An Assessment of Research-Doctorate Programs in the United States: Engineering

Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, Editors; Committee on an Assessment of Quality-Related Characteristics of Research-Doctorate Programs in the United States

ISBN: 0-309-56952-4, 205 pages, 8.5 x 11, (1982)

An Assessment of Research-Doctorate Programs in the United States: Engineering

Committee on an Assessment of Quality-Related Characteristics of Research-Doctorate Programs in the United States

Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, *Editors*

Sponsored by
The Conference Board of Associated Research Councils
American Council of Learned Societies
American Council on Education
National Research Council
Social Science Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1982

NOTICE: The project that is the subject of this report was approved by the Conference Board of Associated Research Councils, whose members are drawn from the American Council of Learned Societies, the American Council on Education, the National Research Council, and the Social Science Research Council. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors and editors according to procedures approved by each of the four member Councils of the Conference Board.

The Conference Board of Associated Research Councils was created to foster discussion of issues of mutual interest; to determine the extent to which a common viewpoint on such issues prevails within the academic community of the United States; to foster specific investigations when so desired; and, when the Conference Board finds joint, common, or other action desirable, to make recommendations to the appropriate Councils.

Library of Congress Catalog Card Number 82-73780
International Standard Book Number 0-309-03336-5
Available from NATIONAL ACADEMY PRESS 2101 Constitution Avenue, N.W. Washington, D.C. 20418

First Printing, November 1982 Second Printing, April 1984 Printed in the United States of America

Acknowledgments

In conducting this assessment the committee has benefited from the support and advice of many individuals and organizations. The assessment was conducted under the aegis of the Conference Board of Associated Research Councils, and special thanks go to Roger Heyns, Robert M. Lumiansky, Jack W. Peltason, Frank Press, Kenneth Prewitt, Eleanor Sheldon, John William Ward, and the late Philip Handler for their efforts in overseeing the planning and execution of this project. Financial support was provided by the Andrew W. Mellon Foundation, the Ford Foundation, the Alfred P. Sloan Foundation, the National Institutes of Health (NIH), the National Science Foundation (NSF), and the National Academy of Sciences. Without the combined support from these organizations the project would not have been undertaken. The committee appreciates the excellent cooperation it received from the staff officers at these organizations--including John Sawyer and James Morris at Mellon; Mariam Chamberlain, Gladys Chang Hardy, and Sheila Biddle at Ford; Albert Rees and James Koerner at Sloan; Helen Gee at NIH; and Bernard Stein at NSF. Some supplemental funds to enhance the study were furnished by the Association of American Geographers, the American Psychological Association, and the American Psychological Foundation.

The committee is most appreciative of the cooperation it received from individuals in the 228 universities participating in the assessment. In particular we thank the university presidents and chancellors who agreed to participate and offered the assistance of staff members at their institutions; the graduate deans, department chairmen, and many other university personnel who helped to compile information about the research-doctorate programs at their own institutions; and the nearly 5,000 faculty members who took the time to complete and return reputational survey forms. This assessment would not have been feasible without the participation of these individuals. Nor would it have been complete without the suggestions from many individuals within and outside the academic community who reviewed the study plans and committee reports.

The committee also acknowledges the contributions of Francis Narin and Paul R. McAllister, whose innovative work in the area of publication productivity in science and engineering fields has been a valuable resource. We thank H. Roberts Coward and his colleagues at the Institute for Scientific Information for their help in compiling publications data as well as William Batchelor and John James at NIH and David Staudt at NSF for their help in acquiring data on individual research grant awards.

Within the National Research Council many individuals have assisted in the planning and completion of this project. Robert A. Alberty, Harrison Shull, and W. K. Estes, former chairmen of the Commission on Human Resources, and William C. Kelly, Executive Director of the commission (now the Office of Scientific and Engineering Personnel), offered assistance and helpful counsel during all phases of the study. Lindsey R. Harmon and C. Alan Boneau contributed greatly to the planning of the assessment.

To Porter E. Coggeshall, Study Director, the committee expresses thanks for a job extremely well done. His ability to translate the committee's directions into compiled data and analyses must be given a large share of the credit for the completion of this project. He has been ably assisted by Prudence W. Brown, who supervised the data collection activities; Dorothy G. Cooper, who provided excellent secretarial support; George A. Boyce, whose programming expertise was invaluable; and Kathleen Drennan and Linda Dix, who helped in preparing final copy of the manuscript.

Committee on an Assessment of Quality-Related Characteristics of Research-Doctorate Programs in the United States

Preface

The genius of American higher education is often said to be in the close association of training and research--that is, in the nation's research-doctorate programs. Consequently, we are not surprised at the amount of worried talk about the quality of the research doctorate, for deterioration at that level will inevitably spread to wherever research skills are needed--and that indeed is a far-flung network of laboratories, institutes, firms, agencies, bureaus, and departments. What might surprise us, however, is the imbalance between the putative national importance of research-doctorate programs and the amount of sustained evaluative attention they themselves receive.

The present assessment, sponsored by the Conference Board of Associated Research Councils--comprised of the American Council of Learned Societies, the American Council on Education, the National Research Council (NRC), and the Social Science Research Council--seeks to correct the imbalance between worried talk and systematic study. In this effort the Conference Board continues a tradition pioneered by the American Council on Education, which in 1966 published An Assessment of Quality in Graduate Education, the report of a study conducted by Allan M. Cartter, and in 1970 published A Rating of Graduate Programs, by Kenneth D. Roose and Charles J. Andersen. The Cartter and Roose-Andersen reports have been widely used and frequently cited.

Some years after the release of the Roose-Andersen report, it was decided that the effort to assess the quality of research-doctorate programs should be renewed, and the Conference Board of Associated Research Councils agreed to sponsor an assessment. The Board of Directors of the American Council on Education concurred with the notion that the next study should be issued under these broader auspices. The NRC agreed to serve as secretariat for a new study. The responsible staff of the NRC earned the appreciation of the Conference Board for the skill and dedication shown during the course of securing funding and implementing the study. Special mention should also be made of the financial contribution of the National Academy of Sciences which, by supplementing funds available from external sources, made it possible for the study to get under way.

To sponsor a study comparing the quality of programs in 32 disciplines and from more than 200 doctorate-granting universities is to invite critics, friendly and otherwise. Such was the fate of the previous studies; such has been the fate of the present study. Scholarship, fortunately, can put criticism to creative use and has done so in this project. The study committee appointed by the Conference Board reviewed the criticisms of earlier efforts to assess research-doctorate programs, and it actively solicited criticisms and suggestions for improvements of its own design. Although constrained by limited funds, the committee applied state-of-the-art methodology in a design that incorporated the lessons learned from previous studies as well as attending to many critics of the present effort. Not all criticism has thus been stilled; nor could it ever be. Additional criticisms will be voiced by as many persons as begin to use the results of this effort in ways not anticipated by its authors. These criticisms will be welcome. The Conference Board believes that the present study, building on earlier criticisms and adopting a multidimensional approach to the assessment of research-doctorate programs, represents a substantial improvement over past reports. Nevertheless, each of the diverse measures used here has its own limitations, and none provides a precise index of the quality of a program for educating students for careers in research. No doubt a future study, taking into account the weaknesses as well as strengths of this effort, will represent still further improvement. One mark of success for the present study would be for it to take its place in a continuing series, thereby contributing to the indicator base necessary for informed policies that will maintain and perhaps enhance the quality of the nation's research-doctorate programs.

For the more immediate future the purposes of this assessment are to assist students and student advisers seeking the best match possible between individual career goals and the choice of an advanced degree program; to serve scholars whose study site is higher education and the nation's research enterprise; and to inform the practical judgment of the administrators, funders, and policymakers responsible for protecting the quality of scholarly education in the United States.

A remarkably hard-working and competent group, whose names appear on page vii of this report, oversaw the long process by which this study moved from the planning stage to the completion of these reports. The Conference Board expresses its warmest thanks to the members of its committee and especially to their co-chairmen, Lyle V. Jones and Gardner Lindzey.

Conference Board of Associated Research Councils

Committee on an Assessment of Quality-Related Characteristics of Research-Doctorate Programs in the United States

LYLE V. JONES (Co-Chairman), Director of the L. L. Thurstone Psychometric Laboratory, University of North Carolina at Chapel Hill

GARDNER LINDZEY (Co-Chairman), Director, Center for Advanced Study in the Behavioral Sciences, Stanford, California

PAUL A. ALBRECHT, Vice-President and Dean, Claremont Graduate School

MARCUS ALEXIS, Department of Economics, Northwestern University

ROBERT M. BOCK, Dean of the Graduate School, University of Wisconsin at Madison

PHILIP E. CONVERSE, Institute for Social Research, University of Michigan

JAMES H. M. HENDERSON, Department of Plant Physiology, Tuskegee Institute of Alabama

ERNEST S. KUH, Department of Electrical Engineering and Computer Sciences, University of California, Berkeley

WINFRED P. LEHMANN, Department of Linguistics, University of Texas at Austin

SAUNDERS MAC LANE, Department of Mathematics, University of Chicago

NANCY S. MILBURN, Dean, College of Liberal Arts and Jackson College for Women, Tufts University

LINCOLN E. MOSES, Department of Statistics, Stanford University

JAMES C. OLSON, President, University of Missouri

C. K. N. PATEL, Director, Physical Research Laboratory, Bell Laboratories

MICHAEL J. PELCZAR, JR., President, The Council of Graduate Schools in the United States

JEROME B. SCHNEEWIND, Department of Philosophy, Johns Hopkins University

DUANE C. SPRIESTERSBACH, Vice-President, Educational Development and Research, University of Iowa

HARRIET A. ZUCKERMAN, Sociology Department, Columbia University

Study Director

PORTER E. COGGESHALL, Office of Scientific and Engineering Personnel, National Research Council

Contents

I	ORIGINS OF STUDY AND SELECTION OF PROGRAMS	1
	Prior Attempts to Assess Quality in Graduate Education	3
	Development of Study Plans	7
	Selection of Disciplines and Programs to be Evaluated	9
II	METHODOLOGY	13
	Program Size	16
	Characteristics of Graduates	17
	Reputational Survey Results	20
	University Library Size	25
	Research Support	26
	Publication Records	27
	Analysis and Presentation of the Data	29
III	CHEMICAL ENGINEERING PROGRAMS	33
IV	CIVIL ENGINEERING PROGRAMS	51
V	ELECTRICAL ENGINEERING PROGRAMS	69
VI	MECHANICAL ENGINEERING PROGRAMS	89
VII	SUMMARY AND DISCUSSION	109
	Summary of the Results	110
	Correlations Among Measures	113
	Analysis of the Survey Response	120
	Interpretation of Reputational Survey Ratings	133
	Comparison with Results of the Roose-Andersen Study	134
	Future Studies	140
	MINORITY STATEMENT	143
	APPENDIXES	
A	Letter to Institutional Coordinators and Accompanying Survey Form (Measures 01-03)	147

B Survey of Earned Doctorates (Measures 04-07) 154
C Letter to Evaluators and Specimen of the Instrument Used in the Reputational Survey (Measures 08-11) 157
D The ARL Library Index (Measure 12) 163
E Data on Faculty Research Support and R&D Expenditures (Measures 13 and 14) 165
F Data on Publication Records (Measures 15 and 16) 170
G Conference on the Assessment of Quality of Graduate Education Programs--Participants and Summary 188
H Planning Committee for the Study of the Quality of Research-Doctorate Programs 192
I Region and State Codes for the United States and Possessions 193

LIST OF FIGURES

3.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--79 programs in chemical engineering 46
3.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--79 programs in chemical engineering 47
3.3 Mean rating of scholarly quality of faculty in 79 programs in chemical engineering 49
4.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--74 programs in civil engineering 64
4.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--73 programs in civil engineering 65
4.3 Mean rating of scholarly quality of faculty in 74 programs in civil engineering 67
5.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--90 programs in electrical engineering 84
5.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--90 programs in electrical engineering 85
5.3 Mean rating of scholarly quality of faculty in 90 programs in electrical engineering 87
6.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--81 programs in mechanical engineering 104
6.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--81 programs in mechanical engineering 105

6.3 Mean ratings of scholarly quality of faculty in 81 programs in mechanical engineering 107
7.1 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--61 programs in chemical engineering 136
7.2 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--57 programs in civil engineering 137
7.3 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--66 programs in electrical engineering 138
7.4 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--61 programs in mechanical engineering 139

LIST OF TABLES

1.1 Number of Research-Doctorates Awarded in Engineering Disciplines, FY1976-78 10
1.2 Number of Programs Evaluated in Each Discipline and the Total FY1976-80 Doctoral Awards from These Programs 12
2.1 Measures Compiled on Individual Research-Doctorate Programs in Engineering 15
2.2 Percentage of FY1975-79 Doctoral Recipients with Definite Commitments for Employment Outside the Academic Sector 20
2.3 Survey Response by Discipline and Characteristics of Evaluator 22
3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering 36
3.2 Summary Statistics Describing Each Program Measure--Chemical Engineering 44
3.3 Intercorrelations Among Program Measures on 79 Programs in Chemical Engineering 45
3.4 Characteristics of Survey Participants in Chemical Engineering 48
4.1 Program Measures (Raw and Standardized Values) in Civil Engineering 54
4.2 Summary Statistics Describing Each Program Measure--Civil Engineering 62
4.3 Intercorrelations Among Program Measures on 74 Programs in Civil Engineering 63
4.4 Characteristics of Survey Participants in Civil Engineering 66
5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering 72
5.2 Summary Statistics Describing Each Program Measure--Electrical Engineering 82
5.3 Intercorrelations Among Program Measures on 91 Programs in Electrical Engineering 83
5.4 Characteristics of Survey Participants in Electrical Engineering 86
6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering 92

6.2 Summary Statistics Describing Each Program Measure--Mechanical Engineering 102
6.3 Intercorrelations Among Program Measures on 82 Programs in Mechanical Engineering 103
6.4 Characteristics of Survey Participants in Mechanical Engineering 106
7.1 Mean Values for Each Program Measure, by Discipline 111
7.2 Correlations of the Number of Program Graduates (Measure 02) with Other Measures, by Discipline 114
7.3 Correlations of the Survey Ratings of Scholarly Quality of Program Faculty (Measure 08) with Other Measures, by Discipline 116
7.4 Correlations of the University Research Expenditures in a Discipline (Measure 14) with Other Measures, by Discipline 118
7.5 Correlations of the Influence-Weighted Number of Publications (Measure 16) with Other Measures, by Discipline 120
7.6 Distribution of Responses to Each Survey Item, by Discipline 122
7.7 Survey Item Response Rates, by Discipline and Mean Rating on Measure 08 123
7.8 Correlations Between Two Sets of Average Ratings from Two Randomly Selected Groups of Evaluators 125
7.9 Comparison of Mean Ratings for 11 Mathematics Programs Included in Two Separate Survey Administrations 126
7.10 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Familiarity with Work of Faculty 128
7.11 Item Response Rate on Measure 08, by Selected Characteristics of Survey Evaluators in Engineering 129
7.12 Mean Ratings of Scholarly Quality of Program Faculty, by Type of Survey Form Provided to Evaluator 130
7.13 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Proximity to Region of Program 131
7.14 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Institution of Highest Degree 132

I

Origins of Study and Selection of Programs

Each year more than 22,000 candidates are awarded doctorates in engineering, the humanities, and the sciences from approximately 250 U.S. universities. They have spent, on the average, five-and-a-half years in intensive education and research in preparation for careers either in universities or in settings outside the academic sector, and many will make significant contributions to research. Yet we are poorly informed concerning the quality of the programs producing these graduates. This study is intended to provide information pertinent to this complex and controversial subject.

The charge to the study committee directed it to build upon the planning that preceded it. The planning stages included a detailed review of the methodologies and the results of past studies that had focused on the assessment of doctoral-level programs. The committee has taken into consideration the reactions of various groups and individuals to those studies. The present assessment draws upon previous experience with program evaluation, with the aim of improving what was useful and avoiding some of the difficulties encountered in past studies. The present study, nevertheless, is not purely reactive: it has its own distinctive features. First, it focuses only on programs awarding research doctorates and their effectiveness in preparing students for careers in research. Although other purposes of graduate education are acknowledged to be important, they are outside the scope of this assessment. Second, the study examines a variety of different indices that may be relevant to the program quality. This multidimensional approach represents an explicit recognition of the limitations of studies that rely entirely on peer ratings of perceived quality--the so-called reputational ratings. Finally, in the compilation of reputational ratings in this study, evaluators were provided the names of faculty members involved with each program to be rated and the number of research doctorates awarded in the last five years. In previous reputational studies evaluators were not supplied such information.

During the past two decades increasing attention has been given to describing and measuring the quality of programs in graduate education. It is evident that the assessment of graduate programs is highly important for university administrators and faculty, for employers in industrial and government laboratories, for graduate students and prospective graduate students, for policymakers in state and national organizations, and for private and public funding agencies. Past experience, however, has demonstrated the difficulties with such assessments and their potentially controversial nature. As one critic has asserted:

> . . . the overall effect of these reports seems quite clear. They tend, first, to make the rich richer and the poor poorer; second, the example of the highly ranked clearly imposes constraints on those institutions lower down the scale (the “Hertz-Avis” effect). And the effect of such constraints is to reduce diversity, to reward conformity or respectability, to penalize genuine experiment or risk. There is, also, I believe, an obvious tendency to promote the prevalence of disciplinary dogma and orthodoxy. All of this might be tolerable if the reports were tolerably accurate and judicious, if they were less prescriptive and more descriptive; if they did not pretend to “objectivity” and if the very fact of ranking were not pernicious and invidious; if they genuinely promoted a meaningful “meritocracy” (instead of simply perpetuating the status quo ante and an establishment mentality). But this is precisely what they cannot claim to be or do.[1]

The widespread criticisms of ratings in graduate education were carefully considered in the planning of this study. At the outset consideration was given to whether a national assessment of graduate programs should be undertaken at this time and, if so, what methods should be employed. The next two sections in this chapter examine the background and rationale for the decision by the Conference Board of Associated Research Councils[2] to embark on such a study. The remainder of the chapter describes the selection of disciplines and programs to be covered in the assessment.

The overall study encompasses a total of 2,699 graduate programs in 32 disciplines. In this report--the third of five reports issuing from the study--we examine 326 programs in four disciplines in engineering: chemical engineering, civil engineering, electrical engineering, and mechanical engineering. These programs account for more than 90 percent of the research doctorates awarded in these four disciplines. It should be emphasized that the selection of disciplines to

[1]William A. Arrowsmith, “Preface” in The Ranking Game: The Power of the Academic Elite, by W. Patrick Dolan, University of Nebraska Printing and Duplicating Service, Lincoln, Nebraska, 1976, p. ix.

[2]The Conference Board includes representatives of the American Council of Learned Societies, American Council on Education, National Research Council, and Social Science Research Council.

be covered was determined on the basis of total doctoral awards during the FY1976-78 period (as described later in this chapter), and the exclusion of a particular discipline was in no way based on a judgment of the importance of graduate education or research in that discipline. Also, although the assessment is limited to programs leading to the research-doctorate (Ph.D. or equivalent) degree, the Conference Board and study committee recognize that graduate schools provide many other forms of valuable and needed education. It may be that in engineering, doctoral education constitutes a smaller portion of the total educational effort than in most science and humanities fields.

PRIOR ATTEMPTS TO ASSESS QUALITY IN GRADUATE EDUCATION

Universities and affiliated organizations have taken the lead in the review of programs in graduate education. At most institutions program reviews are carried out on a regular basis and include a comprehensive examination of the curriculum and educational resources as well as the qualifications of faculty and students. One special form of evaluation is that associated with institutional accreditation:

> The process begins with the institutional or programmatic self-study, a comprehensive effort to measure progress according to previously accepted objectives. The self-study considers the interest of a broad cross-section of constituencies--students, faculty, administrators, alumni, trustees, and in some circumstances the local community. The resulting report is reviewed by the appropriate accrediting commission and serves as the basis for evaluation by a site-visit team from the accrediting group. . . . Public as well as educational needs must be served simultaneously in determining and fostering standards of quality and integrity in the institutions and such specialized programs as they offer. Accreditation, conducted through nongovernmental institutional and specialized agencies, provides a major means for meeting those needs.[3]

Although formal accreditation procedures play an important role in higher education, many university administrators do not view such procedures as an adequate means of assessing program quality. Other efforts are being made by universities to evaluate their programs in graduate education. The Educational Testing Service, with the sponsorship of the Council of Graduate Schools in the United States and the Graduate Record Examinations Board, has recently developed a set

[3]Council on Postsecondary Accreditation, The Balance Wheel for Accreditation, Washington, D.C., July 1981, pp. 2-3.

of procedures to assist institutions in evaluating their own graduate programs.[4]

While reviews at the institutional (or state) level have proven useful in assessing the relative strengths and weaknesses of individual programs, they have not provided the information required for making national comparisons of graduate programs. Several attempts have been made at such comparisons. The most widely used of these have been the studies by Keniston (1959), Cartter (1966), and Roose and Andersen (1970). All three studies covered a broad range of disciplines in engineering, the humanities, and the sciences and were based on the opinions of knowledgeable individuals in the program areas covered. Keniston[5] surveyed the department chairmen at 25 leading institutions. The Cartter[6] and Roose-Andersen[7] studies compiled ratings from much larger groups of faculty peers. The stated motivation for these studies was to increase knowledge concerning the quality of graduate education:

> A number of reasons can be advanced for undertaking such a study. The diversity of the American system of higher education has properly been regarded by both the professional educator and the layman as a great source of strength, since it permits flexibility and adaptability and encourages experimentation and competing solutions to common problems. Yet diversity also poses problems. . . . Diversity can be a costly luxury if it is accompanied by ignorance. . . . Just as consumer knowledge and honest advertising are requisite if a competitive economy is to work satisfactorily, so an improved knowledge of opportunities and of quality is desirable if a diverse educational system is to work effectively.[8]

Although the program ratings from the Cartter and Roose-Andersen studies are highly correlated, some substantial differences in successive ratings can be detected for a small number of programs--suggesting changes in the programs or in the perception of these programs. For the past decade the Roose-Andersen ratings have

[4]For a description of these procedures, see M. J. Clark, Graduate Program Self-Assessment Service: Handbook for Users, Educational Testing Service, Princeton, New Jersey, 1980.

[5]H. Keniston, Graduate Study in Research in the Arts and Sciences at the University of Pennsylvania, University of Pennsylvania Press, Phildelphia, 1959.

[6]A. M. Cartter, An Assessment of Quality in Graduate Education, American Council on Education, Washington, D.C., 1966.

[7]K. D. Roose and C. J. Andersen, A Rating of Graduate Programs, American Council on Education, Washington, D.C., 1970.

[8]Cartter, p. 3.

generally been regarded as the best available source of information on the quality of doctoral programs. Although the ratings are now more than 10 years out of date and have been criticized on a variety of grounds, they are still used extensively by individuals within the academic community and by those in federal and state agencies.

A frequently cited criticism of the Cartter and Roose-Andersen studies is their exclusive reliance upon reputational measurement.

> The ACE rankings are but a small part of all the evaluative processes, but they are also the most public, and they are clearly based on the narrow assumptions and elitist structures that so dominate the present direction of higher education in the United States. As long as our most prestigious source of information about postsecondary education is a vague popularity contest, the resultant ignorance will continue to provide a cover for the repetitious aping of a single model. . . . All the attempts to change higher education will ultimately be strangled by the "legitimate" evaluative processes that have already programmed a single set of responses from the start.[9]

A number of other criticisms have been leveled at reputational rankings of graduate programs.[10] First, such studies inherently reflect perceptions that may be several years out of date and do not take into account recent changes in a program. Second, the ratings of individual programs are likely to be influenced by the overall reputation of the university--i.e., an institutional "halo effect." Also, a disproportionately large fraction of the evaluators are graduates of and/or faculty members in the largest programs, which may bias the survey results. Finally, on the basis of such studies it may not be possible to differentiate among many of the lesser known programs in which relatively few faculty members have established national reputations in research.

Despite such criticisms several studies based on methodologies similar to those employed by Cartter and Roose-Andersen have been carried out during the past 10 years. Some of these studies evaluated post-baccalaureate programs in areas not covered in the two earlier reports--including business, religion, educational administration, and medicine. Others have focused exclusively on programs in particular disciplines within the sciences and humanities. A few attempts have been made to assess graduate programs in a broad range of disciplines, many of which were covered in the Roose-Andersen and Cartter ratings, but in the opinion of many each has serious deficiencies in the methods and procedures employed. In addition to such studies, a

[9] Dolan, p. 81.

[10] For a discussion of these criticisms, see David S. Webster, "Methods of Assessing Quality," Change, October 1981, pp. 20-24.

myriad of articles have been written on the assessment of graduate programs since the release of the Roose-Andersen report. With the heightening interest in these evaluations, many in the academic community have recognized the need to assess graduate programs, using other criteria in addition to peer judgment.

> Though carefully done and useful in a number of ways, these ratings (Cartter and Roose-Andersen) have been criticized for their failure to reflect the complexity of graduate programs, their tendency to emphasize the traditional values that are highly related to program size and wealth, and their lack of timeliness or currency. Rather than repeat such ratings, many members of the graduate community have voiced a preference for developing ways to assess the quality of graduate programs that would be more comprehensive, sensitive to the different program purposes, and appropriate for use at any time by individual departments or universities.[11]

Several attempts have been made to go beyond the reputational assessment. Clark, Harnett, and Baird, in a pilot study[12] of graduate programs in chemistry, history, and psychology, identified as many as 30 possible measures significant for assessing the quality of graduate education. Glower[13] has ranked engineering schools according to the total amount of research spending and the number of graduates listed in Who's Who in Engineering. House and Yeager[14] rated economics departments on the basis of the total number of pages published by full professors in 45 leading journals in this discipline. Other ratings based on faculty publication records have been compiled for graduate programs in a variety of disciplines, including political science, psychology, and sociology. These and other studies demonstrate the feasibility of a national assessment of graduate programs that is founded on more than reputational standing among faculty peers.

[11] Clark, p. 1.

[12] M. J. Clark, R. T. Harnett, and L. L. Baird, Assessing Dimensions of Quality in Doctoral Education: A Technical Report of a National Study in Three Fields, Educational Testing Service, Princeton, New Jersey, 1976.

[13] Donald D. Glower, "A Rational Method for Ranking Engineering Programs," Engineering Education, May 1980.

[14] Donald R. House and James H. Yeager, Jr., "The Distribution of Publication Success Within and Among Top Economics Departments: A Disaggregate View of Recent Evidence," Economic Inquiry, Vol. 16, No. 4, October 1978, pp. 593-598.

DEVELOPMENT OF STUDY PLANS

In September 1976 the Conference Board, with support from the Carnegie Corporation of New York and the Andrew W. Mellon Foundation, convened a three-day meeting to consider whether a study of programs in graduate education should be undertaken. The 40 invited participants in this meeting included academic administrators, faculty members, and agency and foundation officials,[15] and represented a variety of institutions, disciplines, and convictions. In these discussions there was considerable debate concerning whether the potential benefits of such a study outweighed the possible misrepresentations of the results. On the one hand, “a substantial majority of the Conference [participants believed] that the earlier assessments of graduate education have received wide and important use: by students and their advisors, by the institutions of higher education as aids to planning and the allocation of educational functions, as a check on unwarranted claims of excellence, and in social science research.”[16] On the other hand, the Conference participants recognized that a new study assessing the quality of graduate education “would be conducted and received in a very different atmosphere than were the earlier Cartter and Roose-Andersen reports. . . . Where ratings were previously used in deciding where to increase funds and how to balance expanding programs, they might now be used in deciding where to cut off funds and programs.”

After an extended debate of these issues, it was the recommendation of this conference that a study with particular emphasis on the effectiveness of doctoral programs in educating research personnel be undertaken. The recommendation was based principally on four considerations:

(1) the importance of the study results to national and state bodies,
(2) the desire to stimulate continuing emphasis on quality in graduate education,
(3) the need for current evaluations that take into account the many changes that have occurred in programs since the Roose-Andersen study, and
(4) the value of extending the range of measures used in evaluative studies of graduate programs.

Although many participants expressed interest in an assessment of master's degree and professional degree programs, insurmountable problems prohibited the inclusion of these types of programs in this study.

Following this meeting a 13-member committee,[17] co-chaired by

[15]See Appendix G for a list of the participants in this conference.
[16]From a summary of the Woods Hole Conference (see Appendix G).
[17]See Appendix H for a list of members of the planning committee.

Gardner Lindzey and Harriet A. Zuckerman, was formed to develop a detailed plan for a study limited to research-doctorate programs and designed to improve upon the methodologies utilized in earlier studies. In its deliberations the planning committee carefully considered the criticisms of the Roose-Andersen study and other national assessments. Particular attention was paid to the feasibility of compiling a variety of specific measures (e.g., faculty publication records, quality of students, program resources) that were judged to be related to the quality of research-doctorate programs. Attention was also given to making improvements in the survey instrument and procedures used in the Cartter and Roose-Andersen studies. In September 1978 the planning group submitted a comprehensive report describing alternative strategies for an evaluation of the quality and effectiveness of research-doctorate programs.

> The proposed study has its own distinctive features. It is characterized by a sharp focus and a multidimensional approach. (1) It will focus only on programs awarding research doctorates; other purposes of doctoral training are acknowledged to be important, but they are outside the scope of the work contemplated. (2) The multidimensional approach represents an explicit recognition of the limitations of studies that make assessments solely in terms of ratings of perceived quality provided by peers--the so-called reputational ratings. Consequently, a variety of quality-related measures will be employed in the proposed study and will be incorporated in the presentation of the results of the study.[18]

This report formed the basis for the decision by the Conference Board to embark on a national assessment of doctorate-level programs in the sciences, engineering, and the humanities.

In June 1980 an 18-member committee was appointed to oversee the study. The committee,[19] made up of individuals from a diverse set of disciplines within the sciences, engineering, and the humanities, includes seven members who had been involved in the planning phase and several members who presently serve or have served as graduate deans in either public or private universities. During the first eight months the committee met three times to review plans for the study activities, make decisions on the selection of disciplines and programs to be covered, and design the survey instruments to be used. Early in the study an effort was made to solicit the views of presidents and graduate deans at more than 250 universities. Their suggestions were

[18]National Research Council, A Plan to Study the Quality and Effectiveness of Research-Doctorate Programs, 1978 (unpublished report).

[19]See p. vii of this volume for a list of members of the study committee.

most helpful to the committee in drawing up final plans for the assessment. With the assistance of the Council of Graduate Schools in the United States, the committee and its staff have tried to keep the graduate deans informed about the progress being made in this study. The final section of this chapter describes the procedures followed in determining which research-doctorate programs were to be included in the assessment.

SELECTION OF DISCIPLINES AND PROGRAMS TO BE EVALUATED

One of the most difficult decisions made by the study committee was the selection of disciplines to be covered in the assessment. Early in the planning stage it was recognized that some important areas of graduate education would have to be left out of the study. Limited financial resources required that efforts be concentrated on a total of no more than about 30 disciplines in the biological sciences, engineering, humanities, mathematical and physical sciences, and social sciences. At its initial meeting the committee decided that the selection of disciplines within each of these five areas should be made primarily on the basis of the total number of doctorates awarded nationally in recent years.

At the time the study was undertaken, aggregate counts of doctoral degrees earned during the FY1976-78 period were available from two independent sources--the Educational Testing Service (ETS) and the National Research Council (NRC). Table 1.1 presents doctoral awards data for 10 disciplines within engineering. As alluded to in footnote 1 of the table, discrepancies between the ETS and NRC counts may be explained, in part, by differences in the data collection procedures. The ETS counts, derived from information provided by universities, have been categorized according to the discipline of the department/academic unit in which the degree was earned. The NRC counts were tabulated from the survey responses of FY1976-78 Ph.D. recipients, who had been asked to identify their fields of specialty. Since separate totals for research doctorates in biomedical engineering, industrial and management engineering, materials engineering, and nuclear engineering were not available from the ETS manual, the committee made its selection of four disciplines primarily on the basis of the NRC data. In the case of electrical engineering, the ETS and NRC estimates of doctoral awards are highly discrepant.[20]

The selection of the research-doctorate programs to be evaluated in each discipline was made in two stages. Programs meeting <u>any</u> of the following three criteria were initially nominated for inclusion in the study:

(1) more than a specified number (see below) of research doctorates awarded during the FY1976-78 period,

[20]See footnote 2 in Table 1.1.

TABLE 1.1 Number of Research-Doctorates Awarded in Engineering Disciplines, FY1976-78

	Source of Data[1]	
	ETS	NRC
Disciplines Included in the Assessment		
Electrical Engineering[2]	1,724	1,916
Mechanical Engineering	1,122	1,166
Civil Engineering	1,087	1,027
Chemical Engineering	856	881
Disciplines Not Included in the Assessment		
Aerospace/Aeronautical Engineering	809	747
Agricultural Engineering	583	755
Biomedical Engineering	N/A	347
Industrial & Management Engineering	N/A	340
Materials Engineering	N/A	227
Nuclear Engineering	N/A	113
Other Engineering	N/A	503

[1]Data on FY1976-78 doctoral awards were derived from two independent sources: Educational Testing Service (ETS), Graduate Programs and Admissions Manual, 1979-81, and NRC's Survey of Earned Doctorates, 1976-78. Differences in field definitions account for discrepancies between the ETS and NRC data.

[2]The ETS data may include some individuals from computer science departments who earned doctorates in the field of electrical engineering and consequently are not included in the NRC data.

(2) more than one-third of that specified number of doctorates awarded in FY1979, or
(3) an average rating of 2.0 or higher in the Roose-Andersen rating of the scholarly quality of departmental faculty.

In each discipline the specified number of doctorates required for inclusion in the study was determined in such a way that the programs meeting this criterion accounted for at least 90 percent of the doctorates awarded in that discipline during the FY1976-78 period. In the engineering disciplines the following numbers of FY1976-78 doctoral awards were required to satisfy the first criterion (above):

Chemical Engineering--5 or more doctorates

Civil Engineering--6 or more doctorates

Electrical Engineering--7 or more doctorates

Mechanical Engineering--7 or more doctorates

A list of the nominated programs at each institution was then sent to a designated individual (usually the graduate dean) who had been appointed by the university president to serve as study coordinator for the institution. The coordinator was asked to review the list and eliminate any programs no longer offering research doctorates or not belonging in the designated discipline. The coordinator also was given an opportunity to nominate additional programs that he or she believed should be included in the study.[21] Coordinators were asked to restrict their nominations to programs that they considered to be “of uncommon distinction” and that had awarded no fewer than two research doctorates during the past two years. In order to be eligible for inclusion, of course, programs had to belong in one of the disciplines covered in the study. If the university offered more than one research-doctorate program in a discipline, the coordinator was instructed to provide information on each of them so that these programs could be evaluated separately.

The committee received excellent cooperation from the study coordinators at universities. Of the 243 institutions that were identified as having one or more research-doctorate programs satisfying the criteria (listed earlier) for inclusion in the study, only 7 declined to participate in the study and another 8 failed to provide the program information requested within the three-month period allotted (despite several reminders). None of these 15 institutions had doctoral programs that had received strong or distinguished reputational ratings in prior national studies. Since the information requested had not been provided, the committee decided not to include programs from these institutions in any aspect of the assessment. In each of the four chapters that follows, a list is given of the universities that met the

[21] See Appendix A for the specific instructions given to the coordinators.

TABLE 1.2 Number of Programs Evaluated in Each Discipline and the Total FY1976-80 Doctoral Awards from These Programs

Discipline	Programs	FY1976-80 Doctorates*
Chemical Engineering	79	1,405
Civil Engineering	74	1,583
Electrical Engineering	91	2,907
Mechanical Engineering	82	1,683
TOTAL	326	7,578

*The data on doctoral awards were provided by the study coordinator at each of the universities covered in the assessment.

criteria for inclusion in a particular discipline but that are not represented in the study.

As a result of nominations by institutional coordinators, some programs were added to the original list and others dropped. Table 1.2 reports the final coverage in each of the four engineering disciplines. The number of programs evaluated ranges from 91 in electrical engineering to 74 in civil engineering. Although the final determination of whether a program should be included in the assessment was left in the hands of the institutional coordinator, it is entirely possible that a few programs meeting the criteria for inclusion in the assessment were overlooked by the coordinators. During the course of the study only one such engineering program--in mechanical engineering--has been called to the attention of the committee.

In the chapter that follows, a detailed description is given of each of the measures used in the evaluation of research-doctorate programs in engineering. The description includes a discussion of the rationale for using the measure, the source from which data for that measure were derived, and any known limitations that would affect the interpretation of the data reported. The committee wishes to emphasize that there are limitations associated with each of the measures and that none of the measures should be regarded as a precise indicator of the quality of a program in educating engineers for careers in research. The reader is strongly urged to consider the descriptive material presented in Chapter II before attempting to interpret the program evaluations reported in subsequent chapters. In presenting a frank discussion of any shortcomings of each measure, the committee's intent is to reduce the possibility of misuse of the results from this assessment of research-doctorate programs.

II

Methodology

> Quality . . . you know what it is, yet you don't know what it is. But that's self-contradictory. But some things are better than others, that is, they have more quality. But when you try to say what the quality is, apart from the things that have it, it all goes poof! There's nothing to talk about. But if you can't say what Quality is, how do you know what it is, or how do you know that it even exists? If no one knows what it is, then for all practical purposes it doesn't exist at all. But for all practical purposes it really does exist. What else are the grades based on? Why else would people pay fortunes for some things and throw others in the trash pile? Obviously some things are better than others . . . but what's the “betterness”? . . . So round and round you go, spinning mental wheels and nowhere finding anyplace to get traction. What the hell is Quality? What is it?

Robert M. Pirsig
Zen and the Art of Motorcycle Maintenance

Both the planning committee and our own study committee have given careful consideration to the types of measures to be employed in the assessment of research-doctorate programs.[1] The committees recognized that any of the measures that might be used is open to criticism and that no single measure could be expected to provide an entirely satisfactory index of the quality of graduate education. With respect to the use of multiple criteria in educational assessment, one critic has commented:

[1]A description of the measures considered may be found in the third chapter of the planning committee's report, along with a discussion of the relative merits of each measure.

> At best each is a partial measure encompassing a fraction of the large concept. On occasion its link to the real [world] is problematic and tenuous. Moreover, each measure [may contain] a load of irrelevant superfluities, "extra baggage" unrelated to the outcomes under study. By the use of a number of such measures, each contributing a different facet of information, we can limit the effect of irrelevancies and develop a more rounded and truer picture of program outcomes.[2]

Although the use of multiple measures alleviates the criticisms directed at a single dimension or measure, it certainly will not satisfy those who believe that the quality of graduate programs cannot be represented by quantitative estimates no matter how many dimensions they may be intended to represent. Furthermore, the usefulness of the assessment is dependent on the validity and reliability of the criteria on which programs are evaluated. The decision concerning which measures to adopt in the study was made primarily on the basis of two factors:

(1) the extent to which a measure was judged to be related to the quality of research-doctorate programs and
(2) the feasibility of compiling reliable data for making national comparisons of programs in particular disciplines.

Only measures that were applicable to a majority of the disciplines to be covered were considered. In reaching a final decision the study committee found the ETS study,[3] in which 27 separate variables were examined, especially helpful, even though it was recognized that many of the measures feasible in institutional self-studies would not be available in a national study. The committee was aided by the many suggestions received from university administrators and others within the academic community.

Although the initial design called for an assessment based on approximately six measures, the committee concluded that it would be highly desirable to expand this effort. A total of 16 measures (listed in Table 2.1) have been utilized in the assessment of research-doctorate programs in chemical engineering, civil engineering, electrical engineering, and mechanical engineering. For nine of the measures data are available describing most, if not all, of the engineering programs included in the assessment. For seven measures the coverage is less complete but encompasses at least a majority of the programs in every discipline. The actual number of programs evaluated on every measure is reported in the second table in each of the next four chapters.

[2] C. H. Weiss, Evaluation Research; Methods of Assessing Program Effectiveness, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1972, p. 56.
[3] See M. J. Clark et al. (1976) for a description of these variables.

