	*Per cent of total broad-casting time*	*Type of knowledge in per cent of total*				
			Practical	Intel-lectual	Pastime	Spiritual	Un-wanted
Entertainment	68.6	58.3			58.3		
Religion	5.2	4.4				4.4	
Agricultural	3.1	2.6	2.6				
Educational	2.2	1.9		1.9			
News	12.8	10.9		3.6	7.3		
Discussion	2.1	1.8		1.8			
Talks	5.5	4.7		4.7			
Other	0.5	0.4	0.4				
Total non-advertising time	100.0	85.0					
Advertising		15.0	7.5				7.5
Total broadcasting time		100.0	10.5	12.0	65.6	4.4	7.5

SOURCES: For the basic percentage distribution, Federal Communications Commission, *Reports*, 1957. The distribution among types of knowledge has been added.

The distribution of time, as computed by the FCC, had to be recomputed in Table VI-22 after allowing for the approximately 15 per cent of broadcasting time that is given to advertising. "Commercials" over the radio are largely information about local buying opportunities and may thus be regarded as conveying practical knowledge. Undoubtedly, to many in the almost captive audience this knowledge is not practical at all, but thoroughly unwanted. In the case of newspapers and periodicals we disregarded the percentage of unwilling readers, on the ground that it is possible to run the eyes over the advertising space of papers and magazines without absorbing any of the messages conveyed. It is much harder to shut one's ears or mind to the radio announcer's voice when one awaits the beginning of a "wanted program" and is subjected to the recital of his "commercials." A 50:50 division between practical and unwanted knowledge is probably a much too charitable evaluation of radio advertising. (To say this is not to criticize radio advertising, nor necessarily to state a preference for "pay-radio," where the consumers, not the advertisers, pay for the broadcasting service and thus, by doing away with commercial sponsors, can avoid listening to unwanted information. The remark was just a statement of fact, to the effect that probably much less than half of the radio audience find the commercials "useful knowledge." The system may justify itself if a minute fraction of listeners is aided in its shopping decisions. Train announcements in a railroad station and plane announcements at an airport concern each time only a small fraction of those waiting for "their" train or plane. Everybody has to listen to a great deal of information in order to learn the few bits that are pertinent to him.)

The results of this primitive allocation of the entire broadcasting time show that 65.6 per cent was devoted to the dissemination of pastime knowledge, and 12 per cent to intellectual knowledge. This distribution was strictly according to the time allocated. One might prefer to see a distribution according to the cost of broadcasting, since programs of the same length may be cheap or expensive; or according to the interest or satisfaction of the listener, since some programs are better liked than others. In other words, instead of distributing broadcasting *time* over the various types of knowledge, one may distribute broadcasting *cost*, or consumers' *satisfaction* measured by the number actually listening to particular programs. One might even combine some of these percentage distributions—if they were at our disposal—into indices giving both cost incurred for, and use made of, the services provided.

THE TYPES OF KNOWLEDGE CONVEYED BY TELEVISION

For television broadcasting, as for radio, it is necessary to distinguish between network programs and non-network programs; and regarding the latter it would be important to distinguish between programs in different localities and regions.

The most comprehensive analysis of TV network programs is contained in the *National Nielsen Television Index,* published semimonthly by A. C. Nielsen Company, Chicago. This report is confined to networks—i.e., it does not include locally produced programs. From an issue of January 1960, the average distribution of a week's broadcasting time of a total of 7-120 minutes was compiled, and is reproduced here in Table VI-23 with the exception of 120 minutes for which the "format varies." The number of minutes given for each "program type" is gross of advertising time; that is to say, a 30-minute "suspense drama" will probably give at least three minutes over to commercials, but in column 1 of the table nothing is deducted for commercials. On the average, a deduction from all time allotments of 15 per cent for advertising will not be unreasonable. Of the 20 program types sharing the 7,000 minutes of weekly network broadcasting time, four programs at most can be classified as "intellectual": they are "general drama," "documentary," "interview," and "news." All others are in the nature of pastime knowledge. Using only a single report, as we do, will introduce a bias, because programs vary with the season; depending on the time of the year, there may be more "sports events," "devotional," "political" programs, etc. During the period of our report, for example, there were neither devotional nor political programs.

The essence of the Nielsen reports is that they state the size of the audience for each program, not in terms of the number of persons but of the number of TV sets tuned in on the particular program. Thus we can show for each program type the average size of the audience, and can calculate the total audience time given to the program. (If one were to assume that an average of two persons were watching per TV set in use, one might multiply the audience time by two.) The idea should be clear: the distribution of broadcasting time is one thing, the distribution of audience time another. If we want to find out what kinds of knowledge are produced, we should not be satisfied with data showing what is transmitted; we must look into what is received. Assume that 50 per cent of the broadcasting time is used for the dissemination of intellectual knowledge and another 50 per cent for popular entertainment. If only 10 per cent of all TV sets were tuned in on the one, but 60 per cent on the other (the remaining 30 per cent of the TV sets not being turned on at all) the distribution of audience time between the reception of intellectual knowledge and pastime knowledge would be 5:30, or 1:6.

As a matter of fact, audience interest *was* somewhat lower, in the

TABLE VI-23

TELEVISION: DISTRIBUTION OF NETWORK BROADCASTING TIME AND AUDIENCE RECEIVING TIME AMONG TYPES OF PROGRAM, JANUARY 1960

TYPE OF PROGRAM	MINUTES PER WEEK	AVERAGE AUDIENCE (millions of sets)	TOTAL AUDIENCE TIME PER WEEK (millions of minutes)	PER CENT DISTRIBUTION OF TIME *Before adjustment for commercials* Broadcasting	Audience	*After adjustment for commercials* Broadcasting	Audience
Intellectual	900	16.8	15,148	12.9	11.4	10.9	9.8
General drama	405	16.5	6,683	5.8	5.0	4.9	4.3
Documentary	60	17.1	1,026	0.9	0.8	0.8	0.7
Interview	120	17.1	2,052	1.7	1.5	1.4	1.3
News	315	17.1	5,387	4.5	4.1	3.8	3.5
Pastime	6,100	19.2	117,304	87.1	88.6	74.1	75.2
Adventure	270	14.7	3,969	3.9	3.0	3.3	2.6
Audience participation	675	18.4	12,420	9.6	9.4	8.2	8.0
Children's program	330	12.4	4,092	4.7	3.1	4.0	2.6
Situation comedy	765	22.6	17,289	10.9	13.1	9.3	11.1
Comedy variety	30	22.3	669	0.4	0.5	0.3	0.4
Daytime serial	555	8.9	4,940	7.9	3.7	6.7	3.1
Daytime western	90	7.1	639	1.3	0.5	1.1	0.4
Western drama	870	26.3	22,881	12.4	17.3	10.5	14.7
General variety	510	22.3	11,373	7.3	8.6	6.2	7.3
Mystery drama	600	23.1	13,860	8.6	10.5	7.3	8.9
Popular music	120	7.1	852	1.7	0.6	1.4	0.5
Quiz-give-away	180	18.4	3,312	2.6	2.5	2.2	2.1
Quiz panel	180	18.4	3,312	2.6	2.5	2.2	2.1
Suspense drama	105	23.1	2,426	1.5	1.8	1.3	1.5
Sports events	580	17.1	9,918	8.3	7.5	7.1	6.4
Musical variety	240	22.3	5,352	3.4	4.0	2.9	3.4
Total broadcasting	7,000	18.9	132,452	100.0	100.0	85.0	85.0
Advertisements	1,050	18.9	19,868			15.0	15.0
						100.0	100.0

SOURCE: The classification of programs, the minutes per week, and the size of the average audience come from *National Nielsen Television Index* of January 24, 1960. The division between the major "types of knowledge" was added, as were the adjustments for advertising time.

period under examination, for the intellectual programs than for the popular entertainment, but the difference was not great. While an average of about 17 million TV sets were tuned in on the intellectual knowledge, an average of about 19 million sets were tuned in to receive pastime knowledge. For particular program types the share of total audience time differed significantly from the share of broadcasting time. For example, "western drama" got 17 per cent of total audience time (before adjustment for commercials) but only 12 per cent of total broadcasting time.

I attempted to apply these time distributions to total dollar revenues of TV stations, but preferred to discard the results because the "time cost" of the broadcasting stations is not the only relevant factor. The preparation and production of the program and the payments for the "talent" involve expenditures that are not at all proportional to the duration of the program. These costs would have to be known and added to the "time sales" by the broadcasting stations before we could start allocating dollar amounts to various types of knowledge disseminated. Again, if we knew the costs, we could also calculate what might be called "utilized costs," by giving the cost of each program a weight according to the size of the audience. But it is idle talk to enumerate the nice things we could do with complete and accurate data *if* we had them.

It is misleading to concentrate on network programs and neglect local programs. An analysis of the programs broadcast by the seven TV channels in New York City shows a slightly different distribution of broadcasting time.[27] There is some spiritual knowledge disseminated —not quite 2 per cent—and a little more intellectual knowledge.

We may be silent at this juncture about the classification of the TV commercials according to the type of knowledge they convey, and leave the question to a more comprehensive discussion of advertising.

CONTROL OVER BROADCASTING PROGRAMS

In discussions of the types of knowledge conveyed by books, periodicals, newspapers, phonograph records, and motion pictures, it is easier than not to indulge in laments about the poor taste of the public or to cheer about signs of improvement. Yet, in all these areas of knowledge-production every interest and taste can be met, provided the groups demanding knowledge of particular kinds are large enough to make it worthwhile to produce it. Even if, for example, the number of readers who want to buy books on palaeontology, statistical mechanics, or linguistics is relatively small, the demand may still be large enough to make publication pay for itself; and if the market is too small to attract the interest of a commercial publisher without subsidy, the amounts of money needed to assure publication are not prohibitive. There will be enough paper and enough printers to allow the demands of minority readers to be met. Similarly, the number of buyers of phonograph records of poetry readings or of serious modern music may be diminutive compared with the number of those who buy jazz and

[27] This analysis was made for me by Thomas Dernburg, using the programs for the week of October 16-23, 1960, as announced by the *New York Times*, October 16, 1960.

rock 'n' roll, yet the productive resources are available to satisfy the small minority of highbrow listeners. No public regulation is needed to "protect" these minorities.

The situation is radically different when it comes to broadcasting. The number of usable wave lengths is strictly limited and the Congress has decided to distribute their use not to the highest bidders but, instead, free of charge on the basis of a commission's discretion. Licenses are issued to selected applicants "to serve the public interest, convenience and necessity." How the licensees allocate the broadcasting time among various areas of knowledge is left to them, or indirectly to the "sponsors of programs" who pay for the broadcasts. The sponsors' choice of program is naturally determined by the "rating" in terms of the size of audience, and thus by the tastes and interests of the majority. Minorities have little chance of having their tastes and interests satisfied, since almost all sponsors want to cater to the largest possible audience. Only to the extent that rich foundations established for the promotion of cultural causes, or corporations with culturally inclined management, are able and willing to sponsor programs for the "eggheads" can the minority's demand for intellectual knowledge be met. Under such a system it is no surprise that radio and television for the most part produce mass entertainment for people who dislike to exercise their minds.

The new chairman of the Federal Communications Commission likened the TV program on most commercial stations to a "vast wasteland":

"You will see a procession of game shows, violence, audience participation shows, formula comedies about totally unbelievable families, blood and thunder, mayhem, violence, sadism, murder, western badmen, western good men, private eyes, gangsters, more violence, and cartoons. And endlessly, commercials—many screaming, cajoling, and offending. And most of all, boredom."[28]

Conceding that "people would more often prefer to be entertained than stimulated or informed," but arguing against the point of view according to which "the public interest is merely what interests the public," he intimated that the Commission in its periodic review of licences would ascertain through public hearings whether the broadcaster has served his community well. When the broadcasting interests

[28] Newton N. Minow, Chairman, Federal Communications Commission, Address to the 39th Annual Convention of the National Association of Broadcasters, May 9, 1961. Reprinted in *Congressional Record*, 87th Congress, 1st Session.

reacted to this "threat" by crying out against attempted "censorship," he reminded them that, according to well-established court opinions, censorship related only to "previous restraint of specific programs" and that the Commission's authority to "consider past programming" in passing on a licence-renewal application had been intended by the Congress and confirmed by the courts.[29]

How seriously will the Commission examine the broadcaster's conscientious effort to serve all sectors of the community, including the lovers of poetry and twelve-tone music? Will an applicant for licence renewal be dumped in favor of a rival applicant who promises to program more chamber music and fewer murder mysteries, more educational discussions and fewer variety shows? How can a broadcaster ascertain whether he is properly serving all legitimate needs or demands of his community? It stands to reason that the Commission will always lean over backward in approving past performance and future promises of a licensee who applies for renewal, and that rival applicants competing with promises of better programs will rarely succeed in getting the award. Hence, the hope for "quality competition" for the allocation of a wavelength is probably illusory. (The possibility of "price competition," the assignment of the scarce and valuable broadcasting channels to the highest bidders, has never been seriously considered, although such a procedure would probably be the most appropriate one in a free-enterprise economy. Discretionary decisions would be excluded and net revenues would accrue to the government.)

The best hopes for improved arrangements allowing better programs without the exercise of governmental discretion seem to lie in the development of pay-television, in an increase in the number of channels (when ultra-high frequency becomes more easily usable), and in the growth of educational television.

EDUCATIONAL BROADCASTING

Educational *radio* broadcasting from noncommercial stations operated by universities, school systems, and municipalities began during the 1930's. There were approximately 20 AM stations before the Second World War. After the war the Federal Communications Commission allocated the 88-92 megacycle band for educational use, so that many FM radio stations became possible.[30] By 1949 there were 34

[29] Newton N. Minow, Address to the Conference on Freedom and Responsibility in Broadcasting. Northwestern University School of Law, August 3, 1961.

[30] Girard Chester and Garnet R. Garrison, *Television and Radio* (New York: Appleton, Century-Croft, 1958), Chapter 13.

educational FM stations on the air, by 1953 there were 106, in addition to 23 AM stations, and by 1958 the number of FM educational stations had increased to 147.[31]

Educational *television* broadcasting began in 1948 in Ames, Iowa, but the first educational television station to go on the air was in Houston, Texas, in 1953. The story of the development of educational television—ETV—cannot be fully understood without a few preliminary distinctions. We must distinguish, before all, between the educational programs of commercial stations and the programs of strictly educational stations. The latter, in turn, may be either "in-school TV" or "community TV" (directed to pre-school children, school-age children, or adults). "In-school TV" (for schools and colleges) may be either over closed-circuit installations (using cables, requiring no television channels and capable of transmitting several programs at the same time) or over open-circuit channels (using either very high frequency, VHF, up to channel 13 or ultra-high frequency, UHF, from channel 14 up). Closed-circuit television can be economically used only within a narrow territory, usually for a particular college or for the schools within a county. The use of UHF is restricted by the fact that the normal receiving sets are not equipped to pick up anything beyond channel 13, and can be so equipped only with a converter, costing approximately $30 per set. (Hence, to prepare the 4 million TV sets in New York City for the reception of UHF would cost about $120 million.) The distinctions just made may be presented in diagrammatic form as follows:

Educational television programs
- of commercial stations
  - commercially sponsored
  - sponsored by foundations
  - as a public service of the station
- of educational stations
  - community programs
    - VHF (for all types of receiving sets)
    - UHF (for sets with special converters)
  - in-school programs
    - open circuit
    - closed circuit

The most widely discussed educational program transmitted from commercial stations is "Continental Classroom," viewed over the NBC network by a remarkably large number of early rising people. In its first year, 1958-1959, a course in physics was telecast by 157 stations at 6:30 in the morning and watched by 400,000 persons; this course

[31] Federal Communications Commission, *Annual Report for the Fiscal Year 1958.*

was repeated in the second year at 6 o'clock, and a chemistry course telecast at 6:30. In the third year, 1960-1961, chemistry was scheduled for 6 o'clock and mathematics for 6:30. The vast majority of the audience did not seek college credit for the course, but some 8,000 persons did receive credit at 300 different institutions. The audience included at least half of the country's 70,000 high-school science teachers. Courses in other disciplines are now prepared by the Learning Resources Institute with the cooperation of recognized authorities chosen by professional organizations.[32] The costs of the project were covered in the first years chiefly by the Ford Foundation, later by a group of ten corporations.

"In-school TV" on the college level was introduced in 1955, also with the aid of Ford Foundation money, at Pennsylvania State University. It proved effective and was expanded to such an extent that in 1958 some 3,700 of the University's 14,000 students were registered for one or more of thirteen courses taught over closed-circuit TV on the campus.[33] All sorts of tests were made to compare the effectiveness of TV instruction with conventional teaching, and no significant differences in achievement or attitude were found. In large classes a majority of students, after receiving both TV instruction and face-to-face instruction, chose TV as the preferred method. The cost of instruction was significantly lowered through the use of television whenever the enrollment in the course exceeded 200 students.

On the elementary and secondary level in-school TV has been used since 1956 by the public school system of Hagerstown, Maryland. Six subjects are telecast at the same time over closed-circuit installations to the 37 schools in the county—Washington County, Maryland—directed to pupils in all twelve grades. Altogether 125 TV lessons a week, in all major subjects, are received by the 16,500 students in the elementary and secondary schools of the county. Normally each student has at least one TV lesson a day.

On a much larger scale are the operations of in-school TV in Alabama, where three stations are used, linked by microwave relay stations. In 1960-1961 the telecasts reached over 300,000 pupils in 600 schools. The scarcity of qualified teachers in the state made the use of instructional TV almost indispensable. Thanks to in-school TV,

[32] *ETV, A Ford Foundation Pictorial Report* (New York, March 1961), pp. 34-36.
[33] *Teaching by Television: A Report from the Ford Foundation and The Fund for the Advancement of Education* (New York, 2nd ed. 1961), p. 19.

subjects can be taught for which many schools had only unqualified teachers or none at all—as in music, art, languages (Russian, Latin), and sciences. In addition, it is contended by the authorities that the telecasting of in-service programs in teaching techniques and guidance may raise the qualifications of the teachers.

A project of even larger dimensions may soon come into effect in the Midwest. The Midwest Program on Airborne Television Instruction (MPATI) will serve parts of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin, by telecasting over two channels—and later perhaps over as many as six channels—from an airplane circling at 25,000 feet. It is expected that five million students in 13,000 schools and colleges, within a radius of between 75 and 100 miles, will receive ETV instruction under this program.

In 1960-1961, in the country as a whole, approximately three million pupils in about 7,500 elementary and secondary schools were receiving part of their regular instruction by TV, though never more than 1½ hours per day. About 250,000 college students were taking credit courses via TV in some 250 colleges and universities. Despite widely publicized tests most teachers remain skeptical about the effectiveness of TV instruction. It stands to reason that good television lectures may be superior to teaching by bad instructors in the classroom, but inferior to the inspiration a good classroom teacher can give to his students. If the supply of qualified teachers should fall seriously short of the demand expected in the next ten or fifteen years, the extension of television in schools and in institutions of higher education may be unavoidable. The best technique of *producing* the TV lectures will probably involve close cooperation between studio teacher, classroom teacher, and curriculum specialist, and the best technique of *using* the TV lectures will probably involve continuing use of classroom teachers in face-to-face communication with the students.

Educational television broadcasting of community programs has had a slow start. Early in 1952 the Federal Communications Commission set aside 12 per cent of all channels for ETV. This would permit some 250 educational stations, but there were only 11 such stations on the air in 1955, compared with 458 commercial TV stations. The chief reason for this poor ratio was that most of the channels reserved for educational TV were ultra-high frequency. The "growth rate" of ETV has not been unsatisfactory, however, as far as the number of stations is concerned. The number increased to 20 in 1956, 32 in 1958, 43 in

1959, 47 in 1960.[34] In the middle of 1961 there were 52 ETV stations on the air and it became customary to refer to them as "the 4th network." They are a network only in a sense different from the usual one, namely, in their being organized in the National Educational Television and Radio Center (NETRC, or more briefly NET for its television activity) and in their exchange of videotape and film programs. Through this exchange NET can provide ten hours of educational programs each week, in the physical sciences, social sciences, humanities, arts, public affairs, and special programs for children between seven and twelve years old.

These educational TV stations are owned and operated locally. Of the 52 stations on the air in mid-1961, 15 were owned by universities, 9 by city, county, or district public schools, 9 by state boards of education or state commissions, and 19 by independent nonprofit corporations. Chicago, Philadelphia, Boston, San Francisco had their ETV stations, but New York, Los Angeles, Cleveland, Detroit, and Washington did not. Just in time to be inserted here, ETMA, Educational Television for the Metropolitan Area, succeeded in purchasing Channel 13 to broadcast educational programs to New York City and the neighboring parts of Connecticut and New Jersey. The purchase price of over $6 million was raised through grants from foundations, from the three commercial networks ABC, CBS, and NBC, and from two independent commercial TV stations.

The stated objectives of ETV are "to awaken curiosity and imagination, to inform, interest and inspire Americans of all ages."[35] If these efforts prove successful, and increasing numbers of TV-watchers get access to ETV and take advantage of this opportunity, the present emphasis of commercial TV on producing pastime knowledge in the form of popular entertainment may eventually give way to a distribution of broadcasting time that gives a better chance to the production of intellectual knowledge.

The cost of in-school TV was, we may assume, included in the cost of education, enumerated in Chapter IV. The operating cost of the ETV stations, broadcasting community programs, was $11.8 million in 1960, and their capital investment was $24.5 million. How much these costs and investments were in 1958, our year chosen for comparison

[34] Federal Communications Commission, *26th Annual Report*, Washington, D.C., 1960, pp. 60-61.

[35] *The 4th Network, The National Educational Television and Radio Center*, New York, 1961.

and aggregation, we do not know. Nor do we know whether or not the incomes covering the operating costs are included among the revenues of broadcasting stations reported in the official statistic (reproduced in Table VI-19) and whether or not the capital outlays for educational stations were included in the investment data shown in Table VI-21. Hence, no separate entries in our summary account will be made for ETV.

Advertising and Public Relations

We have seen that advertising paid for over 60 per cent of the cost of periodicals, for over 70 per cent of the cost of newspapers, and for 100 per cent of the cost of commercial radio and TV broadcasting. In these circumstances the advertising industry rates a special discussion in this chapter, although it is not a "medium" of communication but rather the chief user and patron of several of the media. Incidentally, one of the media used by advertisers—the postal service, employed for direct mail advertising—will come up for discussion later on. It is felt, however, that the best place for a discourse on advertising is immediately after the report on the broadcasting services.

Often lumped together with advertising and yet jealously distinct from it is the sub-industry or profession of public relations. It is easier to lump them than to separate them and it will therefore be worthwhile to discuss the differences.

ADVERTISING EXPENDITURES

The rise of the advertising industry has been definitely "above par," but modest in comparison with such real "growth industries" as television, research and development, higher education, or secondary education. Total advertising expenditures in 1958 were $10,302 million, as against $5,710 million in 1950, $2,088 million in 1940, $2,067 million in 1930, and $2,935 million in 1920. Thus the growth was much more impressive from 1940 to 1958 than from 1920 to 1958. The 1958 expenditures were almost twice those of 1950, almost five times those of 1940—but only three and a half times those of 1920.

The composition of advertising, as far as the media employed are concerned, has changed considerably in recent years, which is to be expected in view of the rise of television and the relative decline of radio. Thus, in 1958 the advertising expenditures for television were 793 per cent of those in 1950, while the expenditures for radio were only 102 per cent of those in 1950, which in terms of constant dollars is a considerable reduction.

The data that underlie these statements are presented in Table VI-24. An interesting feature in the development during the 1950's is that advertising by direct mail kept its second place among the media employed. Newspapers hold the number one position, far ahead of all the rest. Radio fell from third place in 1950, to fifth in 1958, while TV has come up from fifth to third. (If advertising through farm and business papers were shown in Table VI-24, TV would be in sixth place in 1950.) Magazines continued in the fourth spot all these years.

TABLE VI-24

ADVERTISING, BY SCOPE AND MEDIUM, 1900-1959
(millions of dollars)

Year	National	Local	Total	News-papers	Maga-zines	Radio	Tele-vision	Direct mail	Others
1900			542	n.a.	n.a.	—	—	n.a.	n.a.
1914			1,302	n.a.	n.a.	—	—	n.a.	n.a.
1920			2,935	n.a.	n.a.	—	—	n.a.	n.a.
1930			2,607	n.a.	n.a.	n.a.	—	n.a.	n.a.
1935	859	831	1,690	762	136	113	—	282	397
1940	1,163	925	2,088	815	198	216	—	334	525
1945	1,775	1,099	2,874	921	364	424	—	290	875
1950	3,257	2,453	5,710	2,076	515	605	171	803	1,540
1951	3,701	2,725	6,426	2,258	574	606	332	924	1,732
1952	4,096	3,059	7,156	2,473	616	624	454	1,024	1,965
1953	4,521	3,235	7,755	2,645	667	611	606	1,099	2,127
1954	4,812	3,352	8,164	2,695	668	559	809	1,202	2,232
1955	5,407	3,788	9,194	3,088	729	545	1,025	1,299	2,508
1956	5,926	3,979	9,905	3,236	795	567	1,207	1,419	2,681
1957	6,253	4,057	10,311	3,283	814	619	1,273	1,471	2,851
1958	6,331	3,971	10,302	3,193	767	616	1,354	1,589	2,783
1959	6,714	4,404	11,117	3,546	866	637	1,495	1,573	2,979

SOURCES: *Historical Statistics of the United States, Colonial Times to 1957. Statistical Abstract of the United States, 1960 and 1961*, p. 859.

NOTE: Among "Other" advertising media are regional farm publications, business papers, outdoor advertising, and miscellaneous advertising expenditures.

Included among "other" media, because total expenditures for it are only a fraction of one per cent of total advertising expenditures, is theatre-screen advertising. The use of commercials in motion-picture theatres is quite customary in many foreign countries. In France, for example, "14 per cent of the advertising expenditure is placed into movie theatre advertising."[36] In the United States the sophisticated audiences in the large cities resent being exposed to commercials, and

[36] "Advertising: Messages on the Movie Screen," *New York Times*, September 3, 1961.

movie screen advertising is therefore confined to smaller cities and rural areas. Even there it is limited to four one-minute advertising films per performance. Thus motion-picture theatres in general probably spend more for advertising, principally in newspapers, than they collect for screen advertising.

A trend toward more "national" advertising has been apparent. Though "local" advertising has increased year after year (since the depression year 1933), "national" advertising has increased faster. In 1935 national and local advertising shared the total expenditures about 50:50; in 1950 the ratio was 57:43; and in 1958, 61.5:38.5. The media used are not the same: television has catered increasingly to national advertising, radio to local advertising. Thus, in 1958 local advertising furnished only 18 per cent of the revenues of television, but about 60 per cent of the revenues of radio. Newspaper advertising is predominantly local in character; indeed, local expenditures have been consistently about three times as high as the national expenditures for newspaper advertisements. It stands to reason that magazines carry chiefly national advertisements.

An alert reader with a good memory may have noticed what looks like flagrant inconsistencies between the advertising expenditures tabulated here and the advertising receipts tabulated in the sections on periodicals, newspapers, radio, and television. To facilitate comparisons, the expenditures by the advertisers and the receipts by the media are put together in Table VI-25, and the differences are shown in dollars and as percentages of the expenditures.

In the case of periodicals it looks as if the publishers collected more

TABLE VI-25

ADVERTISING: EXPENDITURES BY ADVERTISERS AND RECEIPTS BY MEDIA, 1954 AND 1958
(millions of dollars)

	1954				*1958*			
Advertising	Magazines or Periodicals	News-papers	Radio	TV	Magazines or Periodicals	News-papers	Radio	TV
Expenditures	668	2,695	559	809	767	3,193	616	1,354
Receipts	882	2,085	450	593	1,031	2,503	523	1,030
Difference	−214	610	109	216	−264	690	93	324
Per cent of Expenditures	−32	23	19	27	−34	22	15	24

SOURCES: Expenditures from Table VI-24, receipts from Tables VI-5, VI-7, and VI-19.

than the advertisers spent. But this discrepancy is explained by the fact that the expenditures are only for *magazine* advertisements, while the receipts are for periodicals of any sort. (Advertising in farm and business papers is included among "others.") In the other three columns, for newspaper, radio, and TV, the advertisers spent much more than the media collected. The differences are evidently "value added by the advertising industry," that is, the fees and commissions collected by advertising agencies and public-relations firms. In the case of television, where the difference is between 24 and 27 per cent, the major factor is probably the cost of some of the programs presented—of the shows, concerts, etc.,—where most of the TV stations sell only the broadcasting time in which the program, paid by the advertising agency, is presented. In the official language, "the cost of preparation" of the programs and "the cost of talent" is often paid out by the advertising agent (sometimes by special TV-show producers) rather than the broadcasting network or station.

THE ADVERTISERS

Who are the biggest advertisers in the country? Official statistics give us only the aggregate expenditures of corporations by industry groups, but the trade journal, *Advertising Age*, publishes the expenditures of individual firms.

According to the aggregative data, the makers of "food and kindred products" and of "chemical and allied products" are the biggest spenders for advertising, but this kind of ranking is not very significant because it depends on what industry classification is used in the statistic. More interesting are the advertising expenditures as percentages of total sales. For all active corporations in the United States, total advertising expenditures in 1955, 1956, and 1957 amounted to 1.1 per cent of total gross sales or gross receipts. On this score, tobacco manufacturers were the biggest spenders, with 4.8 and 5.2 per cent, in 1956 and 1957, respectively. Manufacturers of food and kindred products were second with 4.6 and 4.9 per cent. Motion pictures came third; chemicals and allied products, fourth; furniture and housefurnishings, fifth. Banks and trust companies were listed as extraordinarily heavy advertisers in some years and as moderate advertisers in other years, depending on what was used as "gross receipts" in this group. The meaning of gross receipts in banking is rather different from that of gross sales in manufacturing industry or trade. (Banks sell their promises to pay and buy borrowers' promises to pay; on the other hand, one might take only the discounts and interest payments as gross receipts.)

The ten largest national advertisers are listed in Table VI-26 with the amounts of their expenditures in 1960, broken down by the media employed. Unfortunately, the statistics collected by *Advertising Age* are incomplete in that not all media are included: radio advertising, strangely enough, is omitted. Expenditures for newspaper, journal, television, and outdoor advertising are tabulated; the "totals" are therefore not really total expenditures for advertising. In terms of these incomplete totals—though probably also in terms of genuine totals—the General Motors Corporation leads the field, and Procter & Gamble Company is second. These two firms are so far out in front that together they spend more than the four next-largest spenders taken together. Since General Motors advertises chiefly in newspapers and magazines, while Procter & Gamble concentrates its efforts on television, Procter & Gamble is the top spender for TV; as a matter of fact, with over

TABLE VI-26

ADVERTISING: THE TEN LARGEST SPENDERS, BY SELECTED MEDIA, 1960
(millions of dollars)

Company	Total	News-papers	General maga-zines	Farm and business publica-tions	Network tele-vision	Spot tele-vision	Outdoor
General Motors Corp.	122	40	38	4	23	6	11
Procter & Gamble Co.	109	4	4	negligible	46	55	...
General Foods, Inc.	65	16	9	negligible	19	19	2
American Home Products	55	4	7	2	33	9	negligible
Ford Motor Co.	54	19	11	2	11	5	6
Lever Bros.	54	5	3	negligible	29	17	...
Chrysler Corp.	43	18	13	1	8	2	1
Colgate-Palmolive Co.	41	5	3	negligible	22	11	...
R. J. Reynolds Tobacco	34	9	5	negligible	16	4	...
General Mills	30	7	5	1	15	2	negligible

SOURCE: *Advertising Age*, Vol. 32 (June 5, 1961).

$100 million for network and spot television, this firm spends more than twice as much as Lever Bros., the second-highest spender for TV. The three largest soap manufacturers, the three largest automobile manufacturers, three food products suppliers (one of which also supplies package drugs and household goods), and one cigarette manufacturer were the top ten national advertisers, according to these admittedly incomplete data.

The preference for different media varies enormously between industies. The liquor industry uses chiefly newspaper advertising (since it cannot use network radio or TV). Some beer breweries use chiefly outdoor advertising (and probably local broadcasting). Industrial chemicals advertise largely in business publications; cosmetics and drugs in network television; and some firms, such as the General Telephone and Electronics Corporation, place the bulk of their advertising in general magazines.

PUBLIC RELATIONS

While some advertisements may serve public-relations functions, and some public-relations counsels may advise on the best ways to advertise, advertising and public relations are different activities.

After studying several definitions of "public relations" appearing at various places or proposed by various members of the profession, I am borrowing what appear to be the most characteristic parts of different descriptions to concoct the following definition. "Public relations" work is the total of activities of, or on behalf of, an organization—corporation or any kind of institution, public or private—designed to create and maintain a good reputation among the public or particular groups such as customers, suppliers, employees, stockholders, creditors, investors, government officials, legislators, voters, etc. The techniques include all sorts of communication, including advertising, but the most important is publicity through the disseminating or planting of news and feature stories in papers, journals, and broadcasts, chiefly through distribution of news releases, press conferences, public meetings, speeches, articles, special events, and other newsworthy affairs.

While "advertising and public relations are always complementary, usually interdependent and frequently indistinguishable," we are warned not to "magnify the overlaps and similarities of advertising and public relations. They are quite different in many important respects." Indeed: "Some advertising agencies have nothing to do with public relations. Some public-relations firms wouldn't be 'caught dead' in advertising."[37]

Perhaps the best way of distinguishing the two functions is to stress their most characteristic tasks. The advertising department or agent designs advertising copy or art and contracts for its publication by print or broadcast; the public-relations department or counsel prepares news

[37] William H. Rodd, "How to Establish Liaison Between Public Relations and Advertising," *Public Relations Journal*, Vol. XVIII (October 1961), pp. 21-22.

releases and feature articles and aids in getting them published. The relative significance of public relations cannot be gauged by estimating total expenditures for this work. We have no such estimates, and the figure would probably be small in comparison with advertising proper. The most telling test of the significance would be to determine the portion of the contents of our newspapers that has originated from public-relations offices. This portion is probably quite remarkable.

