ON OBTAINING AN ANSWER TO THE QUESTION: "IS THERE A SHORTAGE OF SCIENTIFIC AND ENGINEERING MANPOWER?"

By: Philip M. Hauser, University of Chicago

The advent of Sputnik about a year ago shocked a United States, unprepared for the event, into a number of frenzied reactions. Two of these reactions bordering on the hysterical, were glaring non-sequiturs in respect of the quality of U.S. education and of the supply of U.S. scientists and engineers. The USSR presumably achieved its triumph in space rocketry because U.S. high school and college training had gone "soft" and did not match Soviet educational standards; and because the U.S. did not have enough, as well as not able enough, scientists and engineers.

The USSR achievement certainly was based on Soviet strength, rather than U.S. weaknesses. The failure of the U.S. to be the first in space rocketry as in many other scientific and engineering developments could conceivably be, and probably was, not an indication of inferior U.S. education or of shortages in scientists and engineers but, rather, a manifestation of the way in which these human resources were allocated. Our scientists and engineers were busy on other matters--including ways and means of cramming more horsepower, more chrome and longer fins into and onto automobiles.

To the pressure for more and better information about scientists and engineers generated by the contrast between U.S. and USSR achievements in rocketry and its implications for national defense, is that produced by the continuing and heightening interest in the role of scientists and engineers in our expanding and increasingly complex economy. The need for information about these highly specialized human resources for "peacetime" purposes is at least as important as that for national defense and, in modern "total war" is in a large measure actually coterminous with national defense needs.

Even if it were demonstrable with available data that there is at present a shortage of scientific and technical manpower, there would still remain large areas of ignorance as to the reason for such a deficiency. Would such a shortage be the result of decreasing, or if not decreasing, in any case, inadequate proportions of students entering the scientific, engineering and technical professions or arts? Of if there were a shortage, would it merely reflect the changes in the age structure of the population? These have in recent years included decreasing proportions and even absolute numbers of persons of labor force entrance age, as a result of the depressed marriage and birth rate of the 1930's. Because of the changing age structure of the U.S. population it has been possible in recent years for the number of new entry scientists, engineers and technicians, as well as new entries to other occupations, to decrease even if the proportion of persons reaching working age entering the occupations increased.

These essayist observations are designed briefly to portray at least parts of the context in which the question was raised: "Is there a shortage of scientific and engineering manpower?" Is there?

The answer is that there are conflicting answers to the question.

In recognition of the inadequacies of the information available about the number and quality of scientists, engineers, and technicians in relation to demand, the President's Committee on Scientists and Engineers, on the one hand, and the Bureau of the Budget through the National Science Foundation, set out to develop a program for the collection of the desired data. An Advisory Panel was jointly established by these agencies to review and evaluate the available information and to make such recommendations as might be indicated for ways and means of improving it.[1] The Advisory Panel was assisted in its work by staff members of the Surveys and Research Corporation which served as its secretariat;[2] and by representatives of several Federal Governmental Agencies who participated as consultants to the Advisory Panel.[3] The results of the labors of the Advisory Panel are reported in A Program for National Information on Scientific and Technical Personnel.[4] The discussion which follows is based on the work of the Advisory Panel, on which the writer was privileged to serve as Chairman.

Available Data

Some data are, of course, available on scientific, engineering and technical personnel. These were inventoried and described in the Report to which reference has been made. They are available as part of the statistical and general informational output of such agencies as the Bureau of the Census, the Bureau of Labor Statistics, the Office of Education, the National Office of Vital Statistics, the National Research Council and of one of the sponsoring agencies of the Advisory Panel—the National Science Foundation.

In addition to these agencies with relatively broad and comprehensive types of information, a number of other agencies have more restricted or spot survey types of information. These include such organizations as the Department of National Defense, the National Education Association, the American Chemical Society, the National Society for Professional Engineers, the National Manpower Council, the National Bureau of Economic Research, and the American Society of Engineering Education.