TABLE 2.1 Measures Compiled on Individual Research-Doctorate Programs in Engineering

Program Size[1]	
01	Reported number of faculty members in the program, December 1980.
02	Reported number of program graduates in last five years (July 1975 through June 1980).
03	Reported total number of full-time and part-time graduate students enrolled in the program who intend to earn doctorates, December 1980.
Characteristics of Graduates[2]	
04	Fraction of FY1975-79 program graduates who had received some national fellowship or training grant support during their graduate education.
05	Median number of years from first enrollment in graduate school to receipt of the doctorate--FY1975-79 program graduates.[3]
06	Fraction of FY1975-79 program graduates who at the time they completed requirements for the doctorate reported that they had made definite commitments for postgraduation employment.
07	Fraction of FY1975-79 program graduates who at the time they completed requirements for the doctorate reported that they had made definite commitments for postgraduation employment in Ph.D.-granting universities.
Reputational Survey Results[4]	
08	Mean rating of the scholarly quality of program faculty.
09	Mean rating of the effectiveness of the program in educating research scholars/scientists.
10	Mean rating of the improvement in program quality in the last five years.
11	Mean rating of the evaluators' familiarity with the work of the program's faculty.
University Library Size[5]	
12	Composite index describing the library size in the university in which the program is located, 1979-80.
Research Support	
13	Fraction of program faculty members holding research grants from the National Science Foundation, National Institutes of Health, or the Alcohol, Drug Abuse, and Mental Health Administration at any time during the FY1978-80 period.[6]
14	Total expenditures (in thousands of dollars) reported by the university for research and development activities in a specified field, FY1979.[7]
Publication Records[8]	
15	Number of published articles attributed to the program, 1978-79.
16	Estimated “overall influence” of published articles attributed to the program, 1978-79.

[1]Based on information provided to the committee by the participating universities.
[2]Based on data compiled in the NRC's Survey of Earned Doctorates.
[3]In reporting standardized scores and correlations with other variables, a shorter time-to-Ph.D. is assigned a higher score.
[4]Based on responses to the committee's survey conducted in April 1981.
[5]Based on data compiled by the Association of Research Libraries.
[6]Based on matching faculty names provided by institutional coordinators with the names of research grant awardees from the three federal agencies.
[7]Based on data provided to the National Science Foundation by universities.
[8]Based on data compiled by the Institute for Scientific Information and developed by Computer Horizons, Inc.

The 16 measures describe a variety of aspects important to the operation and function of research-doctorate programs--and thus are relevant to the quality and effectiveness of programs in educating engineers for careers in research. However, not all of the measures may be viewed as "global indices of quality." Some, such as those relating to program size, are best characterized as "program descriptors" that, although not dimensions of quality per se, are thought to have a significant influence on the effectiveness of programs. Other measures, such as those relating to university library size and support for research and training, describe some of the resources generally recognized as being important in maintaining a vibrant program in graduate education. Measures derived from surveys of faculty peers or from the publication records of faculty members, on the other hand, have traditionally been regarded as indices of the overall quality of graduate programs. Yet these too are not true measures of quality.

> We often settle for an easy-to-gather statistic, perfectly legitimate for its own limited purposes, and then forget that we haven't measured what we want to talk about. Consider, for instance, the reputation approach of ranking graduate departments: We ask a sample of physics professors (say) which the best physics departments are and then tabulate and report the results. The "best" departments are those that our respondents say are the best. Clearly it is useful to know which are the highly regarded departments in a given field, but prestige (which is what we are measuring here) isn't exactly the same as quality.[4]

To be sure, each of the 16 measures reported in this assessment has its own set of limitations. In the sections that follow an explanation is provided of how each measure has been derived and its particular limitations as a descriptor of research-doctorate programs.

PROGRAM SIZE

Information was collected from the study coordinators at each university on the names and ranks of program faculty, doctoral student enrollment, and number of Ph.D. graduates in each of the past five years (FY1976-80). Each coordinator was instructed to include on the faculty list those individuals who, as of December 1, 1980, held academic appointments (typically at the rank of assistant, associate,

[4]John Shelton Reed, "How Not to Measure What a University Does," The Chronicle of Higher Education, Vol. 22, No. 12, May 11, 1981, p. 56.

and full professor) and who participated significantly in doctoral education. Emeritus and adjunct members generally were not to be included. Measure 01 represents the number of faculty identified in a program. Measure 02 is the reported number of graduates who earned Ph.D. or equivalent research doctorates in a program during the period from July 1, 1975, through June 30, 1980. Measure 03 represents the total number of full-time and part-time students reported to be enrolled in a program in the fall of 1980, who intended to earn research doctorates. All three of these measures describe different aspects of program size. In previous studies program size has been shown to be highly correlated with the reputational ratings of a program, and this relationship is examined in detail in this report. It should be noted that since the information was provided by the institutions participating in the study, the data may be influenced by the subjective decisions made by the individuals completing the forms. For example, some institutional coordinators may be far less restrictive than others in deciding who should be included on the list of program faculty. To minimize variation in interpretation, detailed instructions were provided to those filling out the forms.[5] Measure 03 is of particular concern in this regard since the coordinators at some institutions may not have known how many of the students currently enrolled in graduate study intended to earn doctoral degrees.

CHARACTERISTICS OF GRADUATES

One of the most meaningful measures of the success of a research-doctorate program is the performance of its graduates. How many go on to lead productive careers in research and/or other activity for which the Ph.D. provides entry? Unfortunately, reliable information on the subsequent employment and career achievements of the graduates of individual programs is not available. In the absence of this directly relevant information, the committee has relied on four indirect measures derived from data compiled in the NRC's Survey of Earned Doctorates.[6] Although each measure has serious limitations (described below), the committee believes it more desirable to include this information than not to include data about program graduates.

In identifying program graduates who had received their doctorates in the previous five years (FY1975-79),[7] the faculty lists furnished by the study coordinators at universities were compared with the names of dissertation advisers (available from the NRC survey). The latter source contains records for virtually all individuals who have earned research doctorates from U.S. universities since 1920.

[5] A copy of the survey form and instructions sent to study coordinators is included in Appendix A.

[6] A copy of the questionnaire used in this survey is found in Appendix B.

[7] Survey data for the FY1980 Ph.D. recipients had not yet been compiled at the time this assessment was undertaken.

The institution, year, and specialty field of Ph.D. recipients were also used in determining the identity of program graduates. It is estimated that this matching process provided information on the graduate training and employment plans of more than 90 percent of the FY1975-79 graduates from the engineering programs. In the calculation of each of the four measures derived from the NRC survey, program data are reported only if the survey information is available on at least 10 graduates. Consequently, in the discipline with the fewest graduates per program--civil engineering--only slightly more than half the programs are included in these measures, whereas almost 90 percent of the electrical engineering programs are included.

Measure 04 constitutes the fraction of FY1975-79 graduates of a program who had received at least some national fellowship support, including National Institutes of Health fellowships or traineeships, National Science Foundation fellowships, other federal fellowships, Woodrow Wilson fellowships, or fellowships/traineeships from other U.S. national organizations. One might expect the more selective programs to have a greater proportion of students with national fellowship support--especially “portable fellowships.” Although the committee considered alternative measures of student ability (e.g., Graduate Record Examination scores, undergraduate grade point averages), reliable information of this sort was unavailable for a national assessment. It should be noted that the relevance of the fellowship measure varies considerably among disciplines. In the biomedical sciences a substantial fraction of the graduate students are supported by training grants and fellowships; in engineering the majority are supported by research assistantships and teaching assistantships.

Measure 05 is the median number of years elapsed from the time program graduates first enrolled in graduate school to the time they received their doctoral degrees. For purposes of analysis the committee has adopted the conventional wisdom that the most talented students are likely to earn their doctoral degrees in the shortest periods of time--hence, the shorter the median time-to-Ph.D., the higher the standardized score that is assigned. Although this measure has frequently been employed in social science research as a proxy for student ability, one must regard its use here with some skepticism. It is quite possible that the length of time it takes a student to complete requirements for a doctorate may be significantly affected by the explicit or implicit policies of a university or department. For example, in certain cases a short time-

[8]For a detailed analysis of this subject, see Dorothy M. Gilford and Joan Snyder, Women and Minority Ph.D.'s in the 1970's; A Data Book, National Academy of Sciences, Washington, D.C., 1977.

to-Ph.D. may be indicative of less stringent requirements for the degree. Furthermore, previous studies have demonstrated that women and members of minority groups, for reasons having nothing to do with their abilities, are more likely than male Caucasians to interrupt their graduate education or to be enrolled on a part-time basis.[8] As a consequence, the median tim to-Ph.D. may be longer for programs with larger fractions of women and minority students.

Measure 06 represents the fraction of FY1975-79 program graduates who reported at the time they had completed requirements for the doctorate that they had signed contracts or made firm commitments for postgraduation employment (including postdoctoral appointments as well as other positions in the academic or nonacademic sectors) and who provided the names of their prospective employers. Although this measure is likely to vary discipline by discipline according to the availability of employment opportunities, a program's standing relative to other programs in the same discipline should not be affected by this variation. In theory, the graduates with the greatest promise should have the easiest time in finding jobs. However, the measure is also influenced by a variety of other factors, such as personal job preferences and restrictions in geographic mobility, that are unrelated to the ability of the individual. It also should be noted parenthetically that unemployment rates for doctoral recipients are quite low and that nearly all of the graduates seeking jobs find positions soon after completing their doctoral programs.[9] Furthermore, first employment after graduation is by no means a measure of career achievement, which is what one would like to have if reliable data were available.

Measure 07, a variant of measure 06, constitutes the fraction of FY1975-79 program graduates who indicated that they had made firm commitments for employment in Ph.D.-granting universities and who provided the names of their prospective employers. This measure may be presumed to be an indication of the fraction of graduates likely to pursue careers in academic research, although there is no evidence concerning how many of them remain in academic research in the long term. In some disciplines the path from Ph.D. to postdoctoral apprenticeship to junior faculty has traditionally been regarded as the road of success for the growth and development of research talent. The committee is well aware, of course, that other paths, such as employment in the major laboratories of industry and government, provide equally attractive opportunities for growth. Indeed, in recent years increasing numbers of graduates are entering the nonacademic sectors. Unfortunately, the data compiled from the NRC's Survey of Earned Doctorates do not enable one to distinguish between employment in the top-flight laboratories of industry and government and employment in other areas of the nonacademic sectors. In each of the four engineering disciplines, more than half of the doctoral graduates accept first employment outside the academic sector (see Table 2.2), and many of the best qualified graduates in these and other disciplines undoubtedly are employed, as a matter of choice, in industrial or government laboratories. Measure 07 reflects only academic employment; it is a program characteristic rather than a dimension of program quality.

[9]For new Ph.D. recipients in science and engineering the unemployment rate has been less than 2 percent (see National Research Council, Postdoctoral Appointments and Disappointments, National Academy Press, Washington, D.C., 1981, p. 313).

TABLE 2.2 Percentage of FY1975-79 Doctoral Recipients with Definite Commitments for Employment Outside the Academic Sector*

Chemical Engineering	74
Civil Engineering	51
Electrical Engineering	66
Mechanical Engineering	65

*Percentages are based on respondents to the NRC's Survey of Earned Doctorates who indicated that they had made firm commitments for postgraduation employment and who provided the names of their prospective employers. These percentages may be considered to be lower-bound estimates of the actual percentages of doctoral recipients employed outside the academic sector.

The inclusion of measure 07 in this report has been an issue of great concern, much debated by the committee. The majority of the committee considers the measure to be of sufficient interest to warrant its inclusion. High values on measure 07 mark programs from which relatively large proportions of graduates accept first employmnt at academic institutions that award the Ph.D. degree. Having assembled data for measure 07 in all 32 disciplines covered in the assessment, the majority of the committee prefers that these data be reported, recognizing that readers will attend to them or not depending on their interest in this measure. Three members of the committee have objected to the majority position and object also to the inclusion of measure 06. Their views are presented in the Minority Statement, which follows Chapter VII in this report.

REPUTATIONAL SURVEY RESULTS

In April 1981, survey forms were mailed to a total of 975 faculty members in chemical engineering, civil engineering, electrical engineering, and mechanical engineering. The evaluators were selected from the faculty lists furnished by the study coordinators at the 228 universities covered in the assessment. These evaluators constituted approximately 16 percent of the total faculty population--6,196 faculty members--in the engineering programs being evaluated (see Table 2.3). The survey sample was chosen on the basis of the number of faculty in a particular program and the number of doctorates awarded in the previous five years (FY1976-80)--with the stipulation that at least one evaluator was selected from every program covered in the assessment. In selecting the sample each faculty rank was represented in proportion to the total number of individuals holding that rank, and preference was given to those faculty members whom the study coordinators had nominated to serve as evaluators. As shown in Table 2.3, 822 individuals, 84 percent of the survey sample in engineering, had been recommended by study coordinators.[10]

Each evaluator was asked to consider a stratified random sample of 50 research-doctorate programs in his or her discipline--with programs stratified by the number of faculty members associated with each program. Every program was included on 150 survey forms. The 50 programs to be evaluated appeared on a survey form in random sequence, preceded by an alphabetized list of all programs in that discipline that were being included in the study. No evaluator was asked to consider a program at his or her own institution. Ninety percent of the survey sample group were provided the names of faculty members in each of the 50 programs to be evaluated, along with data on the total number of doctorates awarded in the last five years.[11] The inclusion of this information represents a significant departure from the procedures used in earlier reputational assessments. For purposes of comparison with previous studies, 10 percent (randomly selected in each discipline) were not furnished any information other than the names of the programs.

The survey items were adapted from the form used in the Roose-Andersen study. Prior to mailing, the instrument was pretested using a small sample of faculty members in chemistry and psychology. As a result, two significant improvements were made in the original survey design. A question was added on the extent to which the evaluator was familiar with the work of the faculty in each program. Responses to this question, reported as measure 11, provide some insight into the relationship between faculty recognition and the reputational standing of a program.[12] Also added was a question on the evaluator's field of specialization--thereby making it possible to compare program evaluations in different specialty areas within a particular discipline.

A total of 579 faculty members in engineering--59 percent of those asked to participate--completed and returned survey forms (see Table 2.3). Two factors probably have contributed to this response rate being approximately 20 percentage points below the rates reported in the Cartter and Roose-Andersen studies.[13] First, because of the considerable expense of printing individualized survey forms (each 25-30 pages), second copies were not sent to sample members not responding to the first mailing[14] --as was done in the Cartter and Roose-Ander

[10]A detailed analysis of the survey participants in each discipline is given in subsequent chapters.

[11]This information was furnished to the committee by the study coordinators at the universities participating in the study.

[12]Evidence of the strength of the relationship is provided by correlations presented in Chapter III, Chapter IV, Chapter V and Chapter VI, and an analysis of the relationship is provided in Chapter VII.

[13]To compare the response rates obtained in the earlier surveys, see Roose and Andersen, Table 28, p. 29.

[14]A follow-up letter was sent to those not responding to the first mailing, and a second copy was distributed to those few evaluators who specifically requested another form.

sen efforts. Second, it is quite apparent that within the academic community there has been a growing dissatisfaction in recent years with educational assessments based on reputational measures. Indeed, this dissatisfaction was an important factor in the Conference Board's decision to undertake a multidimensional assessment, and some faculty members included in the sample made known to the committee their strong objections to the reputational survey.

TABLE 2.3 Survey Response by Discipline and Characteristics of Evaluator

	Total Program Faculty	Survey Sample		
		Total	Respondents	
	N	N	N	%
Discipline of Evaluator				
Chemical Engineering	979	237	164	69
Civil Engineering	1,461	222	129	58
Electrical Engineering	2,134	273	142	52
Mechanical Engineering	1,622	243	144	59
Faculty Rank				
Professor	3,698	597	377	63
Associate Professor	1,401	244	123	50
Assistant Professor	1,008	132	79	60
Other	89	2	0	0
Evaluator Selection				
Nominated by Institution	1,901	822	518	63
Other	4,295	153	61	40
Survey Form				
With Faculty Names	N/A*	876	525	60
Without Names	N/A*	99	54	55
Total All Fields	6,196	975	579	59

*Not applicable.

As can be seen in Table 2.3, there is some variation in the response rates in the four engineering disciplines. Of particular interest is the relatively high rate of response from chemical engineers and the low rate from those in electrical engineering--the latter may be related to the difficulties encountered in distinguishing between electrical engineering and computer science program faculty members. It is not surprising to find that the evaluators nominated by study coordinators responded more often than did those who had been selected at random.

Each program was considered by an average of approximately 90 survey respondents from other programs in the same discipline. The evaluators were asked to judge programs in terms of scholarly quality of program faculty, effectiveness of program in educating research scholars/scientists, and change in program quality in the last five years.[15] The mean ratings of a program on these three survey items constitute measures 08, 09, and 10. Evaluators were also asked to indicate the extent to which they were familiar with the work of the program faculty. The average of responses to this item constitutes measure 11.

In making judgments about the quality of faculty, evaluators were instructed to consider the scholarly competence and achievements of the individuals. The ratings were furnished on the following scale: Evaluators were asked to indicate their familiarity with the work of the program faculty according to the following scale:

5	Distinguished
4	Strong
3	Good
2	Adequate
1	Marginal
0	Not sufficient for doctoral education
X	Don't know well enough to evaluate

In assessing the effectiveness of a program, evaluators were asked to consider the accessibility of faculty, the curricula, the instructional and research facilities, the quality of the graduate students, the performance of graduates, and other factors that contribute to a program's effectiveness. This measure was rated accordingly:

3	Extremely effective
2	Reasonably effective
1	Minimally effective
0	Not effective
X	Don't know well enough to evaluate

Evaluators were instructed to assess change in program quality on the basis of whether there has been improvement in the last five years in both the scholarly quality of faculty and the effectiveness in educating research scholars/scientists. The following alternatives were provided:

2	Better than five years ago
1	Little or no change in last five years
0	Poorer than five years ago
X	Don't know well enough to evaluate

[15]A copy of the survey instrument and accompanying instructions is included in Appendix C.

Evaluators were asked to indicate their familiarity with the work of the program faculty according to the following scale:

2	Considerable familiarity
1	Some familiarity
0	Little or no familiarity

In the computation of mean ratings on measures 08, 09, and 10, the "don't know" responses were ignored. An average program rating based on fewer than 15 responses (excluding the "don't know" responses) is not reported.

Measures 08, 09, and 10 are subject to many of the same criticisms that have been directed at previous reputational surveys. Although care has been taken to improve the sampling design and to provide evaluators with some essential information about each program, the survey results merely reflect a consensus of faculty opinions. As discussed in Chapter I, these opinions may well be based on out-of-date information or be influenced by a variety of factors unrelated to the quality of the program. In Chapter VII a number of factors that may possibly affect the survey results are examined. In addition to these limitations, it should be pointed out that evaluators, on the average, were unfamiliar with almost one-third of the programs they were asked to consider.[16] As might be expected, the smaller and less prestigious programs were not as well known, and for this reason one might have less confidence in the average ratings of these programs. For all four survey measures, standard errors of the mean ratings are reported; they tend to be larger for the lesser known programs. The frequency of response to each of the survey items is discussed in Chapter VII.

Two additional comments should be made regarding the survey activity. First it should be emphasized that the ratings derived from the survey reflect a program's standing relative to other programs in the same discipline and provide no basis for making cross-disciplinary comparisons. For example, the fact that a larger number of chemical engineering programs received "distinguished" ratings on measure 08 than did electrical engineering programs indicates nothing about the relative quality of faculty in these two disciplines. Nor is it advisable to compare the rating of a program in one discipline with that of a program in another discipline because the ratings are based on the opinions of different groups of evaluators who were asked to judge entirely different sets of programs. Second, early in the committee's deliberations a decision was made to supplement the ratings obtained from faculty members with ratings from evaluators who hold research-oriented positions in institutions outside the academic sector. These institutions include industrial research laboratories, government research laboratories, and a variety of other research establishments. Over the past 10 years increasing numbers of doctoral

[16] See Table 7.6 in Chapter VII.

recipients have taken positions outside the academic setting. The extensive involvement of these graduates in nonacademic employment is reflected in the percentages reported in Table 2.2: An average of as many as 65 percent of the recent graduates in engineering disciplines indicated that they planned to take positions in nonacademic settings. Data from another NRC survey suggest that the actual fraction employed outside academia may be significantly higher. The committee recognized that the inclusion of nonacademic evaluators would furnish information valuable for assessing nontraditional dimensions of doctoral education and would provide an important new measure not assessed in earlier studies. Results from a survey of this group would provide an interesting comparison with the results obtained from the survey of faculty members. A concentrated effort was made to obtain supplemental funding for adding nonacademic evaluators in selected disciplines to the survey sample, but this effort was unsuccessful. The committee nevertheless remains convinced of the importance of including evaluators from nonacademic research institutions. These institutions are likely to employ increasing fractions of graduates in many disciplines, and it is urged that this group not be overlooked in future assessments of graduate programs.

UNIVERSITY LIBRARY SIZE

The university library holdings are generally regarded as an important resource for students in graduate (and undergraduate) education. The Association of Research Libraries (ARL) has compiled data from its academic member institutions and developed a composite measure of a university library's size relative to those of other ARL members. The ARL Library Index, as it is called, is based on 10 characteristics: volumes held, volumes added (gross), microform units held, current serials received, expenditures for library materials, expenditures for binding, total salary and wage expenditures, other operating expenditures, number of professional staff, and number of nonprofessional staff.[17] The 1979-80 index, which constitutes measure 12, is available for 89 of the 228 universities included in the assessment. (These 89 tend to be among the largest institutions.) The limited coverage of this measure is a major shortcoming. It should be noted that the ARL index is a composite description of library size and not a qualitative evaluation of the collections, services, or operations of the library. Also, it is a measure of aggregate size and does not take into account the library holdings in a particular department or discipline. Finally, although universities with more than one campus were instructed to include figures for the main campus only, some in fact may have reported library size for the entire system. Whether this misreporting occurred is not known.

[17]See Appendix D for a description of the calculation of this index.

RESEARCH SUPPORT

Using computerized data files[18] provided by the National Science Foundation (NSF) and the National Institutes of Health (NIH), it was possible to identify which faculty members in each program had been awarded research grants during the FY1978-80 period by either of these agencies or by the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA). The fraction of faculty members in a program who had received any research grants from these agencies during this three-year period constitutes measure 13. Since these awards have been made on the basis of peer judgment, this measure is considered to reflect the perceived research competence of program faculty. However, it should be noted that significant amounts of support for research in engineering come from other federal agencies as well, but it was not feasible to compile data from these other sources. It is estimated[19] that 35 percent of the university faculty members in these disciplines who received federal R&D funding obtained their support from NSF and another 10 percent from NIH. The remaining 55 percent received support from the Department of Energy, Department of Defense, National Aeronautics and Space Administration, and other federal agencies. It also should be pointed out that only those faculty members who served as principal investigators or coinvestigators are counted in the computation of this measure.

Measure 14 describes the total FY1979 expenditures by a university for R&D in all fields of engineering. These data have been furnished to the NSF[20] by universities and include expenditures of funds from both federal and nonfederal sources. If an institution has more than one program being evaluated in the same discipline, the aggregate university expenditures for research in that discipline are reported for each of the programs. In each discipline data are recorded for the 100 universities with the largest R&D expenditures. Unfortunately, these data are available only for aggregate expenditures in engineering and are not for expenditures in the individual engineering disciplines; thus, the value reported for an individual program represents the total university expenditures in engineering.

This measure has several limitations related to the procedures by which the data have been collected. The committee notes that there is evidence within the source document[21] that universities employ varying

[18] A description of these files is provided in Appendix E.

[19] Based on special tabulations of data from the NRC's Survey of Doctorate Recipients, 1979.

[20] A copy of the survey instrument used to collect these data appears in Appendix E.

[21] National Science Foundation, Academic Science: R and D Funds, Fiscal Year 1979, U.S. Government Printing Office, Washington, D.C., NSF 81-301, 1981.

practices for categorizing and reporting expenditures. Apparently, institutional support of research, industrial support of research, and expenditure of indirect costs are reported by different institutions in different categories (or not reported at all). Since measure 14 is based on total expenditures from all sources, the data used here are perturbed only when these types of expenditures are not subsumed under any reporting category. In contrast with measure 13, measure 14 is not reported on a scale relative to the number of faculty members and thus reflects the overall level of research activity at an institution in a particular discipline. Although research grants in the sciences and engineering provide some support for graduate students as well, these measures should not be confused with measure 04, which pertains to fellowships and training grants.

PUBLICATION RECORDS

Data from the 1978 and the 1979 Science Citation Index have been compiled[22] on published articles associated with research-doctorate programs. Publication counts were associated with programs on the basis of the discipline of the journal in which an article appeared and the institution with which the author was affiliated. Coauthored articles were proportionately attributed to the institutions of the individual authors. Articles appearing in multidisciplinary journals (e.g., Science, Nature) were apportioned according to the characteristic mix of subject matter in those journals. For the purposes of assigning publication counts, this mix can be estimated with reasonable accuracy.[23]

Two measures have been derived from the publication records: measure 15--the total number of articles published in the 1978-79 period that have been associated with a research-doctorate program and measure 16--an estimation of the "influence" of these articles. The latter is a product of the number of articles attributed to a program and the estimated influence of the journals in which these articles appeared. The influence of a journal is determined from the weighted number of times, on the average, an article in that journal is cited--with references from frequently cited journals counting more heavily. A more detailed explanation of the derivation of these measures is given in Appendix F. Neither measure 15 nor measure 16 is based on actual counts of articles written only by program faculty. However, extensive analysis of the "influence" index in the fields of physics, chemistry, and biochemistry has demonstrated the stability of this index and the

[22]The publication data have been generated for the committee's use by Computer Horizons, Inc., using source files provided by the Institute for Scientific Information.
[23]Francis Narin, Evaluative Bibliometrics; The Use of Publications and Citations Analysis in the Evaluation of Scientific Activity, Report to the National Science Foundation, March 1976, p. 203.

reliability associated with its use.[24] Of course, this does not imply that the measure captures subtle aspects of publication "influence." It is of interest to note that indices similar to measures 15 and 16 have been shown to be highly correlated with the peer ratings of graduate departments compiled in the Roose-Andersen study.[25]

It must be emphasized that these measures encompass articles (published in selected journals) by all authors affiliated with a given university. Included therefore are articles by program faculty members, students and research personnel, and even members of other departments in that university who publish in those journals. Moreover, these measures do not take into account the differing sizes of programs, and the measures clearly do depend on faculty size. Although consideration was given to reporting the number of published articles per faculty member, the committee concluded that since the measure included articles by other individuals besides program faculty members, the aggregate number of articles would be a more reliable measure of overall program quality. It should be noted that if a university had more than one program being evaluated in the same discipline, it is not possible to distinguish the relative contribution of each program. In such cases the aggregate university data in that discipline were assigned to each program.

Since the data are confined to 1978-79, they do not take into account institutional mobility of authors after that period. Thus, articles by authors who have moved from one institution to another since 1979 are credited to the former institution. Also, the publication counts fail to include the contributions of faculty members' publications in journals outside their primary discipline. This point may be especially important for those programs with faculty members whose research is at the intersection of several different disciplines.

The reader should be aware of two additional caveats with regard to the interpretation of measures 15 and 16. First, both measures are based on counts of published articles and do not include books. Since in engineering most scholarly contributions are published as journal articles, this may not be a serious limitation. Second, the "influence" measure should not be interpreted as an indicator of the impact of articles by individual authors. Rather it is a measure of the impact of the journals in which articles associated with a particular program have been published. Citation counts, with all their difficulties, would have been preferable since they are attributable to individual authors and they register the impact of books as well as

[24] Narin, pp. 283-307.

[25] Richard C. Anderson, Francis Narin, and Paul McAllister, "Publication Ratings Versus Peer Ratings of Universities," Journal of the American Society for Information Science, March 1978, pp. 91-103; and Lyle V. Jones, "The Assessment of Scholarship," New Directions for Program Evaluation, No. 6, 1980, pp. 1-20.

journal articles. However, the difficulty and cost of assembling reliable counts of articles by individual faculty members made their use infeasible.

ANALYSIS AND PRESENTATION OF THE DATA

The next four chapters present all of the information that has been compiled on individual research-doctorate programs in chemical engineering, civil engineering, electrical engineering, and mechanical engineering. Each chapter follows a similar format, designed to assist the reader in the interpretation of program data. The first table in each chapter provides a list of the programs evaluated in a discipline--including the names of the universities and departments or academic units in which programs reside--along with the full set of data compiled for individual programs. Programs are listed alphabetically according to name of institution, and both raw and standardized values are given for all but one measure.[26] For the reader's convenience an insert of information from Table 2.1 is provided that identifies each of the 16 measures reported in the table and indicates the raw scale used in reporting values for a particular measure. Standardized values, converted from raw values to have a mean of 50 and a standard deviation of 10,[27] are computed for every measure so that comparisons can easily be made of a program's relative standing on different measures. Thus, a standardized value of 30 corresponds with a raw value that is two standard deviations below the mean for that measure, and a standardized value of 70 represents a raw value two standard deviations above the mean. While the reporting of values in standardized form is convenient for comparing a particular program's standing on different measures, it may be misleading in interpreting actual differences in the values reported for two or more programs--especially when the distribution of the measure being examined is highly skewed. For example, the numbers of published articles (measure 15) associated with four electrical engineering programs are reported in Table 5.1 as follows:

Program	Raw Value	Standardized Value
A	1	41
B	2	42
C	11	45
D	16	47

[26]Since the scale used to compute measure 16--the estimated “influence” of published articles--is entirely arbitrary, only standardized values are reported for this measure.

[27]The conversion was made from the precise raw value rather than from the rounded value reported for each program. Thus, two programs may have the same reported raw value for a particular measure but different standardized values.

Although programs C and D have many times the number of articles as have programs A and B, the differences reported on a standardized scale appear to be small. Thus, the reader is urged to take note of the raw values before attempting to interpret differences in the standardized values given for two or more programs.

The initial table in each chapter also presents estimated standard errors of mean ratings derived from the four survey items (measures 08-11). A standard error is an estimated standard deviation of the sample mean rating and may be used to assess the stability of a mean rating reported for a particular program.[28] For example, one may assert (with .95 confidence) that the population mean rating would lie within two standard errors of the sample mean rating reported in this assessment.

No attempt has been made to establish a composite ranking of programs in a discipline. Indeed, the committee is convinced that no single measure adequately reflects the quality of a research-doctorate program and wishes to emphasize the importance of viewing individual programs from the perspective of multiple indices or dimensions.

The second table in each chapter presents summary statistics (i.e., number of programs evaluated, mean, standard deviation, and decile values) for each of the program measures.[29] The reader should find these statistics helpful in interpreting the data reported on individual programs. Next is a table of the intercorrelations among the various measures for that discipline. This table should be of particular interest to those desiring information about the interrelations of the various measures.

The remainder of each chapter is devoted to an examination of results from the reputational survey. Included are an analysis of the characteristics of survey participants and graphical portrayals of the relationship of mean rating of scholarly quality of faculty (measure 08) with number of faculty (measure 01) and the relationship of mean rating of program effectiveness (measure 09) with the number of graduates (measure 02). A frequently mentioned criticism of the Roose-Andersen and Cartter studies is that small but distinguished programs have been penalized in the reputational ratings because they are not as highly visible as larger programs of comparable quality. The comparisons of survey ratings with measures of program size are presented

[28] The standard error estimate has been computed by dividing the standard deviation of a program's ratings by the square root of the number of ratings. For a more extensive discussion of this topic, see Fred N. Kerlinger, Foundations of Behavioral Research, Holt, Reinhart, and Winston, Inc., New York, 1973, Chapter 12. Readers should note that the estimate is a measure of the variation in response and by no means includes all possible sources of error.

[29] Standardized scores have been computed from precise values of the mean and standard deviation of each measure and not the rounded values reported in the second table of each chapter.

as the first two figures in each chapter and provide evidence about the number of small programs in each discipline that have received high reputational ratings. Since in each case the reputational rating is more highly correlated with the square root of program size than with the size measure itself, measures 01 and 02 are plotted on a square root scale.[30] To assist the reader in interpreting results of the survey evaluations, each chapter concludes with a graphical presentation of the mean rating for every program of the scholarly quality of faculty (measure 08) and an associated "confidence interval" of 1.5 standard errors. In comparing the mean ratings of two programs, if their reported confidence intervals of 1.5 standard errors do not overlap, one may safely conclude that the program ratings are significantly different (at the .05 level of significance)--i.e., the observed difference in mean ratings is too large to be plausibly attributable to sampling error.[31]

The final chapter of this report gives an overview of the evaluation process in the four engineering disciplines and includes a summary of general findings. Particular attention is given to some of the extraneous factors that may influence program ratings of individual evaluators and thereby distort the survey results. The chapter concludes with a number of specific suggestions for improving future assessments of research-doctorate programs.

[30]For a general discussion of transforming variables to achieve linear fits, see John W. Tukey, Exploring Data Analysis, Addison-Wesley, Reading, Massachusetts, 1977.

[31]This rule for comparing nonoverlapping intervals is valid as long as the ratio of the two estimated standard errors does not exceed 2.41. (The exact statistical significance of this criterion then lies between .050 and .034.) Inspection of the standard errors reported in each discipline shows that for programs with mean ratings differing by less than 1.0 (on measure 08), the standard error of one mean very rarely exceeds twice the standard error of another.

III

Chemical Engineering Programs

In this chapter 79 research-doctorate programs in chemical engineering are assessed. These programs, according to the information supplied by their universities, have accounted for 1,405 doctoral degrees awarded during the FY1976-80 period--approximately 97 percent of the aggregate number of chemical engineering doctorates earned from U.S. universities in this five-year span.[1] On the average, 24 full-time and part-time students intending to earn doctorates were enrolled in a program in December 1980, with an average faculty size of 12 members.[2] Only three of the programs were initiated since 1970, and no two programs are located in the same university. In addition to the 79 institutions represented in this discipline, one other--Colorado School of Mines--was initially identified as meeting the criteria[3] for inclusion in the assessment. However, this institution chose not to participate in the assessment in any discipline.

Before examining individual program results presented in Table 3.1, the reader is urged to refer to Chapter II, in which each of the 16 measures used in the assessment is discussed. Summary statistics describing every measure are given in Table 3.2. For 10 of the measures, data are reported for at least 69 of the 79 chemical engineering programs. For measures 04-07, which pertain to characteristics of the program graduates, data are presented for only approximately three-fourths of the programs; the other fourth had too few graduates on which to base statistics.[4] For measure 12, a composite index of the size of a university library, data are available for 52

[1]Data from the NRC's Survey of Earned Doctorates indicate that 1,453 research doctorates in chemical engineering were awarded by U.S. universities between FY1976 and FY1980.

[2]See the reported means for measures 03 and 01 in Table 3.2.

[3]As mentioned in Chapter I, the primary criterion for inclusion was that a university had awarded 5 or more doctorates in chemical engineering during the FY1976-78 period.

[4]As mentioned in Chapter II, data for measures 04-07 are not reported if they are based on the survey responses of fewer than 10 FY1975-79 program graduates.

programs. The programs not evaluated on this measure are typically smaller--in terms of faculty size and graduate student enrollment--than other chemical engineering programs. With respect to measure 13, the fraction of faculty with research support from the National Science Foundation, the National Institutes of Health, and the Alcohol, Drug Abuse, and Mental Health Administration, data are reported for 55 programs that had at least 10 faculty members. Were data on measure 12 and 13 available for all 79 programs, it is likely that the reported means would be appreciably lower (and that some of the correlations of these measures with others would be higher).

Intercorrelations among the 16 measures (Pearson product-moment coefficients) are given in Table 3.3. Of particular note are the high positive correlations of the measures of the numbers of recent graduates (02) and numbers of students (03) with the measures of publication records (15, 16) and reputational survey ratings (08, 09). Figure 3.1 illustrates the relation between the mean rating of the scholarly quality of faculty (measure 08) and the number of faculty members (measure 01) for each of 79 programs in chemical engineering. Figure 3.2 plots the mean rating of program effectiveness (measure 09) against the total number of FY1976-80 program graduates (measure 02). Although in both figures there is a significant positive correlation between program size and reputational rating, it is quite apparent that some of the smaller programs received high mean ratings and that some of the larger programs received low mean ratings.

Table 3.4 describes the 164 faculty members who participated in the evaluation of chemical engineering programs. These individuals constituted 69 percent of those asked to respond to the survey in this discipline and 17 percent of the faculty population in the 79 research-doctorate programs being evaluated.[5] More than one-third of the survey participants had earned their highest degree since 1970, and a majority held the rank of full professor.

To assist the reader in interpreting results of the survey evaluations, estimated standard errors have been computed for mean ratings of the scholarly quality of faculty in 79 chemical engineering programs (and are given in Table 3.1). For each program the mean rating and an associated "confidence interval" of 1.5 standard errors are illustrated in Figure 3.3 (listed in order of highest to lowest mean rating). In comparing two programs, if their confidence intervals do not overlap, one may conclude that there is a significant difference in their mean ratings at a .05 level of significance.[6] From this figure it is also apparent that one should have somewhat more confidence in the

[5] See Table 2.3 in Chapter II.