THE TYPES OF KNOWLEDGE PRODUCED BY ADVERTISING

When one asks what type of knowledge is furnished to the public as a result of the expenditures of the advertisers, a distinction must be made between (1) the entertainment for which they pay when they sponsor radio or TV programs, and the general information for which they help pay when they buy space in newspapers and periodicals, and (2) the information they provide about their own products and services. When only three minutes of a 30-minute show on TV are devoted to a commercial on the sponsor's product, 90 per cent of the knowledge furnished by his advertising effort may be of intellectual or pastime character. But we must avoid double counting. The types of knowledge produced by television, radio, periodicals, and newspaper have been discussed, and there is no point in going over this ground again. Hence, only the second kind of knowledge, about the advertised goods and services, warrants additional comment.

The bulk of the advertised information can be classified into five classes, of which the first two are chiefly local, the other three chiefly national advertising. (1) The public is told about a special opportunity for buying particular products at favorable prices during the next few days at a particular place. (2) The public is reminded of a general opportunity for finding certain kinds of product at a particular place. (This is chiefly for articles which a person buys only once in a long while, so that he would have to get this information when the need arises—which is of course always the case for some small portion of the public.) (3) The public is told that a new product, or a new style or quality of a product, has become available, or that a certain price change is to take effect. (4) The public is assured that the quality of a certain product is superior to that of any other in the market. (5) The public is reminded of the fact that a particular well-known corporation continues to appreciate good public relations, customer loyalty, and good will.

How "practical" is the knowledge produced in these instances?

Practical, that is, to the receivers of the knowledge, in the sense that it aids them in making decisions; and practical also in the sense that these decisions would be less sensible or less prudent if they had to be made without the knowledge conveyed by the advertisement. In the cases of classes (1) and (3) both these tests seem to be met. This might also be said for class (2) were it not for a question of comparative efficiency: in the absence of daily or weekly advertisements the buyer would have to consult some other source of information (perhaps the annual advertisements in the form of the yellow pages of the telephone directory) giving a complete listing of all suppliers and hence affording him a wider choice. On the other hand, being too lazy to make a "search," and perhaps unwilling to choose from a long list, the buyer may actually prefer to make a quick decision in favor of the more frequently advertising firm. In the case of class (4) advertising, the first test only is met, in that the buyer is "aided" in his decision; but as the claims of the ad are probably false or misleading—since not all advertised products can be the best—this aid is of doubtful value (though one may hold that the buyer's happiness is increased as long as he believes the false claims). The knowledge conveyed by advertisements of class (5) is not "practical" by either test. To state this is not to imply that such advertising should be discouraged. It depends on one's social and political philosophy what positions one wishes to take on such matters of waste avoidable at the expense of freedom from interference.

No matter what one thinks about waste and efficiency, interference and freedom, it might be interesting to examine a large sample of advertising via the various media and see how it is distributed among the classes we have distinguished. Although this would not be a particularly difficult undertaking, we shall not attempt it. We have a more urgent task to attend to before we can leave the subject of advertising.

SELLING COST, SUBSIDIZED PRODUCT, BY-PRODUCT

The expenditures for advertising, as we have seen, include payments to newspapers, periodicals, radio, and television, that are reported among the receipts of these media. In summarizing the total cost of all these activities, we must not add them all together, or we would count some items twice. On the other hand, in reporting on the cost of any of these activities separately, we cannot reasonably omit expenditures made in connection with the others. We are facing here problems of cost allocation to joint products.

Think again of a TV program and the knowledge it conveys, for example, a drama introduced and concluded with a commercial of the sponsor, say, a soap manufacturer. What is the cost of all this knowledge received by the TV audience, and who pays for it? There is the cost of the receiving equipment and its repair, borne by the owner of the set. There is the cost of the transmitting equipment, its maintenance and operation, the studio staff and auxiliary personnel, borne initially by the TV station, but recovered by its sale of broadcasting time, say, to an advertising agency. There is the cost of producing the TV drama with the actors and the director, perhaps borne initially by a motion-picture studio, but recovered in the form of film rentals paid by the advertising agency. Or, if it is a "live performance," there is again the cost of producing the drama with its actors and the director, borne either by the network or by an advertising agency, but recovered ultimately from the advertiser. Now should all these costs, or any particular parts of them, be regarded as (1) cost of the TV program, (2) cost of the advertisement, or (3) cost of selling the sponsor's product and hence a part of the cost of that product?

We have already decided *not* to regard advertising as a cost of the advertised product—despite the contrary decision of the National Income statistician—but rather as another product. This decision must be justified in the light of the two possibilities that advertising is or is not "necessary" for the product to be sold. Assume first that it is necessary, in the sense that without advertising the same quantity of soap could not be sold except at a lower price. To simplify the argument, we may suppose that the manufacturer's receipts for his soap at that lower price would fall short of the receipts at the (actual) higher price by just a little more than the amount he spends on advertising. The consumers, getting the soap at the lower price, would have the money left to buy themselves some nice entertainment, equivalent to the TV show for which the soap manufacturer pays as advertisement for the soap. In either case, the consumer gets both the show and the soap. If both these products are counted as national product, the total product, in terms of money, would be lower if the consumer pays for the show himself and pays a lower price for the soap than in the case in which he pays a higher price for soap and lets the manufacturer pay for the show. Perhaps it is somewhat disturbing that the national product in money terms would be different depending on the payments arrangement; in real terms, however, it would be more disturbing if we decided that the show is a product only if it is paid by the consumer (or by the government) but not if it is paid by the manufacturer.

Assume now, to take account of the other possibility, that the advertising would not be necessary for the soap to be sold at the present price at the present time. The manufacturer merely likes to keep the good will of the customers for the future and thus buys for the public some entertainment he thinks they enjoy and for which they might be grateful to him. He might take larger profits and buy entertainment all for himself, but he is the kind of fellow who likes to share his fun with others, and thus lets the public watch his show on television. In either case, the show is a product to be counted, apart from the soap which he makes and sells.

This should be enough to justify our decision to count advertising as product in the GNP, and not let it disappear as part of the soap or of any other advertised product. There is still the question whether we enter the advertising cost on the account for the particular *medium* of advertising or rather on the *advertising* account itself. The answer is of no great importance, as long as we avoid counting the same outlay twice. Perhaps it would be neater to fish out of the pool of total advertising expenditures all items that are clearly allocable to a particular form of advertising—for example, to ascertain all expenditures which the advertising agencies make to produce TV shows, and show these expenditures as cost of television. This would, however, be too troublesome. It is much simpler to take out from the total advertising expenditures only the amounts paid over to the TV stations, and show the balance as "advertising cost." But one will have to bear in mind that some of this advertising cost pays for activities contributing to TV shows. Likewise, some of the unallocated advertising cost pays for activities contributing to radio programs. This holds to a much smaller extent for newspapers and periodicals, except if one wishes to count the work of designing an ad and preparing copy for the printer as a contribution to the contents of the newspaper or periodical in which the ad appears.

NET EXPENDITURES

Carrying out the resolutions of the preceding paragraph, we present the final account in Table VI-27. It shows that, after deducting what was paid over to the four previously discussed media, the net expenditures for advertising were $4,154 million in 1954, and $5,215 million in 1958. The only noteworthy defect in these figures refers to a medium not yet discussed: the postal service. The cost of direct-mail advertising, included in these figures, contains an unknown amount for postage for third-class mail, which will be comprised in the account for postal service. The entire postage for third-class mail—advertising and everything else—was $252 million in 1954 and $288 million in 1958. In order to avoid even this much double counting, let us reduce the total expenditures for advertising net of those elsewhere reported to $4,000 million in 1954 and $5,000 million in 1958.

TABLE VI-27

Advertising: Expenditures Net of Payments Accounted for in the Cost of Advertising Media, 1954 and 1958
(millions of dollars)

	1954	1958
Total advertising expenditures, all media	8,164	10,302
Receipts from advertising		
Periodicals	882	1,031
Newspapers	2,085	2,503
Radio	450	523
Television	593	1,030
Total accounted for	4,010	5,087
Other advertising expenditures, all media	4,154	5,215
Deduct for postage	154	215
Net expenditures	4,000	5,000

Sources: Tables vi-24 and vi-25.

Telephone, Telegraph, and Postal Service

We now come to the communications industries in the narrowest sense of the word: the industries carrying messages from sender to addressee over some distance. The receiver in this instance is called an addressee because typically, and in contrast to all other media of communication, he is specified by the sender to receive the message. The three industries serving in this field render services that are to some extent substitutable for one another. A technical difference lies in the fact that the postal service is strictly "transportation" of messages, whereas some "transformation" is involved in the other media—for example, from sound to electrical impulses and back to sound in the case of the telephone.

Postal service is a government monopoly in all countries; telephone and telegraph services are government monopolies in many countries, but not in the United States. Measured in dollar expenditures, telephone service is by far the biggest of the three telecommunication industries.

TELEPHONE

The telephone industry had its commercial beginnings in the middle 1870's, and grew most rapidly until about 1910. During these decades the number of telephones increased about six-fold in every ten years. (See Table VI-28.) After the last six-fold increase during the first decade of this century, the number almost doubled between 1910 and 1920, and increased by another 50 per cent during the 1920's. This growth was halted by the great depression; indeed the number of telephones fell from 20 million in 1930 to 16.7 million in 1933. By

TABLE VI-28

TELEPHONE: NUMBERS OF TELEPHONES AND CALLS, OPERATING REVENUES, AND RELATED DATA, 1880-1958

Year (Dec. 31)	*Total telephones* Number (thousands) (1)	Per 1000 population (2)	*Percentage of households with telephone service* (3)	*Dial telephones as percentage of all telephones* (4)	*Average daily calls* Local (thousands) (5)	Toll (thousands) (6)	*Operating revenues* (million dollars) (7)	*Operating revenues* (as percentage of GNP) (8)
1880	54	1.1	......	......	......	......	3	.03
1890	234	3.7	......	......	......	......	16	.12
1900	1,356	17.6	......	......	7,689	193	46[a]	......
1910	7,635	82.0	......	......	35,299	862	164[a]	......
1920	13,329	123.9	35.0	3.6	50,207	1,607	529	.60
1930	20,202	163.4	40.9	27.7	80,225	3,295	1,186	1.30
1940	21,928	165.1	37.0	53.6	95,150	3,150	1,286	1.28
1950	43,004	280.9	63.0	70.7	164,400	6,200	3,611	1.27
1958	66,645	379.5	78.0	91.9	242,076	10,482	7,642	1.73

SOURCES: Columns (1), (2), (5), (6), and (7): *Historical Statistics of the United States* and *Statistical Abstract of the United States, 1960*. Columns (3) and (4): American Telephone and Telegraph Company.

[a] These figures do not include the operating revenues of the independent telephone companies that are not available for these years. In 1917 operating revenues of the independents were 1/6 those of the Bell System. The proportion was probably larger in the years 1900 and 1910.

1940 it had recovered absolutely to just a little above the 1930 figure, though the percentage of households with telephone service was down from 41 to 37. Growth was resumed in the 1940's with another doubling of the number of telephones, and another 55 per cent increase from 1950 to 1958. From 1940 to 1958 the number more than tripled, and the households with telephones increased from 37 to 78 per cent.

Since in some previous sections comparisons were made between the United States performance and that of some other countries, and the relatively poor showing of our performance—for example, in book publications or the theatre—was commented upon, it may be interesting to note that, so far as the number of telephones is concerned, the United States is ahead not only of every single country in the world but also of all of them taken together. Starting with a big lead over the rest of the world, the United States held a diminishing lead until 1935, when the rest of the world caught up so that all other countries together had as many telephones as the United States. Beginning in 1940, the United States moved ahead faster and by 1950 had one third more telephones than all the rest. In 1958 the numbers were 67 million in the United States (including Alaska and Hawaii) and 58 million in the rest of the world.

The depressed 1930's, when the number of telephones in the United States first declined and then recovered just enough to finish the decade slightly above its start, proceeded however with another form of development, the change-over to dial telephones. The dial telephone had come in after the First World War. In 1920 only 3.6 per cent of all telephones were equipped with dials; in 1930 there were 27.7 per cent; in 1940, 53.6 per cent. This trend has continued, so that in 1958 almost 92 per cent of all phones had dials.

Two other developments have had a slower start but a very fast growth in recent years: the number of extension telephones (for given lines) and the change in "class of service" (one party versus more parties per line). The number of extension telephones increased more than six-fold from 1940 to 1959, and more than three-fold from 1949 to 1959. The percentage of one-party lines among all residence-telephone subscribers increased from about 22 in 1948 to about 53 in 1959, while the relative share of two-party lines, four-party lines, and rural telephone lines decreased accordingly.

Average daily telephone calls—average per day, not per telephone—increased steadily, except during the depression years 1930 to 1933 and the war years 1917 to 1919 and 1942 to 1944. The percentage increase, however, was usually not as great as that of the number of telephones. This fact would seem to contradict a popular hypothesis: that the number of calls per telephone increases with the number of persons that can be reached by telephone. Of course, the hypothesis may still hold within a given community or for large numbers of individual subscribers, while it does not apply to the total number of telephones in the country as a whole. After all, the "opportunity" to reach many more people in a faraway part of the country with whom he has nothing to do will hardly cause anybody to make more phone calls. In addition, the statistics of the "number of telephones" may be somewhat inflated by the inclusion of extension telephones. (To have an extra telephone in the kitchen or in the bedroom is convenient, but it does not signify an increase in the number of persons that can be reached.) Incidentally, if we looked at year-to-year changes in the number of telephones and the average number of daily calls, we should see that for a few years after the Second World War the number of calls did actually increase faster than the number of telephones. This increase in the number of calls per telephone, consistent with the general hypothesis, was in fact due to a large volume of unfilled orders for telephones which caused a doubling up in the use of existing phones—the neighbors' and public telephones.

Operating revenue of the telephone companies increased sometimes more slowly, sometimes faster than the number of telephones. This is partly a function of the rates for telephone service. Thus, in a period of inflation it is clear that revenues must rise faster than the physical volume of business, though perhaps with some time lag due to the role of public regulation. But even in per cent of GNP, operating revenues have increased. The twenty-fold increase from 0.03 per cent in 1880 to 0.6 per cent in 1920 is impressive, but the increase from 1.27 per cent in 1950 to 1.73 per cent in 1958 is perhaps more surprising. Revenues as per cent of GNP had stopped increasing in 1930, and had even slightly decreased from 1.30 per cent in 1930 to 1.27 per cent in 1950. Then suddenly came the new upsurge to 1.73 per cent in 1958. The explanation lies partly in the delaying effects of rate regulation: the rates had been generally frozen during the war and only moderately increased in the late 1940's, but the 1950's brought authorizations for larger rate increases. Evidently the income elasticity of demand was considerable and the price elasticity of demand quite small.

The telephone system is often regarded as a "natural monopoly," and this is certainly correct as far as local telephone service is concerned. Nevertheless, many communities in the United States were, not very long ago, served by two competing telephone companies, although the arrangement was surely less than satisfactory. Many persons still remember, not with any nostalgia, that they had two telephones in their home or office in order to be able to talk with the subscribers of both services. These local duopoly systems have now disappeared in the United States, but for the country as a whole the Bell System has no complete monopoly—and probably does not aspire to have it since some of the connotations of the word "monopoly" are not favorable in the public mind. There are a good many communities or regions that are served by telephone companies independent of the Bell System, the system headed by the American Telephone and Telegraph Company. Almost all of their telephones connect with those of the Bell System, but even this is not universal.

The share of the Bell System in the total telephone industry of the country has changed in the course of time. Table VI-29 presents the relevant data. In 1895 over 91 per cent of all telephones belonged to the Bell System, but soon afterwards many independent companies appeared on the scene. By 1907 the share of the Bell System in the total number of telephones had fallen below 50 per cent. From 1909 on, the Bell System increased its share, but more by a faster rate of growth than by take-over of independent companies. As a matter of fact, until 1920 the number of telephones served by independent companies grew absolutely while the Bell share increased to 63 per cent of

TABLE VI-29

TELEPHONE: SHARE OF BELL SYSTEM AND INDEPENDENT COMPANIES IN TOTAL NUMBER OF TELEPHONES AND OPERATING REVENUES, 1895-1958

	Number of telephones				*Operating revenues*			
Year	Total (thousands) (1)	Independent Companies (thousands) (2)	Bell System (thousands) (3)	Bell System (percentage of total) (4)	Total (million of dollars) (5)	Independent Companies (millions of dollars) (6)	Bell System (millions of dollars) (7)	Bell System (percentage of total) (8)
1895	340	30	310	91.2	n.a.	n.a.	24	n.a.
1900	1,356	520	836	61.7	n.a.	n.a.	46	n.a.
1905	4,127	1,842	2,285	55.4	n.a.	n.a.	97	n.a.
1907	6,119	3,106	3,013	49.2	n.a.	n.a.	128	n.a.
1908	6,484	3,308	3,176	49.0	n.a.	n.a.	137	n.a.
1910	7,635	3,702	3,933	51.5	n.a.	n.a.	164	n.a.
1916	11,241	4,696	6,545	58.2	312	49	263	84.3
1920	13,329	4,995	8,334	62.5	529	81	448	84.7
1930	20,202	4,520	15,682	77.6	1,186	91	1,095	92.3
1940	21,928	3,862	18,066	82.4	1,286	81	1,205	93.7
1950	43,004	6,526	36,478	84.8	3,611	270	3,341	92.5
1958	66,645	9,886	56,759	84.6	7,642	704	6,938	90.8

SOURCES: *Historical Statistics of the United States*, and *Statistical Abstract of the United States, 1960*.

the total. From 1920 to 1934 the independent companies lost ground both absolutely and relatively, and by 1940 the Bell System had 82.4 per cent of the total. It looks as if the Bell System since then has tried hard not to grow at the expense of the independents, for its share in the 1950's has been consistently around 85 per cent.

Bell's share in total operating revenues has been consistently above its share in the number of telephones. As far back as 1916, it was over 84 per cent and ever since the 1930's it has been over 90 per cent. An obvious explanation is the operation of the "long lines" over almost the entire country. Most of the toll charges for long-distance service are received by the Bell System.

THE TYPES OF KNOWLEDGE CONVEYED BY TELEPHONE

Data on the type of subscribers—business or residence—and to some extent also data on the kind of call—local or long-distance—can shed some light on the use that is made of telephone communication. All these data are available for the Bell System.

The number of residence telephones has increased relatively faster than the number of business telephones: the former was 59 per cent of the total in 1920, 62 per cent in 1940, and 71 per cent in 1958. If extension telephones and private branch exchanges are not counted, but only main telephones, the share of residence telephones is even greater: it was 75 per cent in 1920, 78 per cent in 1940, and 85 per cent in 1958. Assuming that business telephones are used chiefly for business talk, and residence telephones for personal talk, and that the amount of talk per telephone is about the same, we find that personal talk predominates. The assumptions may be contrary to fact: more business may be discussed over residence telephones than personal matter over business telephones (though the opposite may be just as likely); in addition there is probably more use of business telephones —that is, a greater number of calls—than of residence telephones. The Telephone Company is convinced of this and there is no doubt that long-distance usage per business telephone is much greater than per residence telephone. Even so, it still looks as if personal telephone talk exceeds business talk.

Not all personal telephone conversation falls into the class of small talk or gossip. The housewife calling the doctor, the grocery store, or the TV repair shop engages in the exchange of practical knowledge, no less than the business man calling an engineering firm, a supplier of fuel, or a customer. But even if all talk over business telephones and half of all talk over residence telephones is taken to be for the communication of practical information, it will probably not be too wrong to assign one third of the total use of the telephone to the communication of pastime knowledge. This does not "depreciate" the role of the telephone in our lives; indeed, it is part of the high standard of living of the American people—male as well as female.

Long-distance calls have increased over the years at about the same rate as local calls, if one compares the number of calls. There has been, in more recent years, an increase in the use of the "long lines" in the sense that the "average length of haul" per toll message has increased. According to information supplied by the Bell System, the average mileage of toll calls has been steadily increasing all during the 1950's, from 189 miles per call in 1950 to 242 miles in 1959. It is interesting to note that the average distance is consistently greater for toll calls from residence telephones than from business telephones. On the other hand, the total number of toll calls—defined as those over 24 miles—is consistently larger for business than for residence telephones. Since there are fewer business telephones, the average monthly toll charge per account is very much greater for business than for residence subscribers. Total operating revenues from long-distance calls have been rising at a slightly faster rate than operating revenues from local service. Thus, the share of revenues from toll calls in total operating revenues increased from 29 per cent in 1935 to 38 per cent in 1958. This is shown in Table VI-30. The peculiar bulge of long-distance business in

TABLE VI-30

TELEPHONE: OPERATING REVENUES FROM LOCAL AND LONG-DISTANCE SERVICE, 1935-1958

	Local service			*Long-distance service*			*Percent of total*		
Year	Total (millions of dollars)	Bell System	Independent companies	Total (millions of dollars)	Bell System	Independent companies	Total	Local charges	Toll charges
1935	687	641	46	286	273	13	100	70.6	29.4
1940	871	811	60	380	361	19	100	69.6	30.4
1945	1,157	1,073	84	893	845	48	100	56.4	43.6
1950	2,167	1,996	171	1,300	1,208	92	100	62.5	37.5
1955	3,497	3,168	329	2,155	2,000	155	100	61.8	38.2
1956	3,829	3,458	371	2,399	2,220	179	100	61.5	38.5
1958	4,509	4,049	460	2,760	2,543	217	100	62.0	38.0

SOURCES: *Historical Statistics of the United States* and *Statistical Abstract, 1960.*

1945 is probably explained by the servicemen in this last year of the war calling their homes and friends from camps, ports, and places en route.

TELEGRAPH

The period of rapid growth of the telegraph industry was between 1870 and 1900. Modest growth continued until 1930. Since then the industry has been declining absolutely as well as relatively. The statistics reproduced in Table VI-31 tell this story in no uncertain terms.

The ten-fold increase in the number of telegraphic messages between 1870 and 1902 constitutes a "good" growth rate, but nothing sensational. The increase from 1902 to 1930 was only 2½ times, which represents a growth rate of less than 3½ per cent annually. Then began the period of decline, interrupted briefly around the end of the Second World War, but then continuing relentlessly, so that the number of telegrams sent in 1958 was below that of 1920. Operating revenues have continued to increase absolutely; they more than doubled from 1940 to 1958 in current dollars (which means little in terms of constant dollars). But relative to GNP they declined from 0.25 per cent in 1902, and 0.20 in 1930, to 0.07 per cent in 1958.

There can be no doubt that the telegraph industry has suffered this decline as a result of the competition from the telephone. The fact that the decline of the telegraph was concentrated in the national communications field while the international business held up or even increased seems to prove the point since, because of the high cost of international telephone service, the telephone has not replaced the telegraph in this area. This may yet happen in the future. At present, however, the number of international telegrams—cablegrams and radiograms—is still near a peak it reached in 1957, and it may well go above it.

Total operating revenues were $312 million in 1956 and $318 million in 1958. These figures include $74 million and $77 million respectively, for international telegrams. If a telegram is regarded as a medium of communication and, hence, a means of producing some sort of knowledge in the mind of the addressee, a telegram to a foreign addressee produces knowledge abroad. The expenses of such messages should not be included in an account of production of knowledge for home use in the United States. On the other hand, there are probably as many telegrams received from abroad as are sent abroad, and we

TABLE VI-31

TELEGRAPH: NUMBERS OF TELEGRAMS AND OPERATING EXPENSES, 1870-1958

Year	*Messages handled (in thousands)* Domestic (1)	International (2)	Total (3)	*Operating revenues (in millions of dollars)* Domestic (4)	International (5)	Total (6)	*Operating revenues as percentage of GNP* (7)
1870	—	—	9,158	—	—	6.7	0.10
1880	—	—	31,703	—	—	16.7	0.18
1902	—	—	91,655	—	—	39.5	0.25
1907	—	—	103,794	—	—	49.7	0.18
1912	—	—	109,378	—	—	62.8	0.17
1920	155,884	4,387	160,271	124.4	40.5	164.9	0.19
1930	211,971	20,409	232,380	148.2	35.4	183.6	0.20
1940	191,645	16,619	208,264	114.6	32.1	146.7	0.15
1950	178,904	22,578	201,482	178.0	50.3	228.3	0.08
1956	151,600	27,348	178,948	238.4	73.5	311.9	0.07
1958	131,867	26,875	158,742	240.4	77.3	317.7	0.07

SOURCES: *Historical Statistics of the United States,* and *Statistical Abstract of the United States, 1960.* The figures for 1870-1912 are considerably less reliable than those for the later years. They are, with the exception of those for 1870, census figures and do not cover all small companies, nor do they include all international cables of the smaller companies covered. The GNP figures on which Column (7) is based are probably even less reliable for those same years. They are rough estimates for the years concerned and are derived from the estimates given in the *Historical Statistics of the United States.*

should add these imports to our account. Let us then assume that the balance of international telegraphing is about even, and we may accept the total revenues without fussing about additions and deductions on account of foreign messages.

No data are available that would indicate what types of knowledge are conveyed by telegraph. There are masses of "greeting" telegrams to convey congratulations and best wishes on all sorts of occasions, but what portion of the total they constitute I do not know. The bulk of all telegrams probably serve some practical purpose, such as letting the receiver know when the sender expects to arrive, or that that sender is glad to accept the position offered to him.

POSTAL SERVICE

Although its chief function is to transport written and printed messages to specified addressees, the U.S. Post Office does a good many more things: among the "third-class mail" it transports all sorts of matter, such as lightweight samples of merchandise; in its "fourth-class mail" it transports parcel post of all sorts; it insures pieces of mail, including parcels, for a fee; it accepts money on savings account or for payment to specified persons; it collects money for the sender on delivery of particular pieces of mail; it rents buses; it sells stationery in the form of postcards and stamped envelopes; it sells postage stamps to collectors; it aids other government agencies in certain clerical tasks, such as the reporting of addresses of aliens, the issuance of migratory-bird stamps, and certain civil-service functions. Most of these special and nonpostal services can still be regarded as communication and knowledge production, except of course the transportation of parcels other than those containing information (printed matter, documents, books, phonograph records, braille for the blind). Since these exceptions are not too important parts of the total, it is not a serious mistake to look first at the total expenditures of the Post Office.

We shall look at total expenditures rather than at total receipts, because the latter have rarely covered the former: the Post Office has normally operated on a deficit, financed out of the general funds of the federal government, that is, by taxation. From 1789 to 1819 there was only one year with a deficit; but from 1820 to 1880 there were 46 years with deficits against 15 years with surpluses; from 1881 to 1919, 30 years with deficits against 9 years with surpluses; and from 1920 to 1959, 37 deficits against only 3 surpluses. Hence, the revenues of the Post Office would not give a good account of the services rendered; we have to use the expenditures for this purpose.[38]

Periods of fast growth of postal services alternated with periods of modest or slow growth. Total expenditures increased six-fold in the decade 1790 to 1800; more than three-fold in the decade 1850 to 1860; almost three-fold in the decade 1940 to 1950; and there were several decades in which they doubled. From 1900 to 1959 they increased from $108 million to $3,640 million, or almost 34 times, while GNP increased 28 times. From 1930 to 1959, however, Post Office expenditures increased only 4½ times, while GNP increased over 5 times.

Since total expenditures of the Post Office pay for so many different services, it may be interesting to focus for a moment on first-class mail and domestic airmail. Since revenues exceed allocated expenses for first-class mail, we may in this case compare revenues. Table VI-32 shows these revenues together with the physical volume of mail handled, from 1930 to 1958. First-class mail during this period doubled in physical volume and tripled in revenue collected. Airmail increased

[38] *Historical Statistics of the United States: Colonial Times to 1957.*

almost 21 times in physical volume and over 30 times in revenue. Relative to GNP, however, total revenues from first-class and domestic airmail declined by 30 per cent.

TABLE VI-32

POSTAL SERVICE: FIRST-CLASS MAIL AND DOMESTIC AIRMAIL, 1930-1958

	First-class mail		*Domestic airmail*		*Total revenues from first-class and domestic airmail*	
Year	Pieces (millions)	Revenues (millions of dollars)	Pieces (millions)	Revenues (millions of dollars)	(millions of dollars)	per cent of GNP
1930	16,832	359	69	5	364	.40
1935	12,498	343	89	6	349	.48
1940	15,224	413	259	19	432	.43
1945	21,010	615	876	81	696	.33
1950	24,500	741	853	74	815	.29
1955	28,713	967	1,467	130	1,097	.28
1956	30,078	1,013	1,487	137	1,150	.27
1958	32,218	1,092	1,435	151	1,243	.28

SOURCES: *Historical Statistics of the United States* and *Statistical Abstract of the United States, 1960.*

TABLE VI-33

POSTAL SERVICE: APPORTIONED EXPENDITURES AND PIECES OF MAIL, 1956 AND 1958

	Pieces of Mail (in millions)		*Expenses (in million dollars)*	
	1956	1958	1956	1958
First-class mail	30,078	32,218	978	1,232
Second-class mail	6,915	7,148	318	352
Third-class mail	14,676	15,849	472	612
Fourth-class mail	1,173	1,170	608	702
Domestic airmail	1,487	1,435	128	142
International mail	534	534	81	97
Other mail	1,579	1,776	44	57
Special services			265	258
Nonpostal services and unassignable expenses			19	26
All operations	56,441	60,130	2,913	3,478

SOURCE: *Statistical Abstract of the United States, 1960.*

There is not much point in following the historical development of second-, third-, and fourth-class mail service. The present distribution of physical volume and allocation of expenses among the various services may, however, be of interest. This is shown in Table VI-33, giving the figures for 1956 and 1958. Perhaps a reminder will be helpful: Second-class mail includes newspapers, magazines, and bulletins under the special low-rate "second-class privilege" granted for purposes set forth in a law of 1879. Third-class mail was until recently all posted matter not exceeding 8 ounces in weight—now raised to 16 ounces—and not qualifying as first or second class; a large portion of it is advertising material, paid for by businesses, whose "direct-mail advertising" was reported previously in this chapter. Fourth-class mail likewise was parcels above 8 ounces in weight—now raised to 16 ounces—including books and catalogues at special rates, and materials for the blind free of charge. In the previous count of the cost of direct-mail advertising an allowance was made to avoid double counting of the postage. But we must allow here for the portion of parcel post that does not relate to the transportation of printed or recorded information. We shall therefore make some flat reductions from the total expenditures of the Post Office and accept $2,600 million for 1956 and $3,000 million for 1958 as the cost of communications through the activities of the Post Office.

TELEPHONE, TELEGRAPH, AND FIRST-CLASS MAIL COMPARED

Since the three services—telephone, telegraph, and first-class mail, including airmail—are substitutes in the communication of messages to distant addressees, a brief comparison of their relative shares in this business may be in order. This can be done on the basis of the figures shown in Table VI-34 for the years 1926 to 1958.

All these data refer to domestic communications only. In the series of physical volume, one telephone call, one telegram, and one piece of first-class mail (or airmail) are taken as units of measurement. Telegrams count hardly at all: one half of one per cent of the total of messages handled in 1926, they accounted for only one tenth of one per cent in 1956, 1957, or 1958. Letter mail, in 1958 more than twice the volume of 1926, had lost in relative terms; the share in the total had declined from 37 per cent to 27 per cent. The telephone gained accordingly from 63 per cent in 1926 to 73 per cent in 1958.

In terms of revenues collected the gain of telephone and the relative loss of mail service was even more conspicuous. The telephone share in total revenues increased from 66 per cent in 1926 to 84 per cent

TABLE VI-34

Communications: Domestic Messages Handled and Revenues Collected, by Telephone, Telegraph, and Postal Service, 1926-1958

	Number of messages handled								Amounts of revenues collected							
	Total		*Telephone*		*Telegraph*		*First class & airmail*		*Total*		*Telephone*		*Telegraph*		*First class & airmail*	
Year	Millions	Per cent	Millions	Per cent	Millions	Per cent	Millions	Per cent	Million dollars	Per cent	Million dollars	Per cent	Million dollars	Per cent	Million dollars	Per cent
1926	41,450	100	25,981	62.7	203	0.5	15,266	36.8	1,367	100	896	65.5	150	11.0	321	23.5
1930	47,598	100	30,485	64.0	212	0.5	16,901	35.5	1,698	100	1,186	69.9	148	8.7	364	21.4
1935	40,503	100	27,740	68.5	176	0.4	12,587	31.1	1,451	100	996	68.6	106	7.3	349	24.1
1940	51,555	100	35,880	69.6	192	0.4	15,483	30.0	1,833	100	1,286	70.2	115	6.3	432	23.5
1945	62,747	100	40,625	64.7	236	0.4	21,886	34.9	2,992	100	2,114	70.7	182	6.1	696	23.2
1950	87,801	100	62,269	70.9	179	0.2	25,353	28.9	4,604	100	3,611	78.4	178	3.9	815	17.7
1955	105,086	100	74,752	71.1	154	0.2	30,180	28.7	7,253	100	5,927	81.7	229	3.2	1,097	15.1
1956	110,776	100	79,059	71.4	152	0.1	31,565	28.5	7,924	100	6,536	82.5	238	3.0	1,150	14.5
1957	120,713	100	87,525	72.5	144	0.1	33,044	27.4	8,567	100	7,102	82.9	246	2.9	1,219	14.2
1958	125,221	100	91,436	73.0	132	0.1	33,653	26.9	9,127	100	7,642	83.7	241	2.7	1,244	13.6

Sources: *Historical Statistics of the United States*, and *Statistical Abstract of the United States, 1960*. The number of telephone calls was obtained by multiplying the "average daily calls" by 365.

in 1958; and the share of letter-mail service fell from 24 per cent to 14 per cent. The telegraph still accounted in 1926 for 11 per cent of the total revenues for domestic communications, and its 1958 share in revenues is not so minute as its share in the physical volume.

