PERIODIC ESTABLISHMENT SURVEYS OF EMPLOYMENT IN SCIENCE AND ENGINEERING

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The starting point for the quantitative appraisal of the supply of scientific and technical manpower is the number of persons employed as scientists, engineers, and technicians and as teachers of these personnel. In fact, this was recommended in the Hauser Committee Report[1] to be one of the "most urgent"projects--that is, the basic counts of persons who are classified as scientific and technical personnel. The term "establishment surveys" as used here refers to surveys of employers and is not confined to "establishment" in the industrial classification sense.

GENERAL FACTORS There are of course varying methods used in the collection of scientific manpower information. Each of them has advantages in given situations, and the most appropriate method applied depends upon several factors such as timing, precision required, and relative expense. In general, the respondent chosen must possess the information or be in a position to secure it and must be willing to supply it.

Collection of data directly from individuals is especially appropriate where detailed information regarding professional or personal characteristics is desired. This includes such information as age, educational attainment, or employment and professional history. Foremost among such programs of collection are the population surveys of the Bureau of the Census and those made in connection with the National Register of Scientific and Technical Personnel of the National Science Foundation.

Employers and employing units or establishments are usually the appropriate respondents for data collections dealing with employment of personnel. There are several reasons for this. The employer represents a repository of information on the individuals in his employ. Also, he judges on a relatively disinterested basis for all employees their field or discipline, their work activity, and their actual employment status.

Two other general factors are considered in the collection of scientific manpower information --the completeness of coverage of respondents and the collection method used. In each case it must be determined whether a universe or partial-coverage survey is to be employed. Complete-coverage surveys are generally more costly and more time consuming. However, in some cases where a high degree of precision or a large volume of detailed characteristics is to be counted, the universe approach is used. In most cases a partial-coverage method is utilized in employer-reporting surveys, particularly when a carefully selected sample base can be employed. Personal interviews, mail questionnaires, or telephone and telegraphic surveys are all applied in collection of information. By and large, however, most surveys of employment of scientific and technical personnel use mail questionnaires, frequently preceeded by detailed pretesting and supplemental interviewing of large employers or those with complex situations.

This paper refers primarily to the National Science Foundation's program in the area of establishment surveys of scientific and technical personnel. There are many organizations, both Government and private, which have contributed much to our knowledge of the Nation's resources of scientists and engineers. Some of the surveys made by these organizations have been supported financially by the Foundation, others have been carried out in coordination with NSF studies; others have been less directly connected with the Foundation or other Government agencies but have contributed valuable data and experience. Though the primary purpose of Foundation-sponsored establishment surveys of manpower is to provide basic counts of employed individuals, they have provided a basis for other types of manpower studies. One such study is the intensive analysis made by the Bureau of Labor Statistics of employment in mathematical work in industry and Government. On the basis of returns to the regular surveys of employment of scientific and technical personnel, the Bureau surveyed employers of mathematicians and persons engaged in mathematical work. These employer surveys of course are essential to such research work as the recently completed study by the BLS of The Long-Range Demand for Scientific and Technical Personnel.[2]

Basically, establishment surveys have been made in the several broad sectors of the economy which employ scientists, engineers, technicians, and teachers in these fields. These sectors are: Private industrial concerns, colleges and universities, the Federal Government, State and local governments, and nonprofit organizations. Such surveys have been carried out on varying bases. The largest employers--industry, educational institutions, and the Federal Government--have been surveyed more frequently than other sectors. Furthermore, in the last decade scientific manpower data collection has been in a developmental or even experimental phase. Each survey has been more comprehensive and more accurate. As concepts and definitions have been clarified, as the need for additional data has arisen, survey questionnaires and techniques have been developed to meet these situations. As many "old hands" know, many of our well-established surveys in the general employment area, or in other data-collection programs, have finally been accepted only after many years of trial and error.

1/ A Program for National Information on Scientific and Technical Personnel, NSF 58-28, National Science Foundation, 1958.

2/ The Long-Range Demand for Scientific and Technical Personnel: A Methodological Study, NSF 61-65, National Science Foundation, 1961.

INDUSTRIAL SURVEYS The first studies of industrial employers of scientific and technical personnel which can be termed comprehensive started in the 1950's. One of the pioneering projects was a nationwide survey of some 2,000 industrial companies made by the Bureau of Labor Statistics for the Department of Defense in 1952.3/ This survey collected information on research and development scientists and engineers in companies having large defense contracts or who were otherwise large employers of such personnel. As part of the first series of studies conducted shortly after it was organized, the Foundation sponsored a more extensive Bureau of Labor Statistics project in the first comprehensive survey of research and development expenditures and manpower in industry.4/ Also collected at that time were 1953-1954 data on scientists and engineers in all activities and on technicians in research and development. A similar survey collected information on research and development expenditures and manpower for the year 1957.