[6] See pp. 29-31 for a discussion of the interpretation of mean ratings and associated confidence intervals.

accuracy of the mean ratings of higher-rated programs than lower-rated programs. This generalization results primarily from the fact that evaluators are not as likely to be familiar with the less prestigious programs, and consequently the mean ratings of these programs are usually based on fewer survey responses.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
001.	Akron, University of *Chemical Engineering*	6	9	4	.18	7.0	.82	.09
		37	*43*	*41*	*45*	*36*	*53*	*44*
002.	Auburn University *Chemical Engineering**	5	3	12	NA	NA	NA	NA
		35	*39*	*44*				
003.	Brigham Young University *Chemical Engineering*	14	10	8	NA	NA	NA	NA
		53	*44*	*43*				
004.	CUNY-Graduate School *Engineering*	7	10	12	.69	7.3	.92	.00
		39	*44*	*44*	*81*	*33*	*61*	*34*
005.	California Institute of Technology *Chemical Engineering*	11	32	68	.35	5.9	.79	.21
		47	*61*	*70*	*57*	*51*	*51*	*57*
006.	California, University of-Berkeley *Chemical Engineering*	23	65	96	.24	5.6	.95	.21
		71	*85*	*83*	*50*	*55*	*63*	*57*
007.	California, University of-Los Angeles *Engineering and Applied Science*	10	7	33	NA	NA	NA	NA
		45	*42*	*54*				
008.	Carnegie-Mellon University *Chemical Engineering*	15	31	40	.29	5.5	.84	.16
		55	*60*	*57*	*53*	*56*	*55*	*52*
009.	Case Western Reserve University *Chemical Engineering*	11	8	6	NA	NA	NA	NA
		47	*43*	*42*				
010.	Catholic University of America *Chemical Engineering*	9	10	5	.27	5.3	.64	.09
		43	*44*	*41*	*52*	*59*	*39*	*44*
011.	Cincinnati, University of *Chemical Engineering*	10	6	10	NA	NA	NA	NA
		45	*41*	*43*				
012.	Clarkson College of Technology *Chemical Engineering*	17	12	31	.15	5.3	.58	.00
		59	*46*	*53*	*43*	*58*	*35*	*34*
013.	Clemson University *Chemical Engineering*	11	6	2	.27	6.2	.82	.36
		47	*41*	*40*	*52*	*46*	*53*	*74*
014.	Colorado, University of *Chemical Engineering*	12	11	NA	.47	6.5	.80	.27
		49	*45*		*65*	*43*	*52*	*63*
015.	Columbia University *Chemical Engineering and Applied Chemistry*	10	26	23	.16	6.0	.83	.17
		45	*56*	*49*	*44*	*49*	*54*	*52*
016.	Connecticut, University of-Storrs *Chemical Engineering*	12	7	12	NA	NA	NA	NA
		49	*42*	*44*				
017.	Cornell University-Ithaca *Chemical Engineering*	15	14	26	.00	5.3	.75	.00
		55	*47*	*51*	*33*	*59*	*48*	*34*
018.	Delaware, University of-Newark *Chemical Engineering*	17	30	52	.54	5.4	.82	.21
		59	*59*	*63*	*70*	*57*	*53*	*57*
019.	Florida, University of-Gainesville *Chemical Engineering*	13	19	35	.29	5.8	.48	.10
		51	*51*	*55*	*53*	*52*	*27*	*45*
020.	Georgia Institute of Technology *Chemical Engineering*	19	13	7	.10	NA	.80	.10
		63	*46*	*42*	*40*		*52*	*45*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
001.	0.9	0.5	0.9	0.3	NA	NA	NA	1		.10	.09	.08	.05
	32	*29*	*42*	*34*				*40*	*41*				
002.	1.2	0.8	1.0	0.7	NA	NA	2450	9		.11	.09	.09	.07
	34	*34*	*49*	*43*			*44*	*49*	*54*				
003.	2.4	1.5	1.2	0.8	`0.6	.29	NA	8		.09	.07	.07	.07
	47	*48*	*55*	*47*	*42*	*45*		*48*	*52*				
004.	2.7	1.6	0.9	0.9	NA	NA	NA	6		.09	.06	.07	.07
	51	*51*	*42*	*48*				*45*	*48*				
005.	4.7	2.7	1.5	1.7	NA	.46	8339	11		.05	.05	.06	.05
	71	*70*	*67*	*68*		*55*	*51*	*51*	*52*				
006.	4.6	2.6	1.0	1.7	2.2	.44	16448	37		.06	.06	.06	.05
	71	*70*	*48*	*70*	*69*	*54*	*60*	*82*	*91*				
007.	2.6	1.4	1.6	0.8	2.0	.50	6168	4		.10	.07	.07	.07
	49	*47*	*69*	*48*	*67*	*58*	*48*	*43*	*45*				
008.	3.6	2.2	0.9	1.4	NA	.33	6409	8		.07	.04	.09	.06
	60	*61*	*44*	*62*		*48*	*48*	*48*	*48*				
009.	2.8	1.8	1.0	0.9	`1.3	.27	8676	6		.10	.07	.06	.06
	51	*53*	*46*	*49*	*36*	*44*	*51*	*45*	*47*				
010.	1.1	0.6	0.7	0.4	NA	NA	NA	1		.10	.09	.10	.05
	34	*32*	*36*	*36*				*40*	*40*				
011.	2.1	1.3	0.9	0.7	`0.2	.30	2360	2		.08	.08	.06	.06
	44	*44*	*45*	*43*	*46*	*46*	*44*	*41*	*43*				
012.	2.5	1.6	0.9	0.9	NA	.35	1791	9		.07	.07	.09	.07
	48	*50*	*44*	*50*		*49*	*43*	*49*	*49*				
013.	1.7	1.1	0.9	0.5	NA	.09	4356	3		.10	.09	.08	.06
	39	*40*	*43*	*40*		*33*	*46*	*42*	*42*				
014.	3.0	1.7	1.2	1.2	`0.9	.33	1849	2		.08	.06	.06	.05
	53	*53*	*54*	*58*	*40*	*48*	*43*	*41*	*42*				
015.	2.3	1.5	0.8	0.8	1.7	.20	5375	5		.09	.07	.08	.07
	47	*48*	*39*	*46*	*65*	*40*	*47*	*44*	*44*				
016.	2.6	1.5	1.4	0.9	`0.5	.33	4069	6		.08	.07	.07	.06
	49	*48*	*63*	*50*	*43*	*48*	*46*	*45*	*48*				
017.	3.4	2.0	1.4	1.3	1.6	.27	13206	10		.07	.06	.07	.06
	57	*57*	*62*	*58*	*63*	*44*	*56*	*50*	*50*				
018.	4.5	2.5	1.0	1.7	NA	.77	3302	25		.06	.05	.07	.05
	69	*67*	*46*	*70*		*74*	*45*	*68*	*74*				
019.	3.0	1.9	0.9	1.0	0.8	.23	13686	14		.07	.04	.08	.06
	54	*55*	*45*	*53*	*55*	*41*	*57*	*55*	*51*				
020.	2.6	1.6	1.6	1.0	NA	.32	29270	7		.08	.06	.07	.06
	50	*50*	*69*	*51*		*47*	*74*	*47*	*46*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
021.	Houston, University of *Chemical*	12	35	45	.28	5.7	.84	.24
	Engineering	*49*	*63*	*60*	*52*	*53*	*55*	*60*
022.	Idaho, University of-Moscow *Chemical*	5	6	4	NA	NA	NA	NA
	Engineering	*35*	*41*	*41*				
023.	Illinois Institute of Technology *Chemical*	6	17	19	.26	6.3	.39	.06
	Engineering	*37*	*49*	*48*	*51*	*45*	*20*	*40*
024.	Illinois, University-Urbana/Champaign	11	43	74	.30	4.9	.91	.11
	Chemical Engineering	*47*	*69*	*73*	*54*	*64*	*60*	*46*
025.	Iowa State University-Ames *Chemical*	16	24	27	.20	6.2	.75	.15
	Engineering	*57*	*55*	*51*	*47*	*46*	*48*	*50*
026.	Kansas State University-Manhattan	9	7	15	.09	7.4	.64	.09
	Chemical Engineering	*43*	*42*	*46*	*39*	*31*	*39*	*44*
027.	Kansas, University of *Chemical and*	13	6	12	NA	NA	NA	NA
	Petroleum Engineering	*51*	*41*	*44*				
028.	Kentucky, University of *Chemical*	10	8	9	NA	NA	NA	NA
	Engineering	*45*	*43*	*43*				
029.	Lehigh University *Chemical Engineering*	14	23	20	.08	5.8	.78	.09
		53	*54*	*48*	*38*	*52*	*50*	*44*
030.	Louisiana State University-Baton Rouge	14	17	21	.21	5.9	.84	.16
	Chemical Engineering	*53*	*49*	*49*	*47*	*51*	*55*	*51*
031.	Maryland, University of-College Park	12	24	13	.20	6.4	.75	.04
	Chemical and Nuclear Engineering	*49*	*55*	*45*	*47*	*44*	*48*	*38*
032.	Massachusetts Institute of Technology	28	47	99	.26	6.2	.76	.24
	Chemical Engineering	*81*	*72*	*84*	*51*	*46*	*49*	*60*
033.	Massachusetts, University of-Amherst	14	22	27	.33	4.9	1.00	.20
	Chemical Engineering	*53*	*53*	*51*	*56*	*64*	*67*	*56*
034.	Michigan State University-East Lansing	9	5	23	NA	NA	NA	NA
	Chemical Engineering	*43*	*40*	*49*				
035.	Michigan, University of-Ann Arbor	19	24	27	.20	6.5	.80	.20
	*Chemical Engineering**	*63*	*55*	*51*	*47*	*43*	*52*	*56*
036.	Minnesota, University of *Chemical*	20	55	72	.20	5.3	.82	.26
	Engineering and Materials Science	*65*	*78*	*72*	*46*	*58*	*54*	*62*
037.	Missouri, University of-Columbia *Chemical*	10	6	5	NA	NA	NA	NA
	Engineering	*45*	*41*	*41*				
038.	Missouri, University of-Rolla *Chemical*	15	15	18	.24	5.3	.82	.12
	Engineering	*55*	*48*	*47*	*49*	*59*	*54*	*47*
039.	Montana State University-Bozeman	5	6	4	NA	NA	NA	NA
	Chemical Engineering	*35*	*41*	*41*				
040.	New Jersey Institute of Technology	28	4	NA	NA	NA	NA	NA
	Chemistry and Chemical Engineering	*81*	*40*					

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
021.	4.1	2.2	1.7	1.6	`0.9	.50	5015	29		.08	.05	.06	.06
	65	*61*	*74*	*66*	*40*	*58*	*47*	*73*	*70*				
022.	1.0	0.8	0.7	0.4	NA	NA	NA	3		.10	.10	.10	.06
	33	*35*	*37*	*36*				*42*	*43*				
023.	2.4	1.5	0.7	1.0	NA	NA	NA	7		.08	.06	.06	.07
	47	*48*	*36*	*53*				*47*	*45*				
024.	4.0	2.4	0.7	1.5	2.0	.73	18980	12		.07	.06	.06	.06
	64	*66*	*37*	*63*	*67*	*71*	*63*	*53*	*52*				
025.	3.1	1.9	1.2	1.0	`0.5	.19	8330	11		.08	.05	.08	.07
	54	*56*	*55*	*53*	*43*	*39*	*51*	*51*	*54*				
026.	2.1	1.3	0.9	0.6	NA	NA	2604	20		.09	.06	.04	.07
	44	*44*	*45*	*43*			*44*	*62*	*56*				
027.	2.1	1.2	1.0	0.5	0.1	.31	1707	3		.11	.09	.05	.06
	44	*43*	*46*	*39*	*49*	*46*	*43*	*42*	*42*				
028.	1.8	1.2	1.1	0.5	`0.1	.20	5056	17		.08	.08	.07	.06
	41	*42*	*51*	*41*	*47*	*40*	*47*	*59*	*56*				
029.	2.7	1.7	1.1	0.9	NA	.36	4568	11		.08	.06	.07	.06
	50	*53*	*51*	*50*		*49*	*46*	*51*	*51*				
030.	2.3	1.4	1.1	0.7	`0.3	.00	4130	3		.09	.07	.07	.06
	47	*47*	*49*	*43*	*45*	*28*	*46*	*42*	*41*				
031.	2.4	1.5	0.9	0.7	0.2	.50	3519	6		.08	.07	.07	.06
	47	*48*	*44*	*45*	*50*	*58*	*45*	*45*	*46*				
032.	4.3	2.4	1.3	1.6	`0.3	.43	59143	26		.06	.05	.07	.05
	67	*65*	*57*	*66*	*45*	*53*	*99*	*69*	*72*				
033.	3.2	1.9	1.5	1.2	`0.7	.43	2256	14		.07	.05	.07	.06
	55	*56*	*65*	*56*	*41*	*53*	*44*	*55*	*59*				
034.	1.9	1.1	1.0	0.6	0.3	NA	2247	2		.11	.08	.09	.07
	42	*40*	*47*	*42*	*51*		*44*	*41*	*40*				
035.	3.4	1.9	0.5	1.4	1.8	.42	19835	9		.08	.05	.06	.06
	57	*57*	*29*	*63*	*65*	*53*	*64*	*49*	*49*				
036.	4.9	2.8	1.1	1.7	1.2	.60	8726	22		.03	.04	.07	.05
	73	*73*	*50*	*70*	*59*	*64*	*51*	*65*	*64*				
037.	2.0	1.2	1.0	0.6	`0.2	.20	1976	1		.08	.08	.06	.07
	43	*43*	*49*	*43*	*46*	*40*	*43*	*40*	*40*				
038.	2.4	1.5	1.2	0.7	NA	.20	3606	7		.09	.07	.08	.06
	47	*47*	*55*	*45*		*40*	*45*	*47*	*49*				
039.	1.0	0.7	0.6	0.4	NA	NA	1689	1		.10	.08	.10	.05
	33	*34*	*31*	*37*			*43*	*40*	*41*				
040.	1.7	0.9	1.1	0.5	NA	.07	NA	0		.12	.09	.07	0.6
	40		*37*	*51*	*40*	*32*		*38*	*39*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
041.	North Carolina State University-Raleigh *Chemical Engineering*	10 *45*	20 *52*	17 *47*	.14 *42*	5.3 *58*	.86 *57*	.05 *39*
042.	Northwestern University *Chemical Engineering*	20 *65*	33 *61*	30 *53*	.24 *50*	6.2 *46*	.70 *44*	.03 *38*
043.	Notre Dame, University of *Chemical Engineering*	6 *37*	14 *47*	17 *47*	.31 *54*	4.2 *73*	.77 *49*	.15 *51*
044.	Ohio State University-Columbus *Chemical Engineering*	13 *51*	16 *49*	30 *53*	.11 *40*	6.1 *47*	.89 *59*	.22 *58*
045.	Oklahoma State University-Stillwater *Chemical Engineering*	9 *43*	15 *48*	12 *44*	.21 *48*	7.5 *30*	1.00 *67*	.14 *50*
046.	Oklahoma, University of-Norman *Chemical Engineering and Materials Science*	12 *49*	16 *49*	13 *45*	.15 *43*	6.1 *47*	.71 *45*	.14 *50*
047.	Oregon State University-Corvallis *Chemical Engineering*	7 *39*	4 *40*	4 *41*	NA	NA	NA	NA
048.	Pennsylvania State University *Chemical Engineering*	13 *51*	23 *54*	24 *50*	.11 *40*	6.8 *38*	.77 *49*	.12 *47*
049.	Pennsylvania, University of *Chemical Engineering*	11 *47*	30 *59*	33 *54*	.33 *56*	5.6 *54*	.85 *56*	.35 *72*
050.	Pittsburgh, University of *Chemical and Petroleum Engineering*	12 *49*	16 *49*	29 *52*	.08 *38*	5.0 *62*	1.00 *67*	.09 *44*
051.	Polytech Institute of New York *Chemical Engineering*	6 *37*	19 *51*	12 *44*	.20 *47*	7.3 *32*	.64 *40*	.00 *34*
052.	Princeton University *Chemical Engineering*	15 *55*	50 *74*	51 *62*	.21 *47*	5.1 *61*	.87 *57*	.06 *41*
053.	Purdue University-West Lafayette *Chemical Engineering*	21 *67*	44 *70*	70 *71*	.27 *51*	5.1 *61*	.82 *53*	.14 *50*
054.	Rensselaer Polytechnic Institute *Chemical and Environmental Engineering*	20 *65*	5 *40*	15 *46*	NA	NA	NA	NA
055.	Rhode Island, University of *Chemical Engineering*	8 *41*	2 *38*	4 *41*	NA	NA	NA	NA
056.	Rice University *Chemical Engineering*	13 *51*	18 *50*	28 *52*	.29 *53*	5.1 *61*	.95 *63*	.24 *60*
057.	Rochester, University of *Chemical Engineering*	10 *45*	14 *47*	18 *47*	.25 *50*	6.4 *44*	.93 *62*	.20 *56*
058.	Rutgers, The State University-New Brunswick *Chemical and Biochemical Engineering*	7 *39*	9 *43*	64 *68*	.08 *38*	6.4 *44*	.92 *61*	.08 *43*
059.	SUNY at Buffalo *Chemical Engineering*	13 *51*	24 *55*	18 *47*	.08 *38*	5.5 *56*	.67 *42*	.04 *39*
060.	SUNY-College of Environ Science & Forestry *Paper Science and Engineering*	9 *43*	5 *40*	9 *43*	NA	NA	NA	NA

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
041.	2.7	1.7	1.4	0.8	NA	.40	8416	8		.08	.06	.08	.07
	50	*52*	*62*	*47*		*52*	*51*	*48*	*48*				
042.	3.8	2.3	1.1	1.5	0.3	.55	5170	17		.07	.05	.06	.06
	62	*63*	*52*	*64*	*51*	*61*	*47*	*59*	*57*				
043.	3.2	1.9	1.5	1.3	`1.3	NA	1544	23		.08	.05	.07	.06
	56	*56*	*67*	*59*	*35*		*43*	*66*	*61*				
044.	2.6	1.7	1.1	0.8	0.9	.15	10926	8		.09	.06	.07	.06
	50	*52*	*49*	*48*	*56*	*37*	*54*	*48*	*48*				
045.	2.3	1.4	1.1	0.6	`1.9	NA	4120	3		.09	.08	.06	.06
	46	*47*	*52*	*42*	*29*		*46*	*42*	*43*				
046.	2.4	1.5	1.0	0.6	`0.6	.42	1834	4		.08	.07	.05	.06
	47	*49*	*46*	*43*	*43*	*53*	*43*	*43*	*43*				
047.	2.8	1.6	1.0	1.1	NA	NA	3128	7		.08	.07	.05	.07
	52	*51*	*47*	*54*			*45*	*47*	*46*				
048.	3.0	1.8	1.4	1.1	0.7	.31	22901	34		.08	.06	.06	.06
	53	*53*	*61*	*55*	*55*	*46*	*67*	*79*	*70*				
049.	3.9	2.2	1.4	1.5	0.7	.36	4579	18		.07	.05	.06	.06
	63	*61*	*63*	*65*	*54*	*49*	*46*	*60*	*61*				
050.	2.2	1.5	1.2	0.7	0.1	.25	2794	18		.09	.08	.07	.07
	45	*48*	*53*	*45*	*49*	*43*	*44*	*60*	*61*				
051.	1.8	1.2	0.6	0.6	NA	NA	5310	6		.11	.08	.09	.06
	41	*42*	*30*	*42*			*47*	*45*	*45*				
052.	4.0	2.3	0.6	1.5	0.9	.47	6358	13		.07	.05	.07	.06
	64	*64*	*32*	*64*	*56*	*56*	*48*	*54*	*53*				
053.	3.7	2.1	1.5	1.5	`0.5	.48	17331	34		.07	.05	.06	.06
	61	*60*	*68*	*64*	*43*	*56*	*61*	*79*	*80*				
054.	2.6	1.6	1.2	0.9	NA	.55	7849	13		.09	.08	.06	.06
	49	*50*	*55*	*49*		*61*	*50*	*54*	*55*				
055.	1.7	0.8	1.2	0.5	NA	NA	2611	1		.13	.10	.08	.05
	40	*36*	*54*	*39*			*44*	*40*	*40*				
056.	3.2	1.9	0.9	1.1	`1.4	.39	1782	11		.08	.05	.08	.07
	56	*55*	*43*	*55*	*34*	*51*	*43*	*51*	*49*				
057.	3.0	1.8	1.2	1.1	`0.6	.70	16764	3		.08	.06	.07	.07
	54	*53*	*54*	*55*	*42*	*70*	*60*	*42*	*43*				
058.	1.8	1.1	1.0	0.5	0.8	NA	1877	0		.10	.08	.07	.06
	41	*41*	*45*	*40*	*56*		*43*	*38*	*39*				
059.	3.1	1.7	1.0	1.2	0.3	.62	3019	15		.07	.05	.08	.06
	55	*52*	*46*	*56*	*51*	*65*	*45*	*56*	*56*				
060.	1.3	0.7	0.9	0.3	NA	NA	1745	0		.14	.10	.05	.05
	36	*33*	*45*	*34*			*43*	*38*	*39*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
061.	Southern California, University of *Chemical Engineering*	8 *41*	5 *40*	12 *44*	NA	NA	NA	NA
062.	Stanford University *Chemical Engineering*	9 *43*	32 *61*	51 *62*	.29 *53*	5.6 *54*	.86 *57*	.17 *53*
063.	Stevens Institute of Technology *Chemistry/ Chemical Engineering*	9 *43*	11 *45*	10 *43*	.27 *52*	7.3 *32*	.55 *32*	.09 *44*
064.	Syracuse University *Chemical Engineering and Materials Science*	12 *49*	29 *58*	10 *43*	.14 *42*	7.1 *34*	.52 *30*	.17 *53*
065.	Tennessee, University of-Knoxville *Chemical, Metallurgical, & Polymer Engin*	25 *75*	19 *51*	15 *46*	.24 *49*	6.3 *46*	.77 *49*	.06 *41*
066.	Texas A & M University *Chemical Engineering*	14 *53*	15 *48*	15 *46*	.39 *60*	5.5 *56*	.69 *43*	.00 *34*
067.	Texas, University of-Austin *Chemical Engineering*	17 *59*	30 *59*	33 *54*	.18 *45*	5.9 *50*	.77 *49*	.12 *47*
068.	Tulane University *Chemical Engineering*	7 *39*	2 *38*	22 *49*	NA	NA	NA	NA
069.	Tulsa, University of *Chemical Engineering*	8 *41*	5 *40*	9 *43*	NA	NA	NA	NA
070.	Utah, University of-Salt Lake City *Chemical Engineering*	10 *45*	12 *46*	15 *46*	.82 *90*	5.8 *52*	.73 *46*	.09 *44*
071.	Vanderbilt University *Chemical Engineering*	9 *43*	6 *41*	2 *40*	NA	NA	NA	NA
072.	Virginia, University of *Chemical Engineering*	10 *45*	9 *43*	13 *45*	NA	NA	.60 *36*	.40 *77*
073.	Washington University-Saint Louis *Chemical Engineering*	9 *43*	12 *46*	13 *45*	.47 *66*	7.0 *36*	.88 *58*	.18 *53*
074.	Washington, University of-Seattle *Chemical Engineering*	18 *61*	26 *56*	9 *43*	.27 *52*	6.2 *47*	.59 *36*	.09 *44*
075.	Wayne State University *Chemical Engineering*	17 *59*	15 *48*	7 *42*	.18 *45*	7.0 *36*	.73 *46*	.27 *64*
076.	West Virginia University *Chemical Engineering*	10 *45*	11 *45*	9 *43*	.18 *45*	5.3 *59*	.82 *53*	.27 *64*
077.	Wisconsin, University of-Madison *Chemical Engineering*	17 *59*	46 *71*	76 *74*	.36 *58*	5.0 *63*	.86 *56*	.24 *60*
078.	Worcester Polytechnic Institute *Chemical Engineering*	8 *41*	7 *42*	7 *42*	NA	NA	NA	NA
079.	Yale University *Engineering and Applied Science*	10 *45*	13 *46*	18 *47*	.18 *45*	4.8 *64*	.64 *39*	.18 *54*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 3.1 Program Measures (Raw and Standardized Values) in Chemical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
061.	2.0	1.2	1.6	0.7	0.4	NA	18269	8		.10	.08	.09	.07
	43	*42*	*69*	*44*	*51*		*62*	*48*	*43*				
062.	4.5	2.7	1.0	1.6	2.0	NA	25196	7		.06	.05	.04	.05
	70	*70*	*48*	*67*	*67*		*70*	*47*	*42*				
063.	1.5	0.9	1.0	0.4	NA	NA	2313	4		.11	.08	.08	.06
	37	*36*	*46*	*38*			*44*	*43*	*43*				
064.	2.4	1.6	1.0	0.7	`0.3	.33	4063	7		.10	.07	.07	.06
	48	*49*	*46*	*44*	*45*	*48*	*46*	*47*	*47*				
065.	2.6	1.5	1.1	0.7	`0.4	.24	4266	8		.10	.08	.05	.06
	49	*49*	*49*	*45*	*44*	*42*	*46*	*48*	*48*				
066.	2.4	1.5	1.0	0.7	`0.5	.21	18988	17		.09	.07	.06	.06
	48	*47*	*48*	*45*	*43*	*40*	*63*	*59*	*50*				
067.	3.7	2.1	1.4	1.4	1.6	.29	10517	22		.08	.05	.05	.06
	61	*60*	*61*	*61*	*63*	*45*	*53*	*65*	*61*				
068.	1.6	0.9	0.6	0.6	`1.0	NA	NA	2		.12	.09	.07	.06
	38	*36*	*31*	*41*	*38*			*41*	*40*				
069.	1.7	1.1	1.2	0.5	NA	NA	NA	10		.09	.08	.08	.06
	40	*40*	*55*	*39*				*50*	*51*				
070.	2.5	1.6	1.1	0.7	`0.6	.30	7123	14		.10	.07	.05	.06
	48	*49*	*51*	*45*	*42*	*46*	*49*	*55*	*46*				
071.	1.6	1.1	0.9	0.4	`0.7	NA	NA	4		.12	.09	.07	.05
	39	*40*	*44*	*36*	*41*			*43*	*44*				
072.	2.5	1.6	1.5	1.1	0.7	.40	4673	3		.07	.06	.06	.07
	48	*50*	*66*	*55*	*55*	*52*	*46*	*42*	*44*				
073.	2.8	1.8	1.3	1.0	`0.4	NA	5257	12		.08	.06	.07	.06
	52	*54*	*58*	*51*	*44*		*47*	*53*	*55*				
074.	3.4	2.0	1.3	1.2	1.5	.56	5430	7		.07	.03	.06	.07
	58	*58*	*60*	*56*	*62*	*61*	*47*	*47*	*45*				
075.	1.7	1.1	1.1	0.4	`0.4	.18	2693	0		.11	.09	.09	.05
	40	*41*	*49*	*37*	*45*	*38*	*44*	*38*	*39*				
076.	2.3	1.5	1.2	0.7	NA	.50	4618	10		.09	.07	.07	.07
	47	*48*	*53*	*45*		*58*	*46*	*50*	*50*				
077.	4.8	2.8	1.0	1.8	1.6	.65	9919	19		.04	.04	.05	.04
	72	*72*	*45*	*71*	*63*	*67*	*52*	*61*	*61*				
078.	1.7	1.0	0.8	0.5	NA	NA	2509	6		.11	.09	.08	.07
	40	*40*	*38*	*41*			*44*	*45*	*48*				
079.	2.7	1.6	0.9	0.8	2.1	.60	2510	0		.11	.08	.06	.07
	50	*50*	*43*	*48*	*68*	*64*	*44*	*38*	*39*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 3.2 Summary Statistics Describing Each Program Measure--Chemical Engineering

Measure	Number of Programs Evaluated	Mean	Standard Deviation	DECILES 1	2	3	4	5	6	7	8	9
Program Size												
01 Raw Value	79	12	5	7	9	9	10	11	12	14	16	19
Std Value	79	50	10	39	43	43	45	47	49	53	57	63
02 Raw Value	79	18	13	5	6	9	11	14	16	22	27	33
Std Value	79	50	10	40	41	43	45	47	49	53	57	61
03 Raw Value	77	24	22	5	9	12	13	16	20	27	33	56
Std Value	77	50	10	41	43	44	45	46	48	51	54	65
Program Graduates												
04 Raw Value	56	.25	.14	.09	.14	.18	.20	.24	.26	.27	.30	.37
Std Value	56	50	10	39	42	45	46	49	51	51	54	59
05 Raw Value	55	5.9	.8	7.2	6.5	6.3	6.2	5.9	5.6	5.4	5.3	5.0
Std Value	55	50	10	34	43	45	47	50	54	57	58	62
06 Raw Value	57	.78	.13	.59	.65	.73	.77	.80	.82	.84	.87	.93
Std Value	57	50	10	35	40	46	49	52	53	55	57	62
07 Raw Value	57	.15	.09	.02	.06	.09	.10	.14	.16	.20	.22	.26
Std Value	57	50	10	36	40	43	44	49	51	56	58	62
Survey Results												
08 Raw Value	79	2.7	1.0	1.6	1.8	2.1	2.4	2.5	2.7	3.0	3.4	4.0
Std Value	79	50	10	39	41	44	47	48	50	54	58	64
09 Raw Value	79	1.6	.5	.9	1.1	1.3	1.5	1.6	1.7	1.8	2.0	2.3
Std Value	79	50	10	37	41	45	48	50	52	54	58	63
10 Raw Value	79	1.1	.3	.7	.9	.9	1.0	1.0	1.1	1.2	1.3	1.5
Std Value	79	50	10	35	43	43	47	47	51	55	58	66
11 Raw Value	79	.9	.4	.4	.5	.7	.7	.8	.9	1.1	1.3	1.5
Std Value	79	50	10	37	40	45	45	47	50	55	60	65
University Library												
12 Raw Value	52	.2	1.0	-1.0	-.6	-.5	-.4	-.1	.3	.8	1.3	1.8
Std Value	52	50	10	38	42	43	44	47	51	56	60	65
Research Support												
13 Raw Value	55	.37	.17	.18	.21	.28	.31	.34	.40	.45	.50	.60
Std Value	55	50	10	39	41	45	46	48	52	55	58	64
14 Raw Value	69	7819	8858	1830	2351	2764	4067	4599	5336	7993	10599	18340
Std Value	69	50	10	43	44	44	46	46	47	50	53	62
Publication Records												
15 Raw Value	79	10	8	1	3	4	6	8	9	11	15	22
Std Value	79	50	10	40	42	43	45	48	49	51	56	64
16 Std Value	79	50	10	40	42	43	46	48	49	52	56	61

NOTE: Standardized values reported in the preceding table have been computed from exact values of the mean and standard deviation and not the rounded values reported here. Since the scale used to compute measure 16 is entirely arbitrary, only data in standardized form are reported for this measure.

TABLE 3.3 Intercorrelations Among Program Measures on 79 Programs in Chemical Engineering

Measure	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Program Size																
01		.53	.52	`.11	.20	.07	.09	.51	.49	.22	.46	.18	.01	.48	.42	.46
02			.82	.00	.32	.22	.14	.83	.83	.07	.79	.40	.45	.42	.66	.69
03				.07	.36	.31	.20	.77	.75	.11	.76	.42	.43	.50	.61	.65
Program Graduates																
04					.00	.09	.13	.20	.18	.00	.18	`.28	.17	`.02	.08	.07
05						.20	.10	.43	.44	.21	.44	.22	.31	.00	.30	.30
06							.24	.27	.28	.18	.21	`.12	.07	.07	.15	.23
07		.25	.23	.27	.28	`.04	.03	.02	.06	.14						
Survey Results																
08		.99	.31	.96	.41	.62	.42	.65	.65							
09		.29	.95	.40	.61	.41	.64	.63								
10		.30	`.14	.01	.18	.36	.34									
11		.39	.61	.41	.67	.68										
University Library																
12		.31	.21	.11	.12											
Research Support																
13		.09	.31	.35												
14		.39	.35													
Publication Records																
15		.96														
16																

NOTE: Since in computing correlation coefficients program data must be available for both of the measures being correlated, the actual number of programs on which each coefficient is based varies.

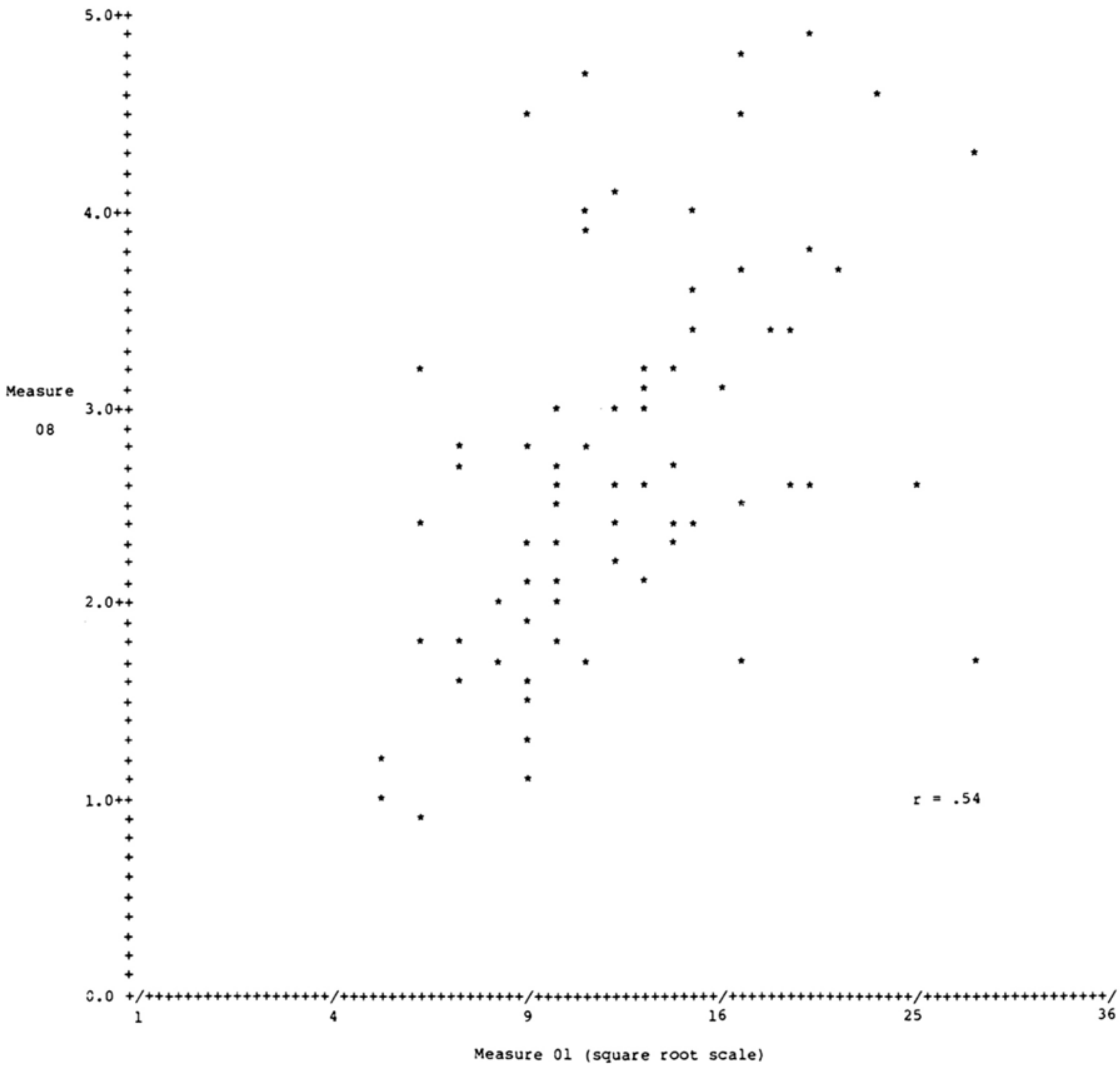

FIGURE 3.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--79 programs in chemical engineering.

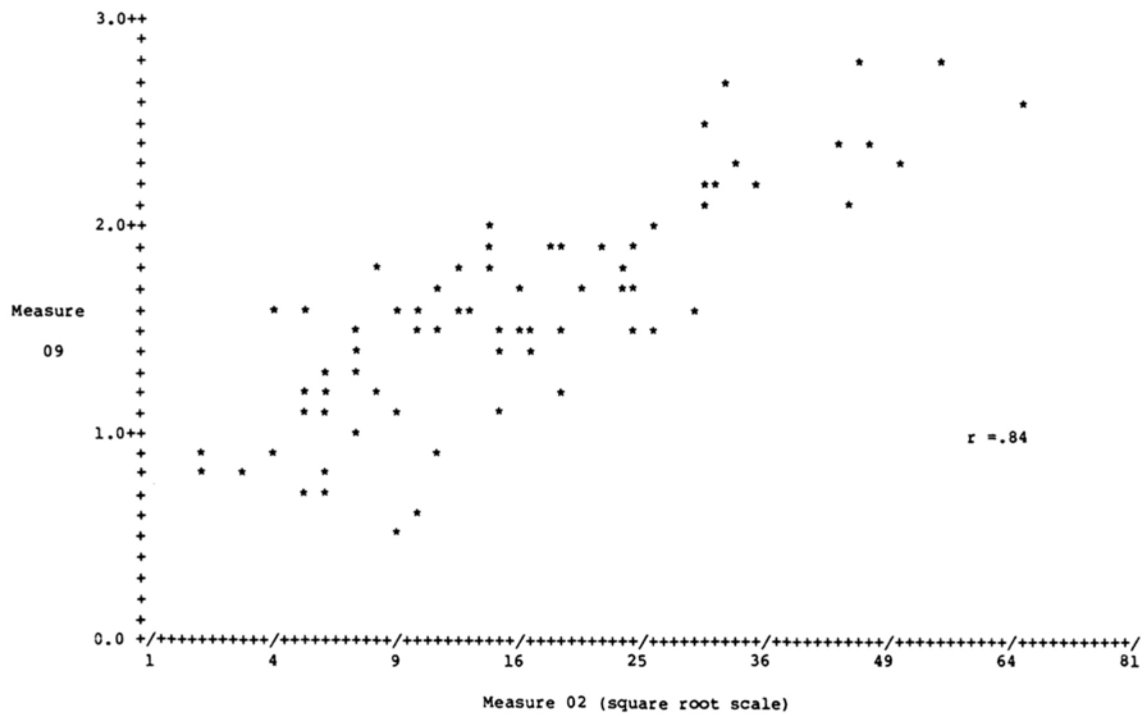

FIGURE 3.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--79 programs in chemical engineering.

TABLE 3.4 Characteristics of Survey Participants in Chemical Engineering

	Respondents	
	N	%
Field of Specialization		
Chemical Engineering	159	97
Other/Unknown	5	3
Faculty Rank		
Professor	99	60
Associate Professor	35	21
Assistant Professor	30	18
Year of Highest Degree		
Pre-1950	6	4
1950-59	38	23
1960-69	59	36
Post-1969	61	37
Evaluator Selection		
Nominated by Institution	145	88
Other	19	12
Survey Form		
With Faculty Names	151	92
Without Names	13	8
Total Evaluators	164	100

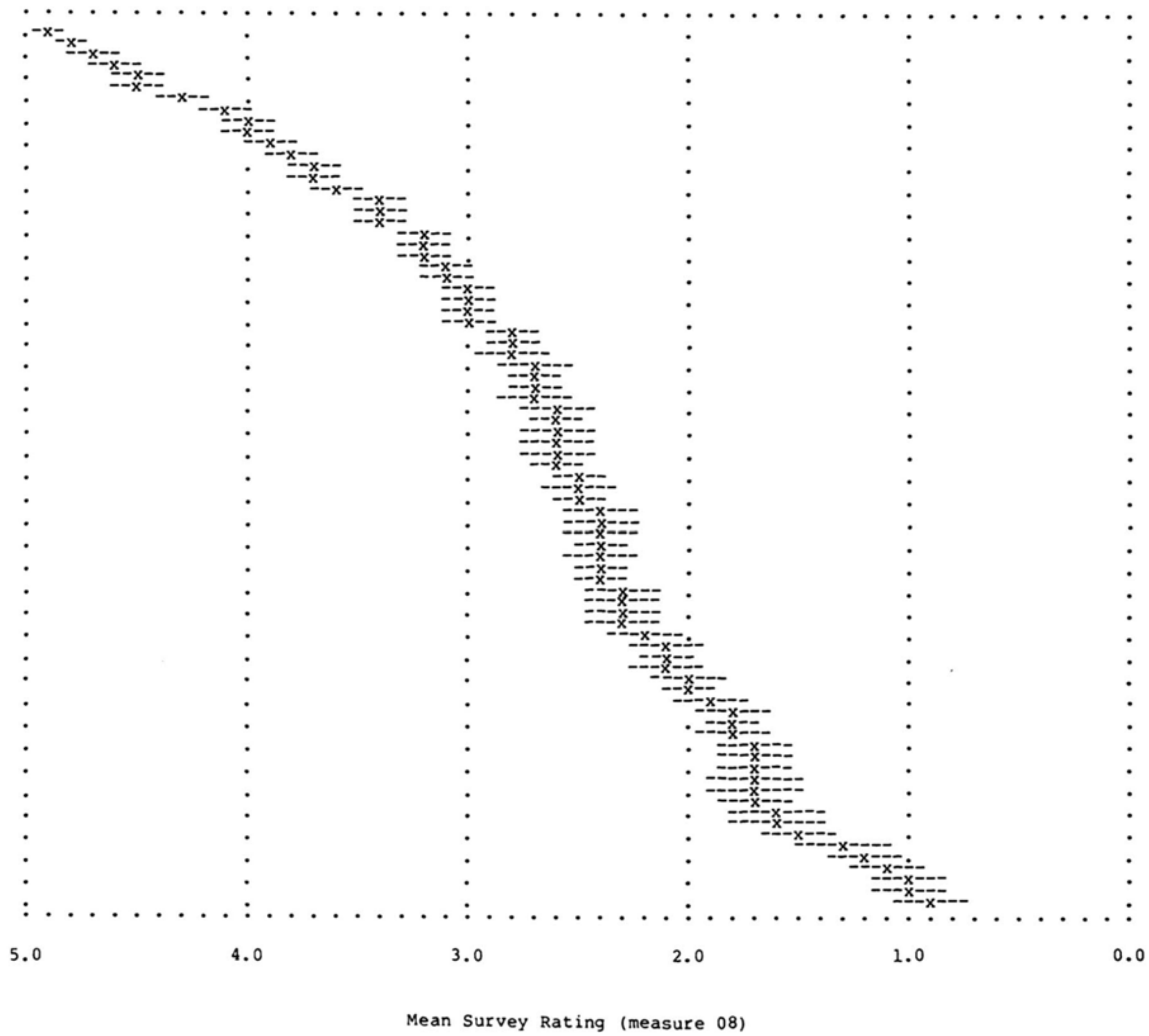

FIGURE 3.3 Mean rating of scholarly quality of faculty in 79 programs in chemical engineering.
NOTE: Programs are listed in sequence of mean rating, with the highest-rated program appearing at the top of the page. The broken lines (---) indicate a confidence interval of ±1.5 standard errors around the reported mean (x) of each program.