A particular kind of communications has not been dealt with so far: private lines for telephone or telegraph. Private lines are leased by the Bell System and by Western Union, and a few industries own and maintain their own microwave private-line systems. Within the Bell System the toll revenues from the private-line business were 5.5 per cent of total toll revenues in 1950, and 10 per cent in 1960. The increase in Bell revenues from private lines was ten-fold from 1940 to 1960, and almost five-fold from 1950 to 1960. Officials of the Telephone Company expect the private-line business to grow fast in the future. A special aspect of private-line communications will be discussed in the next chapter in connection with electronic data processing—where "machines talk to machines" over leased wires or owned microwave systems.

One more statistical estimation must be performed before we can leave this section: we must separate the parts of total expenditure that were made by consumers and by government (and thus were included as "final product" in the national-product account) from the parts incurred by business firms as cost of producing whatever goods or services they were selling. Since the Bell Telephone companies have such elaborate statistics broken down for business telephones and residence telephones, one might think they would have separate data for operating revenues from business and residence subscribers. No such data, however, are available,[39] and other ways must be used to obtain the needed estimates.

Personal-consumption expenditures tabulated by the National Income Division contain an item for "telephone, telegraph, cable, and wireless." The excess of the total revenues of the telephone and telegraph companies over consumer expenditures for these services must obviously be payments by business and government, if appropriate account is taken of the indirect taxes collected for the government. (The consumer expenditures are inclusive of taxes, while the operating revenues are reported net of indirect taxes collected by the companies but remitted to the authorities.) Since tax exemptions in the case of

[39] Data from a special study by the Pennsylvania Telephone Company were made available but proved not to be representative of the pattern for the entire country. They showed an abnormally large share of revenue from residence telephones.

consumer telephone charges are rare, we may safely take the full 10 per cent federal excise tax and, hence, deduct 9.1 per cent of gross expenditures to obtain revenues collected from consumers. Deducting the latter from total operating revenues, we obtain revenues collected from business and government. The division of expenditures between business and government can be made by inferring that all excise taxes not paid by consumers must have been paid by business, since government offices are exempt, and by assuming that total indirect taxes collected by telephone and telegraph companies were 8 per cent of net revenues. (This was approximately the percentage collected in 1956 and 1958 by the Bell companies, according to information furnished to the author. The 8 per cent of total revenue is explained chiefly by the fact that government offices are tax exempt.[40])

These computations are carried out in Table VI-35, which starts from three official figures—the operating revenues for telephone and telegraph separately (lines 1 and 2) and the consumption expenditures for telephone and telegraph combined (line 4). All other figures are derived by the computation just described. The division of expenditures between telephone and telegraph (lines 7 and 8, 14 and 15, 17 and 18) is made on the assumption that the same ratios as are found for total operating revenues (lines 1 and 2) can be applied to the distributions by consumers, business, and government.

Summarizing the results for 1958, we find telephone bills (net of excise taxes) were $3,300 million to consumers, $2,813 million to business, and $1,529 million to government; and the telegraph charges were $137 million to consumers, $117 million to business, and $64 million to government.

No information is available to enable us to separate the cost of postal service according to the sectors paying for it. The portion paid by consumers is included in the national-income account in an item called "Other Household Operation." This amounted to $1,615 million in 1956, and $1,800 million in 1958, but the National Income Division cannot tell how much of this was for postage. Since "Stationery and Writing Supplies" absorbed personal-consumption expenditures of $819 million and $952 million, respectively, in these two years, and since stationery and postage are more or less complementary and about

[40] The tax rate on wire and equipment service is only 8 per cent. On the other hand, some state tax authorities levy separate indirect taxes on telephone charges. We are probably safe in attributing the entire 2 per cent difference (between the 10 per cent federal excise and the 8 per cent collected by the Bell companies) to government purchases of communications services.

TABLE VI-35

TELEPHONE AND TELEGRAPH: EXPENDITURES BY CONSUMERS, BUSINESS, AND GOVERNMENT, 1956 AND 1958

		1956		*1958*	
		Million dollars	Per cent	Million dollars	Per cent
	Operating revenues				
(1)	Telephone	6,536	95.5	7,642	96
(2)	Telegraph	311	4.5	318	4
(3)	Together	6,847	100	7,960	100
	Consumer expenditures				
(4)	Telephone and telegraph (incl. taxes)	3,244	110	3,781	110
(5)	Excise taxes (9.1% of gross expenditures)	295	10	344	10
(6)	Net of excise taxes	2,949	100	3,437	100
(7)	Telephone	2,816	95.5	3,300	96
(8)	Telegraph	133	4.5	137	4
	Business and Government expenditures				
(9)	Telephone and telegraph [(3) — (6)]	3,898		4,523	
	Excise taxes				
(10)	Total [8% of (3)]	548		637	
(11)	Consumer excise taxes [(5)]	295		344	
(12)	Business excise taxes [(3) — (5)]	253		293	
	Business expenditures				
(13)	Telephone and telegraph [(10) × (12)]	2,530	100	2,930	100
(14)	Telephone	2,416	95.5	2,813	96
(15)	Telegraph	114	4.5	117	4
	Government expenditures				
(16)	Telephone and telegraph [(9) — (13)]	1,368	100	1,593	100
(17)	Telephone	1,306	95.5	1,529	96
(18)	Telegraph	62	4.5	64	4

SOURCES: For operating revenues, Table VI-27.
For consumer expenditures, *Survey of Current Business.*
All other estimates by computation.

equally expensive per letter, we shall assume that personal-consumption expenditures for postage were $800 million in 1956 and $900 million in 1958. As a check of these estimates, we may note that these figures imply an expenditure of $4.76 per capita in 1956 and $5.17 in 1958, which seems not unreasonable. Deducting the consumer expenditures for postage from the totals, previously stated as $2,600 million for 1956 and $3,000 million for 1958, we obtain $1,800 million and

$2,100 million as the postage paid by government and business. Government mail was reported as $34 million in 1956 and $52 million in 1958, which leaves $1,766 million and $2,048 million for postage paid as business expense.

Conventions

The rostrum and the podium were mentioned earlier in this chapter among the ancient media of oral communication to large audiences. The theatre was discussed among the media of communication of intellectual and pastime knowledge. Any institution designed to assemble masses of people at one place for the purpose of exposing them to the oratory of selected or self-appointed disseminators of knowledge would merit inclusion in this chapter. The convention is such an institution, and since it has assumed surprising dimensions in the United States it will be briefly discussed here.[41]

THE ASSOCIATIONS AND THEIR CONVENTIONS

Conventions are the organized and formally arranged meetings of associations whose members live in widely scattered places and are, as members or delegates, brought together to receive or exchange ideas on matters connected with the purposes of the association. It has been contended, and we have no evidence to the contrary, that Americans are particularly inclined to form and join associations, that, to use the economist's favorite jargon, their "propensity to associate" is exceedingly high. This was also the judgment of a keen observer of American institutions at a very early phase of our national life, the Frenchman de Tocqueville:

"Americans of all ages, all conditions, and all dispositions constantly form associations. They have not only commercial and manufacturing companies in which all take part, but associations of a thousand other kinds, religious, moral, serious, futile, general or restricted, enormous or diminutive. The Americans make associations to give entertainments, to found seminaries, to build isms, to construct churches, to diffuse books, to send missionaries to the antipodes. . . . Whenever at the head of some new undertaking you see the govern-

[41] I am indebted to Robert W. Michie, Vice-President of the Chesapeake and Potomac Telephone Companies, for suggesting the inclusion of this topic in the survey of the production of knowledge. Mr. Michie also kindly sent me a copy of *Conventions: An American Institution,* which is the source of the quantitative information in this section.

ment in France, or a man of rank in England, in the United States you will be sure to find an association."[42]

Members of an association, by definition, have certain objectives, experiences, outlooks, or prejudices in common, which they desire to pursue, recount, express, or reinforce by assembling for talk, oratory, debate, resolutions, and also for some plain sociability and "a good time." As members of a profession they have joined their professional association—the American Astronomical Society, the American Bar Association, the American Association of School Administrators, the Society of American Bacteriologists, the American Chemical Society, the American Economic Association, the American Medical Association, the American Pharmaceutical Association, the American Physical Society, the American Association of University Professors, or any other of hundreds of such groups—and meet at the annual convention, or even more often, to listen to learned papers and discussions. As members of religious organizations—the Baptist Youth Fellowship, the B'nai B'rith, the National Council of Catholic Men; as members of youth groups—the Boy Scouts of America, the Camp Fire Girls; as members of the female set with particular *Weltanschauung*—the Daughters of the American Revolution, the National Woman's Christian Temperance Union; as former members of the armed services—the American Legion, the Veterans of Foreign Wars; as business men—the American Bankers Association, the Chamber of Commerce, the National Association of Manufacturers; as persons sharing particular views or objectives—the United Nations Associations, the American Civil Liberties Union; as members of all sorts of social clubs and fraternities—the Elks, Kiwanis, Lions, Masons, Moose, Rotary; and as members of all the other societies and associations, they meet and listen to speeches, exchange memories, and sometimes pass resolutions.

It has been estimated that, in 1957, 20,000 national, regional, and state conventions were attended by slightly more than 10,000,000 members or delegates—a considerable portion of whom are identical individuals attending two or more conventions.[43]

Presumably all of them have a serious and virtuous purpose in mind, a purpose duly written down in the bylaws of the organization. Basically this purpose may be characterized as the dissemination and ex-

[42] Alexis de Tocqueville, *Democracy in America* (New York: Alfred Knopf, 1946), Vol. II, p. 106. (Original edition, Paris, 1835.)

[43] J. S. Turner, ed., *Conventions: An American Institution* (Cincinnati, Ohio: International Association of Convention Bureaus, 1958), p. 46.

change of knowledge—practical, intellectual, pastime, or religious—in the form of statements of fact, theory, or value, or of forecasts, tips, or guesses, or in the form of statements of goals, recommended policies, or concrete measures. To be sure, not all the time at conventions is spent on these worthy purposes; indeed there are those who contend that three fourths of the time actually is diverted to other purposes such as fun, play, gossip, and the consumption of spirits, the latter producing neither spiritual nor much of any other kind of knowledge. This is a matter of relative "efficiency," which one may comment upon, but it does not change the fact that society is devoting resources to these conventions for the purpose of producing knowledge in the receptive minds of most of those who attend.

THE COST OF CONVENTIONS

What, then, are the resources allocated to this way of knowledge production? In 1957 the International Association of Convention Bureaus supervised a survey on the basis of which it was estimated that the ten million delegates who attended the 20,000 national, regional, and state conventions in that year spent almost $1,200 million on room, food, and entertainment in the cities where the meetings were held.[44] One may question whether, for example, the amounts spent on drinks should properly be counted in the cost of this form of knowledge production. If these expenditures were made in connection with the conventions and would not have been incurred otherwise, the question has to be answered affirmatively. There are the additional questions as to whether the knowledge produced at the conventions should be regarded as investment, consumption, or cost of producing other things; and if it is investment or consumption, whether national-income statistics include them as final product. The meetings of learned societies might pass as social investment, yielding returns in future years. Most of the other meetings will probably serve short-run objectives, and the expenditures would then be either personal consumption or cost of producing other things. In national-income statistics the decision will be according to who pays the bill: what the individual consumes—knowledge as well as drinks—is a final product if he pays for himself, but it is cost of producing some other things if he is on an expense account of a business firm or if someone on such an expense account picks up his check.

[44] *Ibid.*, p. 46.

To the expenditures in the convention cities travel expenses have to be added. On the basis of reasonable assumptions regarding distances traveled, the amounts spent in 1957 for traveling to and from conventions were estimated at a little more than $400 million.[45] Thus, total expenditures for this medium of communication were $1,600 million in 1957. On the assumption that conventions of learned societies represent only a very small portion of this total, we may forget the investment part and divide the whole amount equally between consumption and business expense.

[45] *Ibid.*, p. 51.

CHAPTER VII · INFORMATION MACHINES

HAD this book been written a few years earlier there would hardly have been enough material for an entire chapter on "information machines." The recent development of the electronic-computer industry, however, provides a story that must not be missed, and which easily fills a chapter, in a book on knowledge-production.

Not that this chapter will be exclusively devoted to electronic computers and their phenomenal career. There are other devices, other engineering products, that serve as knowledge-producers. Incidentally, if the word "machines" is used for all devices, this use is partly metaphorical: the word is meant to stand for apparatuses, instruments, or gadgets of any size, simplicity or complexity, as long as they are "produced" and are devised to provide information. Some people, fastidious on the matter of distinctions, find it ludicrous to call an "instrument" a "machine," or to call a "machine" an "apparatus" or an "instrument"; but the dictionaries use each of these words in the definitions of the others, and the actual usage is different in different industries. It may be inappropriate to speak of thermometers, compasses, watches, and scales under the heading of "machines," but it would be equally inappropriate to speak of typewriters, duplicating machines, and electronic computers as "instruments." Thus, we must plead for semantic tolerance, and pray that it will be granted.

Information Machines for Knowledge Industries

If the information-machine industry were treated here with all its products, and the values of the products were added to the values reported for the output of all knowledge industries, a good deal of double counting would be involved. For, unquestionably, many information machines are purchased by knowledge-producing industries and their cost may have been taken into account in the preceding chapters. To ascertain the extent to which this has been done is our first task.

INFORMATION MACHINES IN EDUCATION

Schools, colleges, and universities purchase equipment of all sorts, including information machines. There are projectors and loudspeakers in the auditorium and in some large classrooms; clocks in corridors and halls; microscopes, scales, and other measuring instruments in science laboratories; calculating machines in statistical laboratories; typewriters and duplicating machines in the offices; private-branch telephone exchanges; and probably other kinds of devices pertinent to this survey. (Many universities have electronic computers, but probably paid for them out of research funds rather than out of their "general" funds.)

The expenditures for schools and institutions of higher education contained items called "expenditures for plant expansion." The cost of equipment of the type mentioned was undoubtedly included in these figures. Yet, of each of the products, the portion purchased by schools, colleges and universities was surely so small that the error involved in neglecting it is probably less than the errors in estimating either the proper adjustment of educational expenditures or the required correction of the production figures for the products in question.

INFORMATION MACHINES IN RESEARCH AND DEVELOPMENT

The danger of double counting is somewhat greater in the case of the cost of information machines included in the expenditures for research and development. With regard to some pieces of equipment the portion of total output acquired by R & D performers may no longer be negligible. For example, a sizeable portion of the output of "optical instruments," "scientific and professional instruments," "electrical measuring instruments," etc., may be purchased by research and development laboratories; and it is an established fact that in the last few years electronic computers for scientific data processing were so important in the computer business that the market was divided into "scientific," "general purpose," and "special purpose."

If the problem of double counting seems serious, the question arises at which end an adjustment would be more appropriate: should the production figures be corrected or rather the expenditures of the users of the information machines? Since we want to judge the relative importance of the industry producing these machines, and its relative growth, we surely must not reduce the value of its output by the outlays of any of the purchasers. If in a summary statement on total costs of knowledge production, adjustments have to be made, they would have to be made by reducing the expenditures of the machine users in the fashion of "value added" accounts. But what is the size of the probable error in total expenditures for research and development? In 1958 these expenditures included 6 per cent for "expansion of R & D plant." Most of this was probably for building and construction; and whatever outlay there was for equipment certainly included much for other things than "information machines." Should we conclude that a reduction of R & D expenditures by 1 or 2 per cent would be in order? The errors and omissions in the statistics of R & D expenditures may be a multiple of this, and indeed these expenditure figures probably neglect most of the outlays for capital items. There would not be much point in a 1 or 2 per cent correction of a figure that may be off by 10 or 15 per cent.

INFORMATION MACHINES IN COMMUNICATIONS INDUSTRIES

The procedures employed in Chapter VI in reporting on the purchases of equipment for various media of communication were not quite consistent. In some instances the outlays for equipment were not discussed at all; for example, no reference was made to plant expansion in the printing industry. In other instances the outlays for equipment constituted a major part of the total expenditures; for example, in photography and phonography, cameras and phonographs were essential items. This inconsistency can be explained: the cost of the printing machines acquired by firms in the printing industry is included, by way of depreciation allowances, in the value of the printed and published product, whereas the cost of cameras and phonographs, purchased chiefly by personal consumers, has to be caught as the purchases are made. In any case, to clarify the issue we shall have to examine how the cost of information machines used by media of communications was treated in the statistics produced in the preceding chapter.

Perhaps the easiest procedure is to collect all the communications industries in one table in which the information machines used by each industry are listed with the approximate investment outlay in 1958 (or in the last year reported) and with an indication whether that outlay was included in the statistics developed in Chapter VI. Table VII-1 presents this information. It should be understood that the investments in information machines are of course not the only investment outlays of the industries in question. For example, for radio and TV broadcasting the gross investment of the broadcasting stations—$806 million in 1957—was included in the total outlays examined in Chapter VI. Of these $806 million only something in the neighborhood of $50 million was for broadcasting equipment. Likewise, the approximately $350 million spent on new printing-trade machines in 1958 was surely only a portion of the total investment of the printing and publishing industry.

The question whether investment outlays should be added to current expenditures even if the latter include an allowance for the deprecia-

TABLE VII-1

INFORMATION MACHINES USED IN COMMUNICATIONS INDUSTRIES: ESTIMATES OF INVESTMENT OUTLAYS IN 1958

(millions of dollars)

		Investment outlay 1958		
Communications industry	*Information machines*	Total	Included before	Not yet included
Books and pamphlets	Printing-trades machinery	350[a]		350
Periodicals				
Newspapers				
Other printed matter				
Photography	Photographic equipment	1,000	1,000	
Phonography	Phonographs and record players	645	645	
Plays, concerts, etc.	Musical instruments	190		190
	Art goods, stage lighting, microphones, etc.	n.a.		
Motion pictures	Motion picture apparatus & equipment	147		147
Radio and TV	Broadcasting equipment	50[b]	50	
	Receiving sets	1,982	1,982	
Other advertising				
Telephone Telegraph	Telephone and telegraph equipment	1,200[c]		1,200
Postal service	Postage meters, etc.	n.a.		
Conventions	Microphones, etc.	n.a.		
	Total	5,564	3,677	1,887

SOURCES: U.S. Bureau of the Census, *1958 Census of Manufactures*; and Chapter VI above.

[a] The f.o.b. value of shipments of printing-trade machines was $311 million; this was rounded to $350 million in order to account for transport and installation costs.

[b] The f.o.b. value of shipments of radio and TV transmitting equipment was $32 million; this was rounded to $50 million in order to account for transport and installation costs.

[c] The last census figure for telephone and telegraph equipment was $797 million for 1954; this was raised to $1,200 million to account for transport and installation costs, higher prices, and greater investment activity in 1958.

tion of past investments has been discussed before in a different context. The conclusion was reached that the addition would be illegitimate for some problems, but appropriate for others. In these circumstances we consider it worth noting that the total outlays which the communications industries made in 1958 for the installation of more information machines—counting only those for which separate figures are available in the Census of Manufactures—were $5,564 million, of which $1,887 million had not been included in our previous estimates of expenditures for communication services.

Signaling Devices

Among the means of communication are devices using light or sound to convey warnings, directions, or other kinds of information to persons familiar with the meaning of the particular signals. Knowledge-production by signals is used in industry, railroad transportation, city traffic, and even in private homes. Signaling devices are not an important item among information machines, but they deserve mention.

The Census of Manufactures used to report signaling devices under the heading "communication equipment n.e.c." (not elsewhere classified). It lists as examples "electric signaling apparatus, audible signals, burglar alarms, electric traffic signals, and railroad signaling devices."

No separate estimate of the sales value of signaling devices is available for 1958. The figure for 1954 was $100 million. On account of distribution cost, installation cost, price increases, and increased volume, an amount of $200 million might be a fair figure to put down under this heading for 1958.

Instruments for Measurement, Observation, and Control

Apart from the information machines for use in knowledge industries, the largest category of information equipment up to the present has been the group of products which the Census Bureau calls "Instruments and related products." They include instruments for indicating, measuring, and recording certain physical magnitudes, instruments for observation, and control equipment.

THE INCLUSION OF CONTROL DEVICES

One may question the legitimacy of extending the concept of "information machine" to instruments which do not only measure and indicate but also control certain quantities. Strict adherence to the definition of knowledge-production formulated in Chapter II would not permit the proposed extension, since the creation of an impression upon a human mind was required. Reading a measuring instrument creates such an impression and hence there is no doubt that such an instrument qualifies as a knowledge-producing device. If the "reader" of the instrument grasps its message and, on the basis of his intentions or instructions, acts in order to influence the measured magnitude, he is what is now called a "feedback link" who detects a deviation from a standard and corrects it. It is often possible to replace the human link by a mechanical (or electrical, etc.) device which "actuates" the same correcting operation. For example, the human heat-control operator may watch a thermometer and open a valve or manipulate a switch as soon as he notices that the room temperature has fallen below 70° Fahrenheit. The thermostat is an automatic heat-control operator, acting upon the "information" received by the thermometer. The point is that the device transmitting the information and actuating an adjustment operation deserves to be called part of an information machine. After all, if the automatic "actuator" should ever stop working, say, because of a break in the connection, the human operator could step in, receive the information conveyed by the measuring instrument and act to correct the observed deviation.

The concept of "automatic control," or automation, is so important in connection with several issues discussed later, that it is permissible to rehearse it once more on the primitive household level. Assume the heating system of your house uses hot-water radiators fed from a tank serving also kitchen and bathroom; to control room temperature—without automatic devices—you will have to check the temperature of the hot water in the tank in the basement as well as the flow of hot water into the radiators. You need one thermometer to tell you the temperature of the water, another to tell you the temperature of the air in the room. If you want to keep the house cool at night and warm in the daytime, you also need a clock, preferably an alarm clock, to tell you when to increase the flow of fuel in the furnace and the flow of water in the radiators. The three instruments, giving you the desired information, may now be linked with automatic control devices—that is, they may be instructed to give their messages to automatic actuators. The clock at the appointed time—say, 6 a.m.—may reset the thermostat to act at 70° room temperature—that is, to start the flow of hot water whenever the thermometer tells that the temperature of the air is down to 70° or less; and the thermostat of the hot-water container starts the flow of fuel (oil, gas, etc.) in the furnace whenever its thermometer tells that the temperature of the water is below, say, 130°. Let us agree that the addition of automatic control devices should not cause us to deprive instruments of the title "information equipment."

OBSERVATION, MEASUREMENT, AND RECORDING

If one is fond of taxonomic considerations he may make several fine distinctions with regard to the exact purposes of information instruments. There are instruments serving exclusively to improve observation, by aiding the human eye to see better, the ear to hear better, etc. Optical instruments are the prime example. Measuring instruments measure either only upon demand or continuously. A caliper, for example, measures the thickness of substances only when a measurement is wanted. A barometer, on the other hand, measures air pressure all the time, even when no one watches. If continuous or periodic readings are desired, a recording device may be attached, enabling the observer to "look back" and examine the record later.

Examples of these various types of knowledge-producing instruments in scientific laboratories, in engineering work, in manufacturing industry, and in households are probably known to every reader. Interesting uses of novel information devices in medicine have recently been reported by the American Medical Association:[1]

"An X-ray fluoroscopy system that utilizes the television image tube and enables teams of consulting physicians to view the diagnostic X-ray images in a normally lighted room with a device like a console-model television set.—A Japanese camera, the size of the tip of an index finger, that can photograph ulcers, gastritis and stomach cancers. —A device that permits up to 200 medical students to observe interviews with neurotic and psychotic patients on a closed-circuit television system.—A detector that can be moved over the entire body to measure distribution of gamma-emitting isotopes in bone, an aid in early diagnosis of some forms of bone cancers.—The development of an eye-camera device in a helmet that records precisely where a patient's eyes are focused.—An electronic device (called an accelerometer) that helps in the diagnosis and treatment of Parkinson's disease. Taped to one of the patient's extremities, the latter tests the amount of tremor present.—A technique using radio-activity and a detector similar to a Geiger counter to measure the coronary blood flow through a heart. When applied to the chest wall over the heart, it will allow a doctor to identify coronary artery arteriosclerosis before a heart attack."

Similar examples could be given from many different fields. The progress in the development of information devices has been fast in recent years and promises to continue. As Wassily Leontief has said, "the best index we have of how far automatization has gone is the annual U.S. production of 'measuring and controlling instruments.'"[2]

[1] "A.M.A. Head Cites '60 Increase in Medical Automation Devices," *New York Times*, January 1, 1961.

[2] Wassily Leontief, "The Economic Impact," in *Automatic Control* (New York: Simon and Schuster, for *The Scientific American*, 1955), p. 75.

THE PRODUCTION OF MEASURING AND CONTROLLING INSTRUMENTS

Table VII-2 reproduces the annual sales figures for industries producing measuring and controlling instruments as reported in the last four Censuses of Manufacture. The 1939 data are for production, while the later data are for shipments. A more serious obstacle to comparability is the absence of a figure in 1939 for sales of "electrical control apparatus," which evidently were reported under a different heading. This item (2), as well as item (1), "electrical measuring instruments," is taken from "Electrical machinery"; item (9), "scales and balances," is from "Machinery, except electrical," sub-class "office and store machines"; the other six items are from "Instruments and related products," a division containing also some groups not pertinent and therefore omitted here. (They are: (a) surgical-medical instruments, (b) surgical appliances and supplies, (c) dental equipment and supplies, and (d) photographic equipment; the first three are omitted because they are not "information devices," save for exceptional items, as those described above, the fourth item is omitted because it was included among the instruments used for media of communications.)

TABLE VII-2

MEASURING AND CONTROLLING INSTRUMENTS: MANUFACTURERS' SALES, 1939, 1947, 1954, 1958

(millions of dollars)

	1939	1947	1954	1958
(1) Electrical measuring instruments	42	153	360	643
(2) Electrical control apparatus	—	579	1,097	1,375
(3) Scientific and professional instruments	61	117	581	946
(4) Mechanical measuring instruments	40	423	804	1,061
(5) Optical instruments and lenses	5	45	118	109
(6) Ophthalmic goods	45	121	158	194
(7) Watches and clocks	74	341	330	335
(8) Watch cases	9	44	35	34
(9) Scales and balances	14	55	64	82
Total	(290)	1,878	3,547	4,779

SOURCE: U.S. Bureau of the Census, *Census of Manufactures.*

"Electrical measuring instruments" are defined, in the standard classification, as "instruments for indicating, measuring, and recording electrical quantities and characteristics." "Electrical control apparatus" contains products that may not qualify for inclusion under the heading of "information instruments," but it is not possible for us to separate the control devices that work together with a measuring device from those that have to be manipulated by a human operator. Perhaps it would have been safer to exclude this group on the supposition that devices that *chiefly* measure would be entered as "measuring" instruments, whereas devices that *chiefly* control are under "control" apparatus.

"Scientific and professional instruments" include, besides "laboratory, scientific, and engineering instruments," such things as "aircraft instruments and automatic pilots." The "mechanical measuring instruments" comprise instruments for "indicating, recording, measuring, and controlling" various things such as "temperature, pressure, rotation, flow," etc. The other industry classes in the table require no explanations.

The growth of three of the tabulated items is noteworthy: Sales of scientific and professional instruments have increased more than eight times within the 11 years from 1947 to 1958, a growth rate of 21 per cent per year. Sales of mechanical measuring instruments have increased more than 20 times, and sales of optical instruments and lenses almost 24 times, within the 15 years from 1939 to 1954. These increases represent annual growth rates of 22 per cent and 23½ per cent respectively.

Some of the instruments included in Table VII-2 are bought by consumers and these purchases are treated as personal consumption, not as business investment. Personal-consumption expenditures, as tabulated in national-income statistics, include such things as ophthalmic goods, watches, and clocks, but these expenditures are in larger categories from which they cannot be separated statistically since no breakdown is available. (Watches and clocks, for example, cannot be separated from jewelry.) We shall make the arbitrary assumption that consumers buy all the ophthalmic goods and one half of all watches and clocks (including watch cases) and pay an extra 50 per cent for retail markups. This gives us for 1958 consumer expenditures in an amount of $568 million—$194 million plus $97 million for ophthalmic goods, and $185 million plus $92 million for watches and clocks. (This disregards the imports of watches.) We must now deduct the wholesale values of the items which we assumed to have gone to consumers—i.e., $194 million plus $185 million, or $379 million—from total manufacturers' sales of measuring and controlling instruments—i.e., from $4,779 million—in order to obtain business investment in these instruments. This gives us $4,400 million as business investment; together with the consumer expenditures of $568 million, the total outlay for the year 1958 will be entered as $4,968 million.

Office Information Machines

The equipment discussed under the heading "office information machines" is used not only in business offices but also in government offices and in research organizations. Electronic computing machines are included in this group of products—but the picture of office information machines in general shall be presented before the story of electronic data processing (EDP) is told. For, as will be shown presently, in 1953 electronic computers did not even rate a separate line in the production statistic; and at as recent a date as 1956 the value of electric computers produced was less than half the value of typewriters produced in the same year. Thus, we shall first look at the full line of "office, computing, and accounting machines."

CENSUS DATA ON OFFICE MACHINES

The Bureau of the Census uses different classifications for the Census of Manufactures and for the Current Industrial Reports, and there are discrepancies between the two sets of figures in the census years. The relevant product group in the Census of Manufactures is named "office and store machines." It is divided into four groups. The first, "computing and related machines," contains mechanical and electromechanical adding and calculating machines as well as electronic computing machines, accounting machines, cash registers, recorders, etc. The next group, "office and store machines, n.e.c.," includes duplicating machines, dictating machines, check-handling machines, addressing and plate-embossing machines, etc. The third group is "typewriters." The fourth group, "scales and balances," was reported on in Table VII-2.

TABLE VII-3

OFFICE AND STORE MACHINES: MANUFACTURERS' SALES, 1947, 1954, 1958
(millions of dollars)

	1947	1954	1958
Computing and related machines	288	614	1,117
Office and store machines, n.e.c.	178	276	380
Typewriters	154	173	238
Total	620	1,063	1,735

SOURCE: U.S. Bureau of the Census, *Census of Manufactures.*

TABLE VII-4

OFFICE, COMPUTING, AND ACCOUNTING MACHINES: VALUE OF SHIPMENTS F.O.B. AND AT RETAIL LIST PRICES OR COST AT CUSTOMER'S PLACE, 1953, 1956, AND 1958

(millions of dollars)

Type of machine	*1953* f.o.b.	*1953* c.i.f.	*1956* f.o.b.	*1956* c.i.f.	*1958* f.o.b.	*1958* c.i.f.
Accounting & bookkeeping machines	79	127	116	185	104	172
Punched-card machines & cash registers	167	250[a]	187	281[a]	195	292[a]
Coin- and currency-handling machines	5	6	5	6	6	8
Adding machines	57	90	60	94	45	73
Calculating machines	44	61	56	83	48	68
Rebuilt computing & accounting machines and rebuilt cash registers	14	20	16	24[a]	38	56[a]
Electronic computing & associated information processing equipment	[c]	[c]	94	157[b]	319	532[b]
Coded (stored) media data processing machines (other than punched cards) sold separately			[d]	[d]	27	29
Other computing machines and calculating devices					8	9
Total computing & related machines	366	554	534	830	790	1,239
Typewriters, electric	28	46	58	93	55	92
Typewriters, manual	95	154	118	192	96	159
Typewriters, specialized and similar machines	4	7	7	11	14	21
Total typewriters	127	207	183	296	165	272
Duplicating machines	24	37	27	41	28	42
Autographic registers	2	2	2	3	1	2
Dictating machines	25	37	28	50	21	35
Check-handling machines	8	14	11	17	13	22
Time-recording & time-stamp machines	10	16	9	13	11	20
Addressing & plate-embossing machines	17	23	16	22	68 (with row below)	109[a] (with row below)
Other office, computing, & accounting machines n.e.c.	58	93[a]	73	116[a]		
Total other office machines	144	222	166	262	142	230
Parts and attachments for above, sold separately	58	87[a]	110	165[a]	217	326[a]

SOURCE: U.S. Bureau of the Census, *Current Industrial Reports*, Series M35R.

[a] Estimated on the basis of a 50% markup (60% markup for *other* office, computing, and accounting machines).

[b] Computed on the basis of information obtained from experts in the field (f.o.b. price approximately 60% of delivered and installed cost to the customer).

[c] Included in "other office, computing, and accounting machines, n.e.c."

[d] Probably included in the figures immediately above.

Manufacturers' sales of products in the first three groups in the last three census years are shown in Table VII-3.

The breakdown in the Current Industrial Reports is more detailed. The data for 1953, 1956, and 1958 are reproduced in Table VII-4, which gives both value of shipments f.o.b. manufacturer's plant and value at "retail list prices." Where the latter are not available or not applicable, values at customers' places of business are estimated by adding an appropriate percentage addition for transportation, installation, and other costs to the customer.

Some of the discrepancies between the census data of 1958, shown in Table VII-3, and the f.o.b. sales data from the Current Industrial Reports, shown in Table VII-4, seem substantial, but the two sets of data can be reconciled. The differences are due chiefly to the treatment of separately sold "parts," which in Table VII-4 are listed separately, but in Table VII-3 are allocated to the individual items. The accuracy of the sales figures for electronic computers in Table VII-4 has been questioned by industry experts who made their own estimates and arrived at a higher figure for 1956 and a lower figure for 1958. These estimates will be reproduced in Table VII-6.

GROWTH ITEMS

In comparing sales of office information machines over only three or five years, to speak of growth or absence of growth is hardly legitimate. "Growth" can be seen only by increases over longer periods. But, taking account of the fact that prices increased somewhat from 1953 to 1958, one is impressed more by the failure of most sales figures to increase than by the increases that did take place. However, three of the 19 or 20 items included in Table VII-4 exhibited relatively large increases: sales of "parts and attachments" nearly quadrupled in the five years; sales of rebuilt machines increased almost two and a half times in two years, and, of course, electronic computing machines began their ascent.