In general, the available data include more about the supply of scientific and engineering personnel, than about the demand for them; more about their quantity than about their quality; more about their placement than about their actual utilization; and more about them in cross section than in longitudinal flow. The Advisory Panel's review of available information disclosed an especially serious deficiency in information about the demand for scientists and engineers, and, also, serious shortcomings in the techniques of anticipating and measuring future demand. Also badly deficient is the available information on the flow of personnel into the scientific, engineering and technical occupations, on their actual utilization, on their quantity, including their innate capacities and training, and on their attrition. Finally, as a climactic indicator of the ignorance we have accumulated about our scientific and technical human resources, it early

became apparent to the Panel that there was not even available an adequate framework for the identification of scientific and technical manpower. No adequate classification of scientists, engineers, and technical personnel is available with which even to delimit the specific occupations of concern, let alone one which provides a frame which analyzes work content, or describes specific jobs for either statistical or use purposes.

The Advisory Panel, after a fairly intensive review of the information on scientific manpower, concluded, with good reason, that "the data found available are in general painfully inadequate."[5] It also concluded that "In the face of the foreseeable long-term manpower needs, the Nation cannot long afford to leave the gaps in its information unfilled and the deficiencies in data unremedied."[6] It was with this perspective and with the instruction from the sponsoring agencies to create a plan for an adequate body of data, that the following framework for a statistical program was developed.

Statistical Program

As a preliminary to the design of a blueprint for an adequate statistical program, consideration was given to the basic issues which confront the agencies faced with the formulation of national policy on scientific and engineering manpower questions. These turned out to be centered largely around problems of recruiting, training, utilizing (including conscripting) compensating, and conserving these relatively scrace and expensive human assets. The issues practically all involved long run considerations. And, as the issues were explicitly stated and specific questions put, the inadequacies of available data became increasingly apparent.[7] The basic issues formulated and the specific questions which were raised led to the development of a conceptual framework around which the statistical collections and reports were to be organized.

Conceptual Framework

The key elements in the conceptual framework which emerged from the deliberations of the Advisory Panel were "supply", "flow" and "demand".

1. Supply. "Supply" was elaborated into four major categories, each with sub-components, namely: 1. current supply; 2. potential increments to supply-short term; 3. potential increments to supply-long term; and 4. "all other." This categorization of the supply factor was made operational through linkage with the concepts used in the labor force measurement as developed by the Bureau of the Census and cooperating agencies. More specifically the total population 14 years of age and over was dichotomized into those "in the labor force" and those "not in the labor force." These groups were then sub-divided into 8 groups, with some sub-total combinations, as indicated:

Total Population 14 Years Old and Over by Labor Force Categories--

In the Labor Force:
1. Employed or Seeking S & T (Scientific & Technical positions)
2. Trained in S & T
3. Could be trained in S & T
4. Could not be trained in S & T

Not in the Labor Force:
5. Trained in S & T
6. Being trained in S & T
7. Could be trained in S & T
8. Could not be trained in S & T

These labor force groupings were then related to the four major categories of supply as follows:

Total Population 14 Years Old and Over by S & T Supply Categories--

A. Current Supply
   1. Employed and seeking work in S & T
B. Potential Increments to Supply - Short term
   2. In Labor Force trained in S & T
   5. Not in Labor Force, trained in S & T
   6. Not in Labor Force, being trained in S&T
C. Potential Increments to Supply - Long term
   3. In Labor Force, could be trained in S&T
   7. Not in Labor Force, could be trained in S & T
D. All Others
   4. In Labor Force - could not be trained in S & T
   8. Not in Labor Force - could not be trained in S & T

With these eight groupings of the population cross-classified by labor force and scientific and technical status identified, the next step was that of determining the kinds of information needed for each group. In general, it was concluded that five types of information were desired; namely, statistics relating to:

1. economic characteristics, including scientific and technical jobs, industries in which utilized, compensation and fringe benefits, functions performed, working conditions and the like;
2. demographic characteristics--location, sex, age, race, etc.;
3. educational and training characteristics
4. aptitude and skill characteristics, including level of mental ability;
5. community characteristics--the prestige accorded science, engineering and technical vocations, status, attitudes, etc.