IV

Civil Engineering Programs

In this chapter 74 research-doctorate programs in civil engineering are assessed. These programs, according to the information supplied by their universities, have accounted for 1,583 doctoral degrees awarded during the FY1976-80 period--approximately 97 percent of the aggregate number of civil, sanitary, and environmental engineering doctorates earned from U.S. universities in this five-year span.[1] On the average, 35 full-time and part-time students intending to earn doctorates were enrolled in a program in December 1980, with an average faculty size of 20 members.[2] Only 5 of the programs were initiated since 1970, and only one institution--Vanderbilt University--had two civil engineering programs included in the assessment. In addition to the 73 institutions represented in this discipline, another 2 were initially identified as meeting the criteria[3] for inclusion in the assessment:

Harvard University

University of North Carolina--Chapel Hill

Civil engineering programs at these two institutions have not been included in the evaluations in this discipline, since in each case the study coordinator either indicated that the institution did not at that time have a research-doctorate program in civil engineering or failed to provide the information requested by the committee.

Before examining individual program results presented in Table 4.1, the reader is urged to refer to Chapter II, in which each of the 16

[1]Data from the NRC's Survey of Earned Doctorates indicate that 1,293 research doctorates in civil engineering and another 341 research doctorates in sanitary and environmental engineering were awarded by U.S. universities between FY1976 and FY1980.

[2]See the reported means for measures 03 and 01 in Table 4.2.

[3]As mentioned in Chapter I, the primary criterion for inclusion was that a university had awarded 6 or more doctorates in civil engineering during the FY1976-78 period.

measures used in the assessment is discussed. Summary statistics describing every measure are given in Table 4.2. For 10 of the measures, data are reported for at least 67 of the 74 civil engineering programs. For measures 04-07, which pertain to characteristics of the program graduates, data are presented for only approximately three-fifths of the programs; the other two-fifths had too few graduates on which to base statistics.[4] For measure 12, a composite index of the size of a university library, data are available for 56 programs; for measure 13, the fraction of faculty members with research support from the National Science Foundation, the National Institutes of Health, and the Alcohol, Drug Abuse and Mental Health Administration, data are reported for 61 programs that had at least 10 faculty members. The programs not evaluated on measures 12 and 13 are typically smaller--in terms of faculty size and graduate student enrollment--than other civil engineering programs. Were data on these two measures available for all 74 programs, it is likely that their reported means would be appreciably lower (and that some of the correlations of these measures with others would be higher).

Intercorrelations among the 16 measures (Pearson product-moment coefficients) are given in Table 4.3. Of particular note are the high positive correlations of the measures of faculty size (01) and numbers of recent program graduates (02) with measures of publication records (15, 16) and reputational survey ratings (08, 09). Figure 4.1 illustrates the relation between the mean rating of the scholarly quality of faculty (measure 08) and the number of faculty members (measure 01) for each of 74 programs in civil engineering. Figure 4.2 plots the mean rating of program effectiveness (measure 09) against the total number of FY1976-80 program graduates (measure 02). Although in both figures there is a significant positive correlation between program size and reputational rating, it is quite apparent that some of the smaller programs received high mean ratings and that some of the larger programs received low mean ratings.

Table 4.4 describes the 129 faculty members who participated in the evaluation of civil engineering programs. These individuals constituted 58 percent of those asked to respond to the survey in this discipline and 9 percent of the faculty population in the 74 research-doctorate programs being evaluated.[5] Approximately one-fourth of the survey participants had earned their highest degree since 1970, and a majority held the rank of full professor.

To assist the reader in interpreting results of the survey evaluations, estimated standard errors have been computed for mean ratings of the scholarly quality of faculty in 74 civil engineering programs (and are given in Table 4.1). For each program the mean rating and an

[4] As mentioned in Chapter II, data for measures 04-07 are not reported if they are based on the survey responses of fewer than 10 FY1975-79 program graduates.

[5] See Table 2.3 in Chapter II.

associated "confidence interval" of 1.5 standard errors are illustrated in Figure 4.3 (listed in order of highest to lowest mean rating). In comparing two programs, if their confidence intervals do not overlap, one may conclude that there is a significant difference in their mean ratings, at a .05 level of significance.[6] From this figure it is also apparent that one should have somewhat more confidence in the accuracy of the mean ratings of higher-rated programs than lower-rated programs. This generalization results primarily from the fact that evaluators are not as likely to be familiar with the less prestigious programs, and consequently the mean ratings of these programs are usually based on fewer survey responses.

[6]See pp. 29-31 for a discussion of the interpretation of mean ratings and associated confidence intervals.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
001.	Arizona, University of-Tucson *Civil Engineering*	14 *45*	7 *44*	15 *45*	NA	NA	NA	NA
002.	Brown University *Engineering*	8 *41*	9 *45*	12 *44*	NA	NA	NA	NA
003.	California Institute of Technology *Engineering and Applied Science*	8 *41*	10 *45*	30 *49*	.18 *57*	NA	.82 *62*	.27 *57*
004.	California, University of-Berkeley *Civil Engineering*	57 *79*	161 *99*	187 *91*	.13 *50*	7.2 *47*	.72 *52*	.18 *48*
005.	California, University of-Davis *Civil Engineering*	25 *54*	21 *50*	141 *78*	.10 *46*	6.3 *56*	.65 *46*	.25 *55*
006.	California, University of-Los Angeles *Engineering and Applied Science*	22 *52*	36 *56*	82 *63*	.04 *38*	7.9 *41*	.73 *53*	.19 *50*
007.	Carnegie-Mellon University *Civil Engineering*	19 *49*	12 *46*	15 *45*	NA	NA	NA	NA
008.	Cincinnati, University of *Civil and Environmental Engineering*	14 *45*	4 *43*	15 *45*	NA	NA	NA	NA
009.	Clemson University *Civil Engineering*	13 *45*	2 *42*	8 *43*	NA	NA	NA	NA
010.	Colorado State University-Fort Collins *Civil Engineering*	49 *73*	80 *73*	76 *61*	.09 *44*	6.9 *50*	.68 *48*	.18 *49*
011.	Colorado, University of *Civil Engineering*	23 *53*	15 *47*	85 *63*	.05 *40*	7.2 *47*	.83 *63*	.44 *73*
012.	Columbia University *Civil Engineering and Engineering Mechanics*	10 *42*	24 *51*	25 *47*	.11 *47*	5.5 *64*	.50 *32*	.17 *47*
013.	Connecticut, University of-Storrs *Civil Engineering*	18 *49*	9 *45*	11 *44*	.08 *44*	7.5 *44*	.91 *70*	.27 *57*
014.	Cornell University-Ithaca *Civil and Environmental Engineering*	32 *60*	47 *60*	73 *60*	.23 *62*	6.9 *51*	.82 *61*	.21 *51*
015.	Drexel University *Civil Engineering**	14 *45*	1 *42*	20 *46*	NA	NA	NA	NA
016.	Duke University *Civil Engineering*	11 *43*	6 *44*	29 *48*	NA	NA	NA	NA
017.	Florida, University of-Gainesville *Civil Engineering*	16 *47*	18 *49*	177 *88*	.22 *61*	7.8 *41*	.58 *40*	.13 *44*
018.	Georgia Institute of Technology *Civil Engineering*	31 *59*	15 *47*	21 *46*	.15 *53*	9.0 *30*	.77 *57*	.15 *46*
019.	Houston, University of *Civil Engineering*	13 *45*	17 *48*	17 *45*	NA	NA	NA	NA
020.	Illinois Institute of Technology *Civil Engineering*	7 *40*	9 *45*	10 *43*	.00 *33*	6.5 *54*	.58 *40*	.08 *40*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
001.	2.2	1.3	1.1	0.6	0.9	.07	5261	22		.13	.10	.11	.06
	44	*43*	*55*	*45*	*57*	*41*	*47*	*60*	*54*				
002.	3.3	2.0	0.7	0.7	`1.1	NA	3497	0		.18	.10	.10	.08
	58	*59*	*37*	*48*	*38*		*45*	*38*	*38*				
003.	4.5	2.6	1.0	1.3	NA	NA	8339	10		.08	.06	.04	.08
	71	*71*	*49*	*66*			*50*	*48*	*53*				
004.	4.8	2.7	1.0	1.7	2.2	.40	16448	38		.05	.05	.07	.05
	75	*74*	*51*	*79*	*70*	*64*	*60*	*76*	*75*				
005.	3.1	1.8	1.4	0.9	0.6	.32	3136	13		.10	.06	.08	.07
	55	*55*	*68*	*55*	*55*	*58*	*44*	*51*	*51*				
006.	3.3	1.9	1.0	1.0	2.0	.55	6168	8		.11	.06	.08	.08
	58	*57*	*51*	*58*	*68*	*74*	*48*	*46*	*46*				
007.	3.3	1.8	1.2	1.1	NA	.26	6409	4		.09	.06	.08	.07
	57	*55*	*59*	*60*		*54*	*48*	*42*	*43*				
008.	1.6	1.0	1.1	0.3	`0.2	.00	2360	1		.16	.12	.13	.06
	38	*39*	*54*	*38*	*46*	*36*	*44*	*39*	*40*				
009.	2.0	1.0	1.0	0.5	NA	.31	4356	8		.16	.13	.12	.06
	42	*38*	*49*	*43*		*57*	*46*	*46*	*48*				
010.	3.6	2.1	1.2	1.0	`1.1	.20	8604	53		.10	.06	.08	.07
	61	*62*	*59*	*59*	*37*	*50*	*51*	*91*	*82*				
011.	2.9	1.7	1.2	0.9	`0.9	.35	1849	8		.10	.06	.08	.07
	53	*54*	*56*	*53*	*40*	*60*	*43*	*46*	*48*				
012.	3.3	2.0	0.7	0.7	1.7	.40	5375	1		.14	.08	.09	.08
	57	*59*	*38*	*49*	*66*	*64*	*47*	*39*	*38*				
013.	1.9	1.1	0.9	0.5	`0.5	.06	4069	10		.12	.11	.12	.07
	41	*40*	*46*	*42*	*43*	*40*	*46*	*48*	*47*				
014.	4.1	2.4	1.3	1.5	1.6	.38	13206	33		.09	.06	.07	.07
	66	*66*	*60*	*71*	*64*	*62*	*56*	*71*	*71*				
015.	2.0	1.0	1.2	0.6	NA	.14	2649	8		.17	.13	.12	.07
	42	*39*	*57*	*46*	*46*		*44*	*46*	*49*				
016.	2.6	1.5	1.0	0.7	0.3	.18	NA	2		.12	.08	.11	.07
	50	*49*	*49*	*49*	*52*	*49*		*40*	*41*				
017.	2.3	1.4	0.9	0.4	0.8	.06	13686	16		.12	.11	.15	.07
	45	*47*	*44*	*41*	*56*	*40*	*56*	*54*	*55*				
018.	3.3	1.9	1.3	1.0	NA	.29	29270	18		.09	.05	.09	.07
	57	*56*	*61*	*57*		*56*	*74*	*56*	*60*				
019.	2.1	1.2	1.4	0.5	`0.9	.15	5015	6		.15	.12	.11	.07
	43	*42*	*66*	*44*	*39*	*47*	*47*	*44*	*44*				
020.	1.7	1.1	0.4	0.6	NA	NA	NA	5		.16	.11	.10	.07
	39	*39*	*24*	*47*				*43*	*45*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
021.	Illinois, University-Urbana/Champaign	67	79	130	.10	6.7	.72	.32
	Civil Engineering	*87*	*73*	*75*	*46*	*52*	*53*	*61*
022.	Iowa State University-Ames *Civil*	19	15	24	NA	5.9	.90	.10
	Engineering	*49*	*47*	*47*		*60*	*69*	*41*
023.	Iowa, University of-Iowa City *Civil and*	19	17	26	.00	6.7	.75	.31
	Environmental Engineering	*49*	*48*	*48*	*33*	*53*	*55*	*61*
024.	Johns Hopkins University *Civil Engineering*	5	NA	2	NA	NA	NA	NA
		38		*41*				
025.	Kansas, University of *Civil Engineering*	23	16	22	NA	NA	NA	NA
		53	*48*	*47*				
026.	Lehigh University *Civil Engineering*	19	8	11	NA	NA	NA	NA
		49	*45*	*44*				
027.	Maryland, University of-College Park *Civil*	19	10	35	.10	6.2	.70	.10
	Engineering	*49*	*45*	*50*	*46*	*58*	*51*	*41*
028.	Massachusetts Institute of Technology *Civil*	53	85	91	.20	5.1	.60	.29
	Engineering	*76*	*75*	*65*	*59*	*68*	*41*	*58*
029.	Massachusetts, University of-Amherst *Civil*	19	21	16	.19	8.5	.75	.20
	Engineering	*49*	*50*	*45*	*58*	*34*	*55*	*50*
030.	Michigan State University-East Lansing	17	13	15	.20	6.5	NA	NA
	Civil and Sanitary Engineering	*48*	*47*	*45*	*59*	*54*		
031.	Michigan, University of-Ann Arbor *Civil*	23	24	39	.26	7.0	.63	.11
	Engineering	*53*	*51*	*51*	*67*	*49*	*44*	*42*
032.	Minnesota, University of *Civil and Mineral*	17	12	22	.15	7.2	.69	.23
	Engineering	*48*	*46*	*47*	*53*	*48*	*50*	*53*
033.	Missouri, University of-Columbia *Civil*	9	12	8	NA	NA	NA	NA
	Engineering	*42*	*46*	*43*				
034.	Missouri, University of-Rolla *Civil*	21	17	21	.11	7.5	.67	.22
	Engineering	*51*	*48*	*46*	*47*	*44*	*48*	*52*
035.	New Jersey Institute of Technology *Civil*	25	4	NA	NA	NA	NA	NA
	*and Environmental Engineering**	*54*	*43*					
036.	New Mexico, University of-Albuquerque	16	6	13	NA	NA	NA	NA
	Civil Engineering	*47*	*44*	*44*				
037.	North Carolina State University-Raleigh	30	20	28	.21	7.8	.86	.09
	Civil Engineering	*58*	*49*	*48*	*60*	*42*	*66*	*40*
038.	Northwestern University *Civil Engineering*	30	51	29	.23	5.9	.55	.14
		58	*62*	*48*	*62*	*60*	*37*	*45*
039.	Notre Dame, University of *Civil*	7	10	6	.29	6.6	.62	.31
	Engineering	*40*	*45*	*42*	*70*	*53*	*43*	*60*
040.	Ohio State University-Columbus *Civil*	14	24	55	.00	6.1	.48	.04
	Engineering	*45*	*51*	*55*	*33*	*58*	*30*	*36*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
021.	4.5	2.6	0.9	1.5	2.0	.30	18980	33		.07	.05	.07	.06
	72	*72*	*44*	*73*	*68*	*57*	*62*	*71*	*70*				
022.	2.7	1.6	0.9	0.8	`0.5	.11	8330	21		.13	.08	.07	.07
	51	*51*	*45*	*51*	*43*	*43*	*50*	*59*	*57*				
023.	2.7	1.7	0.9	0.6	0.3	.21	2117	10		.13	.09	.09	.07
	50	*52*	*43*	*47*	*51*	*51*	*43*	*48*	*46*				
024.	1.4	0.8	0.7	0.4	`0.4	NA	1741	4		.28	.19	.15	.07
	35	*33*	*34*	*39*	*44*		*43*	*42*	*42*				
025.	2.7	1.5	1.3	0.7	0.1	.09	1707	3		.14	.10	.09	.07
	50	*49*	*63*	*50*	*49*	*42*	*43*	*41*	*40*				
026.	3.4	1.9	0.9	1.1	NA	.16	4568	3		.11	.07	.07	.08
	59	*57*	*45*	*60*		*47*	*46*	*41*	*38*				
027.	2.3	1.5	1.1	0.7	0.2	.16	3519	14		.12	.08	.10	.06
	46	*48*	*54*	*47*	*50*	*47*	*45*	*52*	*56*				
028.	4.7	2.6	0.9	1.6	`0.3	.38	59143	31		.07	.07	.07	.06
	74	*72*	*46*	*76*	*45*	*62*	*99*	*69*	*58*				
029.	2.7	1.7	1.3	0.8	`0.7	.26	2256	16		.11	.07	.09	.07
	50	*52*	*63*	*51*	*41*	*54*	*43*	*54*	*53*				
030.	2.4	1.5	0.8	0.6	0.3	.29	2247	9		.13	.11	.15	.07
	47	*48*	*39*	*46*	*52*	*56*	*43*	*47*	*51*				
031.	3.7	2.1	0.9	1.2	1.8	.35	19835	12		.09	.06	.07	.08
	61	*62*	*44*	*62*	*66*	*60*	*63*	*50*	*50*				
032.	2.7	1.6	0.9	0.7	1.2	.29	8726	10		.13	.09	.10	.07
	51	*50*	*47*	*49*	*60*	*56*	*51*	*48*	*48*				
033.	2.2	1.4	1.0	0.5	`0.2	NA	1976	8		.14	.09	.11	.07
	45	*47*	*48*	*43*	*46*		*43*	*46*	*47*				
034.	2.3	1.5	1.0	0.7	NA	.14	3606	8		.13	.09	.08	.07
	46	*48*	*48*	*48*		*46*	*45*	*46*	*48*				
035.	1.5	0.9	NA	0.3	NA	.08	NA	0		.20	.12	NA	.06
	37	*35*		*36*		*41*		*38*	*38*				
036.	2.2	1.3	1.0	0.5	`1.0	.06	6575	3		.13	.09	.11	.07
	45	*43*	*49*	*44*	*39*	*40*	*48*	*41*	*41*				
037.	3.0	1.7	1.1	0.8	NA	.10	8416	14		.10	.09	.07	.07
	54	*52*	*52*	*51*		*43*	*50*	*52*	*51*				
038.	3.9	2.3	1.1	1.3	0.3	.47	5170	26		.11	.07	.08	.07
	64	*65*	*54*	*65*	*51*	*68*	*47*	*64*	*69*				
039.	1.9	1.2	0.7	0.5	`1.3	NA	1544	10		.17	.10	.13	.07
	41	*42*	*36*	*44*	*35*		*43*	*48*	*51*				
040.	2.7	1.7	0.8	0.7	0.9	.21	10926	10		.11	.07	.09	.06
	51	*52*	*39*	*48*	*57*	*51*	*53*	*48*	*53*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
041.	Oklahoma State University-Stillwater *Civil Engineering*	18 *49*	34 *55*	26 *48*	.03 *36*	7.0 *49*	.57 *39*	.14 *45*
042.	Oklahoma, University of-Norman *Civil Engineering and Environmental Science*	15 *46*	28 *53*	16 *45*	.15 *53*	6.3 *57*	.50 *32*	.00 *32*
043.	Oregon State University-Corvallis *Civil Engineering*	20 *50*	7 *44*	20 *46*	NA	NA	NA	NA
044.	Pennsylvania State University *Civil Engineering*	15 *46*	17 *48*	18 *46*	.09 *45*	9.0 *30*	.73 *53*	.46 *74*
045.	Pennsylvania, University of *Civil and Urban Engineering*	10 *42*	6 *44*	9 *43*	NA	NA	NA	NA
046.	Pittsburgh, University of *Civil Engineering*	17 *48*	20 *49*	38 *51*	.08 *43*	6.1 *58*	.62 *43*	.08 *39*
047.	Polytech Institute of New York *Civil and Environmental Engineering*	9 *42*	6 *44*	22 *47*	NA	NA	NA	NA
048.	Princeton University *Civil Engineering*	20 *50*	15 *47*	38 *51*	.13 *49*	5.3 *66*	.60 *41*	.20 *50*
049.	Purdue University-West Lafayette *Civil Engineering*	54 *77*	69 *69*	84 *63*	.09 *44*	6.4 *56*	.70 *50*	.22 *52*
050.	Rensselaer Polytechnic Institute *Civil Engineering*	14 *45*	6 *44*	25 *47*	NA	NA	NA	NA
051.	Rhode Island, University of *Civil and Environmental Engineering**	9 *42*	2 *42*	4 *42*	NA	NA	NA	NA
052.	Rice University *Civil Engineering*	6 *39*	4 *43*	9 *43*	NA	NA	NA	NA
053.	Rutgers, The State University-New Brunswick *Civil and Environmental Engineering*	13 *45*	12 *46*	67 *59*	.17 *55*	9.3 *26*	.58 *40*	.00 *32*
054.	SUNY at Buffalo *Civil Engineering*	15 *46*	12 *46*	32 *49*	NA	NA	NA	NA
055.	Southern California, University of *Civil Engineering*	16 *47*	19 *49*	32 *49*	.14 *52*	9.2 *28*	.67 *48*	.08 *40*
056.	Stanford University *Civil Engineering*	24 *53*	58 *65*	60 *57*	.12 *48*	6.4 *55*	.74 *54*	.29 *58*
057.	Syracuse University *Civil Engineering*	11 *43*	7 *44*	8 *43*	NA	NA	NA	NA
058.	Tennessee, University of-Knoxville *Civil Engineering**	13 *45*	14 *47*	16 *45*	.07 *42*	5.5 *64*	.79 *59*	.36 *65*
059.	Texas A & M University *Civil Engineering*	39 *65*	29 *53*	35 *50*	.10 *46*	8.0 *39*	.73 *54*	.40 *69*
060.	Texas Tech University-Lubbock *Civil Engineering*	11 *43*	10 *45*	6 *42*	NA	NA	NA	NA

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
041.	2.3	1.4	0.9	0.6	`1.9	.00	4120	7		.15	.10	.11	.07
	45	*47*	*47*	*44*	*29*	*36*	*46*	*45*	*47*				
042.	2.1	1.4	0.8	0.4	`0.6	.00	1834	5		.13	.10	.09	.06
	43	*46*	*39*	*41*	*43*	*36*	*43*	*43*	*38*				
043.	2.5	1.5	1.2	0.6	NA	.30	3128	16		.11	.09	.10	.07
	48	*49*	*59*	*47*		*57*	*44*	*54*	*54*				
044.	2.5	1.6	0.8	0.7	0.7	.07	22901	17		.13	.09	.10	.07
	48	*50*	*40*	*50*	*55*	*41*	*67*	*55*	*57*				
045.	2.4	1.5	0.9	0.6	0.7	.20	4579	5		.18	.10	.10	.07
	46	*48*	*44*	*45*	*55*	*50*	*46*	*43*	*42*				
046.	2.3	1.3	0.9	0.5	0.1	.24	2794	6		.14	.10	.11	.06
	46	*45*	*45*	*43*	*49*	*52*	*44*	*44*	*45*				
047.	1.7	1.2	0.6	0.3	NA	NA	5310	6		.17	.11	.10	.05
	39	*43*	*34*	*38*			*47*	*44*	*47*				
048.	3.6	2.1	1.3	1.1	0.9	.45	6358	10		.09	.06	.08	.07
	61	*60*	*60*	*62*	*57*	*67*	*48*	*48*	*44*				
049.	3.9	2.2	1.1	1.4	`0.5	.20	17331	23		.10	.07	.07	.07
	64	*63*	*54*	*68*	*43*	*50*	*61*	*61*	*66*				
050.	2.8	1.6	1.4	0.9	NA	.29	7849	9		.12	.07	.11	.08
	51	*50*	*67*	*53*		*56*	*50*	*47*	*51*				
051.	1.5	0.8	NA	0.3	NA	NA	2611	5		.18	.17	NA	.06
	36	*35*		*38*			*44*	*43*	*43*				
052.	2.8	1.5	0.8	0.7	`1.4	NA	1782	5		.16	.09	.07	.08
	52	*49*	*42*	*49*	*34*		*43*	*43*	*42*				
053.	1.9	1.1	0.8	0.5	0.8	.00	1877	13		.13	.08	.08	.06
	41	*41*	*42*	*43*	*56*	*36*	*43*	*51*	*51*				
054.	2.3	1.4	0.9	0.6	0.3	.13	3019	14		.12	.09	.11	.07
	46	*46*	*46*	*46*	*51*	*45*	*44*	*52*	*51*				
055.	2.7	1.5	1.1	0.6	0.4	.31	18269	9		.12	.08	.09	.07
	50	*49*	*52*	*47*	*52*	*58*	*62*	*47*	*50*				
056.	4.1	2.5	1.1	1.4	2.0	.58	25196	17		.09	.06	.07	.07
	67	*70*	*52*	*69*	*68*	*77*	*70*	*55*	*53*				
057.	1.9	1.2	1.0	0.4	`0.3	.36	4063	7		.16	.10	.13	.06
	40	*43*	*49*	*40*	*45*	*61*	*46*	*45*	*47*				
058.	2.2	1.3	1.2	0.5	`0.4	.00	4266	4		.13	.09	.11	.06
	44	*45*	*57*	*42*	*44*	*36*	*46*	*42*	*41*				
059.	3.2	1.8	1.2	0.8	`0.5	.03	18988	7		.10	.08	.09	.07
	56	*55*	*59*	*53*	*44*	*38*	*62*	*45*	*45*				
060.	1.7	1.0	1.1	0.4	NA	.18	5513	5		.15	.12	.09	.07
	39	*37*	*53*	*40*		*49*	*47*	*43*	*46*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
061.	Texas, University of-Arlington *Civil Engineering**	14 *45*	6 *44*	28 *48*	NA	NA	NA	NA
062.	Texas, University of-Austin *Civil Engineering*	42 *67*	62 *66*	69 *59*	.09 *45*	6.4 *56*	.56 *37*	.13 *44*
063.	Tulane University *Civil Engineering*	8 *41*	2 *42*	3 *42*	NA	NA	NA	NA
064.	Utah State University-Logan *Civil and Environmental Engineering*	20 *50*	21 *50*	30 *49*	.21 *60*	7.5 *44*	.74 *54*	.21 *51*
065.	Utah, University of-Salt Lake City *Civil Engineering*	10 *42*	13 *47*	11 *44*	.00 *33*	7.5 *44*	NA	NA
066.	Vanderbilt University *Civil and Environmental Engineering*	5 *38*	6 *44*	2 *41*	NA	NA	NA	NA
067.	Vanderbilt University *Environmental and Water Resources Engin*	10 *42*	12 *46*	18 *46*	.27 *69*	7.0 *49*	.91 *70*	.27 *57*
068.	Virginia Polytechnic Institute & State Univ *Civil Engineering*	29 *57*	17 *48*	15 *45*	.05 *40*	6.4 *55*	.72 *53*	.22 *52*
069.	Virginia, University of *Civil Engineering*	15 *46*	10 *45*	14 *44*	NA	NA	NA	NA
070.	Washington University-Saint Louis *Civil Engineering*	7 *40*	13 *47*	8 *43*	.08 *44*	5.5 *64*	.67 *48*	.17 *47*
071.	Washington, University of-Seattle *Civil Engineering*	42 *67*	43 *59*	41 *52*	.15 *53*	6.8 *52*	.75 *55*	.11 *42*
072.	Wayne State University *Civil Engineering*	9 *42*	8 *45*	7 *43*	NA	NA	NA	NA
073.	West Virginia University *Civil Engineering*	16 *47*	11 *46*	NA	.21 *61*	7.5 *44*	.71 *52*	.00 *32*
074.	Wisconsin, University of-Madison *Civil and Environmental Engineering*	29 *57*	37 *56*	43 *52*	.24 *64*	6.7 *53*	.75 *55*	.25 *55*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 4.1 Program Measures (Raw and Standardized Values) in Civil Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
061.	1.6	1.0	1.0	0.4	NA	.00	NA	0		.22	.13	.10	.06
	37	*38*	*51*	*39*		*36*		*38*	*38*				
062.	4.2	2.3	1.7	1.5	1.6	.26	10517	27		.08	.05	.06	.06
	67	*65*	*80*	*71*	*64*	*54*	*53*	*65*	*66*				
063.	1.5	0.8	0.9	0.4	`1.0	NA	NA	1		.14	.08	.08	.06
	36	*35*	*46*	*40*	*38*			*39*	*40*				
064.	2.7	1.7	1.2	0.4	NA	.00	5513	27		.14	.10	.14	.07
	50	*53*	*57*	*41*		*36*	*47*	*65*	*71*				
065.	1.7	1.2	1.1	0.3	`0.6	.10	7123	0		.17	.11	.19	.06
	39	*43*	*52*	*38*	*42*	*43*	*49*	*38*	*38*				
066.	1.4	0.8	0.5	0.5	`0.7	NA	NA	6		.17	.11	.10	.07
	36	*34*	*29*	*43*	*41*			*44*	*44*				
067.	2.4	1.5	0.7	0.5	`0.7	.00	NA	6		.20	.13	.11	.08
	47	*48*	*35*	*43*	*41*	*36*		*44*	*44*				
068.	2.8	1.6	1.4	0.8	`0.0	.17	7243	29		.10	.07	.09	.06
	52	*50*	*65*	*51*	*48*	*48*	*49*	*67*	*77*				
069.	2.4	1.1	1.1	0.5	0.7	.07	4673	10		.12	.10	.12	.07
	47	*40*	*55*	*43*	*56*	*41*	*46*	*48*	*46*				
070.	2.7	1.6	0.9	0.9	`0.4	NA	5257	7		.13	.08	.08	.07
	50	*51*	*44*	*56*	*44*		*47*	*45*	*38*				
071.	3.6	2.0	1.4	1.1	1.5	.19	5430	13		.09	.05	.10	.08
	61	*60*	*66*	*60*	*63*	*49*	*47*	*51*	*51*				
072.	1.1	0.8	0.7	0.4	`0.4	NA	2693	1		.16	.12	.16	.07
	32	*34*	*35*	*41*	*45*		*44*	*39*	*39*				
073.	2.2	1.3	1.2	0.6	NA	.25	4618	13		.13	.10	.09	.06
	44	*44*	*57*	*45*		*53*	*46*	*51*	*48*				
074.	3.4	2.0	1.1	0.9	1.6	.17	9919	21		.08	.04	.08	.07
	59	*59*	*54*	*53*	*64*	*48*	*52*	*59*	*59*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 4.2 Summary Statistics Describing Each Program Measure--Civil Engineering

Measure	Number of Programs Evaluated	Mean	Standard Deviation	DECILES 1	2	3	4	5	6	7	8	9
Program Size												
01 Raw Value	74	20	13	8	10	13	14	16	19	20	25	36
Std Value	74	50	10	41	42	45	46	47	49	50	54	63
02 Raw Value	73	22	25	5	7	9	12	13	17	20	26	50
Std Value	73	50	10	43	44	45	46	47	48	49	52	61
03 Raw Value	72	35	37	7	10	15	17	22	26	32	42	81
Std Value	72	50	10	43	43	45	45	47	48	49	52	62
Program Graduates												
04 Raw Value	45	.13	.08	.01	.07	.09	.10	.11	.15	.18	.21	.23
Std Value	45	50	10	35	43	45	46	48	53	56	60	63
05 Raw Value	45	6.9	1.0	8.8	7.8	7.5	7.0	6.8	6.6	6.4	6.2	5.7
Std Value	45	50	10	31	41	44	49	51	53	55	57	62
06 Raw Value	44	.69	.11	.55	.58	.62	.67	.70	.73	.74	.75	.83
Std Value	44	50	10	37	40	44	48	51	54	55	55	63
07 Raw Value	44	.19	.11	.06	.10	.13	.16	.19	.21	.25	.28	.32
Std Value	44	50	10	38	42	45	47	50	52	55	58	62
Survey Results												
08 Raw Value	74	2.7	.9	1.6	1.9	2.2	2.3	2.5	2.7	3.0	3.3	3.9
Std Value	74	50	10	38	41	45	46	48	50	54	57	64
09 Raw Value	74	1.6	.5	1.0	1.1	1.3	1.4	1.5	1.6	1.7	2.0	2.3
Std Value	74	50	10	38	40	44	46	49	51	53	59	66
10 Raw Value	72	1.0	.2	.7	.8	.9	.9	1.0	1.1	1.1	1.2	1.3
Std Value	72	50	10	37	41	45	45	50	54	54	58	63
11 Raw Value	74	.7	.4	.4	.5	.5	.6	.6	.7	.8	1.0	1.3
Std Value	74	50	10	40	43	43	46	46	49	52	57	66
University Library												
12 Raw Value	56	.2	1.0	-1.1	-.7	-.5	-.4	.1	.3	.7	.9	1.7
Std Value	56	50	10	37	41	43	44	49	51	55	57	65
Research Support												
13 Raw Value	61	.20	.14	.00	.06	.10	.16	.19	.23	.29	.31	.38
Std Value	61	50	10	36	40	43	47	49	52	56	58	63
14 Raw Value	67	7998	8804	1869	2626	3499	4338	5214	5644	7788	10278	18482
Std Value	67	50	10	43	44	45	46	47	47	50	53	62
Publication Records												
15 Raw Value	74	12	10	1	4	6	7	9	10	13	17	27
Std Value	74	50	10	39	42	44	45	47	48	51	55	65
16 Std Value	74	50	10	38	41	44	46	48	50	51	55	66

NOTE: Standardized values reported in the preceding table have been computed from exact values of the mean and standard deviation and not the rounded values reported here. Since the scale used to compute measure 16 is entirely arbitrary, only data in standardized form are reported for this measure.

TABLE 4.3 Intercorrelations Among Program Measures on 74 Programs in Civil Engineering

Measure	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Program Size																
01		.83	.65	.02	.08	.07	.15	.73	.70	.42	.74	.37	.28	.56	.74	.69
02			.71	.01	.16	`.11	.05	.72	.73	.18	.75	.39	.39	.51	.73	.65
03				.03	`.02	`.12	.02	.57	.57	.20	.57	.47	.31	.38	.56	.52
Program Graduates																
04					`.12	.15	`.10	.18	.17	.00	.11	.12	.03	.16	.19	.17
05						`.25	.00	.25	.26	`.06	.24	`.03	.24	`.02	.04	`.05
06							.43	.05	.02	.18	.03	`.11	`.16	`.02	.09	.10
07		.21	.22	.08	.18	`.13	.04	.21	.05	.05						
Survey Results																
08		.98	.35	.94	.54	.62	.57	.62	.57							
09		.30	.92	.53	.62	.55	.62	.57								
10		.34	.20	.14	.04	.34	.35									
11		.52	.63	.58	.63	.58										
University Library																
12		.54	.26	.32	.32											
Research Support																
13		.29	.27	.26												
14		.44	.36													
Publication Records																
15		.95														
16																

NOTE: Since in computing correlation coefficients program data must be available for both of the measures being correlated, the actual number of programs on which each coefficient is based varies.

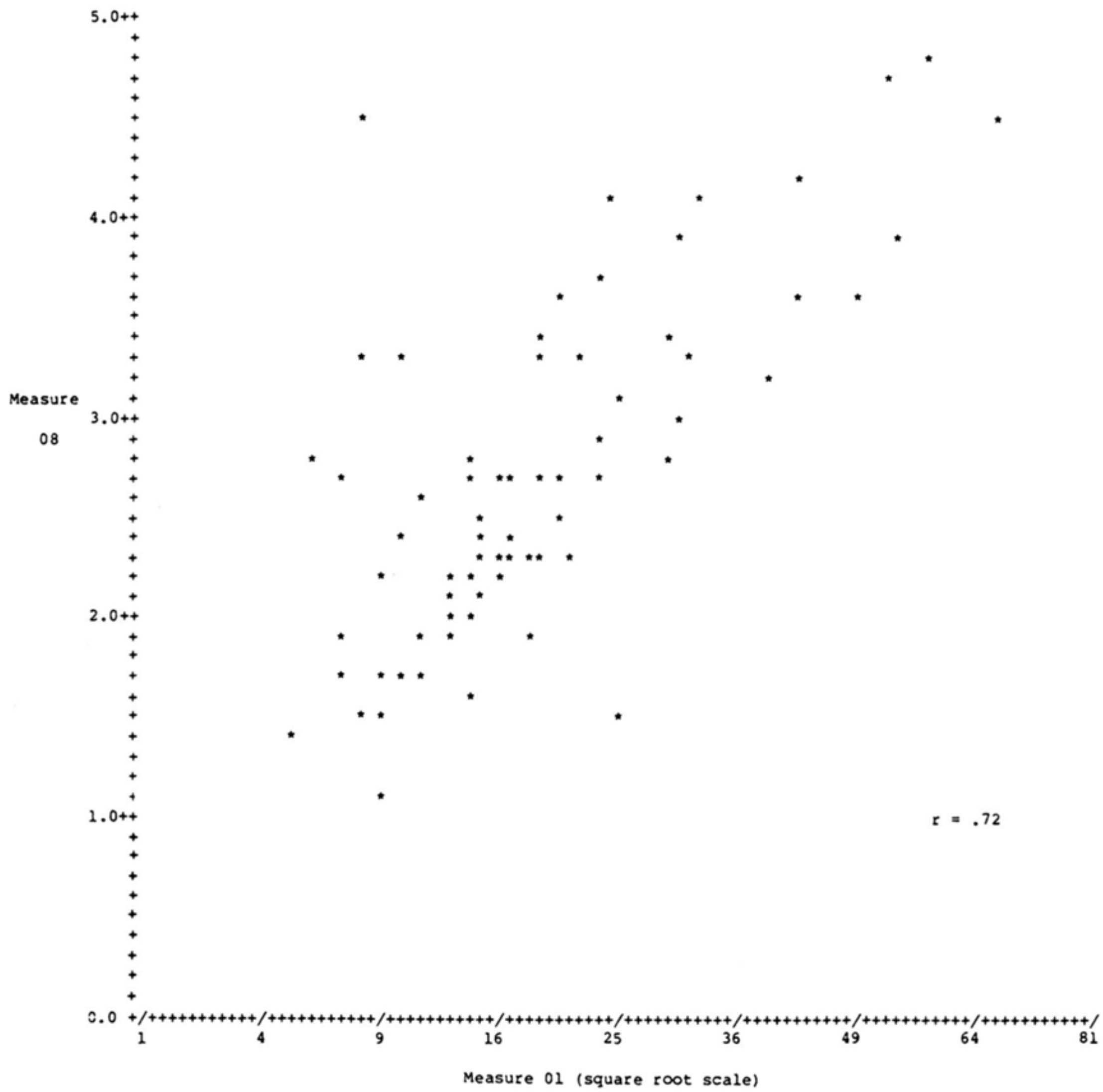

FIGURE 4.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--74 programs in civil engineering.