Electronic Computers

Man has created power machines that can do infinitely more than he could do with his muscles, and has created computing and controlling machines that can do infinitely more than he could do with his brain. This does not mean that electronic computers can outdo the human brain or replace it in all mental operations; far from it. Although computing machines have a "memory" capable of storing certain amounts of information, they are, up to now at least, substantially inferior to the human brain in storing and retrieving information. The brain with its more than ten billion cells can remember much more than even the largest machines are capable of storing.[3] Where the machine can greatly excel is in the speed of computation. The time it takes to do certain operations is no longer measured in seconds, but in milliseconds, microseconds (millionths of a second), and even nanoseconds (billionths of a second).

THE MYSTERIES OF THE COMPUTING MACHINE

It would be nice to understand how an electronic computer works. But the reader must not demand an explanation of these mysteries in this book, which, after all, has also been silent about the workings of the radio, the television, and the telephone. There is a difference, though, in that every reader knows at least what a radio, a TV, or a telephone can do and, indeed, he uses these information machines to great advantage even if he knows little or nothing about how they work. This is not so with regard to most people in their relations to the electronic computer, and it is therefore appropriate to say a few words about this amazing machine.

TYPES OF ELECTRONIC COMPUTERS

The adjective "electronic" sets the computer apart from mechanical and electromechanical adding and calculating machines, but also from some "analogue computers" that work with other media—e.g., hydraulic machines. Computers are "electronic" when they use vacuum tubes or transistors. *Digital* computers are machines in which numbers, represented by electrical pulses, are used to process information. An example of an electric *analogue* computation: "we can multiply by electric analogue with the aid of the well known relationship *current* $\times$ *resistance* $=$ *voltage*. That is, to multiply 36 by 53 we can run a current of 36 amps through a resistance of 53 ohms and read their product on a voltmeter."[4]

Until very recently the economic significance of analogue computers has been rated much below that of digital computers, and in the statistics of sales values the former do play a very subordinate role:

[3] John G. Kemeny, "Man Viewed as a Machine," in Scientific American, *Automatic Control*, p. 135. Kemeny wrote that the brain can remember 1,000 times more than the most advanced computing machine, but he wrote this in 1954. In the meantime the memory of computers has been greatly improved.

[4] William J. Baumol, *Economic Theory and Operations Analysis* (Englewood Cliffs: Prentice Hall, 1961), p. 415.

they comprised only 5 and 6 per cent of total computer sales in 1958 and 1959. In some quarters, however, the future prospects of analogue computers are judged favorably, chiefly because they can be used with less-skilled personnel after relatively little training and are especially serviceable for automatic process controls where no "memory" (information storage in the computer) is required.[5]

In the following discussion we shall speak chiefly of digital electronic computers, because these are the machines which have had the remarkable growth record in the last few years. We shall not repeat the adjectives every time; let us agree that a digital electronic computer will be referred to when we say "computer" or "computing machine."

The distinctions commonly used for classifications of computing machines are based on the *uses* for which they are designed, on their *size* (ordinarily in terms of prices or rentals), or on the *technology* employed in various essential parts of the machine. As to use, one distinguishes (1) general-purpose computers, (2) scientific computers, (3) specialized data-processing systems, and (4) process-control computers. The difference between the first two of these machines lies chiefly in the speed required of different parts: a scientific computer must make a large number of calculations with a relatively small number of data, and therefore needs great speed in its "central processor" and in its "arithmetical" unit; on the other hand, general-purpose computers, such as those used in government and business offices, must process large numbers of data with relatively fewer calculations, and consequently need great speed in their "input-output units." Specialized data-processing systems ordinarily use standard computer types as components, supplemented by special equipment designed to serve particular needs of the military or business organization. Process-control computers are designed to yield some action, rather than series of numbers or forms with numbers, and hence to transform the results of computation into some kind of control action. Standard computer types can often be used for this purpose, supplemented by specialized "actuators."

Distinctions as to size imply arbitrary lines between small, medium, and large. Using price brackets as a basis, one source has called small computers those selling for less than $100,000, medium-sized computers those selling at prices between $100,000 and $500,000, and large those above $500,000. Using monthly rentals as a basis, another source

[5] See, for example, the story about the analogue-computer control in a synthetic rubber plant, published in *Chemical and Engineering News*, Vol. 39 (May 22, 1961), pp. 54-56.

proposed to consider small those computers that rent for $1,000 to $6,000 a month, medium those with rentals between $6,000 and $12,000, and large those renting at more than $12,000 a month. (The UNIVAC 1107 costs up to $60,000 a month, the LARC $135,000.) Proposals to use "speed" as a basis of size classifications—small computers doing up to 1,000 operations per second, medium-sized up to 4,000, and large ones more than 4,000—are not accepted, because speed may refer to different units and different operations of the machine. For example, the "add time," "multiply time," "divide time," "invert matrix time," etc., all referring to operations of the arithmetical unit of a computer, are by no means proportional to one another, different machines being especially fast in one kind of arithmetical operation but not in others. For data processing, arithmetical speed means little, since the interest is in "average access time" (i.e., access to the "memory"), "characters per second," "punched cards per minute," "paper-tape characters per minute," "printed lines per minute," etc. Hence, speed can hardly be used for a general classification of computing machines.

Technological distinctions refer to different operating units of the computer. With respect to general processing and the "control unit" in particular, one distinguishes between vacuum-tube circuitry and solid-state circuitry. Since the latter was developed later than the early computer models, only the more recent computers are "transistorized." In a few years probably all computers will work with transistors rather than vacuum tubes because this permits the machines to be smaller in physical size and faster in several respects. With regard to the storage or memory unit, one distinguishes several types according to the device used, such as magnetic drums, cores, disks, or tape. With regard to the input unit, the distinction is between keyboard, punched cards, paper tape, magnetic tape. The same differences apply to output, though there are even more possibilities available through the use of "peripheral equipment," such as a high-speed printer.

PROGRAMMING IN "COMPUTER LANGUAGE"

Since computers have to perform several different operations—addition, multiplication, inversion of matrices, etc.—they must be told what to do. The set of instructions given to the machine is called the "program." This program must be given to the machine in a language it understands, a kind of mathematical code.[6] There are "instruction

[6] Some of the explanations that follow are from Alice Mary Hilton, "Digital Computing Machines," *Electro Technology*, Vol. 66 (October 1960), pp. 163-185.

codes" and "pseudo codes," the latter conveying instructions that cannot be followed directly by the machine but serve as signals to initiate the linking of a required "sub-routine"—another sequence of prearranged operations—into the main program. Different machines have different systems of receiving instructions: that is to say, "they speak different languages." This provides plenty of headaches for users of computers who have to write their programs in different ways for different machines. Programming is not an easy thing to learn.

Each computer language has its "vocabulary": a number of operating codes, or instructions, available in the specific machine. It consists of "words," that is, groups of characters occupying *one* storage location and treated and transported as one unit of information. A "word" is used in the control as an instruction, in the arithmetical unit as a quantity.

The smallest unit of information is the "bit." A bit of information means neither "a little bit" nor 12½ cents worth of information, but rather the information conveyed by a "binary digit," answering by either 0 or 1 which one of two alternatives holds. We get an idea of relative amounts of information if we try to express the contents of a printed page in "bits." It takes seven bits to identify one letter; if there are 300 words with an average of five letters on one page, it would take about 10,000 bits to transmit the complete page without shortcuts as a coded message.[7]

The difficulties of translating instructions from business or engineering language into computer language have been reduced by the development of coding aids such as FORTRAN (Formular Translator) or COBOL (Common Business Oriented Language Translator). The availability of "canned programs" relieves the user of the need of composing his own program. A glance at the description of the programming systems specified for the different computer models overwhelms the reader with so many different polysyllables that he is perhaps even excessively flustered by the variety of computer languages. But the sob-stories of many researchers trying for the *n*th time to find and correct errors in programs they have written for scientific computers confirm that the language difficulties are real. This does not apply to EDP programs in business offices where the computing machine may have its tasks set for months without change. The routine programs of business administration, once they are satisfactorily worked out, raise no further problems; the tailor-made programs of research

[7] Gilbert King, "What is Information?" in *Automatic Control*, p. 85.

workers, each for different kinds of calculations with different kinds of data, call for ingenuity and patience. Perhaps this may be the place to state that at present approximately one third of all computers in operation are used for scientific and engineering calculations, while the other two thirds are used in government and business offices.

ELECTRONIC DATA PROCESSING IN GOVERNMENT

According to an inventory, prepared for a Congressional report,[8] of EDP equipment installed by the federal government, there were 524 computers used by government offices as of June 30, 1960. This represented almost 20 per cent of the sales value of all computers produced and delivered in the United States up to the end of 1959.

The Bureau of the Census operates six large-scale EDP machines at the present time. For its 1960 census of population the Bureau expected to employ a maximum of 4,000 employees, or only 45 per cent of the maximum employed for the 1950 census, although the population is about 20 per cent larger, and published results will be available much faster than ever before.

The Federal Aviation Agency uses six UNIVAC systems for air traffic control to determine flight fixes, arrival times, and flight conflicts over a given area.

The Bureau of Old-Age and Survivors Insurance, of the Social Security Administration, installed IBM computers in 1956 for the records of earnings and contributions by all covered individuals. The largest employers in the country are now reporting about 1,500,000 earnings items quarterly on magnetic tape, eliminating the need for manual punching of these items by the Bureau.

The Department of the Treasury instituted EDP systems for its check-payment activities, with a saving of operating cost of almost $3 million annually, and for the issuance and retirement of U.S. Savings Bonds, with a saving between $750,000 and $1 million annually. The Internal Revenue Service, realizing that proper processing of the 93 million tax returns and 325 million "information returns" on taxable income requires automatic machinery, formulated a "long-range plan" for automatic processing. The plan called for the establishment in 1961 of a National Computer Center in Martinsburg, West Virginia—which was completed in time—and in 1962 of a pilot Service Center in the Atlanta region. The objectives are to provide (1) systematic

[8] *Report on the Use of Electronic Data-Processing Equipment in the Federal Government*, U.S. House of Representatives, Committee on Post Office and Civil Service, 86th Congress, 2nd Session (Washington, 1960), p. 61.

checks on failure of individuals and businesses to file returns, (2) verification of the mathematical accuracy of returns filed and computation of taxes or refunds due, (3) determination of taxpayer indebtedness for prior years, (4) consolidation of tax accounts for each taxpayer, (5) matching of data reported on information returns with data on tax returns, (6) classification of returns for audit purposes, and (7) "preparation of management, operating, and statistical reports."[9]

The Department of Defense uses computer systems in the Finance Center and the Ballistic Research Laboratories of the Army, in the Electronics Supply Office and the Manpower Information System of the Navy, and in the Engine Management System of the Air Force, to mention only operations described in the Congressional report cited.

ELECTRONIC DATA PROCESSING IN BUSINESS

Scientific research organizations were the first users of automatic computers, government offices were second, and business offices third. If one speculates why business was not the pioneer in this development, one may mention, first, that work on the computer began during the war with military operations research and, secondly, that the initial investment in the development work was so large that one could not expect private enterprise to put up the whole venture capital and bear the entire risk. We shall see later that private enterprise came in at a remarkable pace as soon as the first indications of success became apparent.

The first uses of the computer in business offices involved routine record keeping: clerical work was replaced by EDP, with the result that the work could be done with less human labor, perhaps with greater accuracy (though this is questioned), but certainly much faster. Later it became apparent that EDP can more effectively be used for other than routine operations, especially for management decisions. Decision-making based on hunches and vague guesses could be replaced by decision-making based on intricate computations of values of carefully selected variables. The improvement of inventory policies is an example of the automatization of managerial decision-making. A third use is the replacement of actual experience by simulated experience in the computation of optimal policy variables: In order to meet potential changes in uncontrollable business conditions—say, potential fluctuations in the flow of orders—with the best possible

[9] Commissioner of Internal Revenue, *Annual Report for the Fiscal Year Ended June 30, 1960* (Washington, 1960), pp. 26-27, 31-32.

policy—e.g., regarding the size of inventories of products in various stages of production—it is not enough to rest one's calculations on actual data on record. The data of the last few years may be insufficient if one wishes to prepare for all sorts of changes in business conditions in the future; the use of "random" numbers in lieu of empirical ones may yield more serviceable results. In general, computers will prove superior to nonautomatic processing the more complicated the problems, and especially the greater the interdependence between the variables—for example "if decision A affects decision B and that changes C which in turn should influence A."[10]

The greatest boon to managerial decision-making, however, is not that it becomes automatic through machine processing but that it becomes more conscious and rational in the course of programming for machine operation. Programming forces "clear definitions of what decisions should be made and of the logic or condition governing such decisions."[11]

EDP is particularly efficient when it involves a combination of tasks that previously were performed by separate departments without automatic checks and were therefore subject to many errors and oversights. For example, the acceptance of orders for prompt delivery, the keeping of records of sales and inventories, the reordering, billing, and periodic reporting, are all combined by the IBM RAMAC 305 (Random Access Method of Accounting and Control). The orders, on punched cards, are fed to the machine, which (1) checks whether the inventory (recorded on magnetic disks in the "file" or memory of the machine) is sufficient, (2) types an order to the supplier to replenish the inventory if necessary, (3) deducts the shipment from the inventory in the "file," (4) types the invoice for the customer, and (5) prints on demand (a) a record of all sales of each item, (b) a statement of the account of each customer, (c) a statement of the account of each supplier, and (d) a record of sales and commissions of each salesman. This machine is used by a firm carrying 26,000 different items (Factory Motor Parts, Inc., San Francisco). The inventory records are filed on 50 spinning disks with magnetic surfaces capable of storing five million digits. The same machine is used also by a firm carrying only four different items (Wrigley Jr. Co.). The "in-line processing," replacing the previous processing "in batches," secures inventory records that are

[10] William J. Baumol, *op.cit.*, p. 418.

[11] Mary K. Hawes, "The Impact of Computers on the Art of Management," an unpublished speech. Mrs. Hawes, Manager of Applications Research, Radio Corporation of America, has given me sound advice and valuable information for the preparation of this chapter.

completely up-to-date, or indeed up-to-the-minute; this has allowed some firms to achieve economies through reductions of inventories by as much as 50 per cent.[12]

The system installed by the Chesapeake and Ohio Railroad is cited as one of the milestones in EDP development for business use. The interesting feature of this system is that flash reports from hundreds of different stations are received and processed by a UNIVAC at the Cleveland headquarters to predict an accurate daily cash position, and thus to enable the railroad company by using its liquid funds in the money market to earn interest in an amount of over one million dollars a year. Incidentally, EDP seems to have helped railroad management in coping with a "paper mountain that . . . exceeded one billion pieces of paper a year."[13]

In some EDP systems substantial economies can be achieved only if all card punching is eliminated and the original papers can be fed to the machine. The development of check-handling machines has taken some time but it seems that the problem has now been solved. Code numbers of the customers as well as of the banks are printed on the check in magnetic ink, and the amount of the check can be imprinted in such ink before the check is fed to the machine. The rest is done by the machine, which locates the customer's account and enters the amount at an average rate of two accounts per second.

FOUR METHODS OF SERVING BUSINESS

Most models of large- and medium-scale computing machines are for sale or for rent, at the customer's choice. Several of the small computers and some medium-scale ones are for sale only. But in either case it will be only a rather large business firm that will find it economical to purchase or to rent a computing machine. Unfortunately, it is not possible to recommend a large computer to a large firm, and a small computer to a small firm. Small machines simply cannot do all kinds of operations that have to be done in even small firms, but there is not enough to do in a small firm, by way of record-keeping, shipping, billing, and reporting, to keep a machine busy all the time. In order to make EDP available to all for whom it could do a good part-time job, two other methods of serving business have been developed: selling machine-time by the hour, and selling complete machine-processing jobs.

[12] Francis Bello, "The War of the Computers," *Fortune*, October 1959, p. 164.
[13] Gordon Smith, "Computers: Man's New Freedom," *Vital Speeches of the Day*, January 1, 1961, p. 187.

Computer time can be bought by the hour in the "data centers" operated by IBM or RCA. One hour on an IBM 7070 costs about $300. A small firm may bring its records or punched cards to the data center and have its weekly work done in one or two hours. The RCA Center on Wall Street, with RCA 501 computers, specializes in stock-broker business. These transistorized machines work with magnetic tape, on which they can write and from which they can read 33,000 characters per second, and with an "on-line printer," which delivers the output of the system in variable format at a rate of 600 lines per minute.

For businesses whose work is not of a routine fashion but calls for individual programming, IBM has set up the Service Bureau Corporation, which does complete programming and operating jobs for the customer.

These are only the beginnings of a potentially very important development: preventing EDP from becoming forever an indivisible lump of fixed cost that only the largest firms can afford. The services rendered by expensive installations can be parceled out to all who want to avail themselves of only a few hours of EDP-service at a time. Of course, this type of service can be only in the nature of "batch processing" while "in-line processing" and "real time" computing—where data are processed immediately as they "arise," without any delay—will necessarily be confined to those whom it pays to have a whole machine to themselves.

MACHINE TALKING TO MACHINE

For firms operating at several different places, centralized data processing requires long-distance transmission of data. Oral telephone communication is much too slow and too inaccurate, and teletypewriter service too slow, for work in combination with EDP. The solution to this problem lies in automatic machines talking to each other over leased wires or microwave systems.

Several kinds of facilities have been developed to achieve long-distance data transmission from machine to machine. The IBM "data Transceiver," for example, transmits punched-card information on leased wires from outlying points to a central computer installation. Other transmitters work with perforated paper tape. To serve machines of these sorts, the Bell Telephone System provides the "Data-Phone" service. It made over 1,000 installations of Data-Phone sets in 1959-1960 and expects to have 5,000 sets in operation by the end of 1962.

The service is used for handling accounting and billing information, invoices, inventories, sales orders, payrolls, etc. Data-Phone sets get information in the form of electrical pulses, or "bits," from the originating machine and convert the pulses to tones suitable for telephone circuit transmission; at the receiving end, Data-Phone sets convert these tones back to electrical pulses which feed into business machines of all sorts.

Western Union also offers private wire systems for data transmission in "integrated data processing." The company provides the engineering of circuits to handle the long-distance interconnection of data-processing equipment of many types, and it offers a "Tele-Card" unit, a converter to assure the compatibility of teleprinter line signals with IBM punch cards.

PROCESS CONTROL

The combination of an information machine with an actuating device results in a machine that transforms information into control action. Computers as parts of process-control systems are becoming increasingly serviceable, and the time may come when automatic data processing takes second place in computer use behind automatic process control.

The most remarkable examples of automatic process control are the systems developed for military use. A Target Intercept Computer was designed by Remington Rand in cooperation with Bell Telephone Laboratories for the guidance of the Army's Nike-Zeus anti-missile missile. The computer, utilizing a steady flow of information from radar tracking stations, dictates a precise launching time and issues necessary steering orders so that the Nike-Zeus will intercept and destroy the enemy missile at a safe distance above the earth. Sperry produces the Gyro Navigator, which automatically plots the course of a submarine to pinpoint missile-launching sites beneath the surface of the sea. As a submarine moves through the water, the inertial system senses its movements and calculates its position. The system can be linked to an "auto-pilot" control system that will guide the vessel automatically.

Automatic computer-actuated process controls in private industry are not yet used to any large extent. If the "experts" are right, there will be plenty of such process control in manufacturing in future years.

HISTORY AND GROWTH OF THE COMPUTER INDUSTRY

Instead of looking into the future we shall take a look back into the past and review the history of the computer. We do not mean to go back to describe the abacus, Napier's bones, Pascal's number wheel, Leibniz's calculating cylinder, Babbage's model, Mannheim's slide rule, Hill's key-driven machine, Baldwin's calculator, Burroughs' keyboard calculator, and the various electromechanical calculating machines. We have decided to talk only about electronic computers.[14]

Development work on the computer began in 1940 or soon thereafter. The first scientific computer, the ENIAC (Electronic Numerical Integrator and Automatic Computer) designed for the U.S. Army, was completed at the University of Pennsylvania in 1947. The next five years saw the development of machines for automatic data processing in government and business. The first EDP system, Remington Rand's UNIVAC I (Universal Automatic Computer), was delivered to the U.S. Bureau of the Census early in 1951 for use in the census of population. The first machines with internal logical control that could change instructions as quickly as they could complete calculations were the IAS (Institute for Advanced Study, Princeton) and MANIAC (Mathematical Analyzer, Numerical Integrator and Computer), both built under the supervision of John von Neumann and completed early in 1952.

The first computers for private-business use were delivered in 1953. Remington Rand, the producer of UNIVAC, was the chief supplier, and IBM was in second place. (We disregard here National Cash Register Corporation, producer of CRC and NCR, electronic bookkeeping machines.) By 1955 IBM had taken the lead, Remington Rand was second, and Burroughs had entered the market with medium-sized and small computers. The number of firms in the industry increased quickly: by 1959 twenty American firms were competing for orders. Large computers were offered by nine firms, medium-sized by nine or ten, and small ones by eighteen firms, counting only machines produced in the United States. A chart published in *Datamation,* a bimonthly journal (November-December 1960, pp. 14-17), gives brief descriptions of 43 models offered by 16 American firms. *Electro-Technology,* a monthly magazine on electrical manufacturing (October 1960, pp. 170-185), surveys 72 models offered by 28 firms—18 American, four German, two British, two French, one Dutch, and one Japanese.

It has been estimated that the industry lost over $500 million during the first years, one firm alone taking a loss of $130 million. But not all computer manufacturers are "in the red." Having captured the lion's

[14] A good chronological survey is contained in Ned Chapin, *An Introduction to Automatic Computers* (Princeton: Van Nostrand, 1957).

share of the market—75 per cent of total sales in 1959—IBM's operations have been highly profitable. The losses of most manufacturers are readily understood if one realizes how long it takes to develop a new machine, how difficult the "debugging" is, and how quickly the machine becomes obsolete. In some instances the time from the beginning of the development work to the delivery of the first operational machine has been more than five years. Philco, for example, entered the computer field in 1952, but the first deliveries of the "Philco 2000" were made in 1958; according to the October 1960 survey, only four of these highly flexible machines were in use, though another 20 were in production. Similarly, Minneapolis-Honeywell, having entered the field in 1955 by taking over a team already at work, had only five of its "Datamatic 1000" in operation at the end of 1958, and only seven in 1959. Of the 72 models surveyed, 19 were only "on order" or "announced," not yet installed anywhere; of eleven no sales reports were available, and of 22 models fewer than ten machines each had been delivered. This leaves 20 models of which ten or more machines each had been sold. Yet one can well understand why so many firms entered the industry: the spectacular increase of sales within two years —at least fifteen-fold between 1954 and 1956—attracted new competition. IBM alone delivered in 1955 computers valued at more than eight times the value of its shipments of the preceding year.

Estimates of shipments and sales values of all computers delivered in the United States from 1954 to 1959 were made by one of the producers in the field. Since these estimates were made as part of a market analysis for the company itself, they are probably more accurate than others published in various journals and books. Table VII-5 reproduces the estimates of the number of machines delivered, and Table VII-6 the estimates of their sales values. Since some companies have been rather secretive about their sales, the estimates are rather rough. Moreover, several models are excluded, either because they are not fully automatic or because they perform primarily non-computing services. But the figures are probably good enough to show the growth of the industry.

Using the size classification indicated in Table VII-5, we find that medium-scale computers comprise approximately 60 per cent of the *number* of computers delivered, both during 1959 and over the entire period 1953-1959. In terms of *sales value*, however, large computers absorbed the biggest share: 54 per cent of the value of shipments in 1959, and 57 per cent of the cumulative value of $1,564 million. Of

TABLE VII-5

ELECTRONIC COMPUTERS: ESTIMATES OF NUMBERS DELIVERED, BY SIZE AND MODEL (WITH SOME EXCLUSIONS), 1954-1959

Producer	Model	Pre-1954	1954	1955	1956	1957	1958	1959
Sperry-Rand Corporation	UNIVAC I	4	4	8	9	11	12	
	UNIVAC 1101-5	1	2	8	18	6	9	6
International Business Machines	IBM 701	4	8	7				
	IBM 702			10	4			
	IBM 704			2	38	50	30	5
	IBM 705			3	42	50	35	35
Minneapolis-Honeywell	Datamatic 1000				1	4		
Radio Corporation of America	BIZMAC				2	3		
Sperry-Rand Corporation	UNIVAC II					1	8	23
International Business Machines	IBM 709						10	40
Burroughs Corporation	Burroughs 220						4	27
Philco Corporation	Philco 2000						1	2
International Business Machines	IBM 7090							4
Radio Corporation of America	RCA 501							7
Total, large (above $500,000)		9	14	38	114	125	109	149
Burroughs Corporation	Datatron 205		5	6	27	33	29	20
International Business Machines	IBM 650		6	174	270	320	230	300
Alwac Corporation	ALWAC			2	7	28	5	
Sperry-Rand Corporation	UNIVAC-FC-0-1				10	30	30	38
International Business Machines	RAMAC 305					20	230	300
Sperry-Rand Corporation	USS 80/90							51
Total, medium ($100,000 to $500,000)			11	182	314	431	524	709
Bendix	G-15			10	26	68	56	120
Burroughs Corporation	Burroughs E-101			12	70	82	11	30
Royal-McBee Corporation	LGP 30				6	88	119	137
International Business Machines	IBM 610						40	
North American Aviation	RECOMP II							24
Total, small (below $100,000)				22	102	238	226	311
Total, all sizes		9	25	242	530	794	859	1169

SOURCE: These data were obtained from an analysis made by one of the leading firms in the industry.
NOTE: Not included in the above figures are (1) not fully automatic machines (e.g., IBM-305, IBM-632, Underwood's ELECOM-50, Monroe's Monrobot MU), (2) machines serving primarily non-computing services (e.g., National Cash Register's CRC, Thomson-Ramo-Wooldridge's R-W-300), and (3) machines produced for only a very short time (e.g., Marchant's MINIAC, Underwood's ELECOM 120 and 125).

this total, medium-sized computers had a share of 39 per cent, and small computers only 4 per cent.

The shares of the largest producers in the market are interesting to observe: IBM has 75 per cent of the sales value of the computers delivered over the 1953-1959 period, Remington (Sperry) Rand has

TABLE VII-6

ELECTRONIC COMPUTERS: ESTIMATES OF SALES VALUE OF COMPUTERS DELIVERED, BY SIZE AND PRODUCER (WITH SOME EXCLUSIONS), 1954-1959
(millions of dollars)

Producer	Pre-1954	1954	1955	1956	1957	1958	1959
Sperry-Rand Corporation	6.3	7.8	21.6	37.8	23.7	39.9	43.5
International Business Machines	4.0	8.0	27.5	143.8	175.0	137.5	174.5
Minneapolis-Honeywell				1.5	6.0		
Radio Corporation of America				3.0	4.5		7.0
Burroughs Corporation						3.2	21.6
Philco Corporation						1.5	3.0
Total, large	10.3	15.8	49.1	186.1	209.2	182.1	249.6
Burroughs Corporation		1.5	1.8	8.1	9.9	8.7	6.0
International Business Machines		1.8	52.2	81.0	100.0	115.0	150.0
Alwac			0.4	1.4	5.6	1.0	
Sperry-Rand Corporation				4.0	12.0	12.0	35.6
Total, medium		3.3	54.4	94.5	127.5	136.7	191.6
Bendix Corporation			0.9	2.3	6.1	5.0	10.8
Burroughs Corporation			0.4	2.5	2.9	0.4	1.1
Royal-McBee Corporation				0.3	4.4	6.0	6.8
International Business Machines						2.2	
North American Aviation							2.2
Total, small			1.3	5.1	13.4	13.6	20.9
International Business Machines	4.0	9.8	79.7	224.8	275.0	254.7	324.5
Sperry-Rand Corporation	6.3	7.8	21.6	41.8	35.7	51.9	79.1
Burroughs Corporation		1.5	2.2	10.6	12.8	12.3	28.7
All others			1.3	8.5	26.6	13.5	29.8
Total, all sizes	10.3	19.1	104.8	285.7	350.1	332.4	462.1

SOURCE: These data were obtained from an analysis made by one of the leading firms in the industry.

NOTE: Not included in the above figures are (1) not fully automatic machines (e.g., IBM-305, IBM-632, Underwood's ELECOM-50, Monroe's Monrobot MU), (2) machines serving primarily non-computing services (e.g., National Cash Register's CRC, Thomson-Ramo-Wooldridge's R-W-300), and (3) machines produced for only a very short time (e.g., Marchant's MINIAC, Underwood's ELECOM 120 and 125).

15.6 per cent, Burroughs 4.3 per cent, and all others together have 5.1 per cent. Taking individual years, we find that IBM had half the market in 1954, 75 per cent in 1955, almost 80 per cent in 1956 and 1957, and 70 per cent in 1959. Remington Rand went down from over 60 per cent in 1953 to 41 per cent in 1954, 21 per cent in 1955, 15 per cent in 1956, and 10 per cent in 1957, but recovered some of the ground lost by raising its share to 16 per cent in 1958 and 17 per cent in 1959. Burroughs increased its share from 2 per cent in 1955 to over 6 per cent in 1959. But the fastest increase is in the share of "all others": from 1.2 per cent in 1955 to 6.4 per cent in 1959. It will be exciting to watch whether this "trend" continues and for how long.

As to the buyers of the computing machines produced in the United States, the share of the government up to 1960 has been approximately 20 per cent. Of the 1958 sales only between 12 and 14 per cent went to the government. Universities, which were so important in the early development of the computers, and especially in the development of large computers, do not now represent a large percentage of the total market. Perhaps some 150 electronic computers have been built or acquired by universities.

ECONOMIC EFFECTS OF COMPUTING MACHINES

In many discussions of the economic effects of EDP the emphasis is on the replacement of clerical labor. This is a one-sided view. Automatic data processing changes not only the *methods* by which information is processed but also the speed and perhaps the accuracy, and therefore permits us to want much *more* such processing. Thus, while firms would unquestionably reduce their clerical work force if they wanted merely an unchanged amount of information produced automatically, their demand for more information may partially offset the labor-replacing effect of the computing machine.

To be sure, increased amounts of information produced by computing machines may promote the adoption of production processes that save labor at other stages besides record keeping. But if improved records, improved decision-making, and improved process controls add up to production techniques that permit economies, there is no reason for these economies to be concentrated on the use of labor. The new techniques may save raw materials, warehouse space, railroad transport, freight cars, trucks, liquid funds, and the economies therefore may reduce the requirements, per unit of output, of land and capital just as of labor. As a matter of fact, the most conspicuous savings achieved as a result of EDP have not been in the payrolls for clerical labor, but rather in inventories. (Some economists have even suggested that the reductions in inventories due to EDP may change the "inventory cycle," one of the chief causes of fluctuations in industrial activity.)

To say this is not to deny that EDP will permit savings in the use of clerical labor per unit of output. Clerical labor, as will be shown in the last chapter of this book, has been on the increase all during the last 60 years; its share in the total labor force in the United States has grown from decade to decade. If automatic data processing stops this trend and allows the share of clerical labor in total employment to decline, this *relative* substitution of machines for labor will be among the beneficial economic effects of the new development. It does not involve the layoff of masses of clerks now employed in trade and industry; but it permits the nation's product to rise without proportionate increases in the clerical work force, and for this very reason to rise faster than it could otherwise.

CHAPTER VIII · INFORMATION SERVICES

This chapter is written in a somewhat defensive tone because some of the "industries" it deals with would not belong here had a stricter concept of "knowledge-production" been adopted. The subjects of the preceding chapters—education, research and development, most of the communication industries, and the information-machine industry—are, I think, recognized by most as eligible for inclusion in a study of the production and distribution of knowledge. The eligibility, however, of some of the service industries to be treated in this chapter may be questioned. Their inclusion is warranted only if our wide concept of knowledge-production is accepted.

The Wide Concept of Knowledge Industries

We decided, in Chapter II, to understand by "knowledge-production" any human or human-induced activity effectively designed to create, alter, or confirm in a human mind—one's own or anyone else's—a meaningful apperception, awareness, cognizance, or consciousness of whatever it may be. The activity of telling anybody anything, by word of mouth or in writing, is knowledge-production in this sense. A person exclusively engaged in this activity belongs to a knowledge-producing occupation. A number of firms exclusively engaged in selling information or advice belong to a knowledge-producing industry. Problems arise where this complete specialization is not achieved and information services are produced together with other goods or services.

DEGREES OF SPECIALIZATION

Almost every industry produces some information. Most firms must inform prospective customers what they have to offer, at what prices, qualities, etc.; they must inform buyers that the orders have been received and executed, that the bill amounts to so and so much, that payments are due, etc.; sometimes they must give their clients directions for the use of the product. All these pieces of information are integral parts of the business in which the firms are engaged, and no one will suggest that these "information services" be listed among the firms' products, and that the firms be listed as members of knowledge-producing industries.

In other instances, however, the information services of firms constitute a very large part of their total activities and could be separated, either practically or only conceivably, from the production of other goods or services offered by these firms. In these instances, if the separate cost or value of the information services can be established, or at least estimated, one may justify the conceptual and statistical separation of the portion of the firm's business that can be regarded as falling into a knowledge industry. Where a firm produces different things in separate establishments, it can be listed as a producer in different industries with separate data for each; the same could also be done if, although the establishments are not separate, the cost accounts and/or sales are separable or if, although the accounts are not separable, at least separate statistical estimates can be made.

Such a conceptual and statistical separation has been successfully performed in the case of industrial research and development. R & D activities are treated by many as an industry although only very few firms have separate R & D establishments. The knowledge produced by the R & D teams or departments of industrial firms is usually not sold to others—except perhaps if R & D contracts awarded by the federal government are regarded as "orders" for technological information produced and "sold" by the firms. Often the information produced by industrial R & D teams are used only within the same firms. Nonetheless, the expenditures for R & D have for a good many years been brought together in carefully designed statistical surveys and are considered significant data on an important branch of knowledge-production.