2. Flow. Concern with scientific and technical manpower necessarily must take the time dimension into account. Such personnel is the product of relatively prolonged training, and the demand for them is vitally affected by trends in research, technology, and economic and social organization. Any cross section picture of scientific and technical personnel must, therefore, be supplemented by longitudinal data--by inflow and outflow information.

The supply of scientific and technical personnel, of course, is first of all a function of the size and composition and changes in size and composition of the total population. Starting with the measurement of total population, happily available even on a current basis for larger areas of the United States, the inflow of scientific and technical personnel is dependent on the following: 1. the formal educational system; 2. special training courses and apprenticeship; 3. informal training; 4. immigration (of trained personnel); 5. reentry of retirees and others not

in the labor force; 6. transfers from other occupations.

The supply of scientific and technical personnel is subject continuously to outflow as well as to inflow. The chief categories of outflow are: 1. mortality, 2. retirement, 3. emigration (of scientific and technical personnel), 4. transfer to other occupations, 5. departure from the labor force, other than through death or retirement.

The information needed about inflow relates both to those who come into the scientific and technical manpower pool and the characteristics of the source. For example, inflow from the formal educational system requires information both about the trainees and the educational system which trains them. Similarly, information is needed both on the trainees and the institutional provisions which provide scientific and technical persons from sources outside the formal educational system--in-plant training and various types of special training programs. The Panel report spells out in some detail the kinds of information needed about each of the inflow sources to provide the needed longitudinal picture.[8]

To complete the flow picture, statistics are also needed on outflow--on the attrition of the scientific and technical manpower pool through death, retirement, emigration, transfer and departure from the labor force, for reasons other than death or retirement. These types of data are also described in the report.[10] Attrition rates, by source, must necessarily be part of any program designed to measure the pool and changes in the pool of scientists, engineers and technicians.

3. Demand. "Demand" was conceived of as consisting not only of unsatisfied but, also, met requirements for scientific and technical personnel. Thus, persons employed in scientific and technical jobs are part of the demand. Moreover, only "effective demand" was considered --demand that was, or could be met, under actual or obtainable salary schedules and working conditions. Demand, for operational purposes, was regarded as consisting of three components: 1. scientific and technical personnel currently employed; 2. established but unfilled scientific and technical positions; and 3. need for scientific and technical personnel recognized by employers (willing and able to attract personnel) but for which positions were not yet established.

To measure demand in cross section, the actual employment of scientific and technical personnel and current needs for additional personnel must be ascertained. Such information is presumably available from employers and potential employers. To measure future demand, however, is not so simple. Even the willing employer respondent is likely not to know. To assay future demand, knowledge of the factors which produce the demand and the trends in these factors is necessary. In consequence, an effort was made to analyze the "determinants of changes in demand" to provide a frame for anticipating future demand. These elements were classified into 7 groups: 1. population growth, 2. economic growth and change; 3. growth in urbanism; 4. levels, content and quality of education; 5. research and development; 6. requirements of national defense; 7. "other factors" including such basic things as the changing role of the United States in world affairs, governmental policies, organization structure of scientific activity, changing practices in use of scientific and technical personnel and the relevant democratic value system.

Trend analyses of each of these factors in relation to demand for scientific and technical personnel, it was posited, could provide a firmer basis than now exists for the quantification of future demand.

Projects

The conceptual framework which was developed served as the basis for the specific project recommendations which were made. The specific statistical and research operations which are proposed are, with a summary of the available data, presented in the Report in relation to, and in the context of, the concepts described. In all, 15 projects involving some 27 surveys or researches are recommended. They are presented in the Report in three classifications: first, in priority order by functional description;[10] second, in relation to the conceptual framework developed--under supply,[11] flow,[12] and demand;[13] and third, in operational terms, in the "Summary" under headings of: 1. "extensions of existing programs of data-collection and analysis"; 2. "new surveys conducted through establishments"; 3. "new surveys of population"; and 4. "new research in special problem areas."[14]