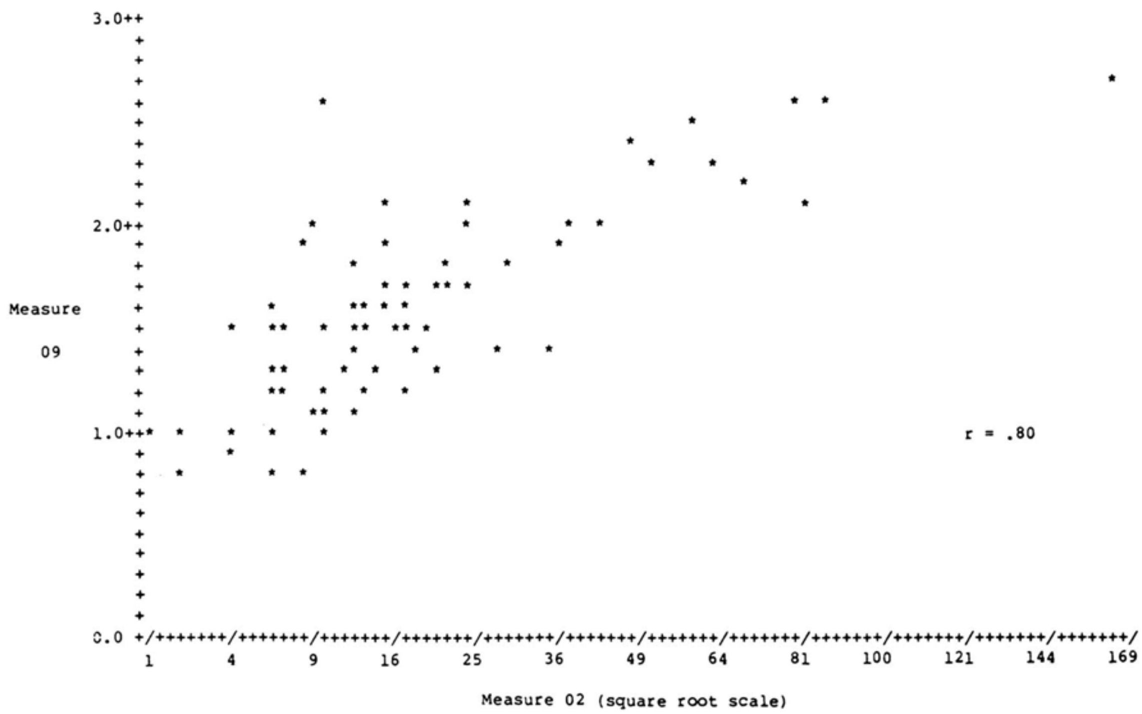

FIGURE 4.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--73 programs in civil engineering.

TABLE 4.4 Characteristics of Survey Participants in Civil Engineering

	Respondents	
	N	%
Field of Specialization		
Civil Engineering	104	81
Sanitary/Environ. Engineering	15	12
Other/Unknown	10	8
Faculty Rank		
Professor	89	69
Associate Professor	24	19
Assistant Professor	16	12
Year of Highest Degree		
Pre-1950	7	5
1950-59	14	11
1960-69	70	54
Post-1969	36	28
Unknown	2	2
Evaluator Selection		
Nominated by Institution	113	88
Other	16	12
Survey Form		
With Faculty Names	118	92
Without Names	11	9
Total Evaluators	129	100

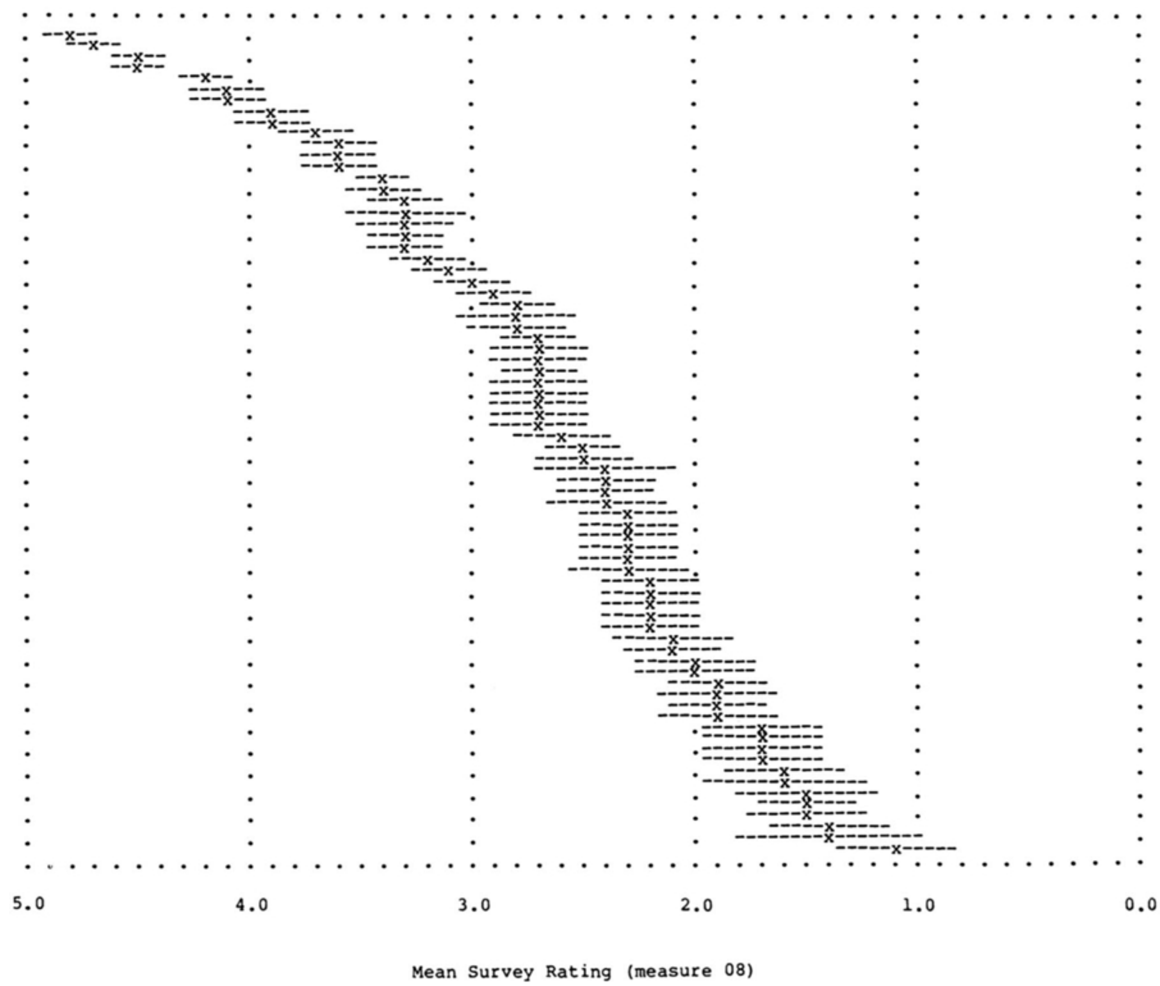

FIGURE 4.3 Mean rating of scholarly quality of faculty in 74 programs in civil engineering.

NOTE: Programs are listed in sequence of mean rating, with the highest-rated program appearing at the top of the page. The broken lines (---) indicate a confidence interval of ±1.5 standard errors around the reported mean (x) of each program.

V

Electrical Engineering Programs

In this chapter 91 research-doctorate programs in electrical engineering programs are assessed. These programs, according to the information supplied by their universities, have accounted for 2,907 doctoral degrees awarded during the FY1976-80 period--approximately 95 percent of the aggregate number of electrical engineering, electronics, and computer engineering doctorates earned from U.S. universities in this five-year span.[1] Because some computer scientists receive their doctoral education in electrical engineering departments and by the same token some electrical engineers receive their doctoral degrees in computer science departments, the committee encountered difficulty in identifying program faculty, graduates, and students in the discipline of electrical engineering.[2] On the average, 49 full-time and part-time students intending to earn doctorates were enrolled in a program in December 1980, with an average faculty size of 23 members.[3] Mostof the 91 programs, listed in Table 5.1, are located in departments of electrical engineering. Approximately one-fourth are found in departments of electrical engineering and computer science. Only two of the programs were initiated since 1970, and no two programs are located in the same university. In addition to the 91 institutions represented in this discipline, another 4 were initially identified as meeting the criteria[4] for inclusion in the assessment:

[1]Data from the NRC's Survey of Earned Doctorates indicate that 2,239 research doctorates in electrical engineering, 371 in electronics, and another 458 research doctorates in computer engineering were awarded by U.S. universities between FY1976 and FY1980.
[2]In the review of this report it has been called to the committee's attention that electrical engineering programs have been changing very rapidly in recent years and that different programs may place substantially different emphases in fields of electronics, applied physics, and computer engineering.
[3]See the reported means for measures 03 and 01 in Table 5.2.
[4]As mentioned in Chapter I, the primary criterion for inclusion was that a university had awarded at least 7 doctorates in electrical engineering during the FY1976-78 period.

George Washington University

University of South Carolina--Columbia

Naval Postgraduate School

University of Santa Clara

The latter two institutions chose not to participate in the assessment in any discipline. Electrical engineering programs at the other two institutions have not been included in the evaluations in this discipline, since in each case the study coordinator either indicated that the institution did not at that time have a research-doctorate program in electrical engineering or failed to provide the information requested by the committee.

Before examining individual program results presented in Table 5.1, the reader is urged to refer to Chapter II, in which each of the 16 measures used in the assessment is discussed. Summary statistics describing every measure are given in Table 5.2. For 15 of the measures, data are reported for at least 76 of the 91 electrical engineering programs. For measure 12, a composite index of the size of a university library, data are available for 62 programs. The programs not evaluated on measure 12 are typically smaller--in terms of faculty size and graduate student enrollment--than other electrical engineering programs. Were data on this measure available for all 91 programs, it is likely that the reported mean would be appreciably lower (and that some of the correlations of this measure with others would be higher).

Intercorrelations among the 16 measures (Pearson product-moment coefficients) are given in Table 5.3. Of particular note are the high positive correlations of the measures of program size (01-03) with measures of publication records (15, 16) and reputational survey ratings (08, 09). Figure 5.1 illustrates the relation between the mean rating of the scholarly quality of faculty (measure 08) and the number of faculty members (measure 01) for each of 90 programs in electrical engineering. Figure 5.2 plots the mean rating of program effectiveness (measure 09) against the total number of FY1976-80 program graduates (measure 02). Although in both figures there is a significant positive correlation between program size and reputational rating, it is quite apparent that some of the smaller programs received high mean ratings and that some of the larger programs received low mean ratings.

Table 5.4 describes the 142 faculty members who participated in the evaluation of electrical engineering programs. These individuals constituted 52 percent of those asked to respond to the survey in this discipline and 7 percent of the faculty population in the 91 research-doctorate programs being evaluated.[5] Almost one-third of the survey participants had earned their highest degree since 1970, and a majority held the rank of full professor. One exception should be noted with regard to the survey evaluations in this discipline. In the program listing on the survey form, New Mexico State University at Las Cruces was identified as being located in Alamogordo, where there is another

[5]See Table 2.3 in Chapter II.

branch of the same university system not offering the research doctorate. Since a large majority of faculty evaluators indicated that they were unfamiliar with this program and it is quite possible that some of them were misled by the inaccurate identification of this institution, the committee has decided not to report the survey results for this program.

To assist the reader in interpreting results of the survey evaluations, estimated standard errors have been computed for mean ratings of the scholarly quality of faculty in 90 electrical engineering programs (and are given in Table 5.1). For each program the mean rating and an associated "confidence interval" of 1.5 standard errors are illustrated in Figure 5.3 (listed in order of highest to lowest mean rating). In comparing two programs, if their confidence intervals do not overlap, one may conclude that there is a significant difference in their mean ratings at a .05 level of significance.[6] From this figure it is also apparent that one should have somewhat more confidence in the accuracy of the mean ratings of higher-rated programs than lower-rated programs. This generalization results primarily from the fact that evaluators are not as likely to be familiar with the less prestigious programs, and consequently the mean ratings of these programs are usually based on fewer survey responses.

[6]See pp. 29-31 for a discussion of the interpretation of mean ratings and associated confidence intervals.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
001.	Air Force Institute of Technology *Electrical Engineering*	9	14	11	.07	9.5	.93	.07
		41	*45*	*43*	*40*	*25*	*67*	*41*
002.	Arizona State University-Tempe *Electrical and Computer Engineering*	15	15	31	.13	5.7	.47	.07
		44	*45*	*47*	*45*	*59*	*33*	*41*
003.	Arizona, University of-Tucson *Electrical Engineering*	17	21	36	.08	7.0	.71	.17
		46	*47*	*48*	*41*	*47*	*51*	*50*
004.	Auburn University *Electrical Engineering*	13	15	8	.09	NA	.82	.09
		43	*45*	*43*	*41*		*59*	*43*
005.	Brown University *Engineering*	13	17	20	.21	6.1	.64	.21
		43	*46*	*45*	*52*	*55*	*46*	*54*
006.	CUNY-Graduate School *Engineering*	14	21	31	.24	7.1	.64	.16
		44	*47*	*47*	*55*	*46*	*46*	*49*
007.	California Institute of Technology *Electrical Engineering*	13	24	56	.29	5.0	.67	.29
		43	*48*	*51*	*59*	*65*	*48*	*61*
008.	California, University of-Berkeley *Electrical Engineering & Computer Sciences*	48	135	211	.09	5.7	.84	.25
		66	*78*	*79*	*42*	*59*	*60*	*57*
009.	California, University of-Davis *Electrical and Computer Engineering*	19	14	18	.07	8.5	.79	.36
		47	*45*	*44*	*40*	*34*	*56*	*67*
010.	California, University of-Irvine *Engineering*	13	12	19	.00	8.3	.77	.08
		43	*45*	*45*	*33*	*36*	*55*	*42*
011.	California, University of-Los Angeles *Engineering and Applied Science*	51	133	225	.08	7.0	.63	.08
		68	*78*	*82*	*40*	*47*	*45*	*42*
012.	California, University of-San Diego *Electrical Engineering & Computer Science*	20	21	46	.14	6.5	.79	.21
		48	*47*	*49*	*46*	*52*	*56*	*54*
013.	California, University of-Santa Barbara *Electrical and Computer Engineering*	21	33	48	.32	8.3	.72	.00
		48	*50*	*50*	*62*	*36*	*52*	*35*
014.	Carnegie-Mellon University *Electrical Engineering*	24	54	60	.32	5.9	.82	.10
		50	*56*	*52*	*62*	*57*	*59*	*44*
015.	Case Western Reserve University *Electrical Engineering and Applied Physics*	16	14	6	.20	6.9	.50	.21
		45	*45*	*42*	*51*	*48*	*35*	*54*
016.	Catholic University of America *Electrical Engineering*	5	14	13	NA	NA	NA	NA
		38	*45*	*44*				
017.	Cincinnati, University of *Electrical and Computer Engineering*	15	14	29	.18	6.5	.60	.00
		44	*45*	*46*	*50*	*52*	*43*	*35*
018.	Clarkson College of Technology *Engineering Science*	19	7	13	NA	NA	NA	NA
		47	*43*	*44*				
019.	Colorado State University-Fort Collins *Electrical Engineering*	16	16	20	.17	5.1	.58	.08
		45	*46*	*45*	*48*	*64*	*41*	*42*
020.	Colorado, University of *Electrical Engineering*	51	16	28	.32	8.0	.94	.11
		68	*46*	*46*	*62*	*38*	*68*	45

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
001.	1.5	1.0	0.9	0.5	NA	NA	NA	0		.14	.09	.09	.06
	37	*37*	*45*	*44*				*41*	*41*				
002.	2.3	1.3	1.4	0.4	`0.3	.00	NA	3		.13	.12	.13	.07
	46	*44*	*68*	*42*	*45*	*34*		*42*	*43*				
003.	2.9	1.8	1.3	0.6	0.9	.24	5261	11		.12	.08	.09	.07
	53	*55*	*60*	*48*	*57*	*48*	*47*	*45*	*47*				
004.	1.8	1.4	1.1	0.3	NA	.08	2450	16		.17	.13	.11	.07
	41	*44*	*53*	*39*		*38*	*44*	*47*	*45*				
005.	3.0	1.8	1.0	0.7	`1.1	.69	3497	23		.12	.08	.09	.08
	55	*55*	*46*	*49*	*38*	*75*	*45*	*50*	*50*				
006.	2.2	1.5	0.8	0.6	NA	.14	NA	15		.12	.09	.12	.06
	45	*48*	*39*	*46*		*42*		*47*	*45*				
007.	3.7	2.2	0.9	1.0	NA	.23	8339	26		.14	.08	.08	.07
	63	*63*	*45*	*57*		*48*	*51*	*52*	*50*				
008.	4.8	2.8	1.2	1.6	2.2	.69	16448	110		.06	.06	.08	.07
	75	*75*	*55*	*77*	*70*	*75*	*60*	*87*	*87*				
009.	2.5	1.5	1.2	0.7	0.6	.47	3136	26		.13	.11	.13	.07
	49	*47*	*56*	*48*	*55*	*62*	*45*	*52*	*51*				
010.	2.1	1.3	1.0	0.7	NA	.23	NA	12		.13	.08	.08	.07
	45	*44*	*48*	*49*		*48*		*46*	*46*				
011.	4.1	2.4	1.2	1.4	2.0	.47	6168	60		.09	.06	.08	.07
	67	*67*	*58*	*70*	*68*	*62*	*48*	*66*	*63*				
012.	3.3	1.7	1.5	0.8	`0.0	.45	NA	20		.15	.09	.10	.08
	58	*53*	*68*	*52*	*48*	*61*		*49*	*51*				
013.	3.2	1.9	1.7	0.9	-0.1	.29	NA	23		.09	.07	.07	.08
	57	*56*	*80*	*55*	*47*	*51*		*50*	*51*				
014.	3.6	2.2	1.4	1.1	NA	.58	6409	42		.09	.05	.08	.08
	62	*62*	*65*	*61*		*69*	*49*	*58*	*64*				
015.	2.7	1.7	0.8	0.8	`1.3	.38	8676	13		.11	.08	.07	.08
	51	*52*	*39*	*52*	*35*	*56*	*51*	*46*	*44*				
016.	0.8	0.8	0.8	0.3	NA	NA	NA	9		.14	.11	.11	.06
	29	*32*	*41*	*37*				*44*	*45*				
017.	1.8	1.2	1.2	0.4	`0.2	.20	2360	4		.14	.11	.10	.06
	40	*41*	*55*	*41*	*46*	*46*	*44*	*42*	*45*				
018.	1.3	0.8	0.8	0.4	NA	.37	1791	9		.13	.08	.10	.07
	35	*32*	*39*	*42*		*56*	*43*	*44*	*44*				
019.	2.4	1.4	1.2	0.6	`1.1	.31	8604	7		.14	.09	.14	.07
	47	*46*	*58*	*47*	*37*	*53*	*51*	*44*	*44*				
020.	3.2	1.7	1.2	1.0	`0.9	.24	1849	50		.11	.07	.08	.07
	57	*53*	*55*	*57*	*40*	*48*	*43*	*62*	*57*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
021.	Columbia University *Electrical Engineering*	15	29	38	.10	6.1	.50	.04
		44	*49*	*48*	*42*	*55*	*35*	*38*
022.	Connecticut, University of-Storrs *Electrical*	12	15	23	.25	7.5	.83	.42
	Engineering & Computer Science	*42*	*45*	*45*	*56*	*43*	*60*	*72*
023.	Cornell University-Ithaca *Electrical*	35	67	79	.15	5.5	.75	.23
	Engineering	*58*	*60*	*55*	*47*	*60*	*54*	*56*
024.	Drexel University *Electrical Engineering*	23	13	36	NA	NA	NA	NA
		50	*45*	*48*				
025.	Duke University *Electrical Engineering*	12	21	20	.17	5.4	.48	.04
		42	*47*	*45*	*49*	*61*	*34*	*39*
026.	Florida, University of-Gainesville *Electrical*	36	38	158	.14	5.9	.56	.33
	Engineering	*58*	*52*	*70*	*46*	*57*	*39*	*65*
027.	Georgia Institute of Technology *Electrical*	22	20	37	.21	6.7	.78	.39
	Engineering	*49*	*47*	*48*	*52*	*50*	*56*	*70*
028.	Hawaii, University of *Electrical*	17	13	12	.13	6.8	.60	.07
	Engineering	*46*	*45*	*43*	*44*	*49*	*43*	*41*
029.	Houston, University of *Electrical*	12	13	25	.36	7.3	.50	.10
	Engineering	*42*	*45*	*46*	*66*	*45*	*35*	*44*
030.	Illinois Institute of Technology *Electrical*	9	17	23	.29	7.5	.57	.14
	Engineering	*41*	*46*	*45*	*59*	*43*	*40*	*48*
031.	Illinois, University of-Chicago Circle	21	12	54	NA	NA	NA	NA
	*Information Engineering**	*48*	*45*	*51*				
032.	Illinois, University-Urbana/Champaign	87	148	166	.06	5.6	.82	.25
	Electrical Engineering	*92*	*82*	*71*	*38*	*59*	*59*	*58*
033.	Iowa State University-Ames *Electrical*	15	31	29	.25	5.9	.66	.13
	Engineering	*44*	*50*	*46*	*56*	*57*	*47*	*46*
034.	Iowa, University of-Iowa City *Electrical*	13	9	15	.27	5.3	.55	.27
	and Computer Engineering	*43*	*44*	*44*	*58*	*63*	*39*	*59*
035.	Johns Hopkins University *Electrical*	13	34	39	.24	5.3	.90	.14
	Engineering	*43*	*51*	*48*	*55*	*63*	*65*	*47*
036.	Kansas, University of *Electrical*	20	17	26	.20	7.5	.75	.10
	Engineering	*48*	*46*	*46*	*51*	*43*	*54*	*44*
037.	Marquette University *Electrical*	21	21	15	.37	6.9	.74	.16
	Engineering and Computer Science	*48*	*47*	*44*	*66*	*48*	*53*	*49*
038.	Maryland, University of-College Park	28	21	134	.13	8.6	.69	.00
	Electrical Engineering	*53*	*47*	*65*	*45*	*33*	*49*	*35*
039.	Massachusetts Institute of Technology	80	141	299	.41	5.8	.74	.28
	Electrical Engineering and Computer Science	*87*	*80*	*95*	*70*	*58*	*53*	*60*
040.	Massachusetts, University of-Amherst	18	22	43	.17	6.1	.94	.11
	Electrical and Computer Engineering	*46*	*47*	*49*	*48*	*55*	*68*	*45*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
021.	3.2	2.0	0.8	1.0	1.7	.53	5375	15		.11	.08	.09	.08
	57	*58*	*39*	*59*	*66*	*66*	*47*	*47*	*46*				
022.	2.2	1.5	1.3	0.6	`0.5	.25	4069	11		.16	.10	.10	.07
	46	*48*	*60*	*47*	*43*	*49*	*46*	*45*	*46*				
023.	4.0	2.3	1.3	1.3	1.6	.26	13206	39		.09	.06	.07	.07
	66	*66*	*61*	*66*	*65*	*49*	*56*	*57*	*55*				
024.	1.9	1.3	1.1	0.5	NA	.22	2649	12		.11	.10	.07	.07
	42	*43*	*51*	*45*		*47*	*44*	*46*	*45*				
025.	2.4	1.6	1.0	0.6	0.3	.17	NA	9		.11	.07	.06	.06
	47	*49*	*49*	*47*	*52*	*44*		*44*	*44*				
026.	3.2	1.8	1.2	0.9	0.8	.31	13686	23		.10	.06	.10	.07
	56	*55*	*55*	*57*	*56*	*52*	*57*	*50*	*49*				
027.	3.2	1.9	1.3	1.0	NA	.27	29270	26		.10	.06	.10	.08
	57	*56*	*62*	*57*		*50*	*75*	*52*	*51*				
028.	2.8	1.6	1.0	0.8	`0.1	.24	2010	11		.17	.10	.11	.09
	52	*50*	*48*	*54*	*47*	*48*	*43*	*45*	*47*				
029.	1.5	1.2	0.9	0.5	`0.9	.17	5015	26		.14	.12	.11	.07
	37	*41*	*45*	*44*	*39*	*44*	*47*	*52*	*49*				
030.	1.8	1.2	0.6	0.5	NA	NA	NA	6		.21	.14	.10	.07
	41	*41*	*32*	*44*				*43*	*45*				
031.	2.2	1.5	1.3	0.5	NA	.14	2144	9		.21	.12	.15	.08
	45	*47*	*61*	*45*		*42*	*44*	*44*	*48*				
032.	4.6	2.6	1.1	1.7	2.0	.51	18980	128		.07	.06	.09	.07
	73	*73*	*51*	*77*	*68*	*64*	*63*	*95*	*88*				
033.	2.6	1.6	0.8	0.4	`0.5	.07	8330	12		.15	.09	.10	.07
	49	*50*	*38*	*42*	*43*	*38*	*51*	*46*	*45*				
034.	1.9	1.2	0.8	0.5	0.3	.39	2117	6		.17	.11	.08	.07
	42	*42*	*40*	*43*	*51*	*57*	*44*	*43*	*43*				
035.	3.1	1.9	0.9	0.8	`0.4	.15	1741	9		.09	.06	.08	.07
	56	*57*	*44*	*51*	*44*	*43*	*43*	*44*	*45*				
036.	2.3	1.5	1.1	0.4	0.1	.20	1707	22		.17	.11	.09	.07
	46	*48*	*53*	*42*	*49*	*46*	*43*	*50*	*50*				
037.	1.6	1.1	1.1	0.2	NA	.05	NA	4		.17	.14	.11	.04
	39	*39*	*51*	*35*		*37*		*42*	*42*				
038.	3.3	1.9	1.3	0.9	0.2	.36	3519	50		.11	.06	.09	.08
	58	*57*	*62*	*55*	*50*	*55*	*45*	*62*	*61*				
039.	4.9	2.7	1.0	1.8	`0.3	.41	59143	99		.04	.05	.07	.06
	76	*75*	*47*	*80*	*45*	*59*	*99*	*82*	*88*				
040.	2.7	1.7	1.2	0.9	`0.7	.61	2256	18		.12	.08	.11	.09
	51	*51*	*58*	*55*	*41*	*70*	*44*	*48*	*48*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
041.	Michigan State University-East Lansing	24	26	40	.14	5.6	.54	.04
	Electrical Engineering & Systems Science	*50*	*48*	*48*	*46*	*59*	*38*	*38*
042.	Michigan, University of-Ann Arbor	51	23	60	.15	7.4	.75	.13
	Electrical and Computer Engineering	*68*	*48*	*52*	*47*	*44*	*54*	*46*
043.	Minnesota, University of *Electrical*	37	24	28	.20	8.3	.64	.12
	Engineering	*59*	*48*	*46*	*51*	*36*	*46*	*46*
044.	Mississippi State University-Starkville	19	12	11	.18	7.8	.91	.18
	Electrical Engineering	*47*	*45*	*43*	*50*	*41*	*66*	*51*
045.	Missouri, University of-Columbia *Electrical*	15	33	39	.05	5.1	.68	.16
	Engineering	*44*	*50*	*48*	*38*	*64*	*48*	*49*
046.	Missouri, University of-Rolla *Electrical*	25	23	11	.08	5.4	.71	.17
	Engineering	*51*	*48*	*43*	*40*	*61*	*51*	*50*
047.	New Jersey Institute of Technology	29	10	NA	NA	NA	NA	NA
	Electrical Engineering	*54*	*44*					
048.	New Mexico State University-Las Cruces	19	15	70	.27	6.4	.70	.10
	Electrical and Computer Engineering	*47*	*45*	*54*	*58*	*53*	*50*	*44*
049.	New Mexico, University of-Albuquerque	23	24	33	.09	8.6	.70	.22
	Electrical and Computer Engineering	*50*	*48*	*47*	*41*	*33*	*50*	*54*
050.	North Carolina State University-Raleigh	29	15	32	.31	7.5	.56	.06
	Electrical Engineering	*54*	*45*	*47*	*61*	*43*	*40*	*41*
051.	Northeastern University *Electrical*	25	10	9	.42	8.5	.64	.00
	Engineering	*51*	*44*	*43*	*71*	*34*	*45*	*35*
052.	Northwestern University *Electrical*	40	39	16	.27	6.2	.66	.24
	Engineering & Computer Sciences	*61*	*52*	*44*	*57*	*55*	*47*	*57*
053.	Notre Dame, University of *Electrical*	10	11	11	NA	NA	NA	NA
	Engineering	*41*	*44*	*43*				
054.	Ohio State University-Columbus *Electrical*	51	66	95	.08	6.0	.57	.16
	Engineering	*68*	*59*	*58*	*40*	*56*	*40*	*49*
055.	Ohio University-Athens *Electrical*	9	7	63	NA	NA	NA	NA
	Engineering	*41*	*43*	*53*				
056.	Oklahoma State University-Stillwater	14	14	10	.19	5.8	.50	.06
	Electrical Engineering	*44*	*45*	*43*	*50*	*57*	*35*	*41*
057.	Oklahoma, University of-Norman *Electrical*	15	16	18	NA	5.5	NA	NA
	Engineering and Computer Science	*44*	*46*	*44*		*60*		
058.	Oregon State University-Corvallis *Electrical*	17	21	30	.06	7.3	.50	.11
	and Computer Engineering	*46*	*47*	*47*	*38*	*45*	*35*	*45*
059.	Pennsylvania State University *Electrical*	25	24	23	.39	7.6	.80	.20
	Engineering	*51*	*48*	*45*	*68*	*42*	*58*	*53*
060.	Pennsylvania, University of *Electrical*	15	31	21	.15	9.3	.81	.07
	Engineering and Science	*44*	*50*	*45*	*47*	*27*	*58*	41

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey RatingsStandard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
041.	2.6	1.7	0.8	0.6	0.3	.17	2247	12		.14	.07	.09	.08
	50	*53*	*38*	*48*	*52*	*44*	*44*	*46*	*45*				
042.	3.8	2.1	0.8	1.3	1.8	.28	19835	28		.08	.05	.07	.06
	64	*61*	*37*	*67*	*66*	*50*	*64*	*53*	*53*				
043.	3.2	1.9	1.0	0.8	1.2	.49	8726	49		.10	.07	.09	.08
	57	*56*	*46*	*54*	*60*	*63*	*51*	*61*	*64*				
044.	1.3	0.8	0.9	0.4	NA	.05	2463	5		.15	.09	.12	.07
	35	*32*	*44*	*40*		*37*	*44*	*43*	*43*				
045.	2.1	1.3	0.8	0.4	`0.2	.07	1976	5		.13	.12	.11	.07
	44	*44*	*40*	*42*	*46*	*38*	*43*	*43*	*42*				
046.	2.5	1.6	1.1	0.6	NA	.12	3606	10		.13	.09	.09	.07
	49	*51*	*51*	*47*		*41*	*45*	*45*	*46*				
047.	1.3	0.8	1.1	0.3	NA	.00	NA	1		.14	.09	.11	.06
	35	*33*	*50*	*38*		*34*		*41*	*41*				
048.	NA	NA	NA	NA	NA	.00	14876	2		NA	NA	NA	NA
						34	*58*	*42*	*42*				
049.	2.1	1.5	1.2	0.6	`1.0	.13	6575	6		.12	.09	.10	.08
	44	*47*	*58*	*48*	*39*	*42*	*49*	*43*	*43*				
050.	2.5	1.6	1.5	0.6	NA	.28	8416	20		.14	.09	.10	.08
	49	*50*	*68*	*47*		*50*	*51*	*49*	*49*				
051.	2.0	1.1	1.0	0.5	NA	.00	1486	7		.14	.11	.10	.07
	42	*40*	*48*	*43*		*34*	*43*	*44*	*44*				
052.	3.1	1.9	1.0	0.9	0.3	.35	5170	17		.11	.06	.09	.08
	56	*57*	*48*	*55*	*51*	*55*	*47*	*48*	*52*				
053.	2.7	1.6	1.0	0.8	`1.3	.30	1544	5		.13	.08	.10	.07
	51	*49*	*48*	*52*	*35*	*52*	*43*	*43*	*43*				
054.	3.3	1.9	1.0	0.9	0.9	.14	10926	59		.11	.07	.10	.08
	58	*57*	*49*	*55*	*57*	*42*	*54*	*66*	*63*				
055.	1.1	0.7	0.7	0.3	NA	NA	NA	1		.16	.12	.14	.05
	32	*30*	*35*	*39*				*41*	*42*				
056.	1.9	1.4	1.0	0.4	`1.9	.00	4120	7		.14	.09	.11	.06
	42	*44*	*48*	*40*	*29*	*34*	*46*	*44*	*42*				
057.	1.6	1.0	0.7	0.4	`0.6	.00	1834	5		.13	.10	.09	.07
	38	*36*	*35*	*41*	*43*	*34*	*43*	*43*	*43*				
058.	1.8	1.3	1.3	0.3	NA	.24	3128	6		.16	.11	.11	.06
	40	*43*	*59*	*39*		*48*	*45*	*43*	*44*				
059.	2.8	1.8	0.9	0.6	0.7	.40	22901	28		.10	.09	.10	.07
	52	*54*	*44*	*47*	*55*	*58*	*68*	*53*	*55*				
060.	3.0	1.9	0.9	0.6	0.7	.13	4579	30		.12	.07	.08	.07
	55	*56*	*44*	*46*	*55*	*42*	*46*	*53*	*52*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
061.	Pittsburgh, University of *Electrical*	20	31	31	.07	6.5	.76	.14
	Engineering	*48*	*50*	*47*	*39*	*52*	*54*	*47*
062.	Polytech Institute of New York *Electrical*	21	85	56	.13	8.5	.64	.07
	Engineering and Computer Science	*48*	*65*	*51*	*44*	*34*	*46*	*42*
063.	Princeton University *Electrical Engineering*	10	42	48	.13	4.4	.78	.36
	and Computer Science	*41*	*53*	*50*	*45*	*70*	*56*	*67*
064.	Purdue University-West Lafayette *Electrical*	55	108	115	.16	5.4	.74	.16
	Engineering	*71*	*71*	*62*	*47*	*62*	*53*	*49*
065.	Rensselaer Polytechnic Institute *Electrical,*	39	37	69	.14	6.1	.81	.10
	Computer, & Systems Engineering	*60*	*51*	*54*	*46*	*55*	*58*	*43*
066.	Rhode Island, University of *Electrical*	16	12	17	.08	9.5	.64	.00
	Engineering	*45*	*45*	*44*	*41*	*25*	*45*	*35*
067.	Rice University *Electrical Engineering*	16	32	42	.28	5.3	.68	.26
		45	*50*	*49*	*58*	*62*	*48*	*58*
068.	Rochester, University of *Electrical*	12	8	15	.40	7.2	1.00	.60
	Engineering	*42*	*43*	*44*	*69*	*46*	*72*	*89*
069.	Rutgers, The State University-New	13	16	159	.27	7.0	.55	.09
	Brunswick *Electrical Engineering*	*43*	*46*	*70*	*58*	*47*	*39*	*43*
070.	SUNY at Buffalo *Electrical Engineering*	20	28	29	.04	6.5	.73	.23
		48	*49*	*46*	*37*	*52*	*52*	*55*
071.	SUNY at Stony Brook *Electrical*	14	21	62	.21	5.6	.56	.06
	Engineering	*44*	*47*	*52*	*52*	*59*	*39*	*40*
072.	Southern California, University of *Electrical*	58	147	116	.18	6.9	.66	.06
	Engineering	*73*	*82*	*62*	*49*	*48*	*47*	*40*
073.	Southern Methodist University *Electrical*	13	29	48	.18	6.2	.45	.07
	Engineering	*43*	*49*	*50*	*50*	*54*	*32*	*41*
074.	Stanford University *Electrical Engineering*	61	212	253	.18	6.4	.81	.24
		75	*99*	*87*	*49*	*53*	*58*	*57*
075.	Syracuse University *Electrical and*	32	25	30	.26	8.3	.90	.16
	Computer Engineering	*56*	*48*	*47*	*56*	*36*	*65*	*49*
076.	Tennessee, University of-Knoxville	22	17	20	.24	6.3	.67	.10
	Electrical Engineering	*49*	*46*	*45*	*55*	*54*	*48*	*43*
077.	Texas A & M University *Electrical*	18	14	16	.07	6.8	.39	.15
	Engineering	*46*	*45*	*44*	*40*	*49*	*27*	*49*
078.	Texas Tech University-Lubbock *Electrical*	21	21	19	.21	5.3	.72	.33
	Engineering	*48*	*47*	*45*	*52*	*63*	*52*	*65*
079.	Texas, University of-Arlington *Electrical*	13	11	32	.00	5.3	.80	.20
	Engineering	*43*	*44*	*47*	*33*	*62*	*58*	*53*
080.	Texas, University of-Austin *Electrical*	37	52	56	.17	6.8	.57	.24
	Engineering	*59*	*55*	*51*	*48*	*49*	*40*	57

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
061.	2.4	1.4	0.9	0.7	0.1	.25	2794	19		.12	.10	.08	.07
	48	*46*	*45*	*48*	*49*	*49*	*44*	*49*	*47*				
062.	3.6	2.1	0.7	0.9	NA	.14	5310	11		.11	.06	.08	.07
	61	*62*	*33*	*56*		*42*	*47*	*45*	*46*				
063.	3.7	2.2	0.7	1.1	0.9	.50	6358	20		.12	.09	.08	.09
	63	*63*	*35*	*61*	*57*	*64*	*48*	*49*	*53*				
064.	3.9	2.3	1.0	1.5	`0.5	.40	17331	69		.10	.06	.07	.06
	65	*65*	*46*	*71*	*43*	*58*	*61*	*70*	*68*				
065.	3.3	1.8	1.5	1.1	NA	.36	7849	31		.10	.06	.07	.07
	58	*55*	*72*	*62*		*55*	*50*	*54*	*52*				
066.	2.1	1.2	1.1	0.3	NA	.31	2611	6		.16	.08	.08	.06
	45	*42*	*53*	*39*		*53*	*44*	*43*	*43*				
067.	3.0	1.9	1.1	0.9	`1.4	.56	1782	11		.12	.06	.10	.09
	55	*57*	*51*	*57*	*34*	*68*	*43*	*45*	*46*				
068.	2.3	1.4	1.0	0.6	`0.6	.33	16764	8		.14	.13	.11	.07
	46	*46*	*46*	*45*	*42*	*54*	*61*	*44*	*46*				
069.	1.8	1.1	0.8	0.4	0.8	.08	1877	21		.14	.09	.10	.06
	40	*39*	*39*	*41*	*56*	*38*	*43*	*50*	*50*				
070.	2.3	1.5	1.1	0.6	0.3	.25	3019	25		.12	.09	.10	.07
	46	*47*	*54*	*48*	*51*	*49*	*45*	*51*	*50*				
071.	2.4	1.5	0.8	0.6	`0.6	.43	1539	14		.11	.10	.09	.06
	48	*48*	*39*	*45*	*42*	*60*	*43*	*47*	*47*				
072.	4.1	2.3	1.4	1.4	0.4	.33	18269	59		.08	.07	.08	.07
	67	*65*	*64*	*69*	*52*	*53*	*62*	*66*	*64*				
073.	2.4	1.5	0.6	0.6	NA	.23	NA	10		.12	.09	.11	.07
	48	*49*	*30*	*46*		*48*		*45*	*45*				
074.	4.8	2.7	1.1	1.7	2.0	.57	25196	92		.06	.05	.08	.06
	75	*75*	*54*	*78*	*69*	*68*	*70*	*80*	*86*				
075.	2.9	1.8	0.9	0.8	`0.3	.19	4063	30		.11	.07	.08	.07
	54	*53*	*43*	*53*	*45*	*45*	*46*	*53*	*51*				
076.	2.3	1.5	1.1	0.4	`0.4	.05	4266	5		.13	.12	.10	.07
	47	*48*	*54*	*41*	*44*	*37*	*46*	*43*	*43*				
077.	2.1	1.3	1.1	0.6	`0.5	.17	18988	27		.15	.11	.11	.08
	45	*44*	*54*	*47*	*44*	*44*	*63*	*52*	*48*				
078.	2.4	1.6	1.4	0.6	NA	.38	5513	14		.12	.10	.09	.08
	47	*51*	*68*	*47*		*57*	*47*	*47*	*46*				
079.	1.7	1.1	1.3	0.4	NA	.00	NA	0		.17	.13	.11	.07
	40	*39*	*63*	*41*		*34*		*41*	*41*				
080.	3.5	2.0	1.3	0.9	1.6	.19	10517	39		.09	.05	.09	.07
	60	*59*	*60*	*56*	*65*	*45*	*53*	*57*	*60*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
081.	Utah State University-Logan *Electrical*	14	11	1	NA	NA	NA	NA
	Engineering	*44*	*44*	*41*				
082.	Utah, University of-Salt Lake City	12	16	15	.62	7.5	.62	.15
	Electrical Engineering	*42*	*46*	*44*	*88*	*43*	*44*	*49*
083.	Vanderbilt University *Electrical and*	10	11	19	.10	NA	.90	.30
	Biomedical Engineering	*41*	*44*	*45*	*42*		*65*	*62*
084.	Virginia Polytechnic Institute & State Univ	35	17	49	.07	6.6	.87	.33
	Electrical Engineering	*58*	*46*	*50*	*39*	*51*	*62*	*65*
085.	Virginia, University of *Electrical*	14	19	15	.19	6.2	.69	.19
	Engineering	*44*	*46*	*44*	*50*	*54*	*49*	*52*
086.	Washington University-Saint Louis	15	18	21	.41	6.6	.75	.38
	Electrical Engineering	*44*	*46*	*45*	*70*	*50*	*54*	*69*
087.	Washington, University of-Seattle *Electrical*	37	31	36	.11	7.1	.75	.22
	Engineering	*59*	*50*	*48*	*43*	*46*	*54*	*55*
088.	Wayne State University *Electrical and*	11	10	17	.10	NA	1.00	.30
	Computer Engineering	*42*	*44*	*44*	*42*		*72*	*62*
089.	West Virginia University *Electrical*	16	9	11	NA	NA	NA	NA
	Engineering	*45*	*44*	*43*				
090.	Wisconsin, University of-Madison	28	45	136	.13	6.9	.76	.22
	Electrical and Computer Engineering	*53*	*54*	*66*	*45*	*48*	*55*	*54*
091.	Yale University *Engineering and Applied*	18	16	30	.09	5.9	.62	.14
	Science	*46*	*46*	*47*	*41*	*56*	*44*	*48*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 5.1 Program Measures (Raw and Standardized Values) in Electrical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
081.	1.4	1.1	0.9	0.3	NA	.29	5513	4		.15	.10	.12	.06
	36	*38*	*45*	*37*		*51*	*47*	*42*	*42*				
082.	2.3	1.5	1.1	0.4	`0.6	.33	7123	20		.17	.10	.13	.06
	46	*47*	*51*	*40*	*42*	*54*	*49*	*49*	*49*				
083.	1.4	0.8	0.8	0.3	`0.7	.30	NA	6		.16	.10	.08	.05
	36	*32*	*40*	*37*	*41*	*52*		*43*	*43*				
084.	2.6	1.6	1.3	0.6	`0.0	.20	7243	21		.13	.09	.10	.07
	50	*51*	*60*	*45*	*48*	*46*	*49*	*50*	*49*				
085.	2.2	1.4	1.3	0.6	0.7	.21	4673	19		.12	.10	.09	.06
	45	*45*	*61*	*46*	*56*	*47*	*46*	*49*	*46*				
086.	2.4	1.6	0.9	0.6	`0.4	.47	5257	9		.12	.09	.10	.07
	48	*51*	*43*	*47*	*44*	*62*	*47*	*44*	*46*				
087.	3.0	1.8	1.3	0.8	1.5	.30	5430	11		.11	.06	.09	.07
	55	*54*	*59*	*53*	*63*	*52*	*47*	*45*	*46*				
088.	1.8	1.1	0.7	0.5	`0.4	.27	2693	16		.13	.12	.14	.08
	41	*38*	*33*	*45*	*45*	*50*	*44*	*47*	*47*				
089.	1.5	1.0	1.1	0.3	NA	.13	4618	8		.16	.11	.11	.06
	38	*38*	*52*	*37*		*41*	*46*	*44*	*44*				
090.	3.1	1.9	0.9	0.9	1.6	.25	9919	48		.10	.06	.08	.07
	56	*56*	*42*	*55*	*64*	*49*	*53*	*61*	*60*				
091.	2.9	1.8	0.9	1.0	2.1	.56	2510	17		.11	.06	.10	.07
	54	*54*	*43*	*57*	*69*	*67*	*44*	*48*	*48*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 5.2 Summary Statistics Describing Each Program Measure--Electrical Engineering