The precedent may guide us in our treatment of some other cases where information is developed and transmitted by firms primarily set up to produce other things. Where information services produced by firms form a practically or conceivably separate part of their activities, and are conceptually and statistically separable, such separation can be attempted. Since "conceptual separability" is a matter of judgment, some of the decisions are likely to be subject to charges of inconsistency or arbitrariness.

TYPES OF INFORMATION

The information developed and delivered by the service industries surveyed in this chapter is of various types. Much of it is "consultation and advice." Consulting services are purchased by consumers, business, or government seeking advice on their problems in fields in which general knowledge (including "techniques") of specialists can be brought to bear on the particular circumstances of concrete situations. Where the consulting service is offered orally or in writing without any complementary performances by the consultant, its characterization as knowledge-production will not be contested. But where advice is given together with other services—physical, financial, risk-taking, or any other—it will be hard to decide how much of the joint services, if anything at all, merits being regarded as knowledge-production.

Some of the information services examined in this chapter consist in "record keeping, data processing, and data transmission"; they are usually combined with other services and the separability is somewhat problematic. In addition, one may deny that processing and transmission of the data in question constitute an essential information service meriting the designation of knowledge-production. Other kinds of information service dealt with here refer to the activities of specialized sales talk and specialized advice in bringing together potential sellers and buyers, provided these information services are divorced from physically handling the objects of trade and from other services ordinarily performed in conjunction with trading or merchandising activity.

The last of the information services examined in this industry survey will be general government. The decision to represent "government" as knowledge-production will probably be objected to on several grounds. We shall argue, however, that the formulation of rules and orders and their communication to those subject to them amount to the production of knowledge in the minds of those to whom they are directed. If this argument is not convincing, no irreparable damage is done: any item not accepted as properly belonging in the account of knowledge-production can be stricken out by those who deny the legitimacy of its inclusion.

Professional Knowledge Services

"Services" are regarded, by the U.S. Census, as an "industry division," and particular services—such as "legal services," "engineering services," etc.,—are regarded as industries. Particular professional groups are, however, "industries" only in so far as they sell their services rather than render them as salaried employees of firms producing other goods or services. For example, lawyers in the full-time employ of a manufacturing firm are members of the legal *occupation* but not of the legal-services *industry*. They are in this industry only if they are in private practice—e.g., as members of law firms—receiving fees and expenses, but not salaries, from the industrial firm that retains them. Likewise, professional engineers who are salaried employees of a firm producing engineering goods are not in the engineering-services industry; they are in this industry only if they are independent consulting engineers or members of a firm of consulting engineers. We shall examine here those service industries that render "professional" services, producing and selling knowledge in the form of information or advice.

PROFESSIONAL SERVICES: KNOWLEDGE FOR SALE

Four of the professional-services industries specialize in producing and selling information and advice: (1) Legal services, (2) engineering services, (3) accounting and auditing services, and (4) medical services. While we have no difficulty in recognizing lawyers as knowledge producers, we shall not be able to recognize all medical practitioners as knowledge producers. Only a part of their output is "information and advice," and the work of dentists must be disallowed altogether as production of knowledge. Perhaps more should be said to explain these decisions.

A lawyer is retained exclusively for the knowledge he conveys, in oral or written representations, to clients, adversary parties, government agencies, juries, and judges. Every phase of the lawyer's work involves specific information in relation to the knowledge of general rules, and communications to others. The physician undoubtedly must possess a great amount of knowledge in order to do his work; yet, what counts is not the amount of knowledge *required* for a particular activity but only whether or not this activity consists largely in *communicating* knowledge. A doctor who examines the patient, takes note of case history and complaints, formulates a diagnosis, writes a prescription, and advises the patient about medicines, diet, bed rest, or exercises is exclusively engaged in the production of knowledge. A doctor, on the other hand, who sets fractured bones, dresses open wounds, paints infected tonsils, opens boils, or removes appendices, does not do mental but physical labor, however skilled, and the patients buy from him surgical operations, not information. The difference, in simplest language, is that medical advice means conveying signals to the mind alone, whereas the physician's manipulations and operations are performed on the patient's body. Since general practitioners as well as most specialists do both types of work in a ratio which we cannot determine, we shall resort to the crude device of dividing the total equally between production of knowledge and other services. Payments to dentists should be regarded entirely as purchases of physical work, rather than purchases of knowledge. This is not because dentists do manual labor—so do the typists and the printers—but because their performance is designed to be impressed on the teeth rather than on the minds of the people.

With regard to both legal and medical services we shall have the statistical problem of determining what portions are rendered to consumers and what portions to business. This is perhaps less important in the rare case of physicians whose fees are paid as business expenses, first because they are likely to be a small part of the total, and secondly because it is quite reasonable to regard such services as final products even if they are recorded as costs of producing other things. In the case of legal services to business, the knowledge conveyed is never a consumer's benefit separate from the goods in the production or sale of which the services were required. Indeed, even where consumers retain lawyers and pay for legal services one may question whether this is a genuine consumption expenditure rather than a cost incurred in earning an income and, therefore, a legitimate deduction from income. But this is not the way our national-income statisticians look at these payments, and this time we shall accept their decision and treat consumers' purchases of legal services as expenditures for "final products."

The services of professional accountants and auditors are to such a large extent purchased by business firms that we shall not mind if we cannot obtain the fees paid by personal taxpayers for help in preparing their income-tax returns. In any case, it is no serious loss if the part paid among personal-consumption expenditures is missed. That accountants' and auditors' services are without exception recognized as knowledge-production will need no special justification. This knowledge, however, constitutes neither consumption nor investment, but rather an intermediate service in the production of other things.

The services of professional engineers consist of knowledge conveyed in the form of reports, calculations, drawings, blueprints, specifications, and similar communications. They are received chiefly by businesses, and the fees paid are treated either as current production cost or as part of the construction cost of new plant and equipment. In neither case will the expenditures for engineering services be treated as purchases of final product; they are included either in the cost of the output produced with the help of the engineers' advice, or in the investment in the fixed assets constructed with their help. The total sales of engineering and architectural services probably contain some relatively small amounts of fees paid by individuals building or remodeling their residences. These payments would not be included among personal-consumption expenditures, but rather among private investment in residential construction. Again, therefore, they need not be treated as purchases of separate final products.

LEGAL SERVICES

The Internal Revenue Service publishes the gross receipts of the "legal services" industry. The National Income Division of the Commerce Department publishes the income originating in this industry, and personal-consumption expenditures for legal services. These data do not always seem to jibe. For example, while it should be understood that gross receipts must exceed income originating in the industry, in 1939 income originating was reported as $692 million, but gross receipts as $597 million. And while consumer purchases of legal services are reported as about one half of gross receipts during the 1950's, they were two thirds in 1947 and even higher in 1939. Could it be that in earlier years the gross receipts reported to and by the Internal Revenue Service were on the low side? If we assume that the difference between gross receipts and consumer expenditures for legal services were business expenditures, we obtain incredibly low figures for the latter, at least for 1939 and 1947. These figures are shown in Table VIII-1.

According to the Lawyers' Census, there were 188,955 lawyers engaged in private practice in 1957. If in 1958 about 190,000 lawyers collected the reported gross receipts of $3,025 million, this would make

TABLE VIII-1

LEGAL SERVICES: GROSS RECEIPTS OF LAW FIRMS AND PERSONAL CONSUMPTION EXPENDITURES, SELECTED YEARS BETWEEN 1939 AND 1958

(millions of dollars)

Gross receipts of	1939	1947	1953	1956	1958
(1) Single proprietorships	289	654	971	1,210	1,487
(2) Active partnerships	308	604	1,051	1,205	1,538
(3) Total	597	1,258	2,022	2,415	3,025
(4) Personal-consumption expenditures	407	825	1,004	1,259	1,507
(5) Business expenses for legal services	190	433	1,018	1,156	1,518

SOURCES: Lines (1), (2), and (3): Internal Revenue Service, *Statistics of Income.* Line (4): U.S. Department of Commerce, *Survey of Current Business.* Line (5): Difference between (3) and (4).

an average gross of $15,920 per lawyer. In addition to lawyers in private practice, there were in 1957 (with some double counting) 24,245 lawyers in government service, 7,910 lawyers in the judicial branch of the government, and 21,054 salaried lawyers, chiefly in business, who are however not included in the legal-services industry. Of the $3,025 million with which this industry is credited in 1958, $1,507 million was consumption expenditure and $1,518 business expense.

ENGINEERING AND ARCHITECTURAL SERVICES

The Internal Revenue Service publishes gross incomes for "engineering and other professional services." The "other professional" services include educational services. Fortunately, the subdivision into corporations, single proprietorships, and partnerships allows a separation of engineering from "other professional services," for the latter are sold by corporations whereas "engineering and architectural services" are sold by proprietorships and partnerships. The pertinent data are presented in Table VIII-2.

TABLE VIII-2

ENGINEERING AND ARCHITECTURAL SERVICES: GROSS RECEIPTS OF ENGINEERING AND ARCHITECTURAL PARTNERSHIPS AND PROPRIETORSHIPS, SELECTED YEARS BETWEEN 1939 AND 1958

(millions of dollars)

Gross receipts of	1939	1947	1953	1956	1958
(1) Single proprietorships	398	484	845	1,199	1,159
(2) Active partnerships	59	252	490	675	819
(3) Total	457	736	1,335	1,874	1,978

SOURCE: Internal Revenue Service, *Statistics of Income*.

Total expenditures for the services of this industry were $1,978 million in 1958.

ACCOUNTING AND AUDITING

Information on the accounting- and auditing-services industry is sparse. Gross receipts of sole proprietorships are available for a few years: they were $208 million in 1949, $336 million in 1953, $385 million in 1955, and $524 million in 1957. Gross receipts of partnerships are available only for 1957, when they were $614 million. Hence, in 1957 total expenditures for the services of this industry were $1,138 million.

MEDICAL SERVICES

Medical services are sold by an industry called "medical and other health services," which consists of a large number of groups not pertinent for our purpose, except for some portions of one or two. The full list includes (1) offices of physicians and surgeons, (2) dentists and dental surgeons, (3) osteopathic physicians, (4) chiropractors, (5) nursing, (6) hospitals, (7) medical and dental laboratories, (8) veterinary services, and (9) health and allied services, n.e.c. (midwives, nutritionists, psychotherapists, sanatoria, etc.). We are interested only in the production of knowledge or, in this case, in the sale of medical advice, prescriptions, and information; we need, therefore, data on the relevant portions of the receipts of physicians, osteopaths, and medical laboratories. However, no breakdown of receipts is available. The receipts of sole proprietorships and partnerships in the entire industry were $8,333 million in 1958, which probably is for all groups except hospitals and sanatoria.

Personal consumption expenditures for medical care are broken down into several items—physicians and surgeons, dentists, hospitals, medical insurance, etc. The expenditures for physicians and surgeons were $866 million in 1939, $2,020 million in 1947, $2,338 million in 1949, $2,840 million in 1953, $3,470 million in 1956, $4,165 million in 1958, and $4,588 million in 1959. We have decided that one half of the payments to physicians and surgeons are for advice and information. Thus, for 1958 we put down $2,083 million as consumer expenditures for medical knowledge. This is only a small part of consumer expenditures for medical care, which in that year were $12,345 million.

Information and Financial Services as Joint Products

The industries to be examined in this section are officially listed in the industry division called "Finance, insurance, and real estate." These industries—banking, securities brokerage, etc.—are included in our survey of knowledge-producing industries because they produce information as a joint product with the financial and other services they provide. The knowledge-producing functions of these industries have never been given much attention by the financial experts, who have concentrated their curiosity and analyses upon such matters as lending capacity, safekeeping, time preference, liquidity preference, securities, net worths and yields, risk pooling, trust functions, actuarial problems, and all the rest, to the exclusion of the tasks of recording, processing, and transmitting information. It happens that precisely these tasks require most of the labor employed in financial institutions, and that therefore the largest part of their total expenditures are incurred in producing information indispensable to both the institutions and the users of their other services.

CHECK-DEPOSIT BANKING

Among the difficulties in ascertaining what the so-called "banking services" really are, just what they produce, and how much they are worth, is the statistically and analytically embarrassing fact that banks do not collect payment for all the services they render. Since they secure reimbursement for their expenditures only indirectly, by not paying interest on checking deposits, the value of the banking services to the holders of these deposits has to be imputed. To be sure, there are some small "service charges" levied against customers who draw too many checks on accounts with too small average or minimum balances, and there are some fees collected for trust services; but there are no explicit payments for the major (and most expensive) banking services. These are rendered to depositors, chiefly in the form of the execution of orders to transfer some of their deposit balances to the accounts of others. The expenses of the banks are met out of their earnings of interest on their loans of funds owed to depositors who are not paid interest on their balances.

In order to cope with this difficulty, the National Income Division makes the fictitious assumption that the interest earned by the banks is distributed to the depositors, and the depositors return this sum to the banks in payment for their services. These fictitious payments for actually unpaid services are entered as business expenses to the extent that bank deposits are held by business firms, and as consumption expenditures to the extent that deposits are held by households. But what part of these fictitious payments should be taken to be payments for information services? Is it possible to analyze the major "banking services" and to separate out the part that consists of keeping the customers' check-accounts and advising them of their balances?

Commercial banks, or deposit banks, to speak of the biggest portion of the banking industry, render services to borrowers, on the one hand, and to depositors, on the other. The former are chiefly "lending services," paid for through interest charges. The latter are "check-deposit services" paid for partly through service charges and chiefly through withholding of the interest earned by the bank on balances held by depositors. These check-deposit services are essentially recording, bookkeeping, and reporting services. The deposit bank is in a sense a big "memory," storing the knowledge of all transactions and periodically furnishing information on the sums and balances on all accounts. Deposit bankers—tellers, accountants, secretaries, and clerks of all sorts—are engaged, almost exclusively, in reading, writing, typing, and punching numerical information. With the exception of the night watchmen, janitors, cleaning ladies, drivers, and guards, nearly everybody in a bank is busy with "pen-pushing" and "paper-shuffling." This is, though not a proof, at least a strong clue to the effect that the main service rendered by deposit banking is the processing and transmission of the knowledge recorded on the millions of slips of paper pushed about during eight hours every working day.

Can the same be said of other kinds of banks? What are the main services rendered by savings and loan associations, mutual savings banks, investment trusts, and credit unions? No doubt, information is also a joint product of these financial intermediaries, but is it sufficiently important a product, demanded for what it contributes to the productivity or satisfaction of its users, or is it, instead, a product needed only in connection with the other services rendered by these institutions? In the case of check-deposit banking, the information produced is separable from any other services rendered in joint production. If a one-hundred-percent-reserve requirement—once proposed by the famous economist Irving Fisher—made it impossible for check-deposit banks to engage in the lending-and-investing business, and other provisions barred them from doing anything besides check-deposit services, these services would be their only product, valued independently from the other functions they now happen to carry out. This is not so in the case of a savings bank: the information it provides is not separable from its function as an intermediary of funds. The financial intermediary—and it is really misleading to call check-deposit banks financial intermediaries—receives funds from savers and passes them on to borrowers and investors, serving the savers as a "liquidifier" of investments. The depositor in the savings bank has a liquid claim although the savings bank itself has only a small fraction of liquid assets. The savings bank thus renders essentially financial services, and the information, the data processing and transmission that goes with them, could not be divorced from them either in practice or in thought.

The decision to count the check-deposit service as production of knowledge will now have to be implemented by statistical estimates of its cost or value. The National Income Division includes as an item among personal consumption expenditures "imputed payments" for "services furnished without payment by financial intermediaries, except insurance companies." (See Table VIII-3, item 2.) This comprises the services of *all* banks and thus we have to separate imputed payments to commercial banks from those to other banks. This can perhaps be done by looking at the other side of the ledger, the imputed payments of interest by commercial banks to their depositors. These can be broken down into three groups: persons, business firms, and government. (See Table VIII-3, item 3.) The open question, however, is whether any of these imputed payments really reflect either the value of the services to the depositors or the cost of the services to the banks; after all, the basis of computation is neither of these but, instead, the interest earned by the banks on funds loaned and invested.

If this question, although designed to raise doubts, is answered in the affirmative, and the imputed payments by check-deposit holders to commercial banks (in addition to actual payments of service charges) are accepted as the value of the check-deposit service, we may take the imputed interest payments by the commercial banks to their depositors as the equivalent amounts. For 1958 this would be approximately $6,000 million, of which $2,928 million was to and from consumers, $2,948 million to and from business, and a relatively small amount (not available) to and from government. One may, however, reject this method of estimation on the ground that the interest earned on funds loaned and invested by the banks is at best a measure of the value of the capital services to bank borrowers and debtors, but not a measure of the value of the check-deposit services to depositors or of their costs to the banks.

Almost all check-deposit business is done by member banks of the Federal Reserve System. Their current expenses, exclusive of interest payments, are shown in Table VIII-3, item 4, but they were incurred for all functions carried out by member banks, not just for the work on checking accounts. No breakdown of expenses is available, and the costs of the savings departments, loan, securities, foreign-exchange, trust, safe-deposit box, and any other departments are all included in the figures reported. Even so, the totals are considerably below the imputed interest payments by commercial banks, and even below the imputed personal consumption expenditures for bank services furnished without payment.

In view of the inconclusive attempt to obtain a statistical estimate of

TABLE VIII-3

BANKING SERVICES: ACTUAL AND IMPUTED PAYMENTS BY AND TO DEPOSITORS OF COMMERCIAL BANKS, CURRENT EXPENSES OF MEMBER BANKS OF THE FEDERAL RESERVE SYSTEM, SELECTED YEARS, 1947-1958
(millions of dollars)

	1947	1949	1954	1956	1958
(1) Personal consumer expenditures for bank service charges, trust services, and safe-deposit box rentals	260	313	467	575	690
(2) Imputed personal consumer expenditures for services furnished without payment by financial intermediaries except insurance companies	1,532	1,877	2,947	3,659	4,068
(3) Imputed interest payments by commercial banks[a] (for balances on deposit without interest)					
(a) to persons (incl. nonprofit organizations)	977	1,384	2,235	2,724	2,928
(b) to business firms	1,164	1,361	2,103	2,672	2,948
(c) to government (Federal, State, local)	186	n.a.	n.a.	n.a.	n.a.
(4) Current expenses[b] of member banks of the Federal Reserve System	1,412	1,624	2,498	2,986	3,470
(a) Salaries of officers	270	318	479	553	632
(b) Salaries and wages of all other employees	528	608	984	1,182	1,349
(c) Fees of directors and committee members	14	16	26	29	33
(d) Taxes other than income taxes	88	96	140	157	185
(e) Recurring depreciation	35	44	76	103	135
(f) Other current expenses	478	542	793	962	1,137

SOURCES: Items (1) and (2): "Personal Consumption Expenditures, by Function." U.S. Department of Commerce, *Survey of Current Business*. Item (3): *Survey of Current Business*. Item (3) (b) estimated by procedures described in *National Income 1954*, p. 100. Item (4): *Federal Reserve Bulletin*.

[a] Item (3) includes also imputed interest payments by Federal Reserve banks, which however is relevant only for the reserve balances of member banks.

[b] Except interest on time deposits and interest on borrowed funds.

the expenditures for the check-deposit service, the most prudent decision will be to report "n.a."

SECURITY AND COMMODITY BROKERS, DEALERS, AND EXCHANGES

The group "security and commodity brokers, dealers, and exchanges" consists of the following five subgroups: (1) Security brokers and dealers, (2) commodity brokers and dealers, (3) exchanges and exchange clearing houses, (4) quotation services, and (5) investment advisers. To what extent can these "industries" be said to be engaged in producing and transmitting information?

We have no trouble reaching the finding that investment advisers and quotation services produce knowledge and nothing else: their product is "intelligence" *par excellence*. Exchange clearing houses, again, have data-processing and data-transmission functions. The exchanges themselves, however, serve primarily other functions, although talking, shouting, and note-taking are the major techniques employed. This applies more or less to the entire brokerage business. In a sense, a broker receives and conveys information from and to potential sellers and buyers, indeed, he produces physically nothing but auditive and visual signals creating certain "states of knowing" in the minds of other brokers and his clients; as an end result of his activities certain persons learn that some pieces of paper conveying certain rights have been added to or deducted from a list of similar assets standing in their names. On these grounds the inclusion of the entire brokerage business among the "knowledge-producing industries" could possibly be defended. The chief argument against it would be the lack of consistency with earlier decisions to exclude activities similarly far removed from physical production. For example, the distinctions made between the check-deposit business and other banking services rested on reasons not consistent with those brought to bear on the present problem. None of the banking services constitutes production in the physical sense—all of them consist chiefly of jotting down pieces of information and shuffling papers around—yet we went out of our way to separate the "pure information" service involved in check transactions from the so-called "financial services" rendered by loan departments, foreign-exchange departments, and all the rest.

As far as the brokerage business is concerned, a notable consideration is that available statistics do not separate investment counseling, quotation services, and clearing-house operations from the brokerage and dealer services in the narrower sense. In these circumstances, it seems no more reasonable to exclude than to include the entire industry.

What is the value of the services sold by the security and commodity brokers, dealers, and exchanges? Gross receipts, if they were available, would be too large for such an estimate because it would include interest paid by customers for their margin debts to brokers. Income originating in this industry, one should think, would still include interest on the brokers' and dealers' own funds but, on the other hand, would omit rents paid for offices and equipment. Employee compensations would presumably be the smallest of the sums considered. Strangely enough, probably because of some imputational quirks, compensation of employees appears in the statistics usually with amounts higher than "income originating," except for 1958, when the same figure is given for both. Table VIII-4 reproduces these data for a series of years. It also reproduces personal consumption expenditures for "brokerage charges and interest, and investment counseling." In order to eliminate interest charges from this item, "customer loans from brokers" were obtained from the statistics of the Federal Reserve Board and were multiplied by interest rates of between 4 and 7 per cent

TABLE VIII-4

SECURITY AND COMMODITY EXCHANGES, BROKERS, AND DEALERS: INCOME ORIGINATING, COMPENSATION OF EMPLOYEES, PERSONAL CONSUMPTION EXPENDITURES, SELECTED YEARS BETWEEN 1931 AND 1959

(millions of dollars)

	1931	1939	1949	1950	1956	1958	1959
Security and commodity brokers, dealers, and exchanges							
(1) Income originating	70	165	179	278	510	647	786
(2) Compensation of employees	267	180	240	312	552	647	820
Personal consumption expenditures							
(3) Brokerage charges and interest, and investment counseling	424	195	247	446	631	756	958
(4) Interest on customer loans by brokers	85	36	40	64	169	181	230
(5) Brokerage and investment counseling	339	159	207	382	462	575	728
(6) Excess of employees' compensation over consumers' payments of brokerage and charges for investment counseling		21	33		90	72	92

SOURCES: Lines (1), (2), and (3): U.S. Department of Commerce, *Survey of Current Business*, and *Supplements to the Survey of Current Business*. Line (4): Computed from customer loans from brokers, *Federal Reserve Bulletin*. Line (5): Line (3) minus line (4). Line (6): Line (2) minus line (5).

(3 per cent above the current discount rate of the Federal Reserve Bank of New York). These interest charges were deducted from the consumer payments to brokers and investment counselors, and thus net payments for brokerage and investment counseling obtained.

Consumer payments for the nonfinancial services of brokers and investment counselors exceeded in two of the seven years the employees' compensation paid by brokers, dealers, and exchanges. In the other five years they did not pay for all, and we assume—crude though this assumption is—that the rest was paid by business firms, who after all must have made some use of brokers' and dealers' services. Thus, in 1949 consumers paid $207 million and business paid $33 million; in 1958 consumers paid $575 million and business paid $72 million for the information services in question.

OTHER FINANCIAL SERVICES, INSURANCE CARRIERS AND AGENTS

The Census of Business includes an industry group called "Finance n.e.c." (Finance not elsewhere classified), which is divided into four subgroups, further subdivided into 21 kinds of businesses. They include, to give some examples, mortgage companies, loan associations, agricultural credit agencies, investment holding companies, oil-royalty companies, trust funds, etc. The size of these industries in terms of annual income originating in them has grown considerably: $168 million in 1939, $390 million in 1949, $839 million in 1956, $863 million in 1958, and $924 million in 1959.

The services of these industries may deserve, perhaps no less than those of brokerage services, to be characterized as knowledge-producing; on the other hand, there may be a more substantial part of "risk bearing" involved, in addition to earnings of pure interest. On these grounds we decide against their inclusion in the list of chiefly knowledge-producing industries.

The next industry to be considered is "Insurance carriers." Although much information service is rendered by this industry—which engages in no physical production and in much paper work, sales talk, data processing and computation—the main product of the industry is not information but investment and risk pooling. The various subgroups—life insurance, fire and marine insurance, accident and health insurance, title insurance, financial-obligation insurance, and insurance carriers n.e.c.—pool very different kinds of risk. At least one of them, title insurance, is really selling information more than anything else. (This kind of insurance is unknown in countries where the legal profession has permitted the legislators to declare governmental records of deeds, or land registers, as presumptive evidence of real-estate ownership.) But there are no separate census data available for the cost of title insurance, and it is not worth the trouble to obtain estimates.

Incomes originating in the business of all kinds of "insurance carriers"—presumably not including such costs as the rent of offices and equipment—are shown in Table VIII-5 together with other related data. The rate of growth has been well above average: the amount almost tripled from 1939 to 1949, and almost quintupled from 1939 to 1959. The question is whether a cost allocation among the various functions performed by the insurers is possible. Perhaps an examination of the next group will throw some light on this question.

"Insurance agents and combination offices" are a separate census industry, composed of "insurance agents," "insurance brokers," "organizations servicing insurance carriers," and "policyholders' consulting service." Their services are designed almost exclusively to produce knowledge, chiefly in the minds of insurance buyers, partly in the minds of the insurance carriers. A comparison of the incomes originating in this business (Table VIII-5, line 2) with those in the business of the insurers themselves (line 1) suggests, however, that it may be inconsistent to exclude all of the carriers' activities from "information services" while the agents' activities are included. This suggestion is reinforced by the large item the National Income Division includes among "personal-consumption expenditures" for "expense of handling life insurance" (Table VIII-5, line 3). This item greatly exceeds income originating in the agents', brokers', and consultants' business—who handle all kinds of insurance, not just life insurance—and thus it obviously includes large consumer payments for services rendered by the carriers, services which are *not* themselves "life insurance."

In elucidation of the preceding statement, it should be understood that the National Income Division divides the premium payments of the policyholders into two parts, one for the death benefits or life annuities acquired, the other for the cost of handling this business. In their own words,

". . . Companies are regarded as explicitly charging policy holders for their services, as measured by operating expenses. An imputation equal to these expenses is entered in the business account under sales to persons. It appears in personal consumption expenditures. . . .

"Claims and premiums have been cancelled as though they constituted transfers among individuals; property income received by these

TABLE VIII-5

INSURANCE: INCOME ORIGINATING IN THE BUSINESS OF CARRIERS, AGENTS, AND SERVICES TO INSURERS AND INSURED, AND CONSUMERS' EXPENSE FOR HANDLING LIFE INSURANCE, 1929-1959

(millions of dollars)

	1929	1939	1949	1950	1956	1958	1959
(1) *Insurance carriers*							
Income originating	888	926	2,720	2,254	3,183	3,989	4,440
(2) *Insurance agents and services*							
Income originating	421	390	969	1,138	1,975	2,173	2,294
(3) *Personal consumption expenditures*							
Expense of handling life insurance	874	1,014	1,688	1,816	3,133	3,694	4,097

SOURCE: U.S. Department of Commerce, *Survey of Current Business* and *Supplements to the Survey of Current Business.*

companies has been converted via the interest imputation into property income received by policy holders; and operating expenses incurred by the companies have been converted by means of the service charge imputation into final purchases made by policy holders."[1]

Total operating expenses include more than cost of information. True enough, all the work of the insurance companies is in the nature of "pen-pushing" and "talking," but a distinction should be made between internal and external knowledge-production. For example, the actuarial work, the management of the investment portfolio, the intelligence work that underlies investment policies, and other functions of this sort are surely not production of knowledge for sale. At best, the "educational" work of the insurance companies and their agents could be so characterized: the promotional and selling efforts, educating and persuading the buyers. In 1959 total operating expenses of life-insurance companies were 17.6 per cent of their total income; commissions to agents were 7.6 per cent while the other 10 per cent were for home-office and other expenses.[2] The commissions amounted to $987 million.

The statistical separation of this particular portion of the insurance business from all the rest might be justified by the analogy to the statistical separation of research and development work from the ordinary business of the industrial firms performing it. However, in-

[1] *National Income Supplement,* 1954, *Survey of Current Business.*

[2] Institute of Life Insurance, *1960 Life Insurance Fact Book,* p. 53.

dustrial firms conceivably could abolish their R & D departments without any effects upon their current business, since the knowledge-producing services of R & D are not needed for the production of whatever the firms offer for sale. Insurance companies, employing their own sales force and customer-consulting staff, could of course divest themselves of these departments and leave the production of the services they perform to separate firms; the services, however, could not be dispensed with, since they are necessary for the current operation of the insurance business. But, though this difference between R & D work and sales work may be worth noting, could we not point to several other "knowledge industries" that are equally indispensable for the operation of many industries? This does not seem to be a significant consideration for our purposes. Perhaps we should go by the safer principle, the actual division of labor, and not place much reliance on the "conceptual and statistical" separability of services which in fact are not separated. On the basis of this principle we disregard the "educational" work of insurance companies, and recognize only the separate census industry, "insurance agents and combination offices" as an industry specializing in "information" services. Gross receipts being unavailable, we take income originating in this industry as the value of its services: it was $2,173 million in 1958.

REAL ESTATE

The last industry in this division is "Real estate." It is subdivided into six groups, five of which are of no relevance to our survey. They relate to the operation of owned or leased real property. Only the sixth group includes businesses qualifying as knowledge-producing industries: rental agents, selling agents, and appraisers of real estate.

No separate data are available, however, to support estimates of the cost or value of the services produced by these activities. We shall enter them in our list of knowledge industries with "n.a." in the dollar column.

The Intelligence Service of Wholesale Traders

The services of brokers, jobbers, dealers, and traders in wholesale trade include "intelligence work," but this is usually jointly produced with a good many other things, such as warehousing, packing, and other kinds of handling physical goods. Even where a trader has no physical contact with the goods traded, he may still provide supplementary services, such as financing or risk bearing. A statistical allocation of the cost among the various jointly produced services seems impossible, and this will force us to forget that so much intelligence work is involved in wholesale trade. Only where trade is "pure" information service will we admit it to the club of knowledge industries.

TYPES OF WHOLESALE TRADE

The following groups are distinguished by the census classification under the heading of "wholesale trade": (1) "service and limited-function wholesalers"—who take title to the goods, store them, handle them, and distribute them to retailers and industrial users; (2) "manufacturers' sales branches and offices"—operated by manufacturing concerns, often performing such functions as delivering and installing machinery, equipment, and fixtures; (3) "agents and brokers"—who negotiate wholesale purchases and sales on a fee or commission basis for others without, as a rule, taking title to the goods; (4) "petroleum bulk tank stations"; and (5) "assemblers of farm products." One will readily conclude that only the "agents and brokers" belong on the list of knowledge industries.

The total of "brokerage and commission" received by wholesale auctioneers, brokers, commission merchants, and agents was, according to the Census of Business, $836 million in 1948 and $1,229 million in 1954. No more recent figure has been reported.

Miscellaneous Service Industries

Among the various service industries listed by the Census of Business but not yet covered in this survey are several that qualify for inclusion because they either provide information or advice to businesses (or private households) or they aid businesses (or private households) in conveying information to others; some do both, acting as middlemen of information. In the first case the buyer pays for knowledge received, in the second for aid in transmitting knowledge, and in the third case knowledge goes both ways.

KNOWLEDGE RECEIVED

The largest of the service industries selling knowledge to businesses is "business management consulting services," whose receipts in 1958 were $653 million. We might have included them among the professional services, along with the lawyers, accountants, and engineers, especially since management consultants are often "industrial engineers" and have formed their professional organizations. But we follow the Bureau of the Census in treating management consulting services under the miscellaneous category.

"Detective agencies" are linked with "protective services." The former can be recognized as knowledge-producing industries, searching for information and reporting their findings to the customer. Protective services are not of this type. The receipts for detective and protective services together are given as $60 million for 1954 and $177 million for 1958. An arbitrary 50:50 split seems reasonable and we shall therefore take $89 million as the cost of knowledge produced by detective services in 1958.

"Interior decorating" as a consulting service is separated by the Census Bureau from other services known by this name and consisting of selling goods and physical labor. Only in the capacity of consultants can the persons in this field qualify as knowledge producers. For advising clients in the selection of furniture, draperies and other interior decorations, they collected fees and commissions in amounts of $43 million in 1954 and $70 million in 1958.

KNOWLEDGE TRANSMITTED

Among the services aiding the client in conveying information to others is the group listed as "Duplicating, addressing, mailing, mailing-list, and stenographic services." These are establishments primarily engaged in mimeographing, multigraphing, rotoprinting, multilithing, addressographing, and mailing services; in compiling and selling mailing lists; and in furnishing court-reporting and public stenographic services. Expenditures for these services were $173 million in 1954, and $222 million in 1958.

Somewhat similar in character are the "blueprinting and photocopying services," for which $95 million were paid in 1954 and $154 million in 1958.

A different kind of service, though still designed to aid business and professional men in transmitting information, is the "telephone-answering service," worth $27 million in 1954 and $46 million in 1958.

KNOWLEDGE GOING BOTH WAYS

Among the groups serving clients in a two-way transmission of intelligence are credit bureaus, employment exchanges, and auctioneers' establishments.

"Credit bureaus and collection agencies" receive and transmit information between lenders and borrowers, creditors and debtors. Collection agencies really provide other services in addition to information, but they cannot be separated from the credit bureaus. For their services both types of business together received $122 million in 1948, $226 million in 1954, and $341 million in 1958.