In 1959, the Foundation supported the first survey oriented directly to employment of scientific and technical personnel, followed by a similar study in 1960; both were carried out by the Bureau of Labor Statistics.5/ A sample of about 11,000 companies selected from the lists of the Bureau of Old Age and Survivors Insurance (as were the 1953-54 and 1957 surveys) was surveyed, and employers were asked to report their scientists and engineers by field and by work activity or function.

Up to this time in these industrial surveys data were collected on a companywide basis. Thus, all employment for each reporter was classified in the one industry believed to represent the major activity of the company. This procedure has obvious defects in dealing with multi-industry companies, and it was decided after consultation with many officials in industry and Government to request reports from a sample of establishments as the best method of improving the industry classification of data. Therefore, the sample for the 1961 survey was drawn from lists of establishments reporting in State Unemployment Compensation programs, and was stratified by industry and size of company. In addition, the sample was supplemented from lists of industrial laboratories and other establishments known to employ large numbers of scientific and technical personnel. All together, nearly 15,000 units were included in the questionnaire mailing list. The response to this survey was excellent; replies were received from about 90 percent of the units in the sample. About 10 percent of these establishments were included in consolidated reports of some 200 companies. A 1962 survey is now in its final planning stages and will be conducted along the lines of the 1961 survey. Questionnaires probably will be mailed in early February 1962.

Another development in connection with these industrial surveys is that beginning with 1962 they will be supported through regular Department of Labor appropriations. This is a welcome development in that it enables the Department to carry out these studies in conjunction with its established programs and at the same time enables the Foundation to use its funds to support other areas of data collection.

COLLEGE AND UNIVERSITY SURVEYS In past years, several types of studies have covered the area of employment by colleges and universities. For example, the Office of Education has regularly collected information on the numbers of personnel employed in these institutions. However, these surveys have not provided information on the fields or occupations with which the Foundation and others are concerned. In 1955, the Foundation as a part of its first series of studies conducted a survey covering academic year 1953-54.6/ This survey provided the first comprehensive data on employment of scientists and engineers in these institutions together with information on the types of activities in which they engage. Since this 1953-54 survey, the Foundation in cooperation with the Office of Education carried out a study of research and development expenditures and professional manpower in educational institutions covering academic year 1957-58 (the manpower information related to April 1958).7/ At the present time, the Foundation and the Office of Education are cooperating in a similar study covering academic year 1960-61. This latter survey includes a detailed breakdown of academic disciplines.

FEDERAL GOVERNMENT SURVEYS In this area, the National Science Foundation has relied on the regular collection program of the Civil Service Commission. Periodically, the Commission has collected information on the occupations of employees of the Federal Government. Comprehensive surveys were made in 1931, 1938, 1947, 1954, and 1957. In 1954, the NSF in cooperation with the Commission collected additional information on the activities of Federal employees related to science--such as research and development, scientific data collection, scientific information, and testing and standardization.8/ In 1958, the

3/ Scientific Research and Development in American Industry, A Study of Manpower and Costs, Bulletin 1148, Bureau of Labor Statistics, 1953.
4/ Science and Engineering in American Industry, Final Report on a 1953-54 Survey, NSF 56-16, National Science Foundation, 1956.
5/ Scientific and Technical Personnel in Industry 1960, NSF 61-75, National Science Foundation, 1961.
6/ Scientific Research and Development in Colleges and Universities, Expenditures and Manpower: 1953-54, NSF 59-10, National Science Foundation, 1959.
7/ Scientists and Engineers Employed at Colleges and Universities, 1958, NSF 61-38, National Science Foundation, 1961
8/ Scientific Manpower in the Federal Government, 1954, NSF 57-32, National Science Foundation, 1957.

the Commission began a regular annual collection, in the fall of each year, and the NSF has included a supplemental form covering those Federal personnel engaged in or administering research and development. Surveys were carried out in 1958, 1959, 1960, and 1961.9/ The Commission is now developing plans for a special "work history" sample of Federal employees. The general outline of this study calls for a sample selected from each agency on the basis of social security numbers. The Foundation hopes the sample will be large enough to permit detailed tabulations for selected scientific occupations.

STATE GOVERNMENT SURVEYS In 1954, the Foundation supported a pilot study of scientific activities in six State governments. The study was conducted by the University of North Carolina and covered California, Connecticut, New Mexico, New York, North Carolina, and Wisconsin. However, until recently there had been no comprehensive study of the employment of scientific and technical personnel in State governments. In 1959, the Foundation supported the Bureau of Labor Statistics work in the first full-coverage survey.10/ This survey covered some 3,300 separate agencies in all 50 States. At the present time, the BLS is completing plans for a second such survey to be conducted in early 1962.