Measure	Number of Programs Evaluated	Mean	Standard Deviation	DECILES 1	2	3	4	5	6	7	8	9
Program Size												
01 Raw Value	91	23	15	12	13	14	16	18	21	24	31	47
Std Value	91	50	10	42	43	44	45	46	48	50	55	65
02 Raw Value	91	32	37	11	13	15	16	21	22	27	33	65
Std Value	91	50	10	44	45	45	46	47	47	49	50	59
03 Raw Value	90	49	55	11	15	19	23	30	36	46	60	116
Std Value	90	50	10	43	44	45	45	47	48	49	52	62
Program Graduates												
04 Raw Value	81	.19	.11	.07	.08	.12	.14	.17	.19	.23	.27	.32
Std Value	81	50	10	39	40	44	45	48	50	54	57	62
05 Raw Value	79	6.7	1.1	8.5	7.5	7.2	6.9	6.6	6.2	5.9	5.6	5.3
Std Value	79	50	10	34	43	45	48	51	54	57	59	62
06 Raw Value	81	.70	.13	.50	.57	.63	.66	.70	.74	.77	.81	.89
Std Value	81	50	10	35	40	45	47	50	53	55	58	65
07 Raw Value	81	.17	.11	.04	.07	.10	.12	.15	.17	.22	.25	.33
Std Value	81	50	10	38	41	44	45	48	50	55	57	65
Survey Results												
08 Raw Value	90	2.6	.9	1.5	1.8	2.1	2.3	2.4	2.7	3.0	3.2	3.7
Std Value	90	50	10	37	41	44	47	48	51	55	57	63
09 Raw Value	90	1.6	.5	1.0	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2.2
Std Value	90	50	10	37	41	46	48	50	52	54	57	63
10 Raw Value	90	1.1	.2	.8	.8	.9	1.0	1.0	1.1	1.2	1.3	1.3
Std Value	90	50	10	39	39	43	48	48	52	57	61	61
11 Raw Value	90	.7	.4	.3	.4	.5	.6	.6	.7	.8	.9	1.1
Std Value	90	50	10	38	41	44	47	47	50	53	55	61
University Library												
12 Raw Value	62	.2	1.0	-1.1	-.6	-.5	-.3	.0	.3	.7	.9	1.7
Std Value	62	50	10	37	42	43	45	48	51	55	57	65
Research Support												
13 Raw Value	87	.27	.17	.05	.13	.17	.23	.25	.29	.33	.40	.50
Std Value	87	50	10	37	42	44	48	49	51	54	58	64
14 Raw Value	76	7679	8560	1817	2249	2684	3789	5015	5513	7945	10397	17706
Std Value	76	50	10	43	44	44	45	47	47	50	53	62
Publication Records												
15 Raw Value	91	22	24	4	6	9	11	14	19	23	28	50
Std Value	91	50	10	42	43	45	45	47	49	50	53	62
16 Std Value	91	50	10	42	43	45	46	46	48	50	52	63

NOTE: Standardized values reported in the preceding table have been computed from exact values of the mean and standard deviation and not the rounded values reported here. Since the scale used to compute measure 16 is entirely arbitrary, only data in standardized form are reported for this measure.

TABLE 5.3 Intercorrelations Among Program Measures on 91 Programs in Electrical Engineering

Measure	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Program Size																
01		.78	.72	`.04	.06	.15	.06	.73	.68	.24	.78	.46	.27	.63	.84	.83
02			.82	`.09	.18	.10	.06	.76	.75	.11	.81	.47	.39	.58	.84	.85
03				`.05	.17	.04	.07	.68	.65	.11	.74	.47	.33	.62	.79	.81
Program Graduates																
04					`.06	`.02	.10	`.03	.00	`.07	`.08	`.37	.03	.20	`.04	.01
05						`.18	.24	.21	.24	`.05	.21	`.02	.13	.12	.09	.10
06							.41	.13	.08	.10	.17	.04	.17	.08	.18	.19
07		.12	.13	`.02	.14	.02	.27	.30	.11	.14						
Survey Results																
08		.98	.23	.94	.56	.56	.59	.78	.80							
09		.22	.91	.54	.55	.57	.76	.78								
10		.18	.06	.07	.09	.17	.17									
11		.52	.59	.62	.82	.84										
University Library																
12		.28	.21	.50	.51											
Research Support																
13		.21	.48	.52												
14		.61	.65													
Publication Records																
15		.98														
16																

NOTE: Since in computing correlation coefficients program data must be available for both of the measures being correlated, the actual number of programs on which each coefficient is based varies.

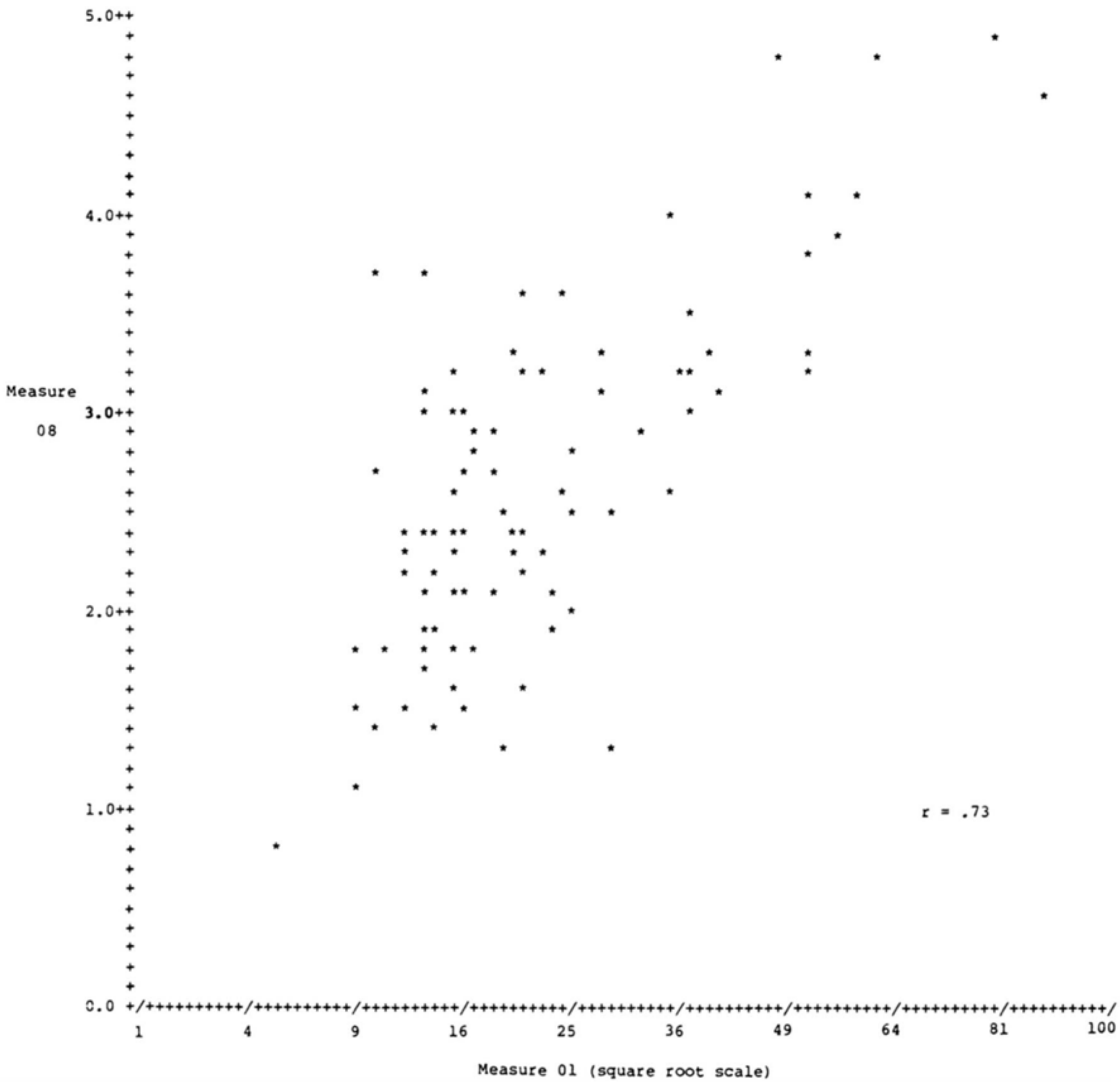

FIGURE 5.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--90 programs in electrical engineering.

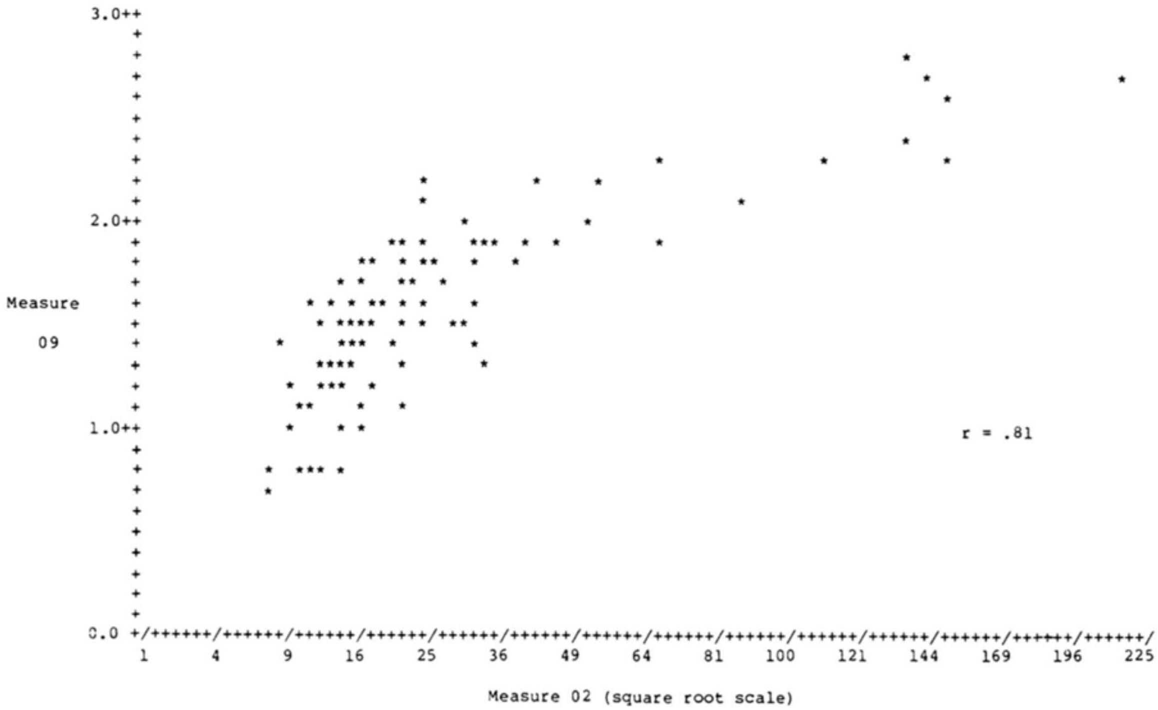

FIGURE 5.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--90 programs in electrical engineering.

TABLE 5.4 Characteristics of Survey Participants in Electrical Engineering

	Respondents	
	N	%
Field of Specialization		
Electrical Engineering	106	75
Electronics	13	9
Other/Unknown	23	16
Faculty Rank		
Professor	90	63
Associate Professor	34	24
Assistant Professor	18	13
Year of Highest Degree		
Pre-1950	4	3
1950-59	31	22
1960-69	63	44
Post-1969	42	30
Unknown	2	1
Evaluator Selection		
Nominated by Institution	128	90
Other	14	10
Survey Form		
With Faculty Names	129	91
Without Names	13	9
Total Evaluators	142	100

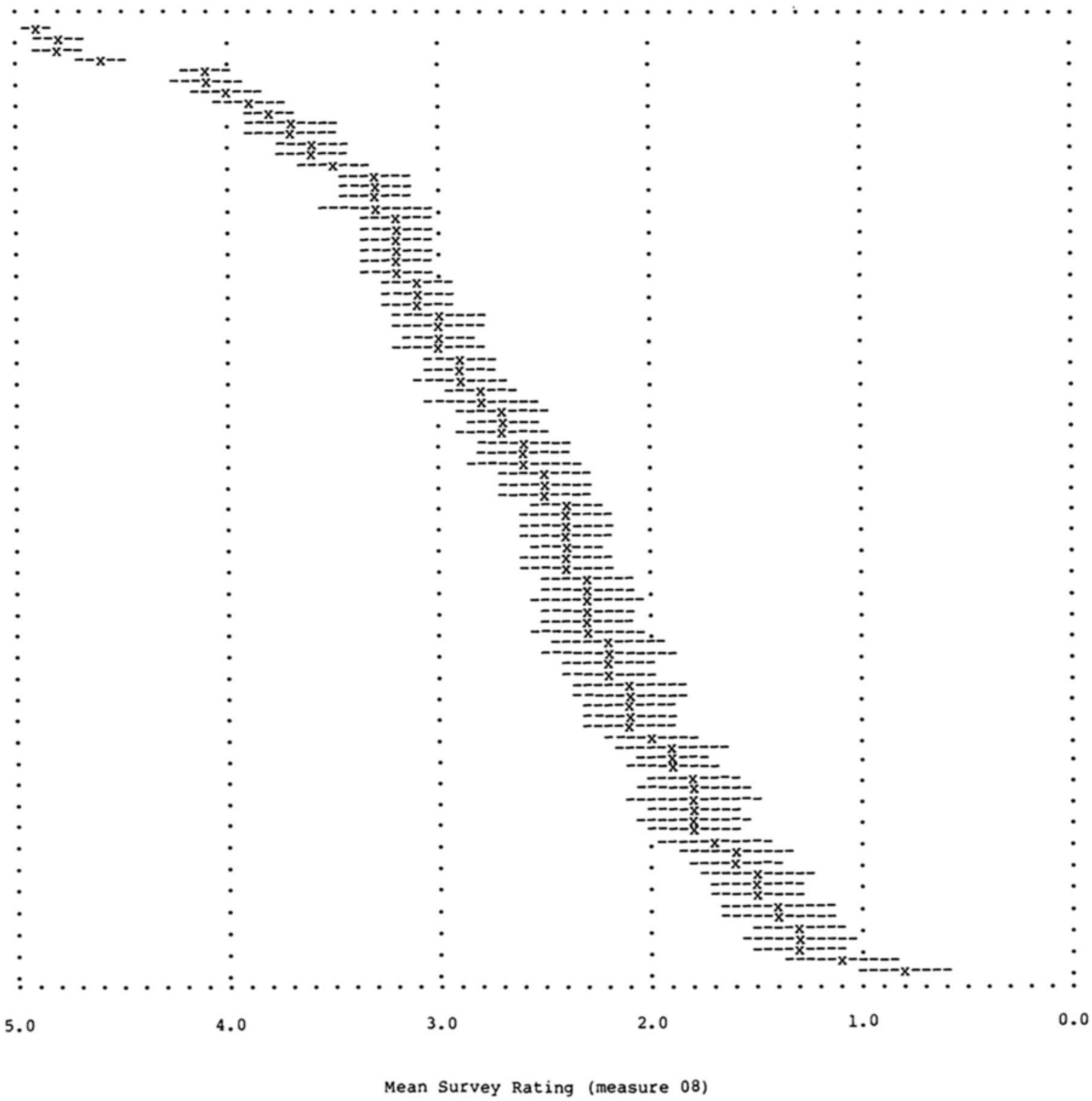

FIGURE 5.3 Mean rating of scholarly quality of faculty in 90 programs in electrical engineering.
NOTE: Programs are listed in sequence of mean rating, with the highest-rated program appearing at the top of the page. The broken lines (---) indicate a confidence interval of ±1.5 standard errors around the reported mean (x) of each program.

VI

Mechanical Engineering Programs

In this chapter 82 research-doctorate programs in mechanical engineering are assessed. These programs, according to the information supplied by their universities, have accounted for 1,683 doctoral degrees awarded during the FY1976-80 period--approximately 88 percent of the aggregate number of mechanical engineering and engineering mechanics doctorates earned from U.S. universities in this five-year span.[1] On the average, 29 full-time and part-time students intending to earn doctorates were enrolled in a program in December 1980, with an average faculty size of 20 members.[2] Most of the 82 programs, listed in Table 6.1, are located in departments of mechanical engineering. Approximately one-fourth are found in departments of mechanical and aerospace engineering. Only three of the programs were initiated since 1970, and no two programs are located in the same university. In addition to the 82 institutions represented in this discipline, another 3 were initially identified as meeting the criteria[3] for inclusion in the assessment:

University of California--San Diego

George Washington University

University of Dayton

The last institution chose not to participate in the assessment in any discipline. Mechanical engineering at the other two institutions have not been included in the evaluations in this discipline, since in each case the study coordinator either indicated that the institution did

[1]Data from the NRC's Survey of Earned Doctorates indicate that 1,430 research doctorates in mechanical engineering and another 486 research doctorates in engineering mechanics were awarded by U.S. universities between FY1976 and FY1980.

[2]See the reported means for measures 03 and 01 in Table 6.2.

[3]As mentioned in Chapter I, the primary criterion for inclusion was that a university had awarded at least 7 doctorates in mechanical engineering during the FY1976-78 period.

not at that time have a research-doctorate program in mechanical engineering or failed to provide the information requested by the committee.

Before examining individual program results presented in Table 6.1, the reader is urged to refer to Chapter II, in which each of the 16 measures used in the assessment is discussed. Summary statistics describing every measure are given in Table 6.2. For 11 of the measures, data are reported for at least 70 of the 82 mechanical engineering programs. For measures 04-07, which pertain to characteristics of the program graduates, data are presented for only approximately 70 percent of the programs; the other 30 percent had too few graduates on which to base statistics.[4] For measure 12, a composite index of the size of a university library, data are available for 59 programs. The programs not evaluated on measure 12 are typically smaller--in terms of faculty size and graduate student enrollment--than other mechanical engineering programs. Were data on this measure available for all 82 programs, it is likely that the reported mean would be appreciably lower (and that some of the correlations of this measure with others would be higher).

Intercorrelations among the 16 measures (Pearson product-moment coefficients) are given in Table 6.3. Of particular note are the high positive correlations of the measures of program size (01-03) with measures of publication records (15, 16) and reputational survey ratings (08, 09). Figure 6.1 illustrates the relation between the mean rating of the scholarly quality of faculty (measure 08) and the number of faculty members (measure 01) for each of 57 programs in mechanical engineering. Figure 6.2 plots the mean rating of program effectiveness (measure 09) against the total number of FY1976-80 program graduates (measure 02). Although in both figures there is a significant positive correlation between program size and reputational rating, it is quite apparent that some of the smaller programs received high mean ratings and that some of the larger programs received low mean ratings.

Table 6.4 describes the 144 faculty members who participated in the evaluation of mechanical engineering programs. These individuals constituted 59 percent of those asked to respond to the survey in this discipline and 9 percent of the faculty population in the 82 research-doctorate programs being evaluated.[5] One-fourth of the survey participants had earned their highest degree since 1970, and a majority held the rank of full professor. Three exceptions should be noted with regard to the survey evaluations in this discipline. The mechanical engineering program at Harvard University was omitted on the survey form since at the time of the survey mailing no information had been provided by the institution. At the request of the study coordinator at Harvard and the department chairman, the program has been included

[4] As mentioned in Chapter II, data for measures 04-07 are not reported if they are based on the survey responses of fewer than 10 FY1975-79 program graduates.

[5] See Table 2.3 in Chapter II.

in all other aspects of the assessment. Also, it has been called to the attention of the committee that the Cornell University program in the Department of Mechanical and Aerospace Engineering was incorrectly identified as "Mechanical Engineering and Aerospace Engineering" and that the Johns Hopkins University program in the Department of Mechanics was incorrectly labeled "Mechanical Engineering." The committee has decided to report the survey results for these two programs but cautions that the reputational ratings may have been influenced by the use of inaccurate program titles on the survey form.

To assist the reader in interpreting results of the survey evaluations, estimated standard errors have been computed for mean ratings of the scholarly quality of faculty in 81 mechanical engineering programs (and are given in Table 6.1). For each program the mean rating and an associated "confidence interval" of 1.5 standard errors are illustrated in Figure 6.3 (listed in order of highest to lowest mean rating). In comparing two programs, if their confidence intervals do not overlap, one may conclude that there is a significant difference in their mean ratings at a .05 level of significance.[6] From this figure it is also apparent that one should have somewhat more confidence in the accuracy of the mean ratings of higher-rated programs than lower-rated programs. This generalization results primarily from the fact that evaluators are not as likely to be familiar with the less prestigious programs, and consequently the mean ratings of these programs are usually based on fewer survey responses.

[6]See pp. 29-31 for a discussion of the interpretation of mean ratings and associated confidence intervals.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
001.	Akron, University of *Mechanical*	11	8	8	NA	NA	NA	NA
	Engineering	*42*	*44*	*43*				
002.	Alabama, University of-Tuscaloosa	9	4	5	NA	NA	NA	NA
	Aerospace Engr/ Mechanical Engr/ Mechanics	*40*	*42*	*42*				
003.	Arizona State University-Tempe	19	4	11	NA	NA	NA	NA
	Mechanical and Energy Systems Engineering	*49*	*42*	*44*				
004.	Arizona, University of-Tucson *Aerospace*	9	12	13	.50	9.8	.75	.17
	and Mechanical Engineering	*40*	*46*	*44*	*75*	*29*	*53*	*50*
005.	Auburn University *Mechanical Engineering*	19	5	6	NA	NA	NA	NA
		49	*43*	*42*				
006.	Brown University *Engineering*	21	22	30	.19	5.8	.65	.35
		51	*51*	*50*	*48*	*59*	*45*	*67*
007.	California Institute of Technology	11	13	NA	.42	5.2	.42	.08
	Mechanical Engineering	*42*	*46*		*68*	*64*	*28*	*42*
008.	California, University of-Berkeley	45	133	125	.17	6.0	.67	.19
	Mechanical Engineering	*73*	*99*	*83*	*46*	*58*	*47*	*51*
009.	California, University of-Davis *Mechanical*	19	20	29	.00	9.2	.91	.14
	Engineering	*49*	*50*	*50*	*31*	*33*	*64*	*47*
010.	California, University of-Los Angeles	34	63	164	.10	7.7	.62	.08
	Engineering and Applied Science	*63*	*70*	*96*	*40*	*44*	*43*	*41*
011.	Carnegie-Mellon University *Mechanical*	14	14	32	.38	7.5	.93	.20
	Engineering	*45*	*47*	*51*	*64*	*46*	*66*	*53*
012.	Case Western Reserve University	16	12	12	.38	5.8	.81	.38
	Mechanical and Aerospace Engineering	*47*	*46*	*44*	*64*	*59*	*57*	*69*
013.	Catholic University of America *Mechanical*	7	20	25	.33	8.8	.73	.09
	Engineering	*38*	*50*	*48*	*61*	*37*	*51*	*42*
014.	Cincinnati, University of *Mechanical*	16	11	39	NA	NA	NA	NA
	Engineering	*47*	*45*	*53*				
015.	Colorado State University-Fort Collins	16	21	12	.16	6.2	.79	.16
	Mechanical Engineering	*47*	*50*	*44*	*45*	*56*	*56*	*49*
016.	Columbia University *Mechanical*	7	18	27	.13	7.3	.53	.07
	Engineering	*38*	*49*	*49*	*42*	*48*	*36*	*40*
017.	Connecticut, University of-Storrs	16	14	16	.30	8.2	.68	.05
	Mechanical Engineering	*47*	*47*	*45*	*58*	*41*	*48*	*39*
018.	Cornell University-Ithaca *Mechanical and*	24	22	25	.17	7.0	.78	.33
	Aerospace Engineering	*54*	*51*	*48*	*46*	*50*	*55*	*65*
019.	Delaware, University of-Newark	15	10	49	.30	8.0	.70	.00
	Mechanical and Aerospace Engineering	*46*	*45*	*57*	*58*	*42*	*49*	*34*
020.	Drexel University *Mechanical Engineering*	18	22	39	.26	6.5	.57	.17
	*and Mechanics**	*48*	*51*	*53*	*54*	*54*	*39*	*50*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
001.	1.4	1.0	1.1	0.3	NA	.00	NA	3		.18	.13	.13	.05
	33	*32*	*54*	*37*		*35*		*43*	*44*				
002.	1.5	0.9	0.7	0.3	`1.3	NA	NA	2		.14	.10	.11	.05
	34	*30*	*33*	*38*	*36*			*42*	*41*				
003.	2.7	1.5	1.4	0.6	`0.3	.32	NA	5		.12	.08	.12	.07
	49	*45*	*69*	*48*	*45*	*57*		*44*	*43*				
004.	2.3	1.5	1.2	0.6	0.9	NA	5261	4		.15	.09	.12	.07
	44	*46*	*60*	*46*	*56*		*47*	*43*	*44*				
005.	1.9	1.3	1.1	0.3	NA	.05	2450	1		.16	.11	.14	.05
	40	*41*	*51*	*37*		*39*	*44*	*41*	*42*				
006.	3.9	2.3	0.9	1.0	`1.1	.71	3497	15		.12	.08	.06	.08
	64	*65*	*43*	*60*	*38*	*85*	*45*	*53*	*53*				
007.	4.3	2.5	0.8	1.1	NA	.27	8339	17		.09	.06	.07	.08
	69	*69*	*37*	*64*		*54*	*51*	*55*	*51*				
008.	4.6	2.6	1.1	1.5	2.2	.40	16448	54		.07	.06	.07	.06
	73	*73*	*56*	*76*	*68*	*63*	*60*	*87*	*81*				
009.	3.0	1.9	1.3	0.7	0.6	.21	3136	9		.09	.07	.09	.07
	53	*54*	*64*	*51*	*54*	*50*	*45*	*48*	*48*				
010.	3.9	2.2	1.2	1.1	2.0	.35	6168	13		.09	.06	.07	.07
	64	*63*	*57*	*65*	*66*	*60*	*48*	*51*	*49*				
011.	3.1	1.9	1.0	0.9	NA	.43	6409	8		.11	.06	.11	.08
	55	*54*	*51*	*56*		*65*	*48*	*47*	*47*				
012.	3.1	1.9	0.9	0.9	`1.3	.06	8676	9		.11	.06	.09	.07
	55	*54*	*43*	*57*	*36*	*39*	*51*	*48*	*45*				
013.	1.6	1.1	0.7	0.3	NA	NA	NA	3		.14	.11	.11	.05
	36	*36*	*33*	*36*				*43*	*43*				
014.	2.1	1.7	1.1	0.4	`0.2	.00	2360	16		.15	.10	.09	.06
	42	*49*	*53*	*40*	*46*	*35*	*44*	*54*	*61*				
015.	2.5	1.7	1.0	0.6	`1.1	.13	8604	3		.12	.08	.10	.07
	47	*49*	*50*	*45*	*38*	*44*	*51*	*43*	*43*				
016.	3.2	1.8	0.7	0.8	1.7	NA	5375	8		.15	.08	.08	.08
	56	*53*	*32*	*52*	*64*		*47*	*47*	*57*				
017.	2.2	1.5	0.9	0.5	`0.5	.00	4069	4		.11	.08	.10	.07
	43	*45*	*44*	*44*	*44*	*35*	*46*	*43*	*45*				
018.	3.8	2.3	1.1	1.0	1.6	.17	13206	22		.09	.05	.08	.07
	64	*64*	*55*	*62*	*63*	*47*	*56*	*59*	*53*				
019.	2.4	1.6	1.3	0.6	NA	.20	3302	6		.12	.08	.09	.06
	45	*47*	*61*	*46*		*49*	*45*	*45*	*47*				
020.	2.3	1.6	1.1	0.6	NA	.11	2649	1		.13	.09	.07	.07
	44	*48*	*53*	*46*		*43*	*44*	*41*	*41*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
021.	Florida, University of-Gainesville	15	11	51	.25	5.6	.75	.17
	Mechanical Engineering	*46*	*45*	*57*	*53*	*60*	*53*	*50*
022.	Georgia Institute of Technology *Mechanical*	16	18	22	.17	7.2	.50	.00
	Engineering	*47*	*49*	*47*	*46*	*49*	*34*	*34*
023.	Harvard University *Applied Sciences*	8	17	22	.20	5.3	.80	.40
		39	*48*	*47*	*49*	*63*	*56*	*71*
024.	Houston, University of *Mechanical*	24	18	42	.10	7.5	.80	.30
	Engineering	*54*	*49*	*54*	*40*	*46*	*56*	*62*
025.	Illinois Institute of Technology *Mechanical*	14	13	17	NA	NA	NA	NA
	and Aerospace Engineering	*45*	*46*	*46*				
026.	Illinois, University of-Chicago Circle	27	13	49	NA	NA	NA	NA
	Materials Engineering	*57*	*46*	*57*				
027.	Illinois, University-Urbana/Champaign	43	38	57	.04	7.3	.86	.18
	Mechanical and Industrial Engineering	*71*	*58*	*59*	*35*	*48*	*61*	*51*
028.	Iowa State University-Ames *Mechanical*	16	17	12	.27	5.3	NA	NA
	Engineering	*47*	*48*	*44*	*55*	*63*		
029.	Iowa, University of-Iowa City *Mechanical*	24	30	31	.07	7.3	.41	.22
	Engineering	*54*	*55*	*51*	*38*	*47*	*27*	*55*
030.	Johns Hopkins University *Mechanics*	3	18	4	NA	5.0	NA	NA
		35	*49*	*41*		*65*		
031.	Kansas State University-Manhattan	13	10	16	NA	NA	NA	NA
	Mechanical Engineering	*44*	*45*	*45*				
032.	Kentucky, University of *Mechanical*	13	7	14	NA	NA	NA	NA
	Engineering	*44*	*44*	*45*				
033.	Lehigh University *Mechanical Engineering*	29	11	25	.21	5.5	.67	.22
	and Mechanics	*58*	*45*	*48*	*50*	*61*	*46*	*55*
034.	Maryland, University of-College Park	27	20	18	.04	12.8	.91	.09
	Mechanical Engineering	*57*	*50*	*46*	*35*	*6*	*64*	*42*
035.	Massachusetts Institute of Technology	59	107	123	.25	5.6	.67	.24
	Mechanical Engineering	*86*	*92*	*82*	*53*	*61*	*47*	*56*
036.	Massachusetts, University of-Amherst	21	13	8	.24	6.8	.80	.27
	Mechanical Engineering	*51*	*46*	*43*	*52*	*52*	*56*	*59*
037.	Miami, University of-Florida *Mechanical*	5	11	14	.00	8.3	.80	.30
	Engineering	*37*	*45*	*45*	*31*	*40*	*56*	*62*
038.	Michigan State University-East Lansing	18	12	18	NA	NA	NA	NA
	Mechanical Engineering	*48*	*46*	*46*				
039.	Michigan, University of-Ann Arbor	57	19	38	.28	7.9	.64	.14
	Mechanical Engineering & Applied Mechanics	*84*	*49*	*53*	*56*	*43*	*44*	*47*
040.	Minnesota, University of *Mechanical*	24	49	63	.29	6.9	.87	.10
	Engineering	*54*	*64*	*62*	*57*	*51*	*62*	*44*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Standard Error Survey Ratings			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
021.	2.4	1.6	1.2	0.7	0.8	.33	13686	10		.12	.08	.10	.07
	45	*46*	*60*	*49*	*55*	*58*	*57*	*49*	*48*				
022.	3.0	1.9	1.0	0.9	NA	.31	29270	21		.12	.06	.09	.08
	54	*54*	*50*	*58*		*57*	*74*	*58*	*58*				
023.	NA	NA	NA	NA	3.0	NA	NA	10		NA	NA	NA	NA
					75			*49*	*46*				
024.	2.9	1.7	1.5	0.8	`0.9	.13	5015	13		.12	.08	.09	.08
	52	*50*	*73*	*53*	*40*	*44*	*47*	*51*	*50*				
025.	2.8	1.7	0.7	0.9	NA	.21	NA	11		.11	.06	.08	.07
	50	*50*	*34*	*58*		*50*		*50*	*54*				
026.	2.7	1.8	1.1	0.5	NA	.26	2144	14		.14	.10	.11	.07
	50	*53*	*52*	*44*		*53*	*43*	*52*	*50*				
027.	3.8	2.2	1.2	1.1	2.0	.23	18980	33		.08	.05	.06	.06
	63	*64*	*57*	*65*	*66*	*51*	*63*	*69*	*66*				
028.	3.0	1.8	1.2	0.8	`0.5	.19	8330	13		.10	.06	.07	.07
	53	*53*	*58*	*52*	*44*	*48*	*50*	*51*	*51*				
029.	2.6	1.8	1.2	0.6	0.3	.33	2117	12		.12	.07	.11	.07
	48	*52*	*58*	*46*	*51*	*58*	*43*	*51*	*48*				
030.	3.7	1.7	0.5	0.8	`0.4	NA	1741	3		.19	.10	.08	.08
	62	*49*	*24*	*55*	*45*		*43*	*43*	*43*				
031.	1.9	1.3	0.9	0.4	NA	.08	2604	5		.11	.10	.08	.06
	39	*41*	*41*	*42*		*40*	*44*	*44*	*45*				
032.	2.4	1.4	0.9	0.5	`0.1	.31	5056	22		.12	.10	.11	.06
	46	*43*	*45*	*42*	*47*	*56*	*47*	*59*	*55*				
033.	3.2	2.0	1.2	0.9	NA	.21	4568	13		.10	.08	.08	.08
	56	*57*	*60*	*58*		*49*	*46*	*51*	*51*				
034.	2.7	1.8	1.0	0.6	0.2	.19	3519	15		.11	.06	.09	.06
	49	*51*	*48*	*47*	*50*	*48*	*45*	*53*	*50*				
035.	4.8	2.7	1.0	1.6	`0.3	.42	59143	41		.05	.05	.05	.05
	76	*74*	*51*	*81*	*45*	*65*	*99*	*76*	*70*				
036.	2.4	1.5	1.1	0.5	`0.7	.14	2256	10		.10	.08	.10	.05
	46	*45*	*51*	*45*	*42*	*45*	*44*	*49*	*48*				
037.	1.0	0.9	1.0	0.3	NA	NA	NA	1		.14	.10	.12	.05
	28	*28*	*46*	*36*				*41*	*42*				
038.	2.7	1.7	1.1	0.6	0.3	.39	2247	8		.12	.08	.09	.07
	49	*49*	*56*	*48*	*51*	*62*	*44*	*47*	*46*				
039.	4.0	2.2	0.8	1.2	1.8	.11	19835	17		.08	.06	.09	.07
	65	*63*	*41*	*66*	*64*	*42*	*64*	*55*	*54*				
040.	4.1	2.4	1.0	1.2	1.2	.33	8726	59		.09	.06	.07	.08
	68	*67*	*51*	*66*	*59*	*58*	*51*	*92*	*82*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
041.	Missouri, University of-Columbia	8	12	3	.29	5.2	.64	.14
	Mechanical and Aerospace Engineering	*39*	*46*	*41*	*57*	*64*	*45*	*47*
042.	Missouri, University of-Rolla *Mechanical*	22	9	9	.38	6.3	.80	.13
	and Aerospace Engineering	*52*	*44*	*43*	*64*	*55*	*56*	*46*
043.	New Jersey Institute of Technology	24	10	NA	.20	NA	NA	NA
	Mechanical Engineering	*54*	*45*		*49*			
044.	New Mexico, University of-Albuquerque	10	9	NA	.08	7.8	.75	.17
	Mechanical Engineering	*41*	*44*		*38*	*44*	*53*	*50*
045.	North Carolina State University-Raleigh	27	45	40	.24	7.7	.67	.15
	Mechanical and Aerospace Engineering	*57*	*62*	*54*	*52*	*45*	*46*	*48*
046.	Northwestern University *Mechanical and*	25	10	23	.15	5.8	.67	.33
	Nuclear Engineering	*55*	*45*	*48*	*45*	*59*	*46*	*65*
047.	Notre Dame, University of *Aerospace and*	11	10	5	.15	6.8	.75	.08
	Mechanical Engineering	*42*	*45*	*42*	*45*	*51*	*53*	*42*
048.	Ohio State University-Columbus	23	20	49	.15	7.8	.78	.15
	Mechanical Engineering	*53*	*50*	*57*	*44*	*44*	*55*	*48*
049.	Oklahoma State University-Stillwater	17	27	20	.09	6.8	.77	.36
	Mechanical and Aerospace Engineering	*47*	*53*	*47*	*39*	*52*	*54*	*68*
050.	Oklahoma, University of-Norman	18	7	12	NA	NA	NA	NA
	Aerospace, Mechanical, and Nuclear Engin	*48*	*44*	*44*				
051.	Old Dominion University *Mechanical*	16	8	25	NA	NA	NA	NA
	*Engineering and Mechanics**	*47*	*44*	*48*				
052.	Oregon State University-Corvallis	14	12	20	.17	6.8	.58	.08
	Mechanical Engineering	*45*	*46*	*47*	*46*	*52*	*40*	*42*
053.	Pennsylvania State University *Mechanical*	23	19	13	.26	6.8	.75	.30
	Engineering	*53*	*49*	*44*	*55*	*51*	*53*	*62*
054.	Pennsylvania, University of *Mechanical*	12	19	24	.38	7.3	.80	.07
	Engineering & Applied Mechanics	*43*	*49*	*48*	*64*	*47*	*56*	*40*
055.	Pittsburgh, University of *Mechanical*	10	9	17	.20	8.5	.90	.10
	Engineering	*41*	*44*	*46*	*49*	*38*	*64*	*43*
056.	Polytech Institute of New York *Mechanical*	15	10	10	.29	7.3	.60	.00
	and Aerospace Engineering	*46*	*45*	*43*	*57*	*48*	*41*	*34*
057.	Princeton University *Mechanical and*	26	47	51	.29	6.0	.86	.28
	Aerospace Engineering	*56*	*63*	*57*	*57*	*57*	*61*	*60*
058.	Purdue University-West Lafayette	45	75	59	.19	5.9	.77	.23
	Mechanical Engineering	*73*	*76*	*60*	*48*	*58*	*54*	*56*
059.	Rensselaer Polytechnic Institute	39	23	64	.05	7.0	.80	.30
	Mechanical, Aeronautical Engin, & Mechanics	*67*	*51*	*62*	*36*	*50*	*56*	*62*
060.	Rhode Island, University of *Mechanical*	16	7	6	NA	NA	NA	NA
	Engineering	*47*	*44*	*42*				