In the priority category of "most urgent" surveys the following are recommended:[15]

1. Identification of Scientific and Technical Occupations
   Analysis of work content and job descriptions in scientific, technical and related fields, to develop a set of job definitions and a classification, and to develop methods for identifying these occupational categories with adequate precision when conducting such surveys.
2. Pool of Scientific and Technical Personnel
   A periodic survey, using appropriate sampling techniques, of organizations and agencies of all types which are employers of scientific and technical personnel, to obtain information on the numbers and characteristics of such personnel.
   From time to time intensive analyses, through personal interviews, of a sub-sample of present and former scientific and technical personnel, to determine the number, occupation, and economic and personal characteristics of these persons; and to obtain information concerning the nature of movement into and out of the supply.
3. Periodic Study of the Demand Outlook for Various Categories of Scientific and Technical Personnel in Each Major Activity
   The study would include the analysis of: (a) employment and production growth trends; and (b) the changing roles of particular

classes of scientific and technical personnel, to develop current estimates and forecasts of demand for such personnel by occupation and educational levels.

These projects would, among other things, provide a better answer than is now possible to the question of whether there is a shortage of scientific and technical personnel. The first of these projects would make possible good identification of the pool of manpower that is included when the rubric "scientific, engineering and technical" is used. The second would provide a much more adequate measurement than now exists, and on a periodic basis, of the actual pool of employed scientific and technical personnel, on their number and their characteristics, including their mobility or flow. The third project would provide a benchmark measurement of current demand, and, eventually, some projection of demand which, in relation to supply, could provide other than a speculative answer to the question of alleged "shortage."

These projects alone could greatly increase our present knowledge about scientific and technical manpower. But they, by themselves, would fall far short of answering the crucial questions which must be answered if policy and action are to be based on sound knowledge. The other projects proposed were also regarded by the Advisory Panel as "urgent"—even if not as "most urgent." On a functional basis these "urgent" projects are listed as follows:[16]

Studies of Supply and Utilization

4. 1960 Census Survey of College Graduates: Scientific, Technical and Other Specialized Personnel
   A special direct survey of a large sample of the persons recorded in the 1960 Census enumeration as college graduates or as persons currently or last employed in scientific and technical positions, whether college graduates or not, to determine relationships between training and subsequent occupation.
5. Sample Population Survey
   An occasional survey similar to the Current Population Survey of the Bureau of the Census, to provide source data for estimating both the current supply of scientific and technical personnel and potential increments to it, as well as net turnover.
6. Analysis of Data from National Register of Scientific and Technical Personnel
   Continuing analysis of Register data on social and economic characteristics of scientific personnel listed, to determine age, levels of education, functions, type of employer, scientific specialization, income level, etc.

Extension of the Coverage of School Reporting Comparison of Data from Diverse Sources, and Other Educational Data

7. Extension of School Reporting
   Extension of the annual and biennial statistical reporting program of the Office of Education to obtain a more complete view of the nation's educational system, with particular reference to private schools, college enrollments and course enrollments.
8. Comparison of Data from Diverse Sources on School Enrollment and Educational Attainment.
   An intensive statistical analysis to compare and coordinate Office of Education data on enrollments and graduates with Bureau of the Census data on enrollment and highest grade of school completed.
9. Reports of Government Technical Schools
   Initiation of annual reports from the appropriate governmental agencies concerning technical schools for higher education operated by them, the character and extent of science instruction provided and the utilization of personnel trained in science and engineering; to determine the level and extent of such training.
10. Analysis of Factors in School Retention
    Studies of the factors related to drop-outs of students in various fields and of different ability levels, at particular grades in school, seeking particularly to measure the effects of financial factors.

Research into Aptitudes in and Attitudes Toward Science and Engineering

Several related types of inquiry: (a) to determine the distribution of youth in terms of general mental ability and other more specific aptitudes; (b) to measure comprehension of scientific subject matter; (c) to ascertain the attitudes of students toward science and engineering at several educational levels; and (d) to ascertain student's occupational conceptions and choice.