"Private employment agencies" shuttle information back and forth between employers and job seekers. For their services they collected $31 million in 1948, $63 million in 1954, and $101 million in 1958. Some of the payments were probably received from employees and thus may have been personal-consumption expenditures. Not knowing, however, what portion may have come from consumers, we shall treat the full amounts as business expenses.

"Auctioneers' establishments," passing information between sellers and buyers—evidently exclusive of the auctioneers listed earlier with the brokers in wholesale trade—received $14 million in 1948, $23 million in 1954, and $38 million in 1958.

Government as Knowledge Industry

Government has played a major role in four of the branches of knowledge-production discussed thus far: education, research and development, book publication, and the postal service. A wide concept of knowledge-production, however, invites the addition of several other activities of the government; indeed, it includes the very act of "governing" in so far as it consists of formulating rules of conduct and communicating them to the governed, as well as to those who administer and enforce the rules.

The nature of the *legislative* branch of the government as a producer of knowledge is probably uncontested; after all, legislatures have often been characterized as debating societies, and debates have no other purpose than to produce and alter ideas in the minds of the participants and their audiences; moreover, the new laws written by the legislatures are socially new knowledge to be heeded by all whom it may concern. Perhaps the *judiciary* will also be accepted without strong resistance as a knowledge-producing activity of the government. For, engaged in the weighing of arguments about the application of the laws to concrete cases and in the making of judgments when particular facts or the interpretation of the law are in dispute, the courts of law make pronouncements designed to alter knowledge in the minds of some, confirm knowledge in the minds of others, and create knowledge in the minds of enforcement officers. Recognition of "general administration" by the *executive* branch of the government as a knowledge-creating activity will be much harder to attain, unless it is agreed that telling anybody what he should do means creating knowledge in his mind. Precisely this, however, is the object of administration.

BREAKDOWN BY FUNCTION

Government expenditures are classified along different lines, such as by level (federal, state, local), branch (legislative, judicial, executive), organization unit (various departments, agencies, offices, etc.), function (national security, international affairs, veterans' services and benefits, etc.), type of budget (investment, operating, other), or type of service (general government, government enterprises). If we want to find out which of the expenditures are for knowledge-producing activities, the classification by function is the relevant one.

We may quickly review the ten "major functions" distinguished in the official statistics of federal government finances and examine them for possibly pertinent items. (1) "Major national security," by far the largest item, contains expenditures for activities that definitely belong in our survey but have already been counted: education in the armed services, and research and development. (2) "International affairs and finance" contains two activities of concern to us: conduct of foreign affairs, and information and exchange activities. (3) "Veterans' services and benefits" includes an item called "education and training," which to the extent that it financed veterans' tuitions has been taken into account in the cost of education. The cost of administering the program will be disregarded. (4) "Labor and welfare" has two items of possible concern: promotion of education and general-purpose research, libraries, and museums. They have been included in the cost of education. (5) "Agriculture and agricultural resources" includes "research and other agricultural services," which in part at least has been accounted for under research and development. (6) "Natural resources" may comprise several pertinent activities, particularly the "general-resource surveys" and certain functions of the naturalists, biologists, and geologists engaged in the acquisition and dissemination of knowledge on wildlife, forest, and mineral resources. (7) "Commerce and housing" contains the postal service already reported, but also expenditures for regulation of commerce and finance. They may be recognized as countable under the heading of knowledge-production, since regulation is the formulation and transmission of rules, rulings, and orders to the managers of the regulated businesses. (8) "General government" contains the largest number of pertinent items:

the legislative functions, judicial functions, executive direction and management, federal financial management, general property and records management, civilian weather services, protective services (Federal Bureau of Investigation) and alien control, and other general government. We exclude "central personnel management and employment costs" because they include payments for retirement funds, unemployment compensation, etc., which are outside the purview of our study. (9) "Interest" and (10) "Reserve for contingencies" are not relevant either. The pertinent items not previously reported are listed in Table VIII-6.

For state and local governments the available breakdowns are not entirely comparable with those for expenditures of the federal government. In one instance, however, analogous activities of government may merit different treatment: the F.B.I. (Federal Bureau of Investigation) was regarded as chiefly an investigative service, whereas state and local police are not so recognized. This is a rather arbitrary decision,

TABLE VIII-6

Federal Government Expenditures for Knowledge Production Not Elsewhere Classified, 1953-1959

(millions of dollars)

	1953	1956	1958	1959
International affairs				
Conduct of foreign affairs	150	120	173	237
Information and exchange services	106	111	149	139
Natural resources				
General resource surveys and administration	34	35	43	60
Commerce				
Regulation of commerce and finance	137	41	49	58
General government				
Legislative functions	49	77	88	102
Judicial functions	29	38	44	47
Executive direction and management	9	9	10	12
Federal financial management	442	475	502	566
General property and records management	185	164	239	291
Civilian weather services	28	34	39	46
Protective services and alien control	147	188	199	216
Other general government	140	238	20	30
Total	1,456	1,530	1,555	1,804

Source: U.S. Bureau of the Census, *Statistical Abstract of the United States, 1960.*

since a good proportion of police activities are investigative and regulatory, and hence knowledge-producing, and some F.B.I. tasks require physical force, e.g., when the G-men "shoot it out" with gangsters. It is assumed here that the proportions between investigative and protective services are sufficiently different to justify putting the F.B.I. and state and local police into different boxes. The pertinent items of state and local government expenditures not previously reported are contained in Table VIII-7.

TABLE VIII-7

State and Local Government Expenditures for Knowledge Production Not Elsewhere Classified, 1952-1958

	1952	1954	1956	1958
Regulation of commerce and finance	364	402	539	576
General control (legislative bodies, administration of justice, governmental chief executives and central staff agencies, financial and other general administration)	1,193	1,375	1,560	1,843
Total	1,557	1,777	2,099	2,419

Sources: U.S. Department of Commerce, *U.S. Income and Output*; U.S. Department of Commerce, *Governmental Finances.*

INVESTMENT, CONSUMPTION, OR COST?

The expenditures for research and development, as also most of the expenditures for education, have been regarded by us as social investment. We do not propose to regard the government activities discussed in this section as investment: the work of the courts or the F.B.I., the Weather Bureau or the public-service commissions, important as they are, are not designed to increase the productivity of the nation's resources in future years. Yet, all government purchases of goods and services are regarded as final product—part of GNP and national income—in the official statistics. Hence, any government activities not qualifying as investment are by implication regarded as consumption.

We have the choice of accepting the method of our official income analysts—thus taking, for example, the intelligence work of the State Department and of the F.B.I., or the work of the General Accounting Office, to be knowledge produced for the enjoyment of the consuming population—or of departing from that method and considering such knowledge as the necessary cost of running the business of a complex society. The second of the alternatives appears as the more appropriate one, even if it involves making arbitrary decisions. It is already somewhat arbitrary to decide whether this or that government agency "produces knowledge" or carries out functions of a different nature; the marginal arbitrariness of the additional decision, whether that knowledge is investment, consumption, or cost of producing other things, is not too great. The only trouble arising from this decision is that it requires recomputations of GNP. Every government expenditure that we demote from the status of final product to the status of intermediate product will have to be deducted from the official GNP figure if we want to express the magnitude of national knowledge-production as a percentage of GNP. But similar recomputations of GNP became unavoidable when we decided to promote business-financed research and development to the status of investment, or business-financed television programs to the status of consumption.

We regard the expenditures for the legislative and judicial branches of the government as designed to produce knowledge needed to provide the legal framework deemed necessary for the economy to function satisfactorily and to produce what it produces. Hence, this is knowledge as an intermediate product. The same is true for a good many "knowledge services" provided by the executive branch. (The only exceptions would be such items as the National Park Service, which include educational activities for tourists, designed for their entertainment as well as their improvement. But we have not included this item in our Table VIII-6, because the naturalists' activities in research and education are not separately reported from the physical work of maintaining the national parks.) Thus, the entire expenditures of government for knowledge-creating activities are regarded here as the cost of running the economic establishment of the nation—neither as an investment nor as consumption.

CHAPTER IX · TOTAL PRODUCTION OF KNOWLEDGE AND THE NATIONAL PRODUCT

THE preceding five chapters presented a survey of more than thirty industries producing knowledge. The present chapter is designed to bring together some of the points raised in connection with particular industries and to draw up a summary statement listing each of the branches of knowledge-production with the value of its product. This will form the basis of a quantitative evaluation of the role of knowledge-production in the national product. After a discussion of the possible relationships between knowledge-production and economic growth at large, the rates of growth in the different branches of knowledge-production will be compared.

Differences in Techniques and Organization

The thirty-odd branches of knowledge-production that have been referred to as "knowledge industries" exhibit such wide differences in organization and in production methods that some comments are called for to explain in what sense they all deserve, despite these differences, to be designated as industries and as producers of knowledge.

DEGREES OF CHANGE IN THE FORM AND CONTENTS OF INFORMATION

Within the spectrum of knowledge-producing activities we distinguished—in Chapter II—several general types according to the similarity and dissimilarity between messages received and messages communicated. The types were those of transporters, transformers, processors, interpreters, analyzers, and original creators of knowledge. The same distinctions can be broadly used for entire industry groups, if only with some difficulties and significant qualifications.

One difficulty in applying to an entire industry a classification of knowledge-producing activities that is designed to fit individuals is that many different kinds of individual workers or occupations participate in the production process of an industry. The charwomen who clean a classroom, a research laboratory, an editor's office, or a television studio, are employed in industry groups that produce knowledge, but they are not knowledge-producing workers themselves. Thus, in tallying the expenditures or value produced in the different branches of knowledge-production, we must not be sidetracked by the occupations approach—which will be pursued in the next chapter. Now we must look at the services rendered by each industry group as a whole.

One industry group of those treated in this book specializes in "knowledge-transportation," that is, in delivering messages in the form in which they were received, without changing their form even temporarily in the process; this is the postal service. The written, typed, or printed messages are delivered as they were received. "Transformation" of the messages in the process of communication with retransformation before they are received takes place in three industry groups: phonography, telephony, and telegraphy. In the telegraph industry written or typed messages are transformed into electric impulses, and transformed back into written or typed form for delivery to the addressee. In the telephone industry, oral messages are transformed from sound to electric impulses and back into sound. The same is true for the phonograph industry, where one of the transformations is mechanical—e.g., by means of grooves on a plastic disk—and where the recipients of the messages are usually not specified by the producer but ordinarily are recipients by their own election.

The printing and publishing industries, likewise, are engaged in the transformation of knowledge with the chief function of reproducing what is first available in typescript, and in only a few copies, in a form that can be delivered to readers at different places in thousands of copies. This limited view of the publishing industry, however, leaves the authors out of the picture. Since their services are paid for—to the extent that they are—out of the receipts of the publishers, the productive contribution of the writers must be appraised alongside the contributions of the editors, printers, and distributors of the published material. The work of newspaper reporters, feature writers, and editorial writers may be chiefly characterized as "interpretation" and "analysis," though there may be some "original creation" in the work of the columnist. There is supposed to be more original creation on the part of contributors to some of the high-class literary and learned journals and on the part of some authors of books. Most of what can be found in the pages of books is, as far as the author's contribution is concerned, still in the nature of "interpretation" and "analysis."

The motion-picture industry, like the publishing industry, has to be subdivided before it can be classified by the type of activity as a branch of knowledge production. The motion-picture theatres—the exhibitors—constitute a knowledge-transforming industry; the film distributors render several services, the most essential of which is to arrange for transportation of selected films to the exhibitors; the motion-picture producers—the studios—can be classified as interpreters of knowledge, and partly as original creators inasmuch as script writers are regarded as part of this industry group.

Most phases of education can be characterized as interpretation. Research and development are analysis chiefly, and original creation to some extent. Legal services are blends of interpretative and analytical activities, occasionally with a dash of originality. The information services rendered by check-deposit banking are routine processing; the services of the broker are partly routine processing, partly analysis of information; the sales spiel of the life-insurance agent is in the nature of interpretation, not much different from the classroom activities of the teacher.

The various functions of government enumerated in the preceding chapter employ different techniques. Certain services connected with natural resources, say, the Geological Survey, involve data processing and analysis; the regulatory functions involve interpretation and some analysis, as does the work of the judiciary. The legislative branch does interpretative and some creative work; but in the execution of several functions of "general administration" data processing plays a major role.

The manufacture of several kinds of information machines serves indirectly the transformation and processing of knowledge.

The preceding comments were not designed to develop a hierarchy of the different branches of knowledge-production, but only to explain on what grounds such very different activities are listed under this heading.

THE ORGANIZATION OF THE INDUSTRIES

The various branches of knowledge-production are organized along very different lines, so different indeed that in some instances the name "industry" or "industry group" fits without reservation, and is actually used by the Census Bureau, while in other instances it does not fit and can be used at best, if at all, as an analogy. "Printing and publishing," or any of its subgroups, or "telephone," or "motion pictures," among others, have no trouble qualifying as industries or industry groups in the census sense. On the other hand, "research and development," "education in the home," and "education on the job" can be called "industries" only if one's imagination is stretched and the word's meaning strained. For, as pointed out more than once, the activities in question are not carried out by firms or establishments specializing in this sort of thing, but engaging in these activities only as a side line supporting their major objectives.

To be sure, there are some firms specializing in research and development, selling either their services (consultation) or their findings (inventions, problem solutions) to other firms. But for the most part research and development is done within firms producing other goods and services. We can count the number of R & D "departments" within firms and the number of firms performing R & D, but only by special statistical efforts can we divorce the R & D activities from the other operations of the firms. The statisticians' efforts have been so successful that one can now report about R & D as if it were an industry of its own.

Similar statistical efforts have not been made with regard to on-the-job training by firms. Our feeble effort to size up the total cost of this knowledge-producing activity has not yielded reliable estimates. We cannot dare pass off an aggregation of this activity as an "industry" or "industry group," but we may yet regard it as a branch of knowledge-production that is integrated with other production and separable only conceptually and statistically. Likewise, education in the home had better not be called an "industry," but there is no reason why it should not be treated as a branch of knowledge-production.

More questionable is perhaps the separation of the information services rendered in connection with finance, brokerage, or trade. Although such separation was attempted, this may have been a *tour de force*, suggestive but not convincing.

The various "branches" or "industries" differ considerably with respect to the number of firms and establishments within each. There are outright monopolies such as the Post Office, which is a national monopoly, or the telephone, a regional monopoly. There are local duopolies or triopolies—the daily newspapers—and oligopolies such as the motion pictures, the radio and television stations, the producers of television sets, phonographs, and business machines. In some of the industries the market positions are difficult to appraise; in book publishing, for example, there may be oligopsony in the acquisition of manuscripts and monopolistic competition (imperfect polypoly) in the sale of the published books.

Several of the industries are operated or regulated by the government. The postal service is a government function everywhere; telephone and telegraph are nationalized in many countries, but in private hands, though regulated, in the United States; radio and television stations are government-operated in some countries, but privately operated under public regulation in the United States. Elementary and secondary education is offered chiefly in government schools, partly in church-affiliated schools, and only to a very small extent in private schools. Higher education is offered both by public and private institutions. Research and development, although performed chiefly by industry, is largely financed with public funds.

The cost of the production of knowledge is sometimes borne entirely by its recipients, as for example in the cases of book publication, phonography, motion pictures, telephone, telegraph, information machines, and engineering services. In other cases, the recipients pay only a part of the cost, as for example in the cases of secondary and higher education (chiefly in the form of foregone earnings), periodical and newspaper publication, radio and television. And in some instances, the recipients pay nothing at all, as in elementary education, the use of public libraries, outdoor advertising, and postal service. In many instances, a party interested in the transmission of knowledge pays part of the cost; for example, advertisers pay large portions of the cost of periodicals, newspapers, radio, and television; and senders of second- and third-class mail pay part of the cost of these mail services. The federal government pays for the postal deficit, for education in the armed forces, and for over one half of research and development; state and local governments pay for elementary education and partly for secondary and higher education, for public libraries, and for other governmental "information services."

We have been able to be so brief and superficial in this review because most of the facts mentioned were recited in detail when the particular branches of knowledge-production were described and examined in the preceding chapters. To bring them together once more in this "running account" has permitted us to see the variety of institutional arrangements in better perspective.

Knowledge Production 1958, by Industry

We shall now start tabulating the numerical findings of our industry survey. The industries or branches of knowledge-production covered in Chapters IV to VIII will be enumerated, in as detailed a breakdown as appears statistically sound, with the value of output in 1958 (or a year as close to 1958 as we have been able to obtain). The enumeration will be in the order in which the industries have been discussed in this book: Education, research and development, media of communications, information machines, and information services.

THE COLUMNS OF THE TABLE

Table IX-1 presents seven columns besides that for the value of output: three columns for a breakdown according to who pays for the production—government, business, or consumers—and four columns for a breakdown relating these expenditures to the national-income accounts.

The breakdown according to who pays for the particular activities is in some instances relatively simple, but in others quite problematic—the problems being either statistical only or also conceptual. A problem is "statistical only" if an unambiguous answer could be given provided the factual information were available. A problem is "conceptual" if even with all factual information answers would depend on choices among alternative ways of looking at things. Some of the conceptual problems are solved by convention; for example, expenditures made by nonprofit organizations—including private universities—are treated as personal-consumption expenditures. Other problems can be solved by analogical reasoning and theoretical analysis, though certain problems call for rather arbitrary decisions; for example, the cost of tax exemptions is regarded as a payment by government rather than a payment by business or by consumers. We shall attempt to explain such decisions in running commentaries on particular items.

The four columns reconciling the production statistics with the national-income accounts are needed because we depart from some of the conventions adopted by the official authorities. Thus, since we regard research work as final output even when it is financed as business expense, we have to enter the business expenditure in question in the column with the caption "Final product, though treated as cost of current production of other goods and services or entirely omitted in official statistics." Conversely, since we regard general expenditures of the government as operating cost of the economy, we have to enter such expenditures in the column with the caption "Intermediate product, though treated as final product in official statistics." The other two columns, one for intermediate and the other for final output, are for entries treated here in the same way as in the official statistics.

COMMENTARIES ON EXPENDITURES FOR EDUCATION, RESEARCH AND DEVELOPMENT

The first four items—education in the home, on the job, in the church, and in the armed services—are results of unofficial estimates. Nevertheless, three of the items require no adjustments of the GNP calculation, because they represent actual money expenditures and the

TABLE IX-1

KNOWLEDGE PRODUCTION, BY INDUSTRY OR BRANCH, SOURCE OF FUNDS, AND CHARACTER OF OUTPUT, 1958
(millions of dollars)

Industry or branch of knowledge production	*Year*	*Total value*	*Paid for by*			*Intermediate product*		*Final product (consumption or investment)*	
			Government	Business	Consumers	though treated as final product in official statistics	recognized in official statistics as cost of current production of other goods and services	though treated as cost of current production or entirely omitted in official statistics	recognized in official statistics as final product
Education									
Education in the home	1958	4,432			4,432			4,432	
Training on the job	1958	3,054		3,054			3,054		
Education in the church	1958	2,467			2,467				2,467
Education in the armed forces	1958	3,410	3,410						3,410
Elementary and secondary schools									
monetary expenditures	1957-1958	16,054	13,569		2,485				16,054
implicit costs	1957-1958	17,285	3,414		13,871		1,022[a]	16,263	
Colleges and universities									
monetary expenditures	1957-1958	4,443	2,423		2,020				4,443
implicit costs	1957-1958	8,314	781		7,533		317[a]	7,997	
Commercial, vocational, and residential schools	1958	253			253				253
Federal programs, n.e.c.	1957-1958	342	342						342
Public libraries	1958	140	140						140
All education		60,194	24,079	3,054	33,061		4,393	28,692	27,109

TABLE IX-1 (continued)

Research and development									
Basic research	1958-1959[b]	1,016	615	275	126			275	741
Applied research and development	1958-1959[b]	9,974	6,515	3,385	74			3,385	6,589
All research and development		10,990	7,130	3,660	200			3,660	7,330
Media of communication									
Printing and publishing									
Books and pamphlets	1958	1,595	347	43	1,205		43		1,552
Periodicals	1958	1,811		1,031	780			1,031	780
Newspapers	1958	3,956		2,503	1,453			2,503	1,453
Stationery and other office supplies	1958	1,852	180	720	952	180	720		952
Commercial printing and lithography	1958	2,879	570	2,280	29	570	2,280		29
		12,093	1,097	6,577	4,419	750	3,043	3,534	4,766
Photography and phonography									
Photography	1958	1,600			1,600				1,600
Phonography	1958	1,035			1,035				1,035
Stage, podium, and screen									
Theatre and concerts	1958	313			313				313
Spectator sports	1958	255			255				255
Motion pictures	1958	1,172			1,172				1,172
Radio and television									
Radio stations revenue	1958	523		523				523	
Television stations revenue	1958	1,030		1,030				1,030	
Radio and TV sets & repairs	1958	1,982			1,982				1,982
Radio & TV stations investment	1957	806		806					806
Other advertising	1958	5,000		5,000				5,000	
Telecommunications media									
Telephone	1958	7,642	1,529	2,813	3,300	1,529	2,813		3,300
Telegraph	1958	318	64	117	137	64	117		137
Postal Service	1958	3,000	52	2,048	900	52	2,048		900
Conventions	1957	1,600		800	800		800		800
All media of communication		38,369	2,742	19,714	15,913	2,395	8,821	10,087	17,066

(continued)

TABLE IX-1 (continued)

Industry or branch of knowledge production	*Year*	*Total value*	*Paid for by*			*Intermediate product*		*Final product (consumption or investment)*	
			Government	Business	Consumers	though treated as final product in official statistics	recognized in official statistics as cost of current production of other goods and services	though treated as cost of current production or entirely omitted in official statistics	recognized in official statistics as final product
Information machines									
Printing trades machinery	1958	350		350					350
Musical instruments	1958	190			190				190
Motion picture apparatus and equipment	1958	147		147					147
Telephone and telegraph equipment	1958	1,200		1,200					1,200
Signaling devices	1958	200		200					200
Measuring and controlling instruments	1958	4,968		4,400	568				4,968
Typewriters	1958	272		272					272
Electronic computers	1958	332	43	289					332
Other office machines	1958	937		937					937
Office-machine parts	1958	326		326					326
All information machines		8,922	43	8,121	758				8,922

TABLE IX-1 (concluded)

Information services									
Professional services									
Legal	1958	3,025		1,518	1,507		1,518		1,507
Engineering and architectural	1958	1,978		1,978			1,978		
Accounting and auditing	1957	1,138		1,138			1,138		
Medical (excluding surgical)	1958	2,083			2,083				2,083
Joint with financial services									
Check-deposit banking		n.a.		n.a.	n.a.		n.a.		n.a.
Securities brokers, etc.	1958	647		72	575		72		575
Insurance agents	1958	2,173			2,173				2,173
Real-estate agents		n.a.		n.a.	n.a.		n.a.		n.a.
Wholesale agents	1954	1,229		1,229			1,229		
Miscellaneous business services	1958	1,714		1,714			1,714		
Government									
Federal	1958	1,555	1,555			1,555			
State and local	1958	2,419	2,419			2,419			
All information services		17,961	3,974	7,649	6,338	3,974	7,649	.	6,338
Total knowledge-production		136,436	37,968	42,198	56,270	6,369	20,863	42,439	66,765
Per cent distribution		100.0	27.83	30.93	41.24	4.67	15.30	31.10	48.93
			100			19.97		80.03	

[a] Transfer payments by government, hence no part of national product.
[b] The hyphenated year 1958-1959 means for R & D expenditures the calendar year 1958 or the 12-month period beginning in 1958.

official treatment suits our purposes. Thus, the cost of on-the-job training is a current business expense; training in the armed forces is paid for by the government and may be regarded as social investment, and religious activities are paid for by nonprofit organizations and hence are treated as consumer expenditures. Education in the home, however, does call for an adjustment, because the implicit cost is not included in the official GNP calculation.

There is no serious difficulty regarding the money expenditures for elementary and secondary education. The expenditures for public schools are in the "government" column, and the expenditures for private schools, together with high-school students' estimated expenses for transportation, supplies, and clothes (see Chapter IV, p. 102) are in the "consumers" column. The treatment of the implicit costs is more complicated. The opportunity cost of students' time—$13,519 million foregone earnings—is, of course, borne by consumers and entered in the column of "final product though omitted in official statistics." In this column also is the opportunity cost of using school property, an implicit rent borne by government for public schools and by consumers for private schools. The amounts so entered can most conveniently be checked against Table IV-18 (p. 104). The imputed cost of tax exemptions, $1,022 million, which had to be estimated chiefly in order to make the real value of expenditures by tax-exempt institutions comparable with virtually all other expenditures, is assumed to be borne by government. For one may argue that a tax exemption is equivalent to payment of full taxes and simultaneous receipt of a government subsidy in the same amount. An additional government expenditure would ordinarily require an addition to GNP; not in this case, however, since this hypothetical subsidy is only a "transfer payment," not a purchase of goods and services. An adjustment of GNP for the part of the cost of education that is represented by tax exemption would be inappropriate, since tax exemptions affect only the allocation of productive resources but, presumably, leave total output unchanged. In order to avoid an adjustment to GNP the amount of $1,022 million is entered in the column for "recognized" intermediate products.

The same explanations hold for the cost of higher education. Again the imputed costs of the students' time, $7,189 million, and of the use of buildings and grounds, $808 million, appear in the column of needed adjustments to GNP. The $808 million are divided between public institutions, $464 million, and private institutions, $344 million. Perhaps it bears repetition: if the opportunity costs of time and facilities are included as part of the educational effort—an effort regarded here as social investment—we must adjust the GNP calculation in order to permit meaningful comparisons. If we want to see the share that knowledge-production represents of GNP, any expenditure for knowledge as investment or consumption must appear both in the outlay for knowledge and in the GNP account. The cost of tax exemptions, however, $317 million, is entered as a government (transfer) payment not affecting GNP.

The money expenditures of colleges and universities are entered net of any expenditures for scientific research and engineering development that are reported under R & D. Not that research is not educational, but we must not count it twice. Some of the R & D expenditures are entered as defrayed by consumers: this is because private universities and other nonprofit organizations are conventionally treated as part of the consumer sector. Since the official statistic of funds for R & D does not divide all funds contributed by universities between public and private institutions, we must use a ratio which the National Science Foundation found for "budgeted" R & D expenditures:[1] 42 per cent of these amounts were budgeted by public institutions and 58 per cent by private. Thus, for basic research we add 42 per cent of the $118 million of university funds, or $50 million, to the $565 million spent by government, and 58 per cent, or $68 million, to the $58 million spent by other nonprofit research organizations. For applied R & D we add $30 million of the university funds to the $6,485 million spent by government, and $42 million of the university funds to the $32 million spent by other nonprofit organizations.

COMMENTARIES ON EXPENDITURES ON MEDIA OF COMMUNICATION, INFORMATION MACHINES, AND INFORMATION SERVICES

The statistics on printing and publishing were explained in detail in Chapter VI, p. 236. The entries for "books and pamphlets" are clear, but those for periodicals and for newspapers may call for a reminder: the whole newspaper, or the whole journal, is treated as final output. That is to say, the portions of the cost that are defrayed by business as advertising expense are treated here not as intermediary but as final product, just as the portions paid by the consumers who buy it. Hence, the payments by business are shown in the column "Final product, though treated as cost etc., in official statistics." An adjustment in the

[1] National Science Foundation, *Review of Data on Research and Development*, NSF-60-21 (April 1960), p. 7.

opposite direction is made with respect to stationery and commercial printing, for which the amounts spent by government are relegated to the column of intermediate rather than final output.

No comments are needed concerning photography and phonography, or concerning stage, podium, and screen. Radio and television, however, require the same kind of adjustment that was made in the cases of periodicals and newspapers: the cost of broadcasting, defrayed as business expense, is made a payment for final output. The same is done with "other advertising" because this is largely an unallocated additional expense of radio, TV, periodicals, and newspapers (together with smaller expenditures for circulars, outdoor advertising, etc.).

The allocation of the cost of telephone, telegraph, and postal service was explained in Chapter VI, p. 290. The government expenditures for the use of these services are not accepted as final output but moved into the columns of intermediate output.

Outlays for information machines are investment and therefore final product, no matter who pays for them. No adjustments are needed for any of these items.

Professional-information services, purchased partly by business, partly by consumers, are treated according to the official rules. Similarly the information services produced jointly with financial services are paid for partly by business and partly by consumers. However, the cost of check-deposit handling, a massive data-processing operation, is not available. The costs of information services produced by securities brokers and insurance agents are entered chiefly under consumer expenditures, where they also appear in national-income statistics. No estimate has been obtained for the services of real-estate agents. The information services of wholesale agents and "miscellaneous business services" are entered as business expenses.

Finally, the small portions of "general government" expenditures that could be identified as knowledge-production—less than 2 per cent of the total budget in the case of federal government expenditures—are treated as intermediate, not final, product; they appear, therefore, in the column designed to collect the required adjustments to GNP.

THE TOTAL AND ITS CHIEF COMPONENTS

Total expenditures for knowledge, in the sense used in this book, were $136,436 million in 1958. Grouping the items into the five categories described by our chapter titles, we see the following composition of the total:

Education	$ 60,194 million	(44.1%)
Research and development	10,990 "	(8.1%)
Media of communication	38,369 "	(28.1%)
Information machines	8,922 "	(6.5%)
Information services (incomplete)	17,961 "	(13.2%)
	$136,436 million	(100.0%)
The expenditures were made by		
Government	$ 37,968 million	(27.8%)
Business	42,198 "	(30.9%)
Consumers	56,270 "	(41.3%)
	$136,436 million	(100.0%)
The total is divided between		
Final product (investment or consumption)	$109,204 million	(80.0%)
Intermediate product (current cost)	27,232 "	(20.0%)
	$136,436 million	(100.0%)

A division of the final product between consumption and investment will not be undertaken, because this would be too much a matter of personal judgment. The larger parts of the educational effort and of research and development work undoubtedly raise future productivity and are therefore in the nature of investment. Some of the school activities, many publications, most photography, motion pictures, radio, and television can be characterized as consumption. By and large, it seems safe to say that the investment portion is larger than the consumption portion.

COMPARISON WITH GROSS NATIONAL PRODUCT

The dollar value of knowledge-production means little except in comparison with total national product, gross or net. Since investment in knowledge—for example, human-capital formation through education—is in the nature of gross investment, comparison with *Gross* National Product makes better sense. We cannot, however, use the unadjusted GNP for this purpose; we must add to it the items we entered as final product though they were not so recognized in official statistics, and must deduct the items we entered as intermediate products though they were treated as final product in official statistics.

The sum of final product treated otherwise or omitted in official statistics is $42,439 million; the sum of intermediate product treated as final product in official statistics is $6,369 million. A net addition of $36,070 must therefore be made to the official GNP of 1958, which was $442,200 million. Since the largest items of knowledge-production refer to the school year October 1957 to September 1958, we may alternatively use the GNP for the last quarter of 1957 and the first three quarters of 1958, or $439,500 million. GNP adjusted by the net addition is, therefore, $478,300 million or, alternatively, $475,600 million. The difference is negligible for our purposes. Total knowledge-production in 1958 was almost 29 per cent of adjusted GNP—provided all our estimates are accepted, our conclusions granted, our omissions disregarded.

The "exact" ratio of knowledge-production to GNP matters little. There are probably some items the inclusion of which will be questioned, particularly among the information services. A few items, on the other hand, were omitted simply because we found it too difficult to estimate their value. But even if questionable items were stricken out, or omitted items included, the total would not be substantially affected; the ratio would not be much different from the 29 per cent calculated on the basis of our figures.

Knowledge Production and Economic Growth

We strongly suspect that the share of knowledge-production in GNP has been increasing over the years. Indeed we can show that in recent years knowledge-production has been growing faster than GNP, and this implies that its share in GNP has increased. But before we examine the data we had better contemplate the possible causal relationships between knowledge-production and economic growth.

COMPLEX INTERRELATIONS

The most plausible relationship that suggests itself in this context is that greater knowledge leads to increased productivity of given resources and hence to faster economic growth. But this causal chain from knowledge-production to growth of total product is only one of numerous relationships that can prevail. Some of them may go in the opposite direction, from higher incomes to higher expenditures for knowledge. Even if one focuses on "productive knowledge" alone, one can easily see the likelihood of an interdependence, or "shuttle-operation," between investment in knowledge permitting an increase in national product, and increases in national product permitting larger investments in knowledge. But the many kinds of knowledge that do not result in greater productivity must not be left out of the picture.

Let us for our present purposes divide knowledge-production into four classes: (1) the production of consumption items, such as comic books, motion pictures, television; (2) the production of current-cost items, such as on-the-job training, office supplies, telephone and postal service, legal, engineering and auditing services, check-deposit operation; (3) the production of investment items, such as education at all levels, research and development; and (4) the production of overhead items, such as general government. Let us now examine what likely relationships can be found between increased activity in any of these classes of knowledge-production and increased national product.

KNOWLEDGE PRODUCTION FOR CONSUMPTION

The production of knowledge for the enjoyment of consumers may increase relative to national income when (1) national income increases and the consumers' income elasticity of demand for the services in question is greater than unity, (2) production costs and prices of these services are reduced and the consumers' price elasticity of demand for them is greater than unity, (3) new types of knowledge services are developed and consumers prefer them to things previously purchased, (4) government, wanting consumers to have more services of the kind, pays more to make them available, and (5) business, believing consumers will be grateful for being given more of these services, pays more to make them available.

Here are examples for these possibilities:

(a) Increased purchases of residential telephone services, stationery, photographic supplies, and magazines are probably the effect of rising incomes and high income elasticities of demand. (Incidentally, if demand is highly income-elastic in one range, it may be income-inelastic in another range; for example, after most households have telephones, rising incomes will not increase purchases of the same service.)

(b) Increased consumer expenditures for books and phonograph records in recent years may be partly due to lower prices and high price elasticities (paperbacks, LP bargains).