NONPROFIT ORGANIZATION SURVEYS The area of nonprofit organizations was also covered in the first series of studies of science activities for the period 1953-54. The emphasis in this area as in others at this time was on research and development activities. Research institutes and commercial laboratories were surveyed by Syracuse University. Battelle Memorial Institute surveyed trade associations, professional and technical societies, and other cooperative groups. Similar coverage was made of philanthropic organizations in a study made by Russel Sage Foundation; however, no manpower information was collected from these latter organizations. In late 1958, the Bureau of Labor Statistics under sponsorship of the Foundation conducted an integrated survey of nonprofit organizations, collecting employment information on scientific and technical personnel for January 1957 and January 1958.11/ The survey covered philanthropic foundations, voluntary health agencies, research institutes, professional and technical societies, science museums, zoological and botanical gardens, and arboretums. The Foundation is now starting another series of surveys in the nonprofit area. A survey of private foundations is now underway, and other organizations will be surveyed in the near future.

9/ Scientists and Engineers in the Federal Government, October 1958, NSF 61-43, National Science Foundation, 1961.
10/ Employment of Scientific and Technical Personnel in State Government Agencies, Report on a 1958 Survey, NSF 61-17, National Science Foundation, 1961
11/Scientific Research and Development of Nonprofit Organizations, Expenditures and Manpower,1957, NSF 61-37, National Science Foundation, 1961.

LOCAL GOVERNMENT SURVEYS Data on employment of scientific and technical personnel by local governments are almost completely lacking. The only effort to date consisted of a pilot project carried out by the Bureau of Labor Statistics in six States. This study was primarily an attempt to determine the availability of information on scientific and technical personnel in local government organizations. It is hoped that at least a limited survey in this area will be launched next year--perhaps covering major local governments.

SELF-EMPLOYED SECTOR SURVEYS Employment of scientific and technical personnel by private consulting firms has been covered in the industrial surveys. However, aside from the limited information available from the Census Bureau and from the National Register almost nothing is known about the volume of employment in this sector. In one sense, it should not be included under the general approach of employer-reporting, or establishment, surveys. This employment--that is, the number of scientists and engineers who are not connected in some manner to an employer--is believed to be relatively small.

PROBLEMS CONNECTED WITH EMPLOYER-REPORTING SURVEYS In any data collection program continuing problems exist to harass the collector. The following is a review of some major problems--not given in terms of how the problems have been solved or not completely solved, but simply as an exposition of them.

Definitions. What is an engineer, a scientist, a technician? What is an employer of such personnel? How can research, development, administration be best defined?

Coverage of occupations. It has been mentioned that the Foundation generally includes the following in its surveys: Scientists, engineers, technicians, and teachers of these personnel. Are we concerned with social scientists? Yes, but this has been a more recent movement and presents some special problems. What is a social scientist in industry, in Government, in a university?

Sampling of employers. Since universe surveys probably will not be used in most situations, how should the samples be chosen? In some areas a universe listing of employers does not exist. How is the list kept current with the rapidly expanding number of newly emerging employers of scientists and engineers? What are the problems connected with changing industrial classifications?

Periodic reporting. How often should each major sector be surveyed? In some areas, employment can shift fairly rapidly, particularly in defense-supported industries. In the college and university area, what is the best time in the academic year for reporting?

Coordination with other surveys. Several agencies of the Federal Government and other nongovernmental organizations have special requirements for data. Can all or most of these requirements be accommodated in one survey? Is it better to expose a respondent to one long, detailed questionnaire or to several relatively specialized ones?

Geographic information. How can the need for information on geographic location be met? To date such questions have not been included in employer surveys directly. Some provide this information--such as the colleges and university sector--but when carried out on a sample basis, some accuracy is lost.

Relationship to surveys of individuals. Surveys of individuals have been regarded as much more appropriate when dealing with personal or professional characteristics. How can information from the Census Bureau surveys or the National Register or other organizations be correlated with employer surveys?

"Crash" studies. No matter how well a manpower data collection program is planned, there probably always will be special needs. Such a special case faces the Foundation and other Federal agencies at the present time. How many scientists and engineers are engaged in work which is directly related to the planned space programs? How many additional personnel will be so engaged with certain expenditures of funds over the next 10 years? How many of the Nation's scientists and engineers are involved in health-related research?

FUTURE PLANS FOR EMPLOYER SURVEYS Very simply, the NSF's program of studies is to provide, within resources provided by Congress and with resources of other organizations, a comprehensive and current analysis of scientific and technical personnel in all sectors of the economy. The Foundation seeks to identify needs for information, build on existing programs of data collection, and select priority areas for support of new information collection. The Foundation generally does not carry out surveys itself but rather supports, wherever necessary and appropriate, existing data collection programs of other organizations. In recent years, the several Federal agencies concerned with scientific manpower information have joined to cosponsor certain projects. Our goal then is to have available current information on the Nation's resources of scientific and technical personnel on a continuing basis. In some areas this will require annual (or even more frequent) surveys; in others less frequent data collection will be required.