12. Follow-up Surveys of Recent College Graduates
    Surveys of samples of recent college graduates made two, four, and six years after graduation to learn the beginning career patterns of young graduates as these relate to their major fields of study and other personal characteristics.
13. Research into Community Attitudes Toward Scientific and Technical Personnel
    Studies of the attitudes of American communities toward science and engineering and the individuals who are occupied in these fields, to determine their importance in influencing occupational choice.

Surveys of Curricula and Physical Facilities Available for the Teaching of Science and Engineering

14. Surveys of Curricula in Science and Engineering
    Periodic surveys of the courses offered in the science and engineering programs of schools and colleges.
15. Surveys of Physical Facilities for the Teaching of Science
    Periodic surveys to determine the adequacy of laboratory and other equipment used for the teaching of specific science and engineering courses in the nation's schools and colleges.
16. Research into the Quality of Science Instruction

Studies to determine the effectiveness of science and engineering teaching, with the principal purposes of isolating the background factors and personal qualities which characterize the most effective teachers.

Surveys of Training Programs in Science and Engineering Outside the Formal Education System

17. Surveys of Training Programs for Scientific and Engineering Technicians in Industrial and Commercial Establishments

Sample surveys to obtain information on formal courses given to technicians within such establishments, including apprenticeship programs for training technicians, to determine their importance in supplementary technical training.

18. Surveys of Advanced Scientific Training Programs of Industrial and Commercial Establishments

Surveys of the formal, advanced scientific and technological training programs conducted by business establishments for their scientific personnel possessing college degrees or equivalent backgrounds, to determine the level, content, and relative importance of such programs in the nation's scientific training effort.

19. Study of Background of Scientific and Technical Personnel Who Have Had No Formal Training

Identification of selected scientists and technicians who have received no formal training and the analysis by case studies of their background and the means through which their status was obtained; in order to appraise the possible importance of the informal training methods disclosed.

Surveys of Changes in Supply from Immigration and Emigration, Retirement, Other Causes and Death

20. Reports on Immigration and Emigration of Scientific and Technical Personnel

Initiation of annual reports on the scientific and technical personnel of foreign citizenship who immigrate into or emigrate from this country. Study the extent and character of emigration of scientific personnel who are citizens to determine its relationship to the overall supply.

21. Interview Survey of Retirees

Special survey to be repeated periodically of a sample of retired scientific and technical personnel, designed to ascertain their ability and willingness to resume active employment full-time or part-time if needed.

22. Additional Study of Occupational Mortality Rates Among Scientific and Technical Personnel

Intensive study of differential mortality among occupational groups of scientific and technical personnel, to improve estimating methods.

Studies of Demand

23. Correlation Regressions Among Major Determinants of Demand for Scientific and Technical Personnel

Historical studies of the regression relationships between demand series and trends in several factors hypothesized to be major determinants of demand with a view to determining the degree of predictive value which each of them may possess.

24. Surveys of Employers Expectations of Demand for Scientific and Technical Personnel

Periodic surveys of the expectations of present and potential employers of scientific and technical personnel as to the numbers and types of such personnel they will need at specified times in the future, and as to the major factors that are expected to determine their future needs with particular attention to lessons that may be learned for improving methods of projection.

Of these proposed projects, eight are new surveys involving the establishment approach. Two of these (numbers 1 and 2 above) are in the "most urgent" category and the remainder are "urgent" (numbers 9, 17, 18, 19, 21, 24). Three additional surveys also are new ones. These would involve the population approach including a follow up of the 1960 Census (numbers 4, 5, 12). In addition to the surveys, four new researches are included in the list, one in four parts (10, 11a,b,c,d; 13, 23). Finally, nine extensions of existing programs of data collection and analysis are also listed. These would involve addition to programs already under way (3, 6, 7, 8, 14, 15, 16, 20, 22).