(c) Increased consumer expenditures for television sets in the early 1950's are evidently explained by a shift in consumer preference away from radio and motion pictures and in favor of the new consumption good.

(d) Increased appropriations by local government for consumer-gratifying parts in the package labeled "education,"—say, for spectator stands and extra-large gyms allowing the town people to watch basketball games of high-school teams—reflect the desire of government (local school boards) to cater to the public's desire for entertainment.

(e) Increased business expenditures for television programs and broadcasting time reflect the advertisers' judgment that consumers will favor products sold by firms that pay for entertainment.

Only one of the five reasons given for increased expenditures for the production of knowledge to satisfy consumers is *directly* related to increased national income. Yet, the other four reasons are indirectly related either to improved technology, resulting from previous investment in knowledge-production, or to increased incomes. Reduced production costs and selling prices, and likewise the development of new consumer goods, are attributable to new technical knowledge, and thus to research and development activities leading to new technology. Increased government spending for the entertainment of students and their elders presupposes that tax revenues can be raised, which in turn presupposes that national income is increasing. Increased advertising budgets by business more often follow than precede increased sales, which in turn are associated with increasing incomes.

KNOWLEDGE PRODUCTION FOR CURRENT PRODUCTION OF OTHER THINGS

Where knowledge-production yields an intermediate product employed in the current production of other goods and services, one would expect this kind of knowledge-production to increase (1) approximately proportionately with the production of the final products which it helps make, if techniques of production and operation are unchanged, or (2) more than proportionately with the production of final output if techniques so change that increased "knowledge" is substituted, absolutely or relatively, for other factors of production.

(a) Business purchases of postal service, office supplies, legal and auditing services increase approximately at the same rate as aggregate business activity increases, though money expenditures for these intermediate products may increase faster or more slowly if relative prices change.

(b) Business purchases of telephone service have increased faster than final output because technological change has promoted the relative substitution of this medium of communication for others.

By and large, then, increases in knowledge-production that is part of the current production process are the consequence of increases in national income, and only changes in technology and in relative prices will enhance the rate of increase ahead of that of the national product.

KNOWLEDGE PRODUCTION AS AN INVESTMENT FOR FUTURE RETURNS

The two chief types of "investment in knowledge" are educational efforts and research and development efforts. The former are designed to produce existing knowledge in new minds and to make these minds more receptive and more capable of absorbing, transforming, creating, or using knowledge. The latter produce new knowledge. Neither of these forms of investment create tangible assets appearing on a balance sheet. Education, if effective, is an investment in human resources. Research and development, if successful, is an investment in new theories, formulas, and recipes. Both are undertaken with a view to future returns in the form of increased productivity of resources, human, natural, or man-made.

It is with respect to knowledge-production as social investment that one expects the two-way link between knowledge-production and national product, successful investment permitting faster growth of national product, and income growth permitting more investment in knowledge-production. This two-way link applies both to highly developed nations and to less developed ones. In the latter it constitutes one of the most serious obstacles to development, for there is little hope for raising the productivity of labor without prior investment in educational efforts and there is little hope for affording such investment at the meagre incomes earned with the low labor productivity. In developed nations the interrelationship operates to facilitate still faster progress. Increases in educational, scientific, and technological efforts promote rising incomes, and rising incomes afford increasing appropriations to education, research, and development.

While one may generalize that a richer community will as a rule devote a larger share of its income to investment in knowledge, there is no inherent necessity for such investment to grow always at a faster rate than total income. This will be the case, however, when the community or nation makes a conscious effort to accelerate its economic growth. Hence, we shall expect to see expenditures for education and for R & D in the United States grow faster than GNP.

KNOWLEDGE PRODUCTION AS SOCIAL OVERHEAD COST

Contrary to widespread usage, we do not treat educational activities as social overhead cost, but rather as investment in human resources. On the other hand, consistent with our wide concept of "knowledge-production," we include such government activities as the debating and formulation of laws and regulations and the dissemination of information, orders, and directives among knowledge-production in the nature of social overhead cost.

One might expect the amounts spent for such general government activities to increase proportionately with GNP, or more slowly, or faster than GNP, depending on what views are held concerning the role of government in our economy. (1) If government confines itself to formulating general "rules of the game," economic activity can grow faster than governmental activity. (2) If government operations are geared to economic transactions, both will grow at the same pace. (3) If government is assigned new and more difficult tasks as the economy grows and becomes more complex in the process, governmental activities may increase relatively faster than the national product. These three possibilities have in common that the amount of business performed by government is expected to be directly related to what is judged to be expedient or necessary. There are two other possibilities: (4) One might assume an increasing propensity to spend collectively, and thus expect the government sector to assume a larger role in the economic life of the nation and to absorb an increasing share of the national product. (5) One might trust in the operation of Parkinson's Law, according to which administrators tend to create more work for more administrators. This too would result in a faster growth of government production of (useless?) knowledge.

Even this does not exhaust the possibilities, since the position of advocates of comprehensive economic planning has not yet been mentioned: (6) Those who believe that central government direction of the economy would accelerate the increase in national product, even if the planning and directive work is treated as a cost and not as final output, will hold that government production of economic plans and of orders to execute these plans will, despite the use of human resources for these governmental activities, result in substantial increases in the nation's product. This is not the position of the author nor of the majority of the American people. This "possibility" certainly has no place in the explanation of the observed growth of governmental activities in the United States.

The Growth Rates of Knowledge Industries

After our speculative discussion of the possible and probable interrelations between rates of increase in certain branches of knowledge-production and rates of increase in total national product we are even more curious about the actually observed rates of increase. This presupposes, of course, that the poor statistical data—to no small degree based on heroic estimates or guesses—can be regarded as empirical "observations." But we shall proceed as if the data reflected what actually happened, even if we must make many mental reservations concerning their reliability.

NOT EVERY INCREASE CONSTITUTES GROWTH

In talking about the increases in the estimated values of production in recent years we shall be guilty of not avoiding the semantic sin committed by almost all economists, statisticians, publicists, and politicians of our day—namely of speaking of "growth" rates although we know only rates of "increase" over a short interval of time. Only looking back over a span of ten to fifteen years would we be justified in speaking of growth. An increase over three or four years may turn out to be only a short-lived upsurge followed by a downturn around a trend line showing no or only very slow growth, or it may even prove to have been a temporary recovery in a long-run decline.

This misuse of terms, serious when the growth record, the growth objectives, and growth policies of a national economy are debated, is relatively harmless in our present survey; hence, we need not be so pure in our language. We shall bear in mind, of course, that a rate of increase observed over a short period does not warrant an assumption that this increase will be "sustained" over a longer period. When we fall into the bad habit of speaking of "growth" instead of an "increase" over a short period, this does not mean that we have forgotten our own warning.

INCREASED MONEY VALUES WITHOUT PRICE DEFLATORS

Another snare to guard against is the identification of increased dollar *sales* or increased dollar *expenditures* with increased *production*, without considering the price changes that have occurred. In order to measure increases or decreases in production, we must "deflate" dollar sales by changes in the prices of the products or, where there is no physical product and production is measured only by inputs, we must "deflate" dollar expenditures for input by the changes in the prices of the inputs used. To do this would be a formidable task. The work involved in finding the price deflators for each industry or branch of knowledge-production would be enormous, and the results would not be worth the effort. Another way of interpreting changes in dollar figures must be found.

A crude but simple method is available: we shall not attempt to measure physical volumes of production, but shall simply use dollar values at current prices and compare the rates of change in dollar expenditures in the different branches of knowledge-production with one another, with the rate of change in dollar expenditures for the total of all knowledge-production, and with the rate of change of GNP at current prices.

For the latter comparison we shall not bother to adjust GNP for changes in the status of certain products as "final" or "intermediate." After all, what matters at this juncture is not the size of GNP in any one year but the rate of change of GNP over certain periods. For this purpose the official estimates at current prices will be used; we choose the period 1954-1958 for the rate of increase "over the most recent period," and 1947-1958 for the rate over a somewhat longer period. GNP at current prices was $234,289 million in 1947, $363,112 million in 1954, $442,224 million in 1958. This involves a "growth" of 21.8 per cent over the four-year period 1954-1958, and a "growth" of 88.8 per cent over the eleven-year period 1947-1958. Translated into annual rates, the short-period increase was 5.1 per cent and the longer-period increase was 5.9 per cent per year. These "growth rates" were the combined reflections of physical increases and price increases. The only use to be made of these annual rates of increase in GNP at current (rising) prices is to compare with them a number of other rates of increase, observed in the same or similar periods and likewise unadjusted for price changes.

GROWTH IN EXPENDITURES FOR KNOWLEDGE PRODUCTION

In Table IX-2 we undertake to show the rates of increase in expenditures for production in the various knowledge industries or branches of knowledge-production, as far as we have obtained data. The table is designed to present (1) the 1958 (or closest available) value of each item, as taken from Table IX-1, to be used later as weight for the "growth rate" in order to arrive at average growth rates for knowledge-production as a whole; (2) growth rates for the most recent period, preferably 1954-1958; and (3) growth rates for a longer period, preferably 1947-1958. Unfortunately, in several instances different periods have to be used because data for the chosen years are not available; and for some items we must resign ourselves to showing blank spaces.

Blank spaces in the growth columns for the recent period are shown for education in the armed forces, conventions, wholesale agents, and three smaller items, because we have only a single recent estimate of each of these expenditures. The combined value of the six items for which no rates of increase are available is only $6,839 million, or 5 per cent of total knowledge-production. Thus we have the short-period rates of increase for the other 46 items, making up 95 per cent of the total. In the columns for longer-period growth rates we have blank spaces in 16 lines, representing 1958 expenditures of $22,625 million, or 16.6 per cent of total knowledge-production. The lack of comparable figures, in some instances due to changes in census classifications, explains several of these blanks. In one case—electronic computers—the industry did not exist in the early years of our longer period, and we do not wish to start with the very first year and have it as a part of a shortened period, because this would give astronomical growth rates. Incidentally, we do catch in our longer period the beginnings of television broadcasting, exhibiting a growth of 54,000 per cent over the eleven years, but this is "only" an annual growth rate of 77 per cent. By clipping off the first two years, 1947-1948, and observing the growth only for 1949 to 1958, we would reduce the "growth rate" for TV broadcasting to 2,930 per cent for the nine years, and 46 per cent per year. We should never forget that the early years of an industry regularly exhibit enormous rates of increase, impressive to those who do not understand the principle. Electronic computers and TV broadcasting are at least as impressive as some of the rates of growth of the output in new industries in Soviet Russia.

Of all the annual "growth rates" tabulated for the various branches of knowledge-production, the short-period rate for computers is the highest: 104 per cent. The second-highest is the longer-period rate for TV broadcasting: 77 per cent. The short-period rates for office-machine parts (30 per cent), Federal education programs (25 per cent), phonography (20 per cent), applied research and development (19 per cent), and basic research (18 per cent), and the longer-period growth rate for broadcasting-station investment (18 per cent) are next in the list of top performers. A considerable number of annual rates above 10 per cent appears in Table IX-2. The most interesting are the short-term rate of over 13 per cent for money expenditures for colleges and universities, the long-term rate of 12 per cent for money expenditures for elementary and secondary schools, and the short-term rate of almost 11 per cent for books and pamphlets.

All these individual annual growth rates should be viewed against the background of the average growth of knowledge-production and

TABLE IX-2

KNOWLEDGE PRODUCTION: RATES OF INCREASE FOR ALL BRANCHES, 1954-1958 AND 1947-1958, OR SIMILAR PERIODS

BRANCH OF KNOWLEDGE PRODUCTION	ANNUAL EXPENDITURES		RATES OF INCREASE ("GROWTH RATES") Most recent period			Longer period		
	Year	*Millions of dollars*	Years	Per cent increase over period	Per cent increase per year	Years	Per cent increase per period	Per cent increase per year
Education								
In the home	1958	4,432	1956-1958	2	1.0			
On the job	1958	3,054	1956-1958	11	5.4			
In the church	1958	2,467	1954-1958[a]	39	8.5			
In the armed forces	1958	3,410						
Elementary & secondary schools—monetary expend.	1957-1958	16,054	1954-1958[b]	44	9.5	1948-1958[b]	210	12.0
Elementary & secondary schools—implicit costs	1957-1958	17,285	1950-1956[c]	64	8.6	1940-1956[c]	293	8.9
Colleges & universities—monetary expenditures	1957-1958	4,443	1954-1958[b]	64	13.2	1948-1958[b]	115	7.5
Colleges & universities—implicit costs	1957-1958	8,314	1950-1956[c]	54	7.5	1940-1956[c]	626	13.2
Commercial vocational & residential schools	1958	253						
Federal funds, n.e.c.	1957-1958	342	1954-1958	144	24.9			
Public libraries	1957-1958	140	1954-1958	37	8.2			
Research and development								
Basic research	1958-1959	1,016	1954-1958	93	17.9	1949-1958	292	16.4
Applied R & D	1958-1959	9,974	1954-1958	99	18.8			

Table IX-2 (continued)

Printing and Publishing								
Books and pamphlets	1958	1,595	1954-1958	50	10.7	1947-1958	119	7.4
Periodicals	1958	1,811	1954-1958	12	2.9	1947-1958	56	4.1
Newspapers	1958	3,956	1954-1958	19	4.5	1947-1958	95	6.3
Stationery and other office supplies	1958	1,852	1954-1958	34	7.5	1947-1958	94	6.2
Commercial printing and lithography	1958	2,879	1954-1958	8	1.9	1947-1958	70	4.9
Photography and phonography								
Photography	1958	1,600	1954-1958[d]	32	7.1	1948-1954[e]	100	12.2
Phonography	1958	1,035	1954-1958	105	19.6	1947-1958[f]	92	6.1
Stage, podium, and screen								
Theatres and concerts	1958	313	1954-1958	39	8.0	1947-1958	67	4.7
Spectator sports	1958	255	1954-1958	13	3.2	1947-1958	15	1.3
Motion pictures	1958	1,172	1954-1958	— 3	— 0.8	1947-1958	— 26	— 2.8
Radio and television								
Radio stations revenue	1958	523	1954-1958	16	3.8	1947-1958	44	3.4
Television stations revenue	1958	1,030	1954-1958	74	14.8	1947-1958	54,110	77.2
Radio & TV sets & repairs	1958	1,982	1954-1958	— 16	— 3.7	1947-1958	81	5.5
Radio & TV stations invest.	1957	806	1954-1957	36	10.7	1947-1957	437	18.3
Other advertising	1958	5,000	1954-1958	26	5.9	1947-1958	150	8.7
Telecommunications media								
Telephone	1958	7,642	1954-1958	43	9.3	1947-1958	211	10.9
Telegraph	1958	318	1954-1958	17	3.9	1947-1958	30	2.4
Postal service	1958	3,000	1954-1958[g]	20	4.7	1947-1958[g]	83	5.6
Conventions	1957	1,600						

(continued)

Table IX-2 (continued)

BRANCH OF KNOWLEDGE PRODUCTION	ANNUAL EXPENDITURES		RATES OF INCREASE ("GROWTH RATES")					
			Most recent period			*Longer period*		
	Year	*Millions of dollars*	Years	Per cent increase over period	Per cent increase per year	Years	Per cent increase per period	Per cent increase per year
Information machines								
Printing trades machinery	1958	350	1954-1958	25	5.7	1947-1958	56	4.1
Musical instruments	1958	190	1954-1958	42	9.1	1947-1958	92	6.1
Motion picture apparatus and equipment	1958	147						
Telephone & telegraph equipment	1958	1,200	1954-1958[h]	50	10.6	1947-1958[h]	94	6.2
Signaling devices	1958	200				1947-1954	43	5.2
Measuring and controlling instruments	1958	4,968	1954-1958	35	7.9	1947-1958	155	13.5
Typewriters	1958	272	1953-1958	31	5.6	1947-1958[k]	55	4.0
Electronic computers	1958	332	1954-1958	1,647	104.4			
Other office machines	1958	937	1953-1958	21	3.8		n.a.	
Office-machine parts	1958	326	1953-1958	275	30.2		n.a.	
Professional services								
Legal	1958	3,025	1953-1958	50	8.4	1947-1958	141	8.3
Engineering and architectural	1958	1,978	1953-1958	48	8.2	1947-1958	169	9.4
Accounting and auditing	1957	1,138	1953-1958[m]	56	11.8	1949-1957	152	12.2
Medical	1958	2,083	1953-1958	47	8.0	1947-1958	106	6.8

Table IX-2 (concluded)

Joint with financial services								
Check-deposit banking	1958	n.a.		n.a.			n.a.	
Securities brokers, etc.	1958	647	1954-1958[n]	44	9.4	1947-1958[n]	390	15.5
Insurance agents	1958	2,173	1954-1958	26	6.0	1947-1958	155	8.9
Real estate agents	1958	n.a.		n.a.			n.a.	
Wholesale agents	1954	1,229		n.a.		1948-1954	47	6.6
Miscellaneous business services	1958	1,714	1954-1958[o]	49	10.6		n.a.	
Government								
Federal	1958	1,555	1953-1958	7	1.3	[p]		
State and local	1958	2,419	1954-1958	36	8.0	[p]		
Total knowledge production	1958	136,436						
with data for recent period		129,597			8.8			
with data for longer period		113,811						10.6

[a] Includes only the congregational outlays of approximately 50 denominations.

[b] Does not include the item "transportation, supplies and clothing."

[c] Includes only items of earnings foregone (Schultz figures).

[d] Includes only receipts of photographic studios.

[e] Includes only receipts of photographic studios and photo-supply stores.

[f] Includes only retail sales of phonograph records.

[g] Includes only first-class and airmail.

[h] Sales receipts of manufacturers of telephone and telegraph equipment.

[k] The data from the Census of Manufactures used here are not quite comparable with those of the Current Industrial Reports used for the more recent period.

[m] Receipts of sole proprietorships only.

[n] Income originating in "securities brokers, etc." industry.

[o] Receipts of business-management consulting services are not included.

[p] Because of changes in reporting during the period, no comparable figures are obtainable.

the growth of GNP. The weighted average of the annual rates of increase over the most recent period of the 46 branches of knowledge-production for which we have data is 8.8 per cent. This compares with a 5.1 per cent rate of increase of GNP (at current prices) per year over the same four years. The weighted average of the annual rates of increase of the 36 branches of knowledge-production for which we have data covering the longer period is 10.6 per cent, which compares with a 5.9 per cent rate of increase of GNP (at current prices) over the same eleven years. The differences in the rates appear even more impressive if knowledge-production is compared with the production of everything else that is included in GNP. If knowledge-production, the sector comprising 28.7 per cent of total GNP, increased by 8.8 per cent (or 10.6 per cent over the longer period) per year, an increase of total GNP by 5.1 per cent (or 5.9 per cent) implies that the production of other goods and services increased by only 3.7 per cent (or 4.1 per cent over the longer period).

RESERVATIONS AND SPECULATIONS

These comparisons must be taken with several grains of salt. The procedure by which the growth of knowledge-production is held up for contrast with the growth of all other things, may be questioned because no account was taken of the missing data for 5 per cent of knowledge-production over the most recent period or 16.6 per cent of knowledge-production over the longer period. If the missing branches happened to be slow-growing, the use of the weighted average of "growth rates" of the branches represented in the tabulation as the rate applicable to the entire knowledge-production would overstate its growth. But it is unlikely that an overstatement on this ground would be serious enough to vitiate the general conclusion. The contrast would remain impressive even if the rates of increase in knowledge-production were not the full 2.4 times (or 2.6 times) the rates of increase in the production of other things.

There are, however, other grounds for objections or reservations. One may question the significance of the comparisons on the ground that the increases refer to amounts not corrected for possibly very different rates of price inflation. But the failure to correct for possible differences in price inflation may just as well involve an understatement as an overstatement of the differences in "real" growth rates. In any case, even if there should be less of a "price inflation effect" in other parts of GNP at current prices than in the expenditures for knowledge-production, the relative money expenditures and relative rates of increase remain interesting. That is to say, it is important to note that the money expenditures for intangible knowledge services rose much faster than the money expenditures for physical goods and other services.

For a better understanding of the meaning of "growth" in areas of production in which *output* cannot be measured, and most of the increase is in terms of expenditures for *input*, it may be helpful to go through a bit of hypothetical reasoning. Imagine an economy divided in two sectors, one, *A*, producing physical goods, the other, *B*, intangible services, *A* employing three fourths, *B* one fourth of the total labor force. Assume now an increase in productivity in sector *A* due to technological progress and a consequent increase in the physical output of sector *A* by, say, 10 per cent; assume further that all wages and salaries, in *A* and *B*, are increased by 10 per cent and that product prices remain unchanged. If there is no change in the allocation of resources, money expenditures will have increased by the same 10 per cent in both sectors. In Sector *A*, where "growth" is measured in terms of sales of output, an increased quantity of goods is sold at unchanged prices; in Sector *B*, where "growth" is measured in terms of payments for input, an unchanged quantity of labor is paid increased wages. Thus, the "real" increase in production in *A*, with no change in activity in *B*, results by way of adjustment in factor incomes in the same relative increase in expenditures for the intangible services of *B*. The "production" of intangible services by an unchanged quantity of labor with unchanged productivity will show the same percentage increase as the production of physical goods.

There is a reverse side to the coin. Increases in productivity in the performance of intangible services cannot be measured; indeed, most of them are in the form of improvements of quality, defying all attempts at quantification. No matter how "real," how substantial, how important they are, they need not be reflected in any increased money values of input—their only measure. As we have seen in the discussion of research and development, an increase in the efficiency and productivity of these activities may eventually result in increased productivity in industries producing physical goods, but the production of knowledge does not exhibit an increase on that score. This failure of "growth indices" to reflect improved efficiency in the production of intangible services has several implications. One of these relates to structural differences between economies: an economy with a large service-producing sector may not be able to "show off" with as large a physical growth rate as an economy that concentrates on the production of tangible goods, the increase of which is shown in the index of physical production and in GNP in constant dollars.

CHAPTER X · KNOWLEDGE PRODUCTION AND OCCUPATIONAL STRUCTURE

At last we are ready to take up the "occupation approach," which in Chapter III was contrasted with the "industry approach." The focus of our attention will now be on the worker, his activity and occupation, rather than on the industry in which he is employed. The question is whether, how, and to what extent the occupational composition of the labor force and of employment has changed, and how this change is connected with the changing role of knowledge-production in the economy.

Technology, Demand, and Occupational Structure

It may seem "self-evident" that great advances in technology and great shifts in demand lead to changes in the occupational composition of the labor force—but actually it is neither self-evident nor necessary in any sense. It is conceivable that all sorts of technological progress and shifts in demand leave the occupational structure of the economy unchanged, provided occupations are not too narrowly defined.

INEVITABLE, IMPOSSIBLE, AND PROBABLE CHANGES

Assume that a technological revolution in an industry allows the same output to be produced with half the quantity of physical labor, or twice the output with an unchanged work force. Even if demand is not sufficiently elastic to permit the same work force to be kept on to produce the doubled output, the workers released from this industry may find jobs requiring very similar kinds of work in other industries. If they cannot find such jobs at their accustomed wage rates, they may find them at relatively reduced wage rates.

Assume next that a drastic switch in demand occurs which, at given price relations, would call for more output of a product made with one type of labor, and less output of a product made with another type of labor. If workers are not flexible and cannot change over from one occupation to another, wage rates will rise in the one industry and fall in the other, and the prices of the products in question will do likewise, until the quantities demanded, despite the changes in demand, will be adjusted to the supply "dictated" by the inflexible occupational structure of the labor force.

Thus neither changes in technology nor in demand *necessarily* result in changes in the composition of the labor force. With inflexible skills and preferences on the part of labor, and flexible relative wage rates, the employed labor force can remain unchanged in composition. Its composition will change only where the labor force is adaptable and adjusts to the "requirements" of changed technology or changed demand.

In the United States, the labor force has been adaptable to a high degree. Workers, by and large, follow the monetary incentives created by changes in relative earnings; even where the wage rate is not sufficiently flexible, they respond to the stimuli of open job opportunities. For this reason it is highly probable that changes in technology or demand will result, with a natural time lag, in a corresponding change in the occupational structure of the labor force. (Incidentally, there can be considerable adaptability in the long run even without any workers changing their occupations: all that is needed is that new entrants into the labor force go into the occupations now favored by the changes in technology or demand, and allow other occupations to decline through death and retirement.)

Even with a highly adaptable labor force, it is not certain that every technological change releasing physical labor in a given industry will necessarily result in a decline in the ratio of physical labor to the labor force as a whole. Consumers, having more of their incomes left to spend on other things when one product becomes cheaper owing to improved technology, may well choose to buy goods and services produced with an even greater share of labor of the type displaced—so that no change in the composition of the labor force may be called for. But to say that not every technological change needs to have an effect upon the occupational structure is one thing; it is another to say what is likely to happen when many technological changes occur. If physical labor is displaced in a large number of industries, the probability is great (1) that some of the consumers' purchasing power will be used for things made with less physical labor and more of other types of labor, (2) that, on balance, therefore, demand will change in favor of these other types of labor, and (3) that consequently there will be a change in the composition of the labor force such that the share of physical labor is reduced.

It helps in the interpretation of observed statistical trends if one clearly understands the difference between what is logically necessary and what is logically probable. The "logic" in this connection refers to the concepts formed and their interrelations posited within the explanatory models of the economy.

MECHANIZATION AND AUTOMATION

Much of the technical progress of the past has consisted of the replacement of men by machines in particular production processes. This will undoubtedly be true also for the technical progress of the future. In recent years much has been heard about "automation" and how it threatens to depopulate entire industries. Automation and mechanization are often confused with each other, though it should not be too hard to keep them apart. Mechanization saves the use of human muscles, automation saves the use of human judgment. Mechanization, therefore, displaces physical labor, while automation displaces mental labor. These displacements occur in particular processes, not necessarily in the economy as a whole. The reabsorption of the displaced labor in other processes, industries, or sectors of the economy, may or may not be causally related to the displacement.

It is not possible to draw a clear and incontrovertible line between "physical" and "mental" labor. Almost every kind of operation requires both physical and mental effort. Even pressing a button, pushing a pen over a piece of paper, or dictating an order call for some muscular activity; on the other hand, lifting a bag, shoveling snow, carrying loads cannot be done without some mental activity. Yet, for theoretical as well as practical purposes it is possible to make the distinction between physical and mental operations, and between predominantly physical and predominantly mental labor. The frequently-used distinction between blue-collar and white-collar workers is designed precisely for this purpose.

When an "automatic control" device reaches "conclusions" and makes "decisions" which even the best human brains could not achieve with the same accuracy and/or the same speed, things become possible which brain power alone simply could not do. In these cases, automation does not "replace" mental labor hitherto employed, but merely permits things to be done that had not been possible before; the "thousands" of brains that are replaced in such instances are only hypothetical brains hypothetically employed. In other cases, however, there is actual replacement of human labor as a result of automation. Masses of clerical workers may be replaced by automatic bookkeeping and data-processing machines. In such instances, automation may reduce the share of white-collar labor in the work force of particular firms or industries.

In particular firms and industries mechanization may reduce the share of physical labor, while automation may reduce the share of mental (clerical, administrative) labor employed. This does not mean that automation tends to reduce the share of brain workers in the labor force of the economy as a whole. The design of automatic devices and their introduction and operation require brain workers of a higher calibre. This suggests that the distinction between physical and mental labor is really not adequate for the description of the consequences of labor replacement by machines. What we would need is a stratification of both physical and mental labor: physical labor of various degrees of manual skill, and mental labor of various degrees of analytical skill. On balance, the end effects of both mechanization and automation may then be found to lie in the demand for more highly skilled labor, manual and mental.

It would go too far beyond the scope of this volume to test this hypothesis on the basis of the statistical data at our disposal, though the census data on the occupational distribution of the labor force would be detailed enough to attempt a stratification of the sort proposed. At this juncture, we shall confine ourselves to two tasks: first, to observe what changes have occurred over the last 60 years in the relative distribution between "white-collar," "manual and service," and "farm" labor; and, secondly, to view the changing picture, over the same period, involving two groups, "knowledge-producing" and "not-knowledge-producing" or "primarily manual" labor. (These findings will be interesting enough, but I do intend in the near future to study the changing distribution of the labor force over *several* strata of skill in both knowledge-producing and manual occupations.)

The Changes in the Occupational Structure

The U.S. Bureau of the Census publishes occupation statistics for all "employed" and for all "economically active" persons. "Employed" includes "self-employed"; "economically active" includes unemployed with previous work experience (who are listed in the occupation in which they were last employed). The labor force is divided into almost 400 occupations within eleven "major occupation groups." These eleven groups are: (1) Professional, technical, and kindred workers, (2) farmers and farm managers, (3) managers, officials, and proprietors, except farm, (4) clerical and kindred workers, (5) sales workers, (6) craftsmen, foremen, and kindred workers, (7) operatives and kindred workers, (8) private household workers, (9) service workers, except private household, (10) farm laborers and foremen, and (11) laborers, except farm and mine. The data are obtained from the decennial population-census *enumerations* and from quarterly *sample surveys.* In the tables used in the following discussion, the figures for 1900, 1910, 1920, 1930, 1940, and 1950 come from the decennial population census, the figures for 1959 from the current population survey.

WHITE-COLLAR, MANUAL AND SERVICE, AND FARM WORKERS

The eleven "major occupation groups" can be regrouped into three categories: (*A*) "white-collar workers," consisting of groups (1) professional, technical, etc. (3) managers, officials, and proprietors (except farm), (4) clerical, etc., and (5) sales workers; (*B*) "manual and service workers," consisting of (6) craftsmen, foremen, etc., (7) operatives, etc., (8) private household workers, (9) service workers (except household), and (11) laborers; and (*C*) "farm workers," consisting of (2) farmers and farm managers, and (10) farm laborers and foremen. Table x-1 shows the number of persons in each of these three categories for given years from 1900 to 1959. This table shows that the number of white-collar workers increased steadily from 5 million in 1900 to 27 million in 1959, the number of manual and service workers increased from 13 million to 31 million, and the number of farm workers decreased from 11 million to 6 million. Thus, in 1959, white-collar workers were 540 per cent, manual and service workers 238 per cent, and farm workers 59 per cent of their respective

TABLE X-1

LABOR FORCE, OR ECONOMICALLY ACTIVE CIVILIAN POPULATION, BY BROAD OCCUPATION CATEGORIES, 1900-1959

(millions of persons)

Category	1900	1910	1920	1930	1940	1950	1959
White-collar	5	8	11	14	16	22	27
Manual and service	13	18	20	24	27	30	31
Farm	11	12	11	10	9	7	6
Total	29	37	42	49	52	59	65

SOURCES: For 1900 to 1950: U.S. Bureau of the Census, *Working Paper No. 5*, "Occupational Trends in the United States, 1900-1950." For 1959: *Current Population Reports*, Series P-60, No. 33, pp. 40-41.

NOTE: Figures do not always add up to total because of rounding. The 1959 data contain almost 4 million unemployed not distributed among occupation groups. In order to make the series comparable, these unemployed are here distributed among the three categories in the proportion in which the figures for "economically active" for 1950 exceeded those for "employed" in 1950, according to the *Current Population Reports*, Series P-60, No. 9 (April 1951), p. 36.

numbers in 1900. In the 19 years between 1940 and 1959 the number of white-collar workers increased by 69 per cent, and the number of manual and service workers by only 16 per cent, while the number of farm workers decreased by almost 29 per cent.

The distribution of the labor force among the three categories is brought out in stronger relief if it is shown as a percentage of the total. This is done in Table X-2. Farm workers, 37.5 per cent of the labor force in 1900, were only 9.9 per cent in 1959. Despite this decline in the percentage of farm workers, other physical workers, manual and service, increased only from 45 to 48 per cent of the total labor force.

TABLE X-2

LABOR FORCE: PERCENTAGE DISTRIBUTION OVER BROAD OCCUPATION CATEGORIES, 1900-1959

Category	1900	1910	1920	1930	1940	1950	1959
White-collar	17.6	21.3	24.9	29.4	31.1	36.6	42.1
Manual and service	44.9	47.7	48.1	49.4	51.5	51.6	48.0
Farm	37.5	30.9	27.0	21.2	17.4	11.8	9.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SOURCES: Same as Table X-1.

If all manual workers, industrial and agricultural, are taken together, their combined share in the labor force decreased from 82.4 per cent in 1900 to 57.9 per cent in 1959. White-collar workers, conversely, increased from 17.6 per cent of the labor force in 1900 to 42.1 per cent in 1959. This trend, uninterrupted for 60 years and probably longer, is most impressive.

KNOWLEDGE-PRODUCING AND NOT KNOWLEDGE-PRODUCING WORKERS

The "major occupation groups" distinguished by the Census Bureau, and the three occupation categories into which they were regrouped, are rather rough classifications for tests of the kinds of hypotheses that have suggested themselves in the course of the discussions in this survey of knowledge-production. Can all white-collar workers be regarded as knowledge-producing workers? Surely not without several qualifications or adjustments. In order to obtain a distribution of the labor force more suitable for our purposes, we must examine all occupations in the major groups distinguished by the Census Bureau, and make appropriate exclusions and inclusions.

In these adjustments we shall be guided by the definition and characterizations, offered in Chapter II, of knowledge-producing activities. Transporters, transformers, processors, interpreters, analyzers, and original creators of communications of all sorts will be regarded as knowledge-*producing* workers. (A narrower definition might well have been more appropriate, but we shall not change it at this point.) On the other hand, knowledge-*using* workers, however knowledgeable, will not be included if their product is not a communication or a service contributing to knowledge-transmission. If their product is a message, a piece of information, anything primarily designed to create an impression on someone's mind, they will be included among knowledge-producers, even if their own mental equipment is relatively poor. (This is emphasized as a reminder and a warning, not as a contention that this is necessarily the best thing to do.) Under this set of rules, the insurance salesman and the mail clerk are in the class of knowledge-producers, but dentists and veterinarians are not.