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviations 10. “NA” indicates that the value for a measure is not available.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
041.	1.7	1.2	0.9	0.4	`0.2	NA	1976	7		.14	.11	.09	.06
	37	*37*	*41*	*41*	*46*		*43*	*46*	*47*				
042.	2.4	1.5	1.0	0.5	NA	.32	3606	14		.11	.09	.08	.06
	46	*45*	*49*	*42*		*57*	*45*	*52*	*53*				
043.	1.6	1.1	1.0	0.4	NA	.08	NA	0		.13	.09	.09	.07
	35	*35*	*49*	*42*		*41*		*40*	*41*				
044.	1.4	1.0	1.1	0.2	`1.0	.10	6575	6		.16	.12	.08	.05
	33	*32*	*55*	*35*	*39*	*42*	*48*	*45*	*45*				
045.	3.0	1.8	1.2	0.6	NA	.11	8416	12		.12	.06	.08	.07
	53	*52*	*58*	*48*		*43*	*51*	*51*	*49*				
046.	3.5	2.0	1.2	1.1	0.3	.40	5170	36		.10	.06	.08	.08
	60	*58*	*58*	*64*	*51*	*63*	*47*	*72*	*71*				
047.	2.7	1.7	0.9	0.8	`1.3	.36	1544	7		.12	.08	.07	.07
	49	*51*	*45*	*53*	*36*	*60*	*43*	*46*	*46*				
048.	3.0	1.8	1.1	0.8	0.9	.13	10926	17		.12	.06	.08	.07
	53	*53*	*52*	*55*	*56*	*44*	*53*	*55*	*55*				
049.	2.7	1.7	1.1	0.7	`1.9	.06	4120	5		.11	.08	.10	.07
	49	*49*	*51*	*50*	*30*	*39*	*46*	*44*	*41*				
050.	2.4	1.3	0.9	0.7	`0.6	.11	1834	3		.13	.10	.10	.08
	46	*41*	*46*	*49*	*43*	*43*	*43*	*43*	*42*				
051.	1.8	1.2	1.1	0.3	NA	.13	NA	3		.18	.12	.10	.05
	39	*37*	*56*	*36*		*44*		*43*	*48*				
052.	2.3	1.6	1.0	0.5	NA	.07	3128	4		.14	.09	.08	.07
	44	*48*	*50*	*43*		*40*	*45*	*43*	*43*				
053.	2.9	1.9	0.9	0.8	0.7	.17	22901	20		.10	.05	.08	.07
	52	*54*	*42*	*53*	*55*	*47*	*67*	*58*	*66*				
054.	3.1	1.9	1.4	0.7	0.7	.25	4579	4		.12	.05	.09	.07
	55	*55*	*66*	*52*	*54*	*52*	*46*	*43*	*44*				
055.	1.8	1.3	0.8	0.3	0.1	.10	2794	5		.14	.10	.09	.05
	38	*40*	*36*	*38*	*49*	*42*	*44*	*44*	*45*				
056.	2.6	1.6	0.5	0.6	NA	.07	5310	4		.14	.10	.09	.07
	48	*47*	*23*	*46*		*40*	*47*	*43*	*44*				
057.	4.0	2.4	1.2	1.1	0.9	.35	6358	17		.10	.06	.08	.08
	66	*69*	*59*	*65*	*56*	*59*	*48*	*55*	*50*				
058.	3.9	2.3	1.0	1.2	`0.5	.20	17331	35		.09	.05	.06	.07
	65	*66*	*49*	*69*	*43*	*49*	*61*	*71*	*66*				
059.	3.4	2.1	1.4	0.9	NA	.21	7849	31		.09	.06	.07	.07
	58	*59*	*66*	*58*		*49*	*50*	*67*	*83*				
060.	2.2	1.3	1.4	0.5	NA	.19	2611	4		.15	.10	.10	.06
	43	*41*	*66*	*43*		*48*	*44*	*43*	*43*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. "NA" indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
061.	Rice University *Mechanical Engineering and Materials Sci*	14 *45*	20 *50*	14 *45*	.19 *48*	5.4 *62*	.75 *53*	.06 *40*
062.	Rochester, University of *Mechanical and Aerospace Sciences*	16 *47*	27 *53*	32 *51*	.11 *41*	6.6 *53*	.78 *55*	.17 *50*
063.	Rutgers, The State University-New Brunswick *Mechanical and Aerospace Engineering*	14 *45*	5 *43*	82 *68*	NA	NA	NA	NA
064.	SUNY at Buffalo *Mechanical and Aerospace Engineering*	21 *51*	13 *46*	12 *44*	.09 *39*	NA	.80 *56*	.10 *43*
065.	SUNY at Stony Brook *Mechanical Engineering*	15 *46*	22 *51*	33 *51*	.05 *35*	7.2 *48*	.38 *25*	.00 *34*
066.	Southern California, University of *Mechanical Engineering*	10 *41*	9 *44*	8 *43*	NA	NA	NA	NA
067.	Stanford University *Mechanical Engineering*	36 *65*	54 *66*	107 *77*	.30 *58*	6.1 *57*	.82 *57*	.19 *51*
068.	Stevens Institute of Technology *Mechanical Engineering*	16 *47*	6 *43*	10 *43*	NA	NA	NA	NA
069.	Syracuse University *Mechanical and Aerospace Engineering*	7 *38*	14 *47*	1 *40*	.29 *57*	7.5 *46*	.69 *48*	.23 *55*
070.	Tennessee, University of-Knoxville *Mechanical and Aerospace Engineering*	19 *49*	14 *47*	17 *46*	.08 *39*	6.5 *54*	.50 *34*	.08 *42*
071.	Tennessee, University of-Space Institute *Mechanical & Aerospace Engineering*	13 *44*	10 *45*	16 *45*	NA	NA	NA	NA
072.	Texas A & M University *Mechanical Engineering*	34 *63*	15 *47*	18 *46*	NA	NA	NA	NA
073.	Texas, University of-Austin *Mechanical Engineering*	35 *64*	42 *60*	55 *59*	.20 *49*	7.3 *47*	.61 *42*	.10 *43*
074.	Tulane University *Mechanical Engineering*	6 *37*	9 *44*	7 *42*	NA	NA	NA	NA
075.	Vanderbilt University *Mechanical and Materials Engineering*	10 *41*	10 *45*	9 *43*	NA	NA	NA	NA
076.	Virginia Polytechnic Institute & State Univ *Mechanical Engineering*	28 *57*	12 *46*	23 *48*	.39 *65*	6.0 *57*	.92 *66*	.00 *34*
077.	Virginia, University of *Mechanical and Aerospace Engineering*	24 *54*	12 *46*	15 *45*	.46 *71*	6.8 *52*	.64 *44*	.27 *59*
078.	Washington University-Saint Louis *Mechanical Engineering*	12 *43*	11 *45*	13 *44*	NA	NA	NA	NA
079.	Washington, University of-Seattle *Mechanical Engineering*	33 *62*	12 *46*	17 *46*	.19 *48*	8.0 *42*	.81 *57*	.25 *57*
080.	Wayne State University *Mechanical Engineering*	15 *46*	19 *49*	13 *44*	.24 *52*	8.8 *37*	.38 *25*	.06 *40*

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
061.	3.0	1.8	1.1	0.6	`1.4	.43	1782	5		.12	.08	.08	.06
	53	*53*	*51*	*48*	*35*	*65*	*43*	*44*	*44*				
062.	2.6	1.7	1.0	0.4	`0.6	.19	16764	5		.17	.09	.12	.06
	49	*49*	*51*	*42*	*42*	*48*	*60*	*44*	*44*				
063.	2.5	1.6	0.8	0.6	0.8	.21	1877	5		.12	.08	.12	.06
	47	*46*	*38*	*47*	*55*	*50*	*43*	*44*	*44*				
064.	2.6	1.6	0.9	0.6	0.3	.24	3019	17		.13	.09	.12	.07
	48	*48*	*41*	*46*	*51*	*52*	*44*	*55*	*55*				
065.	2.9	1.8	0.9	0.5	`0.6	.53	1539	1		.13	.09	.13	.06
	51	*52*	*45*	*45*	*42*	*72*	*43*	*41*	*41*				
066.	2.4	1.5	1.0	0.5	0.4	.30	18269	6		.15	.08	.06	.06
	45	*45*	*50*	*44*	*51*	*56*	*62*	*45*	*45*				
067.	4.6	2.7	1.1	1.6	2.0	.47	25196	13		.07	.05	.04	.06
	74	*75*	*52*	*79*	*67*	*68*	*70*	*51*	*49*				
068.	2.0	1.2	0.9	0.4	NA	.13	2313	2		.14	.11	.11	.06
	41	*38*	*44*	*42*		*44*	*44*	*42*	*41*				
069.	2.1	1.4	0.8	0.5	`0.3	NA	4063	2		.15	.10	.07	.06
	42	*41*	*39*	*42*	*45*		*46*	*42*	*42*				
070.	2.1	1.4	0.9	0.4	`0.4	.05	4266	1		.12	.09	.08	.05
	42	*42*	*45*	*40*	*44*	*39*	*46*	*41*	*42*				
071.	1.8	1.4	0.8	0.3	NA	.00	NA	0		.16	.10	.11	.06
	39	*43*	*41*	*37*		*35*		*40*	*41*				
072.	2.4	1.5	1.3	0.7	`0.5	.03	18988	10		.13	.08	.08	.06
	46	*45*	*63*	*49*	*44*	*37*	*63*	*49*	*55*				
073.	3.3	2.0	1.4	0.8	1.6	.23	10517	19		.10	.07	.08	.08
	57	*57*	*69*	*54*	*63*	*51*	*53*	*57*	*57*				
074.	1.9	1.2	0.7	0.5	`1.0	NA	NA	3		.17	.10	.13	.06
	39	*38*	*36*	*43*	*39*			*43*	*41*				
075.	2.0	1.5	1.0	0.4	`0.7	.20	NA	5		.18	.13	.09	.06
	41	*46*	*51*	*41*	*42*	*49*		*44*	*44*				
076.	3.0	1.9	1.2	0.6	`0.0	.07	7243	17		.12	.07	.08	.07
	53	*54*	*58*	*48*	*48*	*40*	*49*	*55*	*56*				
077.	2.6	1.9	1.3	0.7	0.7	.13	4673	14		.12	.06	.09	.07
	49	*54*	*61*	*50*	*55*	*44*	*46*	*52*	*80*				
078.	2.4	1.5	1.2	0.4	`0.4	.42	5257	2		.15	.09	.10	.06
	46	*45*	*57*	*42*	*45*	*64*	*47*	*42*	*41*				
079.	3.1	1.8	0.8	0.8	1.5	.09	5430	6		.11	.09	.08	.07
	54	*51*	*40*	*53*	*61*	*41*	*47*	*45*	*44*				
080.	2.2	1.4	1.2	0.4	`0.4	.40	2693	3		.13	.11	.12	.06
	44	*43*	*57*	*42*	*45*	*63*	*44*	*43*	*43*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	University - Department/Academic Unit	Program Size			Characteristics of Program Graduates			
		(01)	(02)	(03)	(04)	(05)	(06)	(07)
081.	Wisconsin, University of-Madison	32	53	54	.15	6.3	.75	.34
	Mechanical Engineering	*61*	*66*	*58*	*45*	*55*	*52*	*66*
082.	Yale University *Engineering and Applied*	9	6	13	NA	NA	NA	NA
	Science	*40*	*43*	*44*				

* indicates program was initiated since 1970.

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available.

TABLE 6.1 Program Measures (Raw and Standardized Values) in Mechanical Engineering

Prog No.	Survey Results				University Library	Research Support		Published Articles		Survey Ratings Standard Error			
	(08)	(09)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(08)	(09)	(10)	(11)
081.	3.5	2.1	1.0	1.0	1.6	.22	9919	28		.11	.06	.07	.07
	60	*61*	*51*	*62*	*62*	*50*	*52*	*65*	*54*				
082.	3.1	1.7	0.8	0.8	2.1	NA	2510	5		.15	.08	.08	.07
	54	*49*	*40*	*55*	*67*		*44*	*44*	*43*				

NOTE: On the first line of data for every program, raw values for each measure are reported; on the second line values are reported in standardized form, with mean = 50 and standard deviation = 10. “NA” indicates that the value for a measure is not available. Since the scale used to compute measure 16 is entirely arbitrary, only values in standardized form are reported for this measure.

TABLE 6.2 Summary Statistics Describing Each Program Measure--Mechanical Engineering

Measure	Number of Programs Evaluated	Mean	Standard Deviation	DECILES 1	2	3	4	5	6	7	8	9
Program Size												
01 Raw Value	82	20	11	8	11	14	15	16	19	23	27	34
Std Value	82	50	10	39	42	45	46	47	49	53	57	63
02 Raw Value	82	21	21	7	9	11	12	13	17	19	22	44
Std Value	82	50	10	44	44	45	46	46	48	49	51	61
03 Raw Value	79	29	29	7	11	13	16	18	24	31	43	57
Std Value	79	50	10	42	44	44	45	46	48	51	55	59
Program Graduates												
04 Raw Value	59	.21	.11	.05	.10	.15	.17	.20	.24	.28	.29	.38
Std Value	59	50	10	35	40	45	46	49	53	56	57	65
05 Raw Value	58	7.0	1.3	8.6	7.8	7.5	7.3	6.9	6.8	6.2	5.9	5.5
Std Value	58	50	10	38	44	46	48	51	51	56	58	61
06 Raw Value	57	.71	.13	.50	.61	.67	.69	.75	.77	.80	.80	.87
Std Value	57	50	10	34	42	47	48	53	55	57	57	62
07 Raw Value	57	.17	.11	.04	.08	.09	.14	.16	.18	.23	.28	.33
Std Value	57	50	10	38	42	43	47	49	51	55	60	65
Survey Results												
08 Raw Value	81	2.7	.8	1.8	2.1	2.3	2.4	2.7	2.9	3.0	3.3	3.9
Std Value	81	50	10	38	42	44	46	50	52	53	57	65
09 Raw Value	81	1.7	.4	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.3
Std Value	81	50	10	38	43	45	48	50	53	55	58	65
10 Raw Value	81	1.0	.2	.8	.9	.9	1.0	1.0	1.1	1.1	1.2	1.3
Std Value	81	50	10	39	44	44	49	49	54	54	59	64
11 Raw Value	81	.7	.3	.3	.4	.5	.6	.6	.7	.8	.9	1.1
Std Value	81	50	10	37	40	44	47	47	50	54	57	64
University Library												
12 Raw Value	59	.2	1.1	-1.3	-.7	-.5	-.4	-.1	.3	.8	1.2	1.8
Std Value	59	50	10	36	42	44	44	47	51	55	59	64
Research Support												
13 Raw Value	71	.22	.14	.05	.09	.12	.15	.20	.22	.29	.33	.40
Std Value	71	50	10	38	41	43	45	49	50	55	58	63
14 Raw Value	70	7893	8769	1976	2450	3019	4063	5015	5430	8330	10517	18269
Std Value	70	50	10	43	44	44	46	47	47	50	53	62
Publication Records												
15 Raw Value	82	11	11	2	3	4	5	8	10	13	17	22
Std Value	82	50	10	42	43	43	44	47	49	51	55	59
16 Std Value	82	50	10	41	43	44	45	47	49	51	55	65

NOTE: Standardized values reported in the preceding table have been computed from exact values of the mean and standard deviation and not the rounded values reported here. Since the scale used to compute measure 16 is entirely arbitrary, only data in standardized form are reported for this measure.

TABLE 6.3 Intercorrelations Among Program Measures on 82 Programs in Mechanical Engineering

Measure	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Program Size																
01		.66	.64	`.12	.06	.09	.18	.65	.67	.34	.69	.35	.11	.60	.65	.59
02			.78	`.11	.17	`.01	.12	.67	.68	.17	.70	.32	.33	.58	.69	.52
03				`.14	.09	`.01	.01	.64	.67	.25	.67	.46	.33	.46	.56	.45
Program Graduates																
04					.20	.03	`.09	.08	.09	`.08	.07	.07	`.03	.04	`.05	.02
05						`.14	.29	.37	.33	`.05	.35	`.10	.23	.19	.21	.18
06							.30	.03	.03	.16	.08	.06	`.19	.03	.16	.10
07		.19	.20	.19	.29	.04	.02	.13	.21	.20						
Survey Results																
08		.97	.14	.95	.52	.52	.52	.70	.57							
09		.21	.92	.52	.50	.52	.71	.61								
10		.13	.12	.11	.07	.22	.24									
11		.51	.45	.61	.73	.60										
University Library																
12		.10	.20	.38	.36											
Research Support																
13		.16	.31	.19												
14		.49	.42													
Publication Records																
15		.88														
16																

NOTE: Since in computing correlation coefficients program data must be available for both of the measures being correlated, the actual number of programs on which each coefficient is based varies.

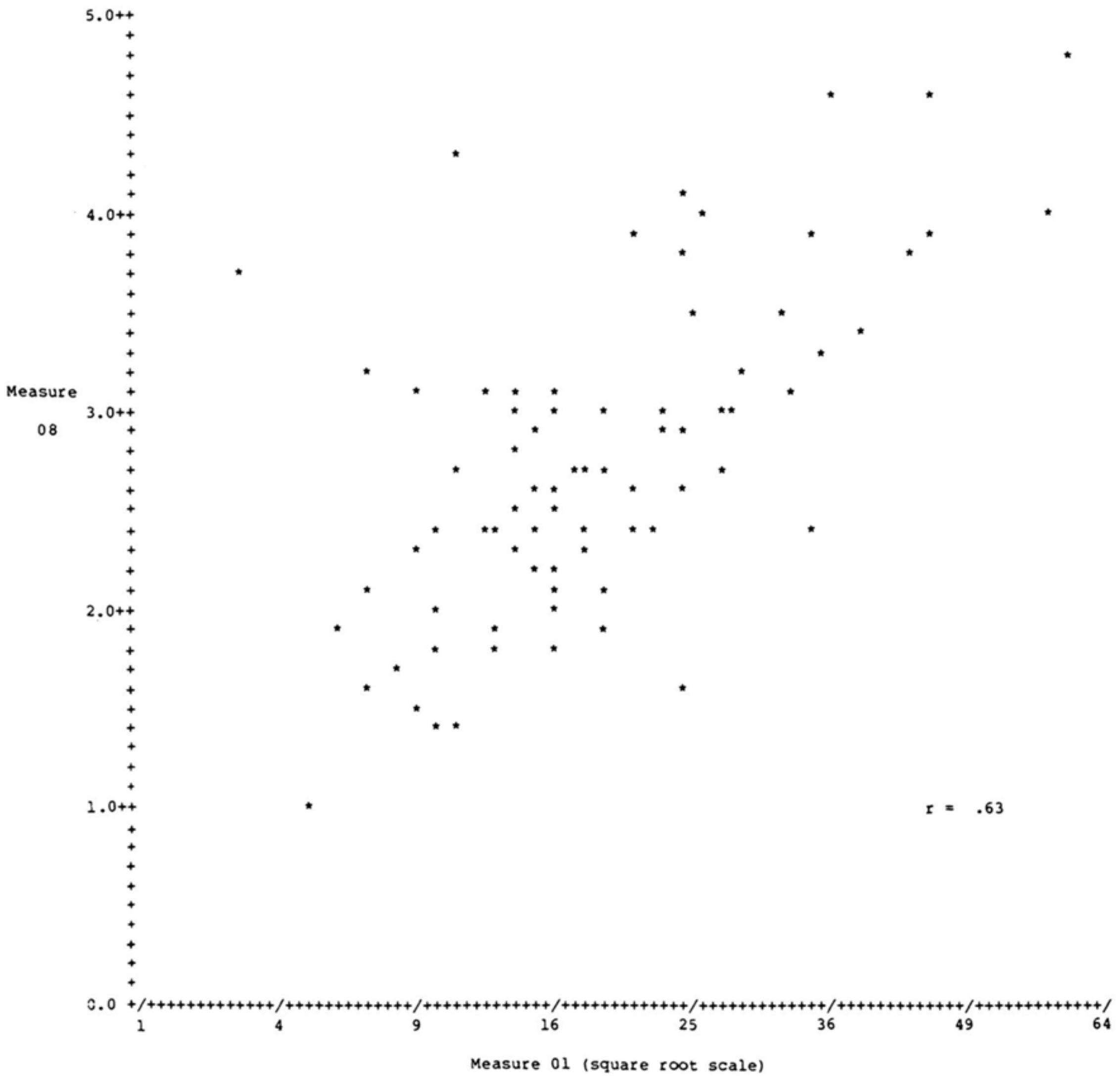

FIGURE 6.1 Mean rating of scholarly quality of faculty (measure 08) versus number of faculty members (measure 01)--81 programs in mechanical engineering.

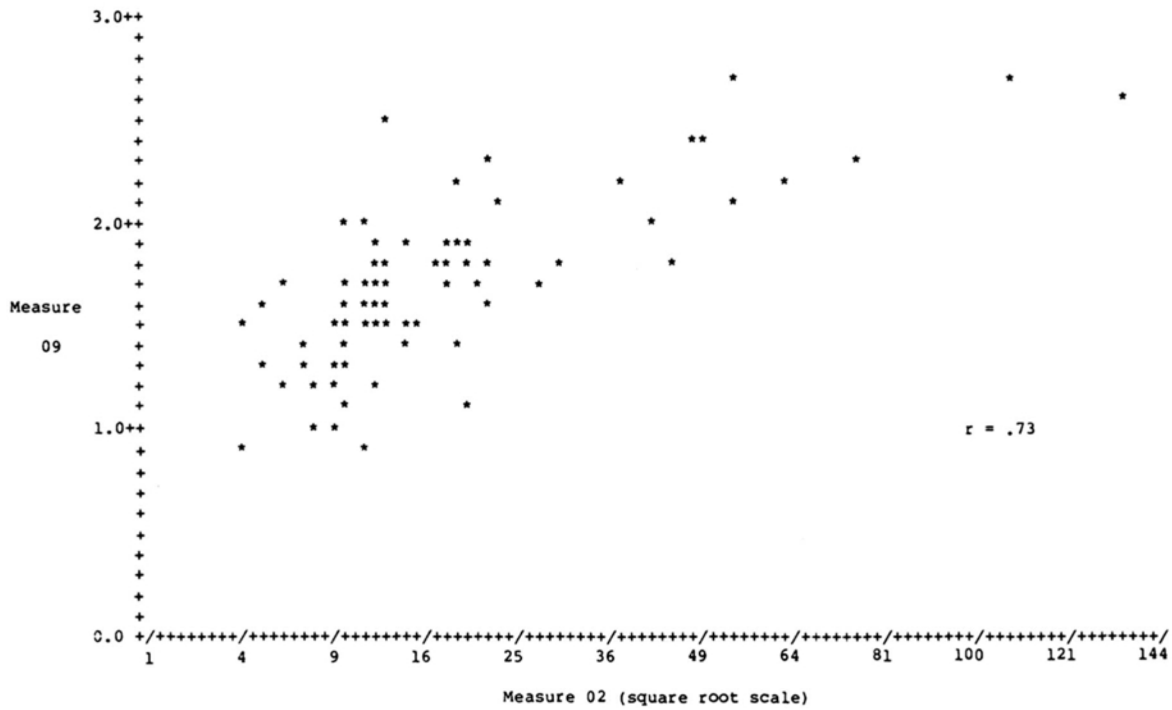

FIGURE 6.2 Mean rating of program effectiveness in educating research scholars/scientists (measure 09) versus number of graduates in last five years (measure 02)--81 programs in mechanical engineering.

TABLE 6.4 Characteristics of Survey Participants in Mechanical Engineering

	Respondents	
	N	%
Field of Specialization		
Engineering Mechanics	15	10
Mechanical Engineering	114	79
Other/Unknown	15	10
Faculty Rank		
Professor	99	69
Associate Professor	30	21
Assistant Professor	15	10
Year of Highest Degree		
Pre-1950	5	4
1950-59	24	17
1960-69	79	55
Post-1969	36	25
Evaluator Selection		
Nominated by Institution	132	92
Other	12	8
Survey Form		
With Faculty Names	127	88
Without Names	17	12
Total Evaluators	144	100

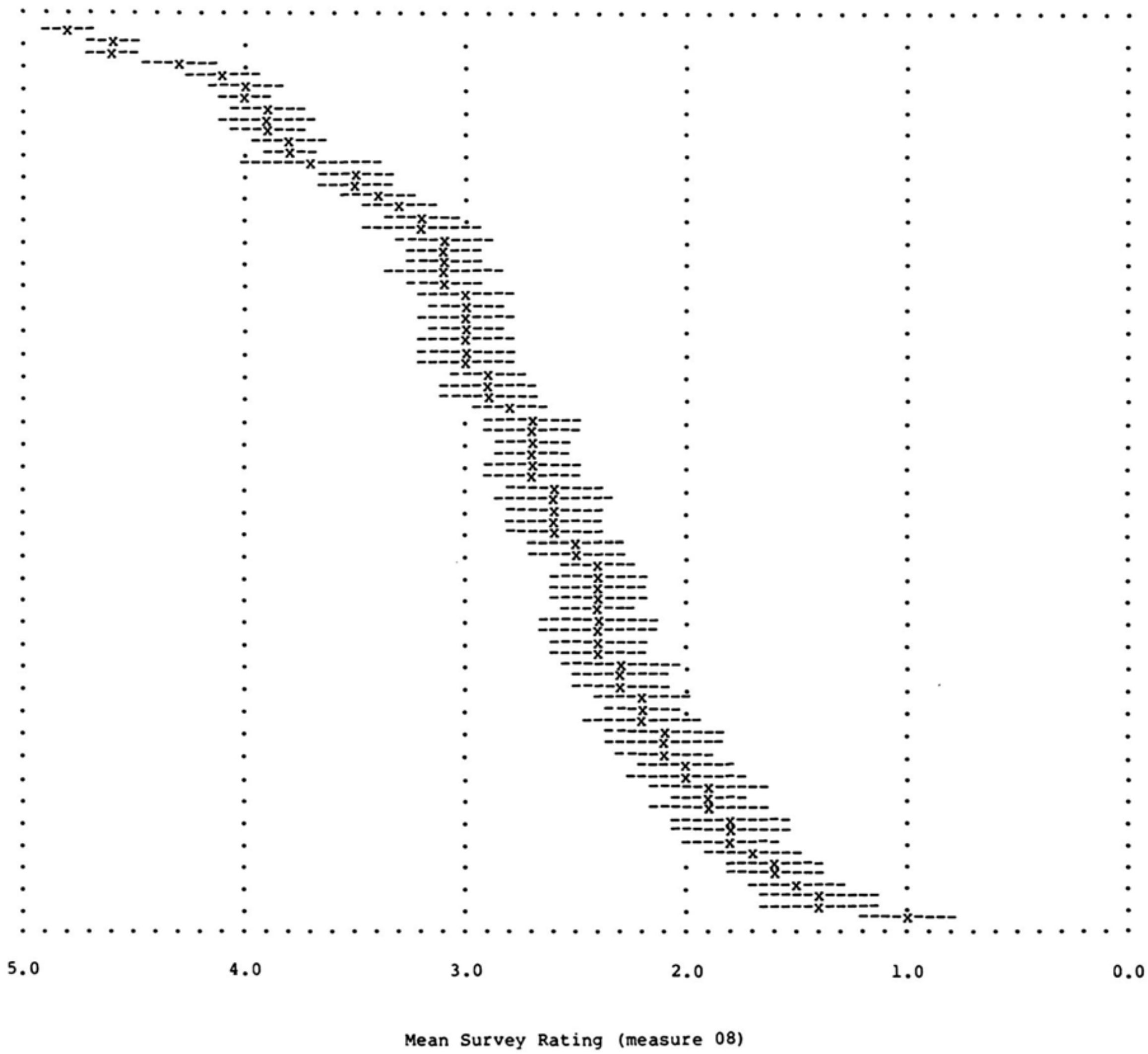

FIGURE 6.3 Mean rating of scholarly quality of faculty in 81 programs in mechanical engineering.
NOTE: Programs are listed in sequence of mean rating, with the highest-rated program appearing at the top of the page. The broken lines (---) indicate a confidence interval of ±1.5 standard errors around the reported mean (x) of each program.

VII

Summary and Discussion

In the four preceding chapters results are presented of the assessment of 326 research-doctorate programs in chemical engineering, civil engineering, electrical engineering, and mechanical engineering. Included in each chapter are summary data describing the means and intercorrelations of the program measures in a particular discipline. In this chapter a comparison is made of the summary data reported in the four disciplines. Also presented here are an analysis of the reliability (consistency) of the reputational survey ratings and an examination of some factors that might possibly have influenced the survey results. This chapter concludes with suggestions for improving studies of this kind--with particular attention given to the types of measures one would like to have available for an assessment of research-doctorate programs.

This chapter necessarily involves a detailed discussion of various statistics (means, standard deviations, correlation coefficients) describing the measures. Throughout, the reader should bear in mind that all these statistics and measures are necessarily imperfect attempts to describe the real quality of research-doctorate programs. Quality and some differences in quality are real, but these differences cannot be subsumed completely under any one quantitative measure. For example, no single numerical ranking--by measure 08 or by any weighted average of measures--can rank the quality of different programs with precision.

However, the evidence for reliability indicates considerable stability in the assessment of quality. For instance, a program that comes out in the first decile of a ranking is quite unlikely to "really" belong in the third decile, or vice versa. If numerical ranks of programs were replaced by groupings (distinguished, strong, etc.), these groupings again would not fully capture actual differences in quality since there would likely be substantial ambiguity about the borderline between adjacent groups. Furthermore, any attempt at linear ordering (best, next best, . . .) may also be inaccurate. Programs of roughly comparable quality may be better in different ways, so that there simply is no one best--as will also be indicated in some of the numerical analyses. However, these difficulties of formulating ranks should not hide the underlying reality of differences in quality or the importance of high quality for effective doctoral education.

SUMMARY OF THE RESULTS

Displayed in Table 7.1 are the numbers of programs evaluated (bottom line) and the mean values for each measure in the four engineering disciplines.[1] As can be seen, the mean values reported for individual measures vary considerably among disciplines. The pattern of means on each measure is summarized below, but the reader interested in a detailed comparison of the distribution of a measure may wish to refer to the second table in each of the four preceding chapters.[2]

Program Size (Measures 01-03). Based on the information provided to the committee by the study coordinator at each university, electrical engineering programs had, on the average, the largest number of faculty members (23 in December 1980), followed by civil (20) and mechanical engineering (20). Electrical engineering programs also graduated the most students (32 Ph.D. recipients in the FY1975-79 period) and had the largest enrollment (49 doctoral students in December 1980). In contrast, chemical engineering programs were reported to have an average of only 12 faculty members, 18 graduates, and 24 doctoral students.

Program Graduates (Measures 04-07). The mean fraction of FY1975-79 doctoral recipients who as graduate students had received some national fellowship or training grant support (measure 04) ranges from .13 for graduates of civil engineering programs to .25 for graduates in chemical engineering. With respect to the median number of years from first enrollment in a graduate program to receipt of the doctorate (measure 05), chemical engineering graduates typically earned their degrees almost a full year sooner than graduates in any other discipline. In terms of employment status at graduation (measure 06), an average of 78 percent of the Ph.D. recipients from chemical engineering programs reported that they had made firm job commitments by the time they had completed requirements for their degree, contrasted with 69-71 percent of the program graduates in the other engineering disciplines. A mean of only 15-19 percent of the graduates in the four engineering disciplines reported that they had made firm commitments to take positions in Ph.D.-granting institutions (measure 07). This low percentage (compared with the humanities and many of the science disciplines) reflects the availability of employment opportunities for engineers outside the academic sector.

Survey Results (Measures 08-11). Differences in the mean ratings derived from the reputational survey are small. In all four disciplines the mean rating of scholarly quality of program faculty (measure 08)

[1] Means for measure 16, “influence” of publication, are omitted since arbitrary scaling of this measure prevents meaningful comparisons across disciplines.

[2] The second table in each of the four preceding chapters presents the standard deviation and decile values for each measure.

TABLE 7.1 Mean Values for Each Program Measure, by Discipline

	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
Program Size				
01	12	20	23	20
02	18	22	32	21
03	24	35	49	29
Program Graduates				
04	.25	.13	.19	.21
05	5.9	6.9	6.7	7.0
06	.78	.69	.70	.71
07	.15	.19	.17	.17
Survey Results				
08	2.7	2.7	2.6	2.7
09	1.6	1.6	1.6	1.7
10	1.1	1.0	1.1	1.0
11	.9	.7	.7	.7
University Library				
12	.2	.2	.2	.2
Research Support				
13	.37	.20	.27	.22
14	7819	7998	7679	7893
Publication Records				
15	10	12	22	11
Total Programs	79	74	91	82

is slightly below 3.0 ("good"), and programs were judged to be, on the average, a bit below "moderately" effective (2.0) in educating research scholars/scientists (measure 09). In the opinions of the survey respondents, there has been "little or no change" (approximately 1.0 on measure 10) in the last five years in the overall average quality of programs. The mean rating of an evaluator's familiarity with the work of program faculty (measure 11) is below 1.0 ("some familiarity") in every discipline--about which more will be said later in this chapter.

University Library (Measure 12). Measure 12, based on a composite index of the size[3] of the library at the university in which a program resides, is calculated on a scale from `2.0 to 3.0, with a mean of .2 in each of the four engineering disciplines. In considering this measure it must be remembered that the index reflects the overall size of the university library and that data are unavailable for some of the smaller universities.

Research Support (Measures 13-14). Measure 13, the proportion of program faculty who had received NSF, NIH, or ADAMHA[4] research grant awards during the FY1978-80 period, has mean values ranging from as high as .37 in chemical engineering to .20 in civil engineering. It should be emphasized that this measure does not take into account research support that faculty members have received from sources other than these three federal agencies. As mentioned in Chapter II, a significant fraction of the engineering faculty receive support from DOD, NASA, DOE, and other federal agencies. In terms of total university expenditures for R&D in engineering (measure 14), the mean value reported in each discipline is slightly less than $8,000,000. It should be emphasized that these figures represent university expenditures in engineering in toto and that data are not available on expenditures in individual engineering disciplines. Thus, the small differences reported here reflect variations in the sets of universities covered in the assessment in the four disciplines.

Publication Records (Measures 15 and 16). Some diversity is found in the mean number of articles associated with a research-doctorate program (measure 15). An average of 22 articles published in the 1978-79 period is reported for programs in electrical engineering; in each of the other three disciplines the mean number of articles ranges from .10 to .12. This difference reflects both the program size in a

[3]The index, derived by the Association of Research Libraries, reflects a number of different measures, including number of volumes, fiscal expenditures, and other factors relevant to the size of a university library. See the description of this measure presented in Appendix D.

[4]Very few faculty members in engineering programs received any research support from the Alcohol, Drug Abuse, and Mental Health Administration.

particular discipline (i.e., the total number of faculty and other staff members involved in research) and the frequency with which engineers in that discipline publish; it may also depend on the length of a typical paper in a discipline. Mean scores are not reported on measure 16, the estimated "overall influence" of the articles attributed to a program. Since this measure is calculated from an average of journal influence weights,[5] normalized for the journals covered in a particular discipline, mean differences among disciplines are uninterpretable.

CORRELATIONS AMONG MEASURES

Relations among the program measures are of intrinsic interest and are relevant to the issue of validity of the measures as indices of the quality of a research-doctorate program. Measures that are logically related to program quality are expected to be related to each other. To the extent that they are, a stronger case might be made for the validity of each as a quality measure.

A reasonable index of the relationship between any two measures is the Pearson product-moment correlation coefficient. A table of correlation coefficients of all possible pairs of measures is presented in each of the four preceding chapters. This chapter presents selected correlations to determine the extent to which coefficients are comparable in the four disciplines. Special attention is given to the correlations involving the number of FY1975-79 program graduates (measure 02), survey rating of the scholarly quality of program faculty (measure 08), university R&D expenditures in a particular discipline (measure 14), and influence-weighted number of publications (measure 16). These four measures have been selected because of their relatively high correlations with several other measures. Readers interested in correlations other than those presented in Table 7.2, Table 7.3, Table 7.4, and Table 7.5 may refer to the third table in each of the preceding four chapters.

Correlations with Measure 02. Table 7.2 presents the correlations of measure 02 with each of the other measures used in the assessment. As might be expected, correlations of this measure with the other two measures of program size--number of faculty (01) and doctoral student enrollment (03)--are quite high in all four disciplines. Of greater interest are the strong positive correlations between measure 02 and measures derived from either reputational survey ratings or publication records. The coefficients describing the relationship of measure 02 with measures 15 and 16 are greater than .60 in all disciplines except mechanical engineering. This result is not surprising, of course, since both of the publication measures reflect total productivity and have not been adjusted for program size. The correlations of measure 02 with measures 08, 09, and 11 are equally as strong. It is quite

[5]See Appendix F for a description of the derivation of this measure.

TABLE 7.2 Correlations of the Number of Program Graduates (Measure 02) with Other Measures, by Discipline

	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
Program Size				
01	.53	.83	.78	.66
03	.82	.71	.82	.78
Program Graduates				
04	.00	.01	`.09	`.11
05	.32	.16	.18	.17
06	.22	`.11	.10	`.01
07	.14	.05	.06	.12
Survey Results				
08	.83	.72	.76	.67
09	.83	.73	.75	.68
10	.07	.18	.11	.17
11	.79	.75	.81	.70
University Library				
12	.40	.39	.47	.32
Research Support				
13	.45	.39	.39	.33
14	.42	.51	.58	.58
Publication Records				
15	.66	.73	.84	.69
16	.69	.65	.85	.52

apparent that the programs that received high survey ratings and with which evaluators were more likely to be familiar were also ones that had larger numbers of graduates. Although the committee gave serious consideration to presenting an alternative set of survey measures that were adjusted for program size, a satisfactory algorithm for making such an adjustment was not found. In attempting such an adjustment on the basis of the regression of survey ratings on measures of program size, it was found that some exceptionally large programs appeared to be unfairly penalized and that some very small programs received unjustifiably high adjusted scores.