With the diversity of projects and the number of different agencies involved, it is clear that the proposed statistical program will necessarily involve provision for implementation and coordination of program. For this reason the Advisory Panel, after pointing to the need for the cooperation of Federal, State and local government agencies and also private organizations, recommended that an appropriate Federal agency be given explicit responsibility for coordinating that part of the program which involves the Federal Government.

Concluding Observations

The situation in respect of knowledge about scientific and technical personnel is reminiscent of the situation in the 1930's in respect of knowledge about unemployment. In the absence of a direct measurement of unemployment various conflicting indirect metrics were obtained which, as the record shows, varied with the interest of the estimator. With the advance of sampling and survey methods utilized in the Monthly Report of the Labor Force, initiated by the W.P.A. and continued by the Bureau of the Census, a direct and reliable measurement of unemployment has been available for almost 20 years. In consequence political squabbles about the facts of unemployment are now mostly a matter of history, and policy and action in respect of employment and unemployment can now be based on fact rather than conjecture.

Adequate facts about the supply of scientific, engineering and technical personnel in relation to demand are not now available. These highly trained and skilled human resources have become of vital moment to national defense and to national economic advance. At the present time considerations of policy and program designed to assure an adequate and capable corps of scientific and technical personnel involve, among other things, debate about the facts themselves. And facts cannot be ascertained by means of polemics and majority vote.

The science and art of statistics has progressed to a point where the needed facts about scientific and technical personnel can be had with relatively little cost and effort. A program has been planned through which the needed information can be collected. It would seem that the course of wisdom is to proceed to obtain them.

Footnotes

1. Members of the Advisory Panel were: Philip M. Hauser, University of Chicago, Chairman; Philip M. Coombs, Fund for the Advancement of Education; Henry David, National Manpower Council; Coleman R. Griffith, American Council on Education; Merriam H. Trytten, National Academy of Sciences and National Research Council; Ralph J. Watkins, Brookings Institution; Dael Wolfle, American Association for the Advancement of Science.

2. The staff who served were: Stuart A. Rice, Libert Ehrman, Robert H. Mugge, Lorand D. Schweng, and Jeremy C. Olin.

3. Agencies represented by the consultants were: National Science Foundation; President's Committee on Scientists and Engineers; U.S. Department of Labor, Bureau of Labor Statistics; U. S. Department of Commerce, Bureau of the Census; U.S. Department of Health, Education and Welfare, Office of Education and National Institutes of Health. The Bureau of the Budget, Office of Statistical Standards, was represented by observers. In addition, the Office of Defense Mobilization and the Interdepartmental Committee on Scientific Research and Development were requested to submit suggestions on the adequacy of and the needs for scientific and technical personnel information on behalf of those agencies not directly represented.

4. Published by the National Science Foundation on behalf of itself and the President's Committee on Scientists and Engineers, NSF-58-28, August, 1958.

5. Ibid., p. 6
6. Ibid., p. 6.
7. Ibid., pp. 15ff.
8. Ibid., pp. 23-24.
9. Ibid., pp. 40-44.
10. Ibid., pp. 7-11.
11. Ibid., pp. 25-28.
12. Ibid., pp. 34-45.
13. Ibid., pp. 58-60.
14. Ibid., pp. 62-63.
15. Ibid., p. 7
16. Ibid., pp. 8-11.

DISCUSSION

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Mr. Blank has indicated some of the difficulties involved in defining a shortage of a particular type of manpower. In his paper, however, he has reiterated the conclusion reached earlier by himself and George J. Stigler that "the record of earnings would suggest that up to at least 1955 there has been no shortage - in fact an increasingly ample supply - of engineers." 1/ This conclusion was based on the finding that up to that year the average salary of engineers had gone up relatively less than the average wage level, and also less than the average increase in earnings of other professional groups.

At least two questions might be raised about the method employed by Mr. Blank and Professor Stigler in reaching this conclusion. First, is it appropriate to apply product market reasoning to the labor market without important qualifications? Second, how relevant is a comparison of the average salaries of engineers and other occupational groups?