The following adjustments are made to carry out these resolutions. From the group of "professional, technical, and kindred workers," the first in the white-collar category, the following occupations are excluded as not knowledge-producing: chiropractors, dentists, funeral directors and embalmers, all nurses, pharmacists, 50 per cent of physicians and surgeons (on the assumption that only one half of their work is diagnostic and therapeutic advice and prescription), all technicians (medical, dental, testing, etc.), therapists and healers, and veterinarians. From the group "managers, officials, and proprietors (except farm)," railroad conductors, and all salaried or self-employed managers in retail trades, automobile repair services and garages, and miscellaneous repair services are excluded on the ground that they usually do not confine their activities to managerial tasks but participate in the physical work carried on in their shops. From the group "sales workers," hucksters, peddlers, and all persons in retail trade are excluded because they are less specialized in "sales talk" than in handling the merchandise sold. Finally, from the group "craftsmen, foremen, and kindred workers," the first in the blue-collar category, the members of the printing trades, particularly the electrotypers and stereotypers, engravers, photoengravers and lithographers, compositors and typesetters, pressmen and plate printers are shifted into the class of knowledge-producing workers.

These adjustments cause no difficulties in the census years. For 1959, however, the absence of detailed breakdowns necessitates some auxiliary manipulation. Assuming that the various detailed occupations

OCCUPATIONS OF THE ECONOMICALLY ACTIVE POPULATIONS,

	1900		1910	
	(thousand)	per cent	(thousand)	per cent
Class I				
Professional, technical and kindred workers	1,234		1,758	
Not knowledge-producing workers of this group	177		285	
Knowledge-producing workers of this group	1,057	3.64	1,473	3.95
Managers, officials and proprietors, excl. farm	1,697		2,462	
Not knowledge-producing workers of this group	973		1,197	
Knowledge-producing workers of this group	724	2.49	1,265	3.39
Clerical and kindred workers	877	3.02	1,987	5.33
Sales workers	1,307		1,750	
Not knowledge-producing workers of this group	1,007		1,199	
Knowledge-producing workers of this group	300	1.03	551	1.48
Knowledge-producing craftsmen, foremen and kindred workers	139	0.48	174	0.47
All knowledge-producing occupations	3,097	10.7	5,450	14.6
Class II				
Craftsmen, foremen and kindred workers (not knowledge-producing)	2,923		4,141	
Operatives and kindred workers	3,720		5,441	
Private household workers	1,579		1,851	
Service workers, except private household	1,047		1,711	
Laborers, except farm and mine	3,620		4,478	
Farmers and farm managers	5,763		6,163	
Farm laborers and foremen	5,125		5,370	
Occupations excluded from Class I	2,157		2,681	
All not knowledge-producing occupations	25,934	89.3	31,836	85.4
Total civilian labor force	29,029	100	37,286	100
Class III				
Full-time students in grades 9 and higher	937	3.2	1,470	3.9
A. Potential civilian labor force	29,966		38,756	
B. Potential civilian labor force in knowledge-producing occupations (Groups I + III)	4,034		6,920	
B as a percentage of A		13.5		17.9

SOURCES: 1900-1950: *Historical Statistics of the United States*, pp. 75-78, based on David L. Kaplan and M. Claire Casey, *Occupational Trends in the United States, 1900-1950*, Bureau of the Census, Working Paper No. 5, 1958. 1959: Bureau of Labor Statistics, *Special Labor Force*

TABLE X-3

BY PARTICIPATION IN KNOWLEDGE-PRODUCING ACTIVITIES, 1900-1959

1920		*1930*		*1940*		*1950*		*1959*	
(thousand)	per cent	(thousand)	per cent	(thousand)	per cent	(thousand)	per cent	(thousand)	per cent
2,283		3,311		3,879		5,081		7,264	
380		619		799		1,033		1,477	
1,903	4.51	2,692	5.53	3,080	5.95	4,048	6.86	5,787	8.42
2,803		3,614		3,770		5,155		7,025	
1,359		1,767		1,748		2,150		2,929	
1,444	3.42	1,847	3.79	2,022	3.91	3,005	5.26	4,096	5.96
3,385	8.02	4,336	8.91	4,982	9.65	7,232	12.25	9,671	14.06
2,058		3,059		3,450		4,133		4,557	
1,270		1,649		1,675		1,996		2,674	
788	1.87	1,410	2.90	1,775	3.43	2,137	3.62	1,883	2.74
187	0.44	251	0.51	257	0.50	284	0.48	317	0.46
7,707	18.3	10,536	21.6	12,116	23.4	16,706	28.3	21,754	31.6
5,295		5,995		5,946		8,066		8,698	
6,587		7,691		9,518		12,030		12,759	
1,411		1,998		2,412		1,539		2,302	
1,901		2,774		3,657		4,641		6,217	
4,905		5,335		4,875		3,885		4,207	
6,442		6,032		5,362		4,375		3,028	
4,948		4,290		3,632		2,578		2,694	
3,009		4,035		4,222		5,179		7,080	
34,498	81.7	38,150	78.4	39,624	76.6	42,293	71.7	46,985	68.4
42,205	100	48,686	100	51,740	100	58,999	100	68,739	100
3,098	7.3	5,905	12.1	8,617	16.7	9,068	15.4	13,340	19.4
45,303		54,581		60,357		68,067		82,079	
10,805		16,441		20,733		25,774		35,094	
	23.9		30.1		34.4		37.9		42.8

Report No. 4, Washington, 1960, Tables C-6 and F-3; and U.S. Office of Education, Advance release.

Explanations of transfers between Classes I and II are given in the discussion.

had in 1959 the same relative membership, in per cent of the "major occupation group" to which they belong, as in 1950, we use the 1950 shares of group totals to find the 1959 numbers of workers to be "transferred" from the knowledge-producing class to the not knowledge-producing class, or *vice versa.* Another makeshift is necessary for all census years because the numbers of retail sales workers are not separately stated. (They are given for 1959.) To make an educated guess of the numbers of retail sales workers, let us assume that they are equal to the numbers of managers or proprietors in the retail trades, an assumption suggested by the fact that they seem to consist chiefly of small-scale establishments with one hired worker helping the owner. The available figure for 1959 indicates that this procedure involves only a slight underestimation of the numbers of sales workers in retail trade in the preceding census years, say 1940 and 1950.

Table X-3 presents the results of all these adjustments and estimates in the form of a total (for each year) of persons in knowledge-producing occupations ("Class I") and a total of persons in not knowledge-producing occupations ("Class II"), adding up to the Total Civilian Labor Force. Added to this is the number of full-time students in grades 9 and higher ("Class III") because, in line with what was said in Chapter IV, students of working age should be considered as engaged in the production of knowledge in their own minds. They are members of a "potential" civilian labor force if labor force refers to "gainful" employment; alternatively, they may be regarded as members of the "actual" labor force, employed in their own education and presumably producing a value (embodied in human capital) at least equal to, and probably exceeding, the earnings foregone by their going to school.

The division of the civilian labor force into classes I and II shows a steady increase of Class I and steady decline of Class II. Class I, the knowledge-producing occupations, increased from 10.7 per cent of the labor force in 1900 to 31.6 per cent of the labor force in 1959. Class III, the potential members of the labor force who worked on producing knowledge in their own heads by going to school, increased from 3.2 per cent in 1900 to 19.4 per cent in 1959. These are percentages of the sums of Classes I and II. Expressed as percentages of the sums of all three classes—that is, of the potential civilian labor force—the combined membership in both kinds of knowledge-producing occupations, Classes I and III, increased from 13.5 per cent in 1900 to 42.8 per cent in 1959. The decision to combine Classes I and III makes good sense or not, depending on the purposes of the analysis. If the purpose is to show how society has changed its allocation of human resources among alternative activities, one will want to see the knowledge-transmitters and the full-time knowledge-receivers combined. If the purpose is to show how the active labor force has changed its composition, largely in response to technological progress and economic growth, one will confine his attention to the relative role of the knowledge-transmitters.

DIFFERENT GROWTH RATES WITHIN THE CLASS

Since the class of knowledge-producing occupations consists of five major occupation groups, we ought to examine whether the large increase is equally distributed among the groups or whether one or another of these groups is chiefly responsible for it. We shall find that over different periods different occupation groups contributed most to the growth of the class.

Looking first at the change in composition over the entire 60-year period, we find that the clerical occupations grew most remarkably, from 3 per cent of the labor force in 1900 to 14 per cent in 1959. But the other occupations in the class of knowledge-producers also assumed enlarged shares in the labor force, except the printers, who barely maintained theirs. Professional and technical workers grew from 3.6 per cent in 1900 to 8.4 per cent in 1959; managers, officials, and proprietors from 2.5 per cent to almost 6 per cent; sales workers (outside the retail field) from 1 per cent to 2.7 per cent.

Taking only the most recent decade into account, the improvement in the relative position of the professional-technical group is the most outstanding: from 6.8 per cent in 1950 to 8.4 per cent in 1959. This may indicate a strong impact of the technological "revolution" of which engineers and operations researchers have been telling us. On the other hand, the decline shown in the share of the sales workers (except retail) must not yet be accepted as a fact, because it may be merely the reflection of the probable underestimation of the retail sales force in 1940 and 1950 that was mentioned above.

Table x-4 presents the same body of data in the form of growth rates over periods of different length. Over the period from 1900 to 1959, when the total civilian labor force increased by 137 per cent, all knowledge-producing occupations increased by 602 per cent, with the clerical workers showing the fastest growth rate: 1,002 per cent. Over the 19 years from 1940 to 1959, the labor force increased by 23 per cent, all knowledge-producing occupations by 80 per cent, while the group of managers, officials, and proprietors led with a growth of 103 per cent. Over the last nine years, from 1950 to 1959, the increase in the labor force was 17 per cent, the increase in all knowledge-producing occupations 30 per cent, and the group of professional and technical workers grew at the fastest rate, 43 per cent.

TABLE X-4

GROWTH RATES OF KNOWLEDGE-PRODUCING OCCUPATIONS OVER THE LAST 9, 19, AND 59 YEARS

Occupation Group	*Percentage Change in Number of Persons* 1900-1959	1940-1959	1950-1959
Professional and technical, (excl. not knowledge-producing occupations)	448	88	43
Managers, officials and proprietors (excl. farm and other partly physically working occupations)	466	103	33
Clerical	1,002	94	34
Sales workers (excl. retail trade)	527	6	–12
Craftsmen and foremen in printing trades	128	23	12
All knowledge-producing occupations	602	80	30
Total civilian labor force	137	23	17

SOURCE: Table x-3.

The Income Shares of Knowledge-Producing Occupations

If the remarkable rise of knowledge-producing occupations in the total labor force is interpreted as an "adjustment" to other economic changes and as a "response" to economic incentives, it would be interesting to see whether the change in the occupational structure was associated with an equal or greater change in income distribution between the two broad occupation classes. If the income share of the knowledge-producers has increased at a faster rate than their share in the employed labor force, one might interpret this as supporting the hypothesis that earnings differentials played a significant role in the change in the occupational structure. If, on the other hand, the income share increased only at the same rate or more slowly, or not at all, other hypotheses would be suggested; for example, that the mere availability of job opportunities accomplished the relative reallocation usually attributed to differentials in the rates of earnings; or that the supply of knowledge-producing labor had increased faster than the demand, causing the relative earnings of such labor to decline and its income share to lag behind its increased share in employment. In any case, we should like to see what happened.

THE INCOMES IN KNOWLEDGE-PRODUCING OCCUPATIONS

In order to be able to assign income data to occupational groups, we shall have to use (1) the "gainfully employed" labor force rather than the "economically active" labor force (which includes unemployed); and (2) separate figures for male and female workers, since their earnings differ substantially (not so much for "equal work" as because they are given different kinds of jobs).

Census data are available for median wage-or-salary incomes for both sexes in each major occupation group. To estimate aggregate incomes we should appropriately have arithmetic means rather than medians, but the means have been estimated only for two years, 1939 and 1949, which is not sufficient for our purposes.[2] In using the medians as a basis for computing the total incomes earned by various occupation groups, we shall have to bear in mind the likelihood of substantial underestimations, and in computing the relative income shares, the possibility of distortions because of different deviations of the medians from the arithmetic means. On the other hand, since we are interested only in changes over time, it is not at all certain that the arithmetic means, if they were available, would give us more relevant information. For the relative attractiveness of different occupations the median incomes may surely be pertinent; and while it may not be sensible to multiply the number of persons by their median income in order to obtain total group incomes, it is sensible to do this multiplication in order to get weighted averages of the medians for aggregations of occupation groups.

In Table x-5 the occupational data are presented for the years 1940, 1950, and 1958, the matching income data for 1939, 1949, and 1958. From each occupation group the same exclusions are made that were described previously in connection with Table x-3, so that all not knowledge-producing occupations are eliminated.[3] It is not appropriate after these exclusions still to use the median incomes of the entire

[2] Herman P. Miller, *Income of the American People* (New York: Wiley, 1955), pp. 173-193.

[3] Since the numbers of employed sales workers in retail trades are given in the population census of 1940 and 1950, they can be eliminated without questionable estimation procedures; for 1958 the retail sales workers have to be estimated (by applying the 1950 ratios to the 1958 data of all sales workers) because they are not separately available in the same form as for 1940 and 1950.

TABLE X-5

INCOMES FROM EMPLOYMENT IN KNOWLEDGE-PRODUCING OCCUPATION GROUPS, 1940, 1950, and 1958

		1940			*1950*			*1958*		
		Number employed (thousand)	Median wage & salary income in dollars 1939	Total income (million dollars)	Number employed (thousand)	Median wage & salary income in dollars 1949	Total income (million dollars)	Number employed (thousand)	Median wage & salary income in dollars 1958	Total income (million dollars)
Professional, technical, and kindred workers	Male	1,875	1,809		2,911	3,699		4,420	5,956	
	Female	1,470	1,023		1,947	2,271		2,541	3,501	
Not knowledge-producing workers of this group[a]	Male	346			422			641		
	Female	391			566			739		
Knowledge-producing workers of this group	Male	1,529		2,766	2,489		9,207	3,779		22,508
	Female	1,079		1,104	1,381		3,136	1,802		6,309
Managers, officials, and proprietors (excl. farm)	Male	3,326	2,136		4,211	4,172		5,751	6,034	
	Female	424	1,107		673	2,296		1,034	3,313	
Not knowledge-producing workers of this group[a]	Male	1,508			1,684			2,300		
	Female	228			318			489		
Knowledge-producing workers of this group	Male	1,818		3,883	2,527		10,543	3,451		20,823
	Female	196		217	355		815	545		1,806
Clerical and kindred workers	Male	2,237	1,421	3,179	2,592	2,926	7,584	2,919	4,398	12,838
	Female	2,376	966	2,295	4,273	2,028	8,666	6,218	2,943	18,300

Table X-5
(concluded)

		1940			1950			1958		
		Number employed (thousand)	Median wage & salary income in dollars 1939	Total income (million dollars)	Number employed (thousand)	Median wage & salary income in dollars 1949	Total income (million dollars)	Number employed (thousand)	Median wage & salary income in dollars 1958	Total income (million dollars)
Sales workers	Male	2,124	1,277		2,570	2,916		2,580	4,291	
	Female	781	636		1,324	1,210		1,592	1,604	
Not knowledge-producing workers of this group[a]	Male	1,069			1,257			1,262		
	Female	726			1,185			1,425		
Knowledge-producing workers of this group	Male	1,055		1,347	1,313		3,829	1,318		5,656
	Female	55		35	139		168	167		268
Craftsmen, foremen, and kindred workers	Male	4,949	1,309		7,464	3,137		8,244	4,970	
	Female	107	827		237	2,001		225	3,000[b]	
Not knowledge-producing workers of this group[a]	Male	4,730			7,208			7,961		
	Female	98			221			210		
Knowledge-producing workers of this group	Male	219		287	256		803	283		1,407
	Female	9		7	16		32	15		45
All knowledge-producing workers		10,573		15,120	15,341		44,783	20,497		89,960
			Average income 1,430			Average income 2,919			Average income 4,389	

SOURCES: 1940-50: U.S. Bureau of the Census, *Census of the United States, 1940* and *1950*, and *Current Population Reports*, Series P-60, No. 33. 1959: U.S. Bureau of Labor Statistics, *Special Labor Force Report* No. 4, 1960, and U.S. Bureau of the Census, *Current Population Reports*, Series P-60, No. 33.

[a] Explanations of exclusions of "not knowledge-producing workers" are given in the discussion.

[b] This median wage income is not given in the Census Bureau reports. The round figure is an estimate not supported by evidence.

groups for the computations of the total incomes of the "expurgated" groups. But this is the best that can be done since income data for the detailed occupations are not available. As a consequence of such crude procedures, the "findings" may easily be vitiated, but we shall examine them none the less.

We find that in 1940 a total of 10,573,000 knowledge-producing workers were employed and earned a total of $15,120 million. In 1950 the number of this type of workers employed was 15,341,000 and their income $44,783 million. In 1958 there were 20,497,000 employed, earning $89,960 million. Their average annual incomes were $1,430 in 1940, $2,919 in 1950, and $4,389 in 1958—increases reflecting in a large part the inflation of the period. To interpret the changes in the total incomes of knowledge-producing workers we may compare these incomes (1) with total "employee compensation," (2) with the sum of employees' and proprietors' incomes, or (3) with national income. Since proprietors are included in one of the occupation groups, their incomes ought to be included too, though these incomes probably contain some returns other than labor income. To look into the ratios to national income will be pertinent because this will later afford us certain comparisons with some of the ratios developed from the industry approach summarized in the preceding chapter.

THE SHARES IN TOTAL INCOME

The results of our calculations, reproduced in Table X-6, conform with our expectations regarding the changes from 1950 to 1959, but are unexpected so far as 1940-1950 is concerned. Despite the large increase in the share of knowledge-producing workers in the total labor force (see Table X-3) and the similar increase in their share in total employment (line 3, Table X-6), their share in total income was the same in 1950 as in 1940. The absence of any growth in their income share is apparent in all three ratios, as per cent of total employee compensation (line 5), as per cent of employees' and proprietors' incomes (line 6), and as per cent of national income (line 7). We must remember, of course, that these "findings" may be only statistical illusions, created by clumsy or crafty juggling of data; and that these data in turn are more or less reliable estimates by economic statisticians who have learned that poor figures are preferable to none. But assuming that the findings conform to actual fact,[4] that is, assuming that between 1940 and 1950 the average salary or wage of knowledge-producing

[4] In order to exclude the possibility that the unexpected findings are not the result of our use of median incomes in lieu of arithmetic means, the computations made in connection with Table X-5 were repeated using the means estimated for 1939 and

TABLE X-6

RELATIVE EMPLOYMENT AND RELATIVE INCOMES FROM EMPLOYMENT IN KNOWLEDGE-PRODUCING OCCUPATION GROUPS, 1940, 1950, AND 1958

	1940 (incomes for 1939)	1950 (incomes for 1949)	1958 (incomes for 1958)
(1) Total employed persons	44.9 million	56.2 million	65.6 million
(2) Knowledge-producing persons employed	10.6 million	15.3 million	20.5 million
(3) Share in total employment $\left[\frac{(2)}{(1)} \times 100\right]$	23.6%	27.3%	31.3%
(4) Income of all knowledge-producing occupations	$15,120 million	$ 44,783 million	$ 89,960 million
(5) Income of all employees	$52,129 million	$154,190 million	$277,400 million
(6) Income of all employees and proprietors	$65,139 million	$191,731 million	$303,386 million
(7) National income	$81,634 million	$241,876 million	$336,183 million
(8) Share in employees' income $\left[\frac{(4)}{(5)} \times 100\right]$	29.0%	29.0%	32.4%
(9) Share in income of employees and proprietors $\left[\frac{(4)}{(6)} \times 100\right]$	23.2%	23.4%	29.7%
(10) Share in national income $\left[\frac{(4)}{(7)} \times 100\right]$	18.5%	18.5%	26.8%

SOURCES: (1): *Census of Population.* (2), (4): Table X-5. (5), (6), (7): *Survey of Current Business.*

1949 by Herman P. Miller. Since these estimates are not available for all occupation groups which we have included among knowledge-producing labor, the tabulation resulted in smaller numbers of workers and smaller income totals, but the comparison between the two years, 1939 and 1949, was still possible. It showed that the income share of the workers in knowledge-producing occupations had even *declined*—not remained constant, as had the shares computed by the use of the median incomes. In other words, their relative incomes had fallen even more, on the basis of the arithmetic means, than on the basis of the medians.

The explanation may lie in the narrowing of wage differentials during the period of inflation, both between and within occupations, and in the fact that the spread between median and average income is usually much wider for high-level white-collar workers than for manual labor. For example, in 1939, before the distortion of the income structure through inflation, the arithmetic means exceeded the median incomes in knowledge-producing occupations by 17.2 per cent on the average (and by as much as 36.4 per cent in the group of managers, officials, and proprietors, and 21.0 per cent in the group of professional and technical workers) but only by 9.9 per cent in not knowledge-producing occupations. The spreads were much smaller in 1949. Hence, on the basis of mean incomes the knowledge-producing labor had suffered an even worse decline, relative to manual labor, than on the basis of median incomes.

workers has actually declined relative to other wages, how can this fact be explained?

Two hypotheses were advanced for such an event in the introduction to this section. One posits an increase in job opportunities for members of knowledge-producing occupations at a time when job opportunities for other types of labor are limited. In such a situation there can be an influx into the occupations favored by better chances of employment even if they do not promise chances for higher earnings than in other occupations. An alternative hypothesis posits an autonomous increase in the supply of workers in knowledge-producing occupations which is not matched by an autonomous increase in demand. A third hypothesis can be based on a peculiarity of periods of inflation, namely, differences in the speed with which incomes in different occupations are adjusted to expansions of effective demand. It is quite likely that wages and salaries in knowledge-producing occupations are less flexible than wages of manual labor, and thus rise more slowly during an inflationary period such as that between 1940 and 1950. Closer inspection of Table x-5, however, reveals a fact which is almost sufficient to explain the relative decline of the earnings rates of knowledge-producing labor from 1940 to 1950: the number of women in clerical work increased by almost 80 per cent and this group commands the lowest pay of all workers in knowledge-producing occupations. (The wage of female sales workers is still lower, but they were largely excluded from Class I.)

From 1950 to 1958 the share of knowledge-producing occupations in total income increased substantially; the income of this class of workers rose from 29 to 32.4 per cent of total employee compensation; from 23.4 to 29.7 per cent of the sum of employees' and proprietors' incomes; and from 18.5 to 26.8 per cent of national income. These increases match or exceed the relative increase in employment in knowledge-producing occupations, which suggests that the demand for labor in these occupations increased more than the demand for other types of labor.

DIFFERENT CHANGES OF INCOME SHARES WITHIN THE CLASS

We strongly suspect that our broad classification involves aggregations of occupation groups so heterogeneous that the most significant structural changes remain hidden. Although professional, technical, clerical, and sales workers all earn their living chiefly by talking and writing—and are for this reason thrown together as members of knowledge-producing occupations—the kinds of talk and the kinds of pen-pushing and paper-shuffling are sufficiently different to merit separate treatment in many respects, particularly with regard to their employment and earnings opportunities. As a matter of fact, the statistical data of Table x-5, however crude, do show that the income shares of particular occupation groups within the class of knowledge-producers have not all changed the same way as the share of the entire class.

Confining ourselves to one of the three ratios, that of the occupational-group income to the sum of all employees' and proprietors' incomes, we find that during the war-and-inflation decade, 1940-1950, the "managers, officials, and proprietors" and the clerical workers lost some ground. The income share of the former fell from 6.1 to 5.9

TABLE X-7

RATIOS OF INCOMES OF CERTAIN OCCUPATION GROUPS TO THE SUMS OF ALL EMPLOYEES' AND PROPRIETORS' INCOMES, 1940, 1950, AND 1958

Occupational Group	1940	1950	1958
Professional and technical workers (excl. not knowledge-producing occupations)	5.9	6.5	9.5
Managers, officials, and proprietors (excl. farm and other partly physically working occupations)	6.1	5.9	7.5
Clerical	8.7	8.5	10.2
Sales workers (excl. retail trade)	2.1	2.1	2.0
Craftsmen and foremen in printing trades	0.45	0.43	0.47
All knowledge-producing occupations	23.2	23.4	29.7

SOURCE: Table x-5.

per cent, the share of the latter from 8.7 to 8.5 per cent. The sales workers barely held their ground, as did the printers, despite their strong trade union. On the other hand, the group of professional and technical workers—although it includes the teachers, who were notorious losers in this respect—improved its income share from 5.9 to 6.5 per cent. Thus, the high-level-knowledge-producers—if we may assume that this group contains more knowledge interpreters, analysts, and creators than the others—gained both from 1940 to 1950 and from 1950 to 1958. The percentages are summarized in Table x-7.

Some Implications

Despite the poverty of the statistical series they do appear to establish certain facts and strong trends that are significant for our discussion.

THE FACTS AND THE TRENDS

Before we formulate what can be said about trends exhibited by our data, we should refer to one or two facts in addition to those already cited, for they throw a sharp light upon the employment situation of manual and white-collar workers.

From 1950 to 1959, while the total number employed increased, employment of "production workers" in manufacturing declined both relatively and absolutely; the employment of nonproduction workers increased by over 48 per cent.[5] This rise in employment of nonmanual labor and fall in employment of manual labor are also reflected in the incidence of unemployment: the ratio of unemployed to employed is now twice as high among blue-collar workers as among white-collar workers.

These are the trends read from the statistical series: (1) The knowledge-producing occupations have grown over the last 60 years much faster than occupations requiring manual labor. (2) The share of knowledge-producing occupations in the total labor force tripled between 1900 and 1959. (3) The share of these occupations in total employment has increased even more. (4) While in the first part of this century growth was fastest in clerical occupations, the lead was then taken by managerial and executive occupations, and more recently by professional and technical personnel. (5) The share of knowledge-producing occupations in total income has increased during the last decade. (6) The share of professional and technical personnel in total income has increased during the last two decades.

INTERPRETATION

From these trends one may safely conclude that both the supply of and the demand for knowledge-producing personnel have been increasing. In particular it seems safe to conclude that technological progress has been such as to favor the employment of knowledge-producing labor; that shifts of demand for final products have been such as to increase the demand for such labor over the demand for unskilled manual labor, and that the supply of labor suitable for knowledge-producing occupations has increased, presumably as a result of more widespread school attendance.

Heavy emphasis, I submit, should be placed upon the fourth of the trend-propositions formulated above. It asserts a trend within a trend: while the ascendancy of knowledge-producing occupations has been

[5] *Statistical Abstract of the United States,* 1960, p. 209.

an uninterrupted process, there has been a succession of occupations leading this movement, first clerical, then administrative and managerial, and now professional and technical personnel. Thus, the changing employment pattern indicates a continuing movement from manual to mental, and from less to more highly trained labor.

IMPLICATIONS

If employment opportunities continue to improve for high-level-knowledge-producing labor and to worsen for unskilled manual labor, the danger of increasing unemployment among the latter becomes more serious. To speak of absolute unemployability of people of low intelligence and little training may be going too far, because employability is partly a matter of the price at which labor is offered. But since society no longer tolerates "cheap" labor, and unskilled physical labor may find uses only if it is cheap, the combination of our social ideas with the continuing technological and economic trends may in fact spell unemployability for certain low-level types of labor. At socially acceptable wage rates, workers of very low economic productivity may remain permanently unemployed; and this unemployment is apt to persist even in the face of attempts to create "effective demand" if wage rates are promptly adjusted to inflated price levels.

A cogent exposition of this "Theory of Creeping Unemployment and Labor Force Displacement" has been presented by Clarence D. Long.[6] The continuing upward creep of the unemployment rate in prosperity periods is, according to this theory, the result of a widening productivity spread and a constant relative-wage spread. Productivity of above-average workers increases faster than productivity of below-average workers: thus productivity differentials among different types of labor become greater. If average wage rates rise at the rate at which average productivity increases, and if the lowest wage rates rise at the same rate as the average—so that the percentage spread between minimum and average wages does not increase—it follows that the minimum wage rates rise faster than the productivity of low-level labor, with the result that such labor can no longer be employed with profit.[7]

[6] Delivered before the Catholic Economic Association at its annual meeting in St. Louis, December 27, 1960. An abstract appeared, under the title "The Challenge of the 1960's," in *Review of Social Economy*, Vol. XIX (1961), pp. 14-17.

[7] It is difficult to adduce empirical evidence for productivity differentials if money earnings cannot be used (since in the present case productivity differentials are compared with "inadequate" earnings differentials). Long does show widening differentials of intelligence scores and of the amount of schooling.

(The minimum wage in this context need not be that prescribed by law; custom or employer ethics may forbid paying less.)

Long's theory is sufficiently general to apply to any kind of labor offered by workers of different ability and training. It applies, however, with special relevance to the situation described here, in which employment opportunities for low-skilled physical labor have been declining, and the economic productivity of high-level-knowledge-producing labor increasing. The implications, then, of the trends observed with regard to the occupational composition of the employed labor force are rather dismal. They seem to leave us with an unpleasant choice: either to resign ourselves to larger wage differentials, increasing spreads between minimum and average earnings, or to face a continuing upward creep of the rate of unemployment, not only in bad times but also in prosperity. Perhaps this dilemma can be avoided by a third possibility, namely, through a drastic improvement of school programs that raises the lazy and unambitious to higher levels of accomplishment. But even if this is a possibility, it can be realized only years after the school reform, a reform which probably is not much less unpopular than low wages or unemployment.

Industries and Occupations: Ratios and Growth Rates

One more promissory note remains to be redeemed. We have promised to compare the findings of the occupation approach with those of the industry approach. In particular, we want to compare (1) the total product of, or rather expenditures in, knowledge-producing *industries*, relative to the total product of the economy, with the total income of knowledge-producing *occupations*, relative to the total income of the economy; and (2) the growth of the output of or expenditures in knowledge-producing *industries* in the recent past with the growth of income of knowledge-producing *occupations* during approximately the same period.

RATIOS TO TOTAL PRODUCT

The first of these comparisons requires only that we set side by side ratios computed earlier in this chapter and in the preceding one.

In Table IX-1 we listed the 1958 expenditures in all branches of knowledge-production and obtained a total of $136,436 million, of which $109, 204 million were regarded as "final product." Since this contained several items not included in the official Gross National Product, we added these items to the GNP and obtained approximately

$478,000 million as the adjusted GNP for 1958. The expenditures for knowledge-production were almost 29 per cent of the adjusted GNP. The expenditures for knowledge as final product were 23 per cent of the adjusted GNP.

In Table x-5 we tabulated estimates of the incomes of workers in knowledge-producing occupations and obtained for 1958 a total of $89,960 million. The national income of the same year was $336,183 million. As shown in Table x-6, the income of knowledge-producing workers was 26.8 per cent of the national income in 1958. Neither the knowledge-workers' income nor the national income contained the earnings foregone by persons engaged in education. If these potential earnings, which we had included among the cost of education—$13,519 million for high-school students, $7,189 million for students in higher education, and $4,432 million for mothers staying home to educate their pre-school children, together $25,140 million—are added, we obtain $115,100 million as the total of actual and foregone incomes of knowledge-producing workers, and $361,323 million as the national income adjusted for the incomes foregone by potential workers giving or receiving education. The former figure is 32 per cent of the latter.

This, then, is the set of ratios: 29 and 23 per cent by the industry approach, and 27 and 32 per cent by the occupation approach. These ratios refer to different things and, naturally, must not be expected to be the same. The discrepancies are certainly not greater than one should expect from an understanding of the concepts involved. As a matter of fact, there is no reason why the various approaches should yield ratios as similar as the above ones. When we first considered the possibility of the two approaches, we pictured an imaginary economy so organized that the results of the two approaches would be almost the same; and we concluded that the economies of the real world were quite different from the imaginary one. (See Chapter III, pp. 4-6.)

GROWTH RATES

There is some reason for expecting that "growth rates" derived from the two approaches are similar, though any optimism in this respect should be tempered by a realization of the roughness of many of the estimates by which our statistical data were obtained.

The industry approach yielded "growth rates" for the four-year period 1954-1958 and for the eleven-year period 1947-1958. The occupation approach furnished growth figures for the eight-year period

1950-1958, for the 18-year period 1940-1958, and for even longer intervals. The only comparisons that can reasonably be made are between annual growth rates computed from the eleven-year period of industry growth and from the eight-year period of growth of workers' incomes.

The weighted average of the approximately eleven-year growth rates of 36 different knowledge industries tabulated in Table IX-2 was 10.6 per cent per year.

Table X-5 showed that for all workers in knowledge-producing occupations the incomes from employment rose from $44,783 million in 1950 to $89,960 million in 1958, or by 100.88 per cent. This growth over eight years constitutes a growth rate of 9.1 per cent per year.

The similarity of these results, 10.6 and 9.1 per cent, is close. No attempt has been made to reconsider or revise any of the estimates in the hope of achieving greater correspondence in the results from the two approaches. All preceding pages of this book had been completed before the consistency of the results was established at this point.

This consistency should not make us overly confident. The reliability of the data with which we worked must not be overestimated, and the legitimacy of several of the uses we made of them may be questioned. Indeed some of the statistical procedures were accepted only as make-shifts and in the hope that others may improve upon our most imperfect effort.

Statistical Accuracy and General Conclusions

Our attitude of caution regarding the accuracy of statistical data and the reliability of ratios between them should not be misread to imply serious reservations concerning the validity of the generalizations developed in this book. Many things can be said about general trends and interrelated developments even if the illustrative or supporting data are less than accurate. What has been said about changes in the occupational structure remains valid even if the basic statistics are somewhat off the mark. And what has been said about the cost and efficiency of education, or research and development, is not vitiated by flaws that can be detected in the statistical data. Thus I hope no one will discard the proposal for educational reform just on the ground that some of the estimates of the expenditures or implicit costs may be questionable. While statistical tables have crowded the pages of this book, concern about their adequacy should not crowd out the message it conveys.

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