It is entirely true that if the demand for a commodity in a competitive market is in excess of the supply there will be an increase in price. And price adjustments occur very rapidly in some types of product markets. Studies of the labor market by Reynolds, Shister, Myers, Shultz and a number of others have indicated rather clearly, however, that there are significant differences in the operation of labor and product markets. For example, wage and salary adjustments occur much more slowly, for a variety of reasons, than do price adjustments in many commodity markets. Even during the capital boom of 1956, when much was heard about a shortage of engineers, the average salary of engineers did not rise sharply. There are, however, anti-pirating conventions among employers; many of long standing. To be sure, these are not entirely adhered to, but even when they listed many engineering job openings employers did not rush to bid up salaries.

One reason for this is that employers are quite aware that aggressive "price competition" of this sort would be a losing game. The supply of engineers cannot be increased quickly by raising the average level of salaries. Various other recruiting tactics were employed during this period in an effort to fill job openings, but it is not surprising that employers failed to engage in an aggressive, and self-defeating, price war in trying to attract more engineers.

To turn to the second question, a comparison of movements of the average salaries of engineers and other professional groups tells us relatively little about the demand for and supply of any of the occupational groups involved. The relevant comparison is

of starting salaries. New entrants into the labor market are typically more mobile than those already established. Hence there is more open bidding for the services of the former than of the latter. During the time when the "engineering shortage" was a topic of widespread discussion, the starting salaries of new engineering graduates did increase substantially more than those of other college graduates. Indeed, this compounded the problem of "salary telescoping" among engineers. Those with long service saw the salaries of new entrants into the profession rising rapidly while their own salaries went up slowly. This encouraged a greater leakage of engineers into non-engineering occupations, further contributing to the imbalance between engineering manpower requirements and the available supply at that time. The leakage of higher-salaried engineers, if they were replaced by younger men at lower rates of pay, also might have exerted downward pressure on the average level of salaries of all engineers.

As Mr. Mills has pointed out there has been much less clamor about an engineering shortage since the beginning of the recession of 1957. At the same time, new engineering graduates have not experienced serious difficulty in finding employment. There are indications, however, that recruiting activities are now being stepped up. While this year's June graduates will undoubtedly not have the range of choice available to those who graduated in June 1956, recruiters are already far more active than they were at this time last year.

Both Mr. Mills and Mr. Trytten have stressed the dynamic, and long-run aspects of the engineering and scientific manpower problem. Mr. Blank, however, has expressed concern that undue stress on the "engineering shortage" will induce too many students to enter the field, and make it difficult for them to find employment upon graduation. It would indeed be unfair to encourage too many students to enter colleges of engineering. But the proportion of engineers and scientists in the labor force has been steadily increasing, and there is a strong likelihood that this proportion will continue to increase in the future. 2/ Given some of the current problems of elementary and secondary education, I doubt that an excessive number of students will be encouraged to seek careers in engineering and science.

Using existing data and the techniques of analysis which have been employed up to the present, the question of an "engineering shortage" could be debated ad infinitum. Professor Hauser's paper goes to the heart of the problem - the lack of reliable data to provide a definitive answer to the question of whether or not there has been a shortage of engineering manpower. It is encouraging that something is to be done about this data deficiency.

The Advisory Panel established by the President's Committee on Scientists and Engineers and the National Science Foundation has done its job well. If the statistical projects proposed by the Panel are carried out, we should know much more about the market for engineering and scientific manpower in the future than we have in the past. A number of important policy issues hinge upon better information about the demand for and supply of scientific, engineering and technical personnel. And as Professor Hauser says, "facts cannot be ascertained by means of polemics and majority vote." If the broad program proposed by the Advisory Panel is carried out with dispatch, it will obviate future meetings of the kind we have had tonight to discuss the controversial question of whether or not there is a shortage of technical manpower.

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1 /The Demand and Supply of Scientific Personnel, New York: National Bureau of Economic Research, Inc., 1957, p. 29.

2 /Since 1870, for example, employment in science and technology has increased about 17 times as fast as the labor force. See Trends in the Employment and Training of Scientists and Engineers, National Science Foundation Publication 56-11, p. 4.