Measure 02 also has positive correlations with measure 12, an index of university library size, and with measures 13 and 14, which pertain to the level of support for research in a program. Of particular note are the moderately large coefficients for measure 14, university R&D expenditures in engineering--in all disciplines but chemical engineering they are above .50. The correlations of measure 02 with measures 04, 05, 06, and 07 are below .20 in all disciplines except chemical engineering.

Correlations with Measure 08. Table 7.3 shows the correlation coefficients for measure 08, the mean rating of the scholarly quality of program faculty, with each of the other variables. The correlations of measure 08 with measures of program size (01, 02, and 03) are .50 or greater for all four disciplines. Not surprisingly, the larger the program, the more likely its faculty is to be rated high in quality.

Correlations of measure 08 with measure 04, the fraction of students with national fellowship awards, are .20 or smaller in each of the engineering disciplines. For programs in the biological and social sciences, the corresponding coefficients (to be presented in subsequent volumes of the committee's report) are found to be greater, typically in the range .40 to .70. Perhaps in engineering, departments with highly regarded faculty are more likely to provide support to doctoral students as teaching assistants or research assistants on faculty research grants--thereby reducing dependency on national fellowships. (The low correlation of rated faculty quality with the fraction of students with national fellowships is not, of course, inconsistent with the thesis that programs with large numbers of students are programs with large numbers of fellowship holders.)

Correlations of rated faculty quality with measure 05, shortness of time from matriculation in graduate school to award of the doctorate, are notably higher for programs in chemical and mechanical engineering than for programs in the other two disciplines. Although the coefficients are by no means as large as many of those discussed above, it is evident that programs producing graduates in shorter periods of time tended to receive higher survey ratings.

Correlations of ratings of faculty quality with measure 06, the fraction of program graduates with definite employment plans, and with measure 07, the fraction with plans for employment in Ph.D.-granting institutions, are positive, but quite low for each of the engineering disciplines.

TABLE 7.3 Correlations of the Survey Ratings of Scholarly Quality of Program Faculty (Measure 08) with Other Measures, by Discipline

	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
Program Size				
01	.51	.73	.73	.65
02	.83	.72	.76	.67
03	.77	.57	.68	.64
Program Graduates				
04	.20	.18	`.03	.08
05	.43	.25	.21	.37
06	.27	.05	.13	.03
07	.25	.21	.12	.19
Survey Results				
09	.99	.98	.98	.97
10	.31	.35	.23	.14
11	.96	.94	.94	.95
University Library				
12	.41	.54	.56	.52
Research Support				
13	.62	.62	.56	.52
14	.42	.57	.59	.52
Publication Records				
15	.65	.62	.78	.70
16	.65	.57	.80	.57

The correlations of measure 08 with measure 09, rated effectiveness of doctoral education, are uniformly very high, at or above .97 in every discipline. This finding is consistent with results from the Cartter and Roose-Andersen studies.[6] The coefficients describing the relationship between measure 08 and measure 11, familiarity with the work of program faculty, are also very high, ranging from .94 to .96. In general, evaluators were more likely to have high regard for the quality of faculty in those programs with which they were most familiar. That the correlation coefficients are as large as observed may simply reflect the fact that “known” programs tend to be those that have earned strong reputations.

Correlations of ratings of faculty quality with measure 10, ratings of perceived improvement in program quality, range from .14 in mechanical engineering to .35 in civil engineering. One might have expected that a program judged to have improved in quality would have been somewhat more likely to receive high ratings on measure 08 than would a program judged to have declined--thereby imposing a small positive correlation between these two variables.

Moderate to high correlations are observed in all four disciplines between measure 08 and university library size (measure 12), support for research (measures 13 and 14), and publication records (measures 15 and 16). With few exceptions these coefficients are .50 or greater. Of particular note are the strong correlations with the two publication measures for electrical engineering programs. It is interesting to note that the correlations with measure 16 are generally no higher than those with measure 15--i.e., the “weighted influence” of journals in which articles are published yields an index that tends to relate no more closely to faculty reputation than does an unadjusted count of the number of articles published. This finding is inconsistent with the findings of Anderson et al.[7] and with the committee's findings in the mathematical and physical sciences.

Correlations with Measure 14. Correlations of measure 14, reported dollars of support for research and development, with other measures are shown in Table 7.4. The reader is reminded that this measure reflects total university expenditures in engineering and not expenditures in the four separate engineering disciplines. The pattern of relations is quite similar for programs in all four engineering disciplines: moderately high correlations with measures of program size and reputational survey results (except measure 10), and slightly lower correlations with publication measures. For programs in electrical engineering some of these relations are stronger than in the other engineering disciplines. Of particular note is strong correlation in electrical engineering between measure 14 and each of the publication measures (15 and 16). In interpreting these relationships one must keep in mind the fact that the research expenditure data have not been

[6] Roose and Andersen, p. 19.

[7] Anderson et al., p. 95.

TABLE 7.4 Correlations of the University Research Expenditures in a Discipline (Measure 14) with Other Measures, by Discipline

	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
Program Size				
01	.48	.56	.63	.60
02	.42	.51	.58	.58
03	.50	.38	.62	.46
Program Graduates				
04	`.02	.16	.20	.04
05	.00	`.02	.12	.19
06	.07	`.02	.08	.03
07	.02	.21	.30	.13
Survey Results				
08	.42	.57	.59	.52
09	.41	.55	.57	.52
10	.18	.04	.09	.07
11	.41	.58	.62	.61
University Library				
12	.21	.26	.21	.20
Research Support				
13	.09	.29	.21	.16
Publication Records				
15	.39	.44	.61	.49
16	.35	.36	.65	.42

adjusted for the number of faculty and other staff members involved in research in a program.

Correlations with Measure 16. Measure 16 is the number of published articles attributed to a program and adjusted for the "average influence" of the journals in which the articles appear. The correlations of this measure with all others appear in Table 7.5. Of particular interest are the moderately high correlations with all three measures of program size and with the reputational survey results (excluding measure 10). Most of those coefficients exceed .60 and are generally somewhat larger for programs in electrical engineering. In this discipline moderately high correlations are also observed between measure 16 and measures 12, 13, and 14. It should be pointed out that the exceptionally large coefficients reported for measure 15 result from the fact that the two publication measures are logically as well as empirically interdependent.

Despite the appreciable correlations between reputational ratings of quality and program size measures, the functional relations between the two probably are complex. If there is a minimum size for a high-quality program, this size is likely to vary from discipline to discipline. Increases in size beyond the minimum may represent more high-quality faculty, or a greater proportion of inactive faculty, or a faculty with heavy teaching responsibilities. In attempting to select among these alternative interpretations, a single correlation coefficient provides insufficient guidance. Nonetheless, certain similarities across disciplines may be seen in correlations among the measures. High correlations consistently appear among measures 08, 09, and 11 from the reputational survey, and these measures also are prominently related to program size (measures 01, 02, and 03), to publication productivity (measures 15 and 16), to R&D expenditures (measure 14), and to library size (measure 12). These results show that for all disciplines the reputational rating measures (08, 09, and 11) tend to be associated with program size and with other correlates of size: publication volume, R&D expenditures, and library size. Also, the reputational measures 08, 09, and 11 tend to be positively related to shortness of time-to-Ph.D. (measure 05) and to the fraction of faculty holding research grants (measure 13).

ANALYSIS OF THE SURVEY RESPONSE

Measures 08-11, derived from the reputational survey, may be of particular interest to many readers since measures of this type have been the most widely used (and frequently criticized) indices of quality of graduate education. In designing the survey instrument for this assessment the committee made several changes in the form that had been used in the Roose-Andersen study. The modifications served two purposes: to provide the evaluators with a clearer understanding of the programs that they were asked to judge and to provide the committee with supplemental information for the analysis of the survey response. One change was to restrict to 50 the number of programs that any

TABLE 7.5 Correlations of the Influence-Weighted Number of Publications (Measure 16) with Other Measures, by Discipline

	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
Program Size				
01	.46	.69	.83	.59
02	.69	.65	.85	.52
03	.65	.52	.81	.45
Program Graduates				
04	.07	.17	.01	.02
05	.30	`.05	.10	.18
06	.23	.10	.19	.10
07	.14	.05	.14	.20
Survey Results				
08	.65	.57	.80	.57
09	.63	.57	.78	.61
10	.34	.35	.17	.24
11	.68	.58	.84	.60
University Library				
12	.12	.32	.51	.36
Research Support				
13	.35	.26	.52	.19
14	.35	.36	.65	.42
Publication Records				
15	.96	.95	.98	.88

individual was asked to evaluate. Probably the most important change was the inclusion of lists of names and ranks of individual faculty members involved in the research-doctorate programs to be evaluated on the survey form, together with the number of doctoral degrees awarded in the previous five years. Ninety percent of the evaluators were sent forms with faculty names and numbers of degrees awarded; the remaining 10 percent were given forms without this information, so that an analysis could be made of the effect of this modification on survey results. Another change was the addition of a question concerning an evaluator's familiarity with each of the programs. In addition to providing an index of program recognition (measure 11), the inclusion of this question permits a comparison between the ratings furnished by individuals who had considerable familiarity with a particular program and the ratings by those not as familiar with the program. Each evaluator was also asked to identify his or her own institution of highest degree and current field of specialization. This information enables us to compare, for each program, the ratings furnished by alumni of that institution with the ratings by other evaluators, as well as to examine differences in the ratings supplied by evaluators in certain specialty fields.

Before examining factors that may have influenced the survey results, some mention should be made of the distributions of responses to the four survey items and the reliability (consistency) of the ratings. As can be seen from Table 7.6, the response distribution for each survey item does not vary greatly from discipline to discipline. For example, in judging the scholarly quality of faculty (measure 08), survey respondents in each discipline rated between 5 and 8 percent of the programs as being “distinguished” and between 1 and 2 percent as “not sufficient for doctoral education.” In evaluating the effectiveness in educating research scholars, they rated 6-9 percent of the programs as being “extremely effective” and approximately 2-4 percent as “not effective.” Of particular interest in this table are the frequencies with which evaluators failed to provide responses to measures 08, 09, and 10. Approximately one-third of the total number of evaluations requested for measure 08 were not furnished because survey respondents in engineering felt that they were not familiar enough with a particular program to evaluate it. The corresponding percentages of “don't know” responses for measures 09 and 10 are considerably larger--42 and 52 percent, respectively--suggesting that survey respondents found it more difficult (or were less willing) to judge program effectiveness and change than to judge the scholarly quality of program faculty.

The large fractions of “don't know” responses are a matter of some concern. However, given the broad coverage of research-doctorate programs, it is not surprising that faculty members would be unfamiliar with many of the less distinguished programs. As shown in Table 7.7, survey respondents in each discipline were much more likely to furnish evaluations for programs with high reputational standing than they were for programs of lesser distinction. For example, for engineering programs that received mean ratings of 4.0 or higher on measure 08, almost 95 percent of the evaluations requested on measure 08 were

TABLE 7.6 Distribution of Responses to Each Survey Item, by Discipline

	Survey Measure	Total	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
08	SCHOLARLY QUALITY OF PROGRAM FACULTY					
	Distinguished	6.5	7.8	6.5	5.4	5.9
	Strong	14.0	14.5	13.8	13.4	14.3
	Good	20.5	24.0	19.2	19.2	19.1
	Adequate	16.7	20.5	14.5	15.3	15.6
	Marginal	7.3	8.6	6.8	7.6	5.8
	Not Sufficient for Doctoral Education	1.8	1.9	2.2	1.8	1.4
	Don't Know Well Enough to Evaluate	33.3	22.6	37.1	37.4	38.0
	TOTAL	100.0	100.0	100.0	100.0	100.0
09	EFFECTIVENESS OF PROGRAM IN EDUCATING SCIENTISTS					
	Extremely Effective	7.1	8.6	7.0	5.9	6.6
	Reasonably Effective	31.6	34.3	28.8	30.0	32.6
	Minimally Effective	16.9	20.4	16.6	15.9	14.1
	Not Effective	2.8	3.8	3.3	2.4	1.7
	Don't Know Well Enough to Evaluate	41.6	32.8	44.3	45.8	45.0
	TOTAL	100.0	100.0	100.0	100.0	100.0
10	CHANGE IN PROGRAM QUALITY IN LAST FIVE YEARS					
	Better	10.6	15.2	8.8	9.3	8.0
	Little or No Change	30.3	36.5	26.5	28.1	28.7
	Poorer	7.4	9.0	7.2	6.7	6.4
	Don't Know Well Enough to Evaluate	51.8	39.2	57.5	55.8	57.0
	TOTAL	100.0	100.0	100.0	100.0	100.0
11	FAMILIARITY WITH WORK OF PROGRAM FACULTY					
	Considerable	16.8	22.8	16.3	14.4	12.9
	Some	42.0	44.7	40.6	40.4	41.7
	Little or None	39.6	31.1	41.5	43.1	44.3
	No Response	1.6	1.5	1.6	2.1	1.1
	TOTAL	100.0	100.0	100.0	100.0	100.0

NOTE: For survey measures 08, 09, 10 the “don't know” category includes a small number of cases for which the respondents provided no response to the survey item.

TABLE 7.7 Survey Item Response Rates, by Discipline and Mean Rating on Measure 08

	Survey Measure	Total	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
08	SCHOLARLY QUALITY OF PROGRAM FACULTY					
	Mean Rating on Measure 08					
	4.0 or Higher	94.5	98.5	91.7	96.3	89.3
	3.0 - 3.9	80.9	92.1	78.0	77.7	76.6
	2.0 - 2.9	62.9	76.2	59.3	57.9	57.4
	Less than 2.0	49.0	59.3	43.8	45.0	42.1
09	EFFECTIVENESS OF PROGRAM IN EDUCATING SCIENTISTS					
	Mean Rating on Measure 08					
	4.0 or Higher	90.4	94.3	88.4	91.4	85.1
	3.0 - 3.9	72.8	83.5	71.7	67.9	69.2
	2.0 - 2.9	53.5	64.0	50.3	49.3	49.7
	Less than 2.0	41.1	48.7	37.9	37.6	36.4
10	CHANGE IN PROGRAM QUALITY IN LAST FIVE YEARS					
	Mean Rating on Measure 08					
	4.0 or Higher	80.2	90.8	75.7	76.2	70.2
	3.0 - 3.9	61.0	77.8	55.4	55.7	55.7
	2.0 - 2.9	43.9	58.2	37.3	40.7	38.6
	Less than 2.0	31.4	39.4	27.3	29.0	24.9

provided; 90 and 80 percent, respectively, were provided on measures 09 and 10. In contrast, the corresponding response rates for programs with mean ratings below 2.0 are much lower--49, 41, and 31 percent response on measures 08, 09, and 10, respectively.

Of great importance to the interpretation of the survey results is the reliability of the response. How much confidence can one have in the mean rating reported for a particular program? In the first table in each of the preceding four chapters, estimated standard errors associated with the mean ratings of every program are presented for all four survey items (measures 08-11). While there is some variation in the magnitude of the standard errors reported in every discipline, they rarely exceed .20 for any of the four measures and typically range from .05 to .10. For programs with higher mean ratings the estimated errors associated with these means are generally smaller--a finding consistent with the fact that survey respondents were more likely to furnish evaluations for programs with high reputational standing. The “split-half” correlations[8] presented in Table 7.8 give an indication of the overall reliability of the survey results in each discipline and for each measure. In the derivation of these correlations individual ratings of each program were randomly divided into two groups (A and B), and a separate mean rating was computed for each group. The last column in Table 7.8 reports the correlations between the mean program ratings of the two groups and is not corrected for the fact that the mean ratings of each group are based on only half rather than a full set of the responses.[9] As the reader will note, the coefficients reported for measure 08, the scholarly quality of program faculty, are in the range of .95 to .98--indicating a high degree of consistency in evaluators' judgments. The correlations reported for measures 09 and 11, the rated effectiveness of a program and the evaluators' familiarity with a program, are somewhat lower but still at a level of .90 or higher in each discipline. Not surprisingly, the reliability coefficients for ratings of change in program quality in the last five years (measure 10) are considerably lower, ranging from .66 to .88 in the four engineering disciplines. While these coefficients represent tolerable reliability, it is quite evident that the responses to measure 10 are not as reliable as the responses to the other three items.

Further evidence of the reliability of the survey responses is presented in Table 7.9. As mentioned in Chapter VI of the first volume (mathematical and physical sciences) of the committee's reports, 11

[8]For a discussion of the interpretation of “split-half” coefficients, see Robert L. Thorndike and Elizabeth Hagan, Measurement and Evaluation in Psychology and Education, John Wiley & Sons, New York, 1969, pp. 182-185.
[9]To compensate for the smaller sample size the “split-half” coefficient may be adjusted using the Spearman-Brown formula: $r' = 2r/(1 + r)$. This adjustment would have the effect of increasing a correlation of .70, for example, to .82, a correlation of .80 to .89, a correlation of .90 to .95, and a correlation of .95 to .97.

TABLE 7.8 Correlations Between Two Sets of Average Ratings from Two Randomly Selected Groups of Evaluators in Engineering

	MEASURE 08: SCHOLARLY QUALITY OF PROGRAM FACULTY					
Discipline	Mean Rating		Std. Deviation		Correlation	
	Group A	Group B	Group A	Group B	N	r
Chemical Engin.	2.65	2.68	.95	.96	79	.98
Civil Engin.	2.67	2.67	.85	.88	74	.95
Electrical Engin.	2.62	2.59	.86	.89	90	.95
Mechanical Engin.	2.75	2.73	.79	.80	81	.96
	MEASURE 09: EFFECTIVENESS OF PROGRAM IN EDUCATING SCHOLARS					
Discipline	Mean Rating		Std. Deviation		Correlation	
	Group A	Group B	Group A	Group B	N	r
Chemical Engin.	1.59	1.60	.54	.53	79	.97
Civil Engin.	1.58	1.56	.48	.49	74	.90
Electrical Engin.	1.60	1.60	.46	.47	90	.92
Mechanical Engin.	1.70	1.71	.41	.40	81	.94
	MEASURE 10: IMPROVEMENT IN PROGRAM IN LAST FIVE YEARS					
Discipline	Mean Rating		Std. Deviation		Correlation	
	Group A	Group B	Group A	Group B	N	r
Chemical Engin.	1.07	1.09	.27	.27	79	.88
Civil Engin.	1.00	1.01	.25	.24	74	.69
Electrical Engin.	1.06	1.04	.25	.24	90	.66
Mechanical Engin.	1.03	1.03	.22	.22	81	.74
	MEASURE 11: FAMILIARITY WITH WORK OF PROGRAM FACULTY					
Discipline	Mean Rating		Std. Deviation		Correlation	
	Group A	Group B	Group A	Group B	N	r
Chemical Engin.	.92	.92	.40	.41	79	.97
Civil Engin.	.73	.75	.35	.35	74	.94
Electrical Engin.	.70	.72	.36	.35	90	.93
Mechanical Engin.	.68	.69	.30	.31	81	.90

TABLE 7.9 Comparison of Mean Ratings for 11 Mathematics Programs Included in Two Separate Survey Administrations

	Survey Measure	All Evaluators				Evaluators Rating the Same Program in Both Surveys			
		First		Second		First		Second	
		N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$
Program A	08	100	4.9	114	4.9	50	4.9	50	4.9
	09	90	2.7	100	2.8	42	2.7	43	2.7
	10	74	1.2	83	1.2	38	1.1	34	1.2
	11	100	1.6	115	1.6	50	1.5	50	1.6
Program B	08	94	4.6	115	4.6	48	4.6	50	4.5
	09	81	2.6	91	2.5	40	2.6	39	2.5
	10	69	1.0	82	1.0	37	1.0	36	0.9
	11	98	1.4	116	1.4	50	1.5	50	1.5
Program C	08	86	3.4	103	3.6	42	3.4	44	3.5
	09	56	2.0	66	2.1	28	2.1	29	2.0
	10	55	1.1	62	1.3	30	1.2	27	1.4
	11	99	1.0	116	1.1	50	1.1	50	1.0
Program D	08	74	3.0	93	3.0	37	2.8	38	2.9
	09	50	1.8	48	1.6	27	1.7	16	1.6
	10	46	1.4	52	1.5	24	1.4	23	1.5
	11	90	1.0	113	0.9	46	1.0	46	0.9
Program E	08	69	3.0	95	3.1	39	3.0	46	3.1
	09	40	1.8	60	1.9	25	1.8	30	1.8
	10	36	0.8	58	0.9	24	0.8	29	0.9
	11	96	0.8	115	0.9	52	0.9	52	1.0
Program F	08	63	2.9	90	3.0	26	3.0	32	3.1
	09	35	1.8	46	1.7	10	1.6	13	1.8
	10	32	1.1	43	1.1	11	1.3	12	1.2
	11	95	0.7	115	0.8	43	0.7	44	0.7
Program G	08	69	2.7	92	2.8	39	2.7	39	3.0
	09	35	1.7	45	1.6	17	1.7	19	1.7
	10	36	1.1	43	1.2	17	1.1	19	1.2
	11	85	0.9	116	0.8	46	0.9	46	0.9
Program H	08	58	2.2	73	2.5	36	2.2	37	2.4
	09	32	1.3	43	1.3	22	1.2	19	1.3
	10	30	1.5	39	1.5	20	1.7	17	1.4
	11	90	0.7	116	0.6	51	0.7	52	0.6
Program I	08	55	2.0	74	1.9	30	1.9	30	2.0
	09	33	1.0	41	0.9	19	1.0	18	0.8
	10	27	1.2	31	1.1	15	1.1	13	1.2
	11	99	0.5	115	0.5	50	0.5	50	0.5
Program J	08	51	1.5	67	1.5	26	1.4	28	1.4
	09	31	0.8	36	0.7	14	0.6	14	0.7
	10	26	1.2	23	1.1	14	1.2	12	1.3
	11	96	0.5	113	0.3	49	0.4	48	0.4
Program K	08	33	1.2	48	1.2	17	1.1	21	1.4
	09	19	0.8	21	0.5	11	0.6	8	0.4
	10	12	0.8	15	0.9	5	1.0	5	0.8
	11	99	0.2	114	0.2	48	0.2	47	0.2

mathematics programs,[10] selected at random, were included on a second form sent to 178 survey respondents in this discipline, and 116 individuals (65 percent) furnished responses to the second survey. A comparison of the overall results of the two survey administrations (columns 2 and 4 in Table 7.9) demonstrates the consistency of the ratings provided for each of the 11 programs. The average, absolute observed difference in the two sets of mean ratings is less than 0.1 for each measure. Columns 6 and 8 of Table 7.9 report the results based on the responses of only those evaluators who had been asked to consider a particular program in both administrations of the survey. (For a given program approximately 40-45 percent of the 116 respondents to the second survey had been asked to evaluate that program in the prior survey.) It is not surprising to find comparable small differences in the mean ratings provided by this subgroup of evaluators.

Critics of past reputational studies have expressed concern about the credibility of reputational assessments when evaluators provide judgments of programs about which they may know very little. As already mentioned, survey participants in this study were offered the explicit alternative, "Don't know well enough to evaluate." This response option was quite liberally used for measures 08, 09, and 10, as is shown in Table 7.6. In addition, evaluators were asked to indicate their degree of familiarity with each program. Respondents reported "considerable" familiarity with an average of only one program in every six. While this finding supports the conjecture that many program ratings are based on limited information, the availability of reported familiarity permits us to analyze how ratings vary as a function of familiarity.

This issue can be addressed in more than one way. It is evident from the data reported in Table 7.10 that mean ratings of the scholarly quality of program faculty tend to be higher if the evaluator has considerable familiarity with the program. There is nothing surprising or, for that matter, disconcerting about such an association. When a particular program fails to provoke more than vague images in the evaluator's mind, he or she is likely to take this as some indication that the program is not an extremely lustrous one on the national scene. While visibility and quality are scarcely the same, the world of research in higher education is structured to encourage high quality to achieve high visibility, so that any association of the two is far from spurious.

From the data presented in Table 7.10 it is evident that if mean ratings were computed on the basis of the responses of only those most familiar with programs, the values reported for individual programs would be increased. A largely independent question is whether a restriction of this kind would substantially change our sense of the relative standings of programs on this measure. Quite naturally, the answer depends in some degree on the nature of the restriction imposed.

[10] Mathematics is the only discipline in which results were obtained from two separate administrations of the survey.

TABLE 7.10 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Familiarity with Work of Faculty

	MEAN RATINGS		CORRELATION	
	Considerable	Some/Little	r	N
Chemical Engin.	2.91	2.58	.93	79
Civil Engin.	2.93	2.56	.87	74
Electrical Engin.	3.01	2.52	.84	89
Mechanical Engin.	3.23	2.65	.84	80

NOTE: N reported in last column represents the number of programs with a rating from at least one evaluator in each of the two groups.

For example, if we exclude evaluations provided by those who confessed “little or no” familiarity with particular programs, then the revised mean ratings would be correlated at a level of at least .99 with the mean ratings computed using all of the data. (This similarity arises, in part, because only a small fraction of evaluations are given on the basis of no more than “little” familiarity with the program.)

The third column in Table 7.10 presents the correlation in each discipline between the array of mean ratings supplied by respondents claiming “considerable” familiarity and the mean ratings of those indicating “some” or “little or no” familiarity with particular programs. This coefficient is a rather conservative estimate of agreement since there is not a sufficient number of ratings from those with “considerable” familiarity to provide highly stable means. Were more such ratings available, one might expect the correlations to be higher. However, even in the form presented, the correlations, which are at least .84 in all four disciplines, are high enough to suggest that the relative standing of programs on measure 08 is not greatly affected by the admixtures of ratings from evaluators who recognize that their knowledge of a given program is limited.

As mentioned previously, 90 percent of the survey sample members were supplied the names of faculty members associated with each program to be evaluated, along with the reported number of program graduates (Ph.D. or equivalent degrees) in the previous five years. Since earlier reputational surveys had not provided such information, 10 percent of the sample members, randomly selected, were given forms without faculty names or doctoral data, as a “control group.” Although one might expect that those given faculty names would have been more likely than other survey respondents to provide evaluations of the scholarly quality of program faculty, consistently large differences were not found (see Table 7.11) between the two groups in their frequency of response to this survey item. (The reader may recall that the provision of faculty names apparently had a positive effect on survey sample members' willingness to complete and return their questionnaires in engineering disciplines.[11])

TABLE 7.11 Item Response Rate on Measure 08, by Selected Characteristics of Survey Evaluators in Engineering

	Total	Chemical Engin.	Civil Engin.	Electrical Engin.	Mechanical Engin.
EVALUATOR'S FAMILIARITY WITH PROGRAM					
Considerable	99.9	99.9	100.0	99.8	99.9
Some	98.2	99.1	96.9	98.5	97.8
Little or None	21.1	31.7	17.1	18.6	18.4
TYPE OF SURVEY FORM					
Names	66.4	76.4	63.3	61.7	62.0
No Names	70.2	88.6	59.3	71.8	62.0
INSTITUTION OF HIGHEST DEGREE					
Alumni	98.5	100.0	97.2	98.2	98.4
Nonalumni	66.4	77.1	62.6	62.3	61.7
EVALUATOR'S PROXIMITY TO PROGRAM					
Same Region	79.0	85.1	78.3	75.8	75.7
Outside Region	65.0	76.2	61.0	60.7	60.1

NOTE: The item response rate is the percentage of the total ratings requested from survey participants that included a response other than “don't know.”

The mean ratings provided by the group furnished faculty names are lower than the mean ratings supplied by other respondents in all disciplines but chemical engineering (see Table 7.12). Although small, the differences found in civil, electrical, and mechanical engineering are not what might have been expected. After all, those programs more familiar to evaluators tended to receive higher ratings, yet when steps were taken to enhance the evaluator's familiarity, the resulting ratings are somewhat lower. One post hoc interpretation of this

[11] As shown in Table 2.3, the survey response rate for those furnished faculty names is approximately 5 percentage points higher than that for those not given this information.

finding is that a program may be considered to have distinguished faculty if even only a few of its members are considered by the evaluator to be outstanding in their field. However, when a full list of program faculty is provided, the evaluator may be influenced by the number of individuals whom he or she could not consider to be distinguished. Thus, the presentation of these additional, unfamiliar names may occasionally result in a lower rating of program faculty.

However interesting these effects may be, one should not lose sight of the fact that they are small at best and that their existence does not necessarily imply that a program's relative standing on measure 08 would differ much whichever type of survey form was used. Since only about 1 in 10 ratings was supplied without the benefit of faculty names, it is hard to establish any very stable picture of relative mean ratings of individual programs. However, the correlations between the mean ratings supplied by the two groups are reasonably high--ranging from .77 to .96 in the four disciplines (see Table 7.12). Were these coefficients adjusted for the fact that the group furnished forms without names constituted only about 10 percent of the survey respondents, they would be substantially larger. From this result it seems reasonable to conclude that differences in the alternative survey forms used are not likely to be responsible for any large-scale reshuffling in the reputational ranking of programs on measure 08. It also suggests that the inclusion of faculty names in the committee's assessment need not prevent comparisons of the results with those obtained from the Roose-Andersen survey.

Another factor that might be thought to influence an evaluator's judgment about a particular program is the geographic proximity of that program to the evaluator. There is enough regional traffic in academic life that one might expect proximate programs to be better known than those in distant regions of the country. This hypothesis may apply especially to the smaller and less visible programs and is confirmed by the survey results. For purposes of analysis, programs

TABLE 7.12 Mean Ratings of Scholarly Quality of Program Faculty, by Type of Survey Form Provided to Evaluator

	MEAN RATINGS		CORRELATION	
	Names	No Names	r	N
Chemical Engin.	2.68	2.47	.96	79
Civil Engin.	2.66	2.91	.77	73
Electrical Engin.	2.60	2.61	.86	90
Mechanical Engin.	2.73	2.81	.87	81

NOTE: N reported in last column represents the number of programs with a rating from at least one evaluator in each of the two groups.

were assigned to one of nine geographic regions[12] in the United States, and ratings of programs within an evaluator's own region are categorized in Table 7.13 as “nearby.” Ratings of programs in any of the other eight regions were put in the “outside” group. Findings reported elsewhere in this chapter confirm that evaluators were more likely to provide ratings if a program was within their own region of the country,[13] and it is reasonable to imagine that the smaller and the less visible programs received a disproportionate share of their ratings either from evaluators within their own region or from others who for one reason or another were particularly familiar with programs in that region.

TABLE 7.13 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Proximity to Region of Program

	MEAN RATINGS		CORRELATION	
	Nearby	Outside	r	N
Chemical Engin.	2.75	2.66	.94	79
Civil Engin.	2.70	2.68	.86	73
Electrical Engin.	2.71	2.61	.86	87
Mechanical Engin.	2.72	2.74	.87	81

NOTE: N reported in last column represents the number of programs with a rating from at least one evaluator in each of the two groups.

Although the data in Table 7.13 suggest that “nearby” programs were given higher ratings than those outside the evaluator's region, the differences in reported means are quite small and probably represent no more than a secondary effect that might be expected, because, as we have already seen, evaluators tended to rate higher those programs with which they were more familiar. Furthermore, the high correlations found between the mean ratings of the two groups indicate that the relative standings of programs are not dramatically influenced by the geographic proximity of those evaluating them.

Another consideration that troubles some critics is that large programs may be unfairly favored in a faculty survey because they are likely to have more alumni contributing to their ratings who, it would stand to reason, would be generous in the evaluations of their alma maters. Information collected in the survey on each evaluator's institution of highest degree enables us to investigate this concern. The findings presented in Table 7.14 support the hypothesis that alumni provided generous ratings--with differences in the mean ratings (for

[12] See Appendix I for a list of the states included in each region.
[13] See Table 7.11.

measure 08) of alumni and nonalumni ranging from .42 to .73 in the four disciplines. Given the appreciable differences between the ratings furnished by program alumni and other evaluators, one might ask how much effect this has had on the overall results of the survey. The answer is "very little." As shown in the table, only about one program in every three received ratings from any alumnus.[14] Moreover, the fraction of alumni providing ratings of a program is always quite small and should have had minimal impact on the overall mean rating of any program. To be certain that this was the case, mean ratings of the scholarly quality of faculty were recalculated for every engineering program--with the evaluations provided by alumni excluded. The results were compared with the mean scores based on a full set of evaluations. Out of the 324 engineering programs evaluated in the survey, only 1 program (in civil engineering) had an observed difference as large as 0.2, and for 306 programs (94 percent) their mean ratings remain unchanged (to the nearest tenth of a unit). On the basis of these findings the committee saw no reason to exclude alumni ratings in the calculation of program means.

TABLE 7.14 Mean Ratings of Scholarly Quality of Program Faculty, by Evaluator's Institution of Highest Degree

	MEAN RATINGS		NUMBER OF PROGRAMS WITH ALUMNI RATINGS
	Alumni	Nonalumni	N
Chemical Engin.	3.77	3.35	32
Civil Engin.	3.96	3.23	27
Electrical Engin.	3.76	3.33	29
Mechanical Engin.	3.99	3.38	27

NOTE: The pairs of means reported in each discipline are computed for a subset of programs with a rating from at least one alumnus and are substantially greater than the mean ratings for the full set of programs in each discipline.

Another concern that some critics have is that a survey evaluation may be affected by the interaction of the research interests of the evaluator and the area(s) of focus of the research-doctorate program to be rated. It is said, for example, that some narrowly focused programs may be strong in a particular area of research but that this

[14]Because of the small number of alumni ratings in every discipline, the mean ratings for this group are unstable and therefore the correlations between alumni and nonalumni mean ratings are not reported.

strength may not be recognized by a large fraction of evaluators who happen to be unknowledgeable in this area. This is a concern more difficult to address than those discussed in the preceding pages since little or no information is available about the areas of focus of the programs being evaluated (although in certain disciplines the title of a department or academic unit may provide a clue). To obtain a better understanding of the extent to which an evaluator's field of specialty may have influenced the ratings he or she has provided, an analysis was made of ratings provided by evaluators in physics and statistics/ biostatistics. In each discipline the survey participants were divided into two groups according to specialty field (as reported on the survey questionnaire). The results of the analysis, which are presented in the mathematical and physical sciences volume of the committee's report, indicate that there is a high degree of correlation in the mean ratings provided by those in differing specialty fields within these two disciplines. Although one cannot conclude from these findings that an evaluator's specialty field has no bearing on how he or she rates a program, these findings do suggest that the relative standings of programs in physics and statistics/biostatistics would not be greatly altered if the ratings by either group were discarded.

INTERPRETATION OF REPUTATIONAL SURVEY RATINGS

It is not hard to foresee that results from this survey will receive considerable attention through enthusiastic and uncritical reporting in some quarters and sharp castigation in others. The study committee understands the grounds for both sides of this polarized response but finds that both tend to be excessive. It is important to make clear how we view these ratings as fitting into the larger study of which they are a part.

The reputational results are likely to receive a disproportionate degree of attention for several reasons, including the fact that they reflect the opinions of a large group of faculty colleagues and that they form a bridge with earlier studies of graduate programs. But the results will also receive emphasis because they alone, among all of the measures, seem to address quality in an overall or global fashion. While most recognize that “objective” program characteristics (i.e., publication productivity, research funding, or library size) have some bearing on program quality, probably no one would contend that a single one of these measures encompasses all that need be known about the quality of research-doctorate programs. Each is obviously no more than an indicator of some aspect of program quality. In contrast, the reputational ratings are global from the start because the respondents are asked to take into account many objective characteristics and to arrive at a general assessment of the quality of the faculty and effectiveness of the program. This generality has self-evident appeal.

On the other hand, it is wise to keep in mind that these reputational ratings are measures of perceived program quality rather than of “quality” in some ideal or absolute sense. What this means is that, just as for all of the more objective measures, the reputational ratings represent only a partial view of what most of us would consider quality to be; hence, they must be kept in careful perspective.

Some critics may argue that such ratings are positively misleading because of a variety of methodological artifacts or because they are supplied by "judges" who often know very little about the programs they are rating. The committee has conducted the survey in a way that permits the empirical examination of a number of the alleged artifacts and, although our analysis is by no means exhaustive, the general conclusion is that their effects are slight.

At the same time, criticisms of reputational ratings from prior studies represent a perspective that may be misguided. This perspective assumes that one asks for ratings in order to find out what "quality" really is and that to the degree that the ratings miss the mark of "quintessential quality," they are unreal, although the quality that they attempt to measure is real. What this perspective misses is the reality of quality and the fact that impressions of quality, if widely shared, have an imposing reality of their own and therefore are worth knowing about in their own right. After all, these perceptions govern a large-scale system of traffic around the nation's graduate institutions--for example, when undergraduate students seek the advice of their professor concerning graduate programs that they might attend. It is possible that some professors put in this position disqualify themselves on grounds that they are not well informed about the relative merits of the programs being considered. Most faculty members, however, surely attempt to be helpful on the basis of impressions gleaned from their professional experience, and these assessments are likely to have major impact on student decision-making. In short, the impressions are real and have very real effects not only on students shopping for graduate schools but also on other flows, such as job-seeking young faculty and the distribution of research resources. At the very least, the survey results provide a snapshot of these impressions from discipline to discipline. Although these impressions may be far from ideally informed, they certainly show a strong degree of consensus within each discipline, and it seems safe to assume that they are more than passingly related to what a majority of keen observers might agree program quality is all about.

COMPARISON WITH RESULTS OF THE ROOSE-ANDERSEN STUDY

An analysis of the response to the committee's survey would not be complete without comparing the results with those obtained in the survey by Roose and Andersen 12 years earlier. Although there are obvious similarities in the two surveys, there are also some important differences that should be kept in mind in examining individual program ratings of the scholarly quality of faculty. Already mentioned in this chapter is the inclusion, on the form sent to 90 percent of the sample members in the committee's survey, of the names and academic ranks of faculty and the numbers of doctoral graduates in the previous five years. Other significant changes in the committee's form are the identification of the university department or academic unit in which each program may be found, the restriction of requesting evaluators to make judgments about no more than 50 research-doctorate programs in their discipline, and the presentation of these programs in random sequence on the survey form. The sampling frames used in the two surveys also differ. The sample selected in the earlier study included only individuals who had been nominated by the participating universities, while more than one-fourth of the sample in the committee's survey were chosen at random from full faculty lists. (Except for this difference the samples were quite similar--i.e., in terms of number of evaluators in each discipline and the fraction of senior scholars.[15])

Several dissimilarities in the coverage of the Roose-Andersen and this committee's reputational assessments should be mentioned. The former included a total of 130 institutions that had awarded at least 100 doctoral degrees in two or more disciplines during the FY1958-67 period. The institutional coverage in the committee's assessment was based on the number of doctorates awarded in each discipline (as described in Chapter I) and covered a total population of 228 universities. Most of the universities represented in the later study but not the earlier one are institutions that offered research-doctorate programs in a limited set of disciplines. Finally, in the Roose-Andersen study, ratings were compiled on only one program from each institution represented in a discipline, whereas in the committee's survey separate ratings were requested if a university offered more than one research-doctorate program in a given discipline. The consequences of these differences in survey coverage are quite apparent: in the committee's survey, evaluations were requested for a total of 326 research-doctorate programs in chemical, civil, electrical, and mechanical engineering compared with 287 programs in the Roose-Andersen study.

Figure 7.1, Figure 7.2, Figure 7.3 and Figure 7.4 plot the mean ratings of scholarly quality of faculty in programs included in both surveys; sets of ratings are graphed for 61 programs in chemical engineering, 57 in civil engineering, 66 in electrical engineering, and 61 in mechanical engineering. Since in the Roose-Andersen study programs were identified by institution and discipline (but not by department) the matching of results from this survey with those from the committee's survey is not precise. For universities represented in the latter survey by more than one program in a particular discipline, the mean rating for the program with the largest number of graduates (measure 02) is the only one plotted here. Although the results of both surveys are reported on identical scales, some caution must be taken in interpreting differences in the mean ratings a program received in the two evaluations. It is impossible to estimate what effect all of the differences described above may have had on the results of the two surveys. Furthermore, one must

[15]For a description of the sample group used in the earlier study, see Roose and Andersen, pp. 28-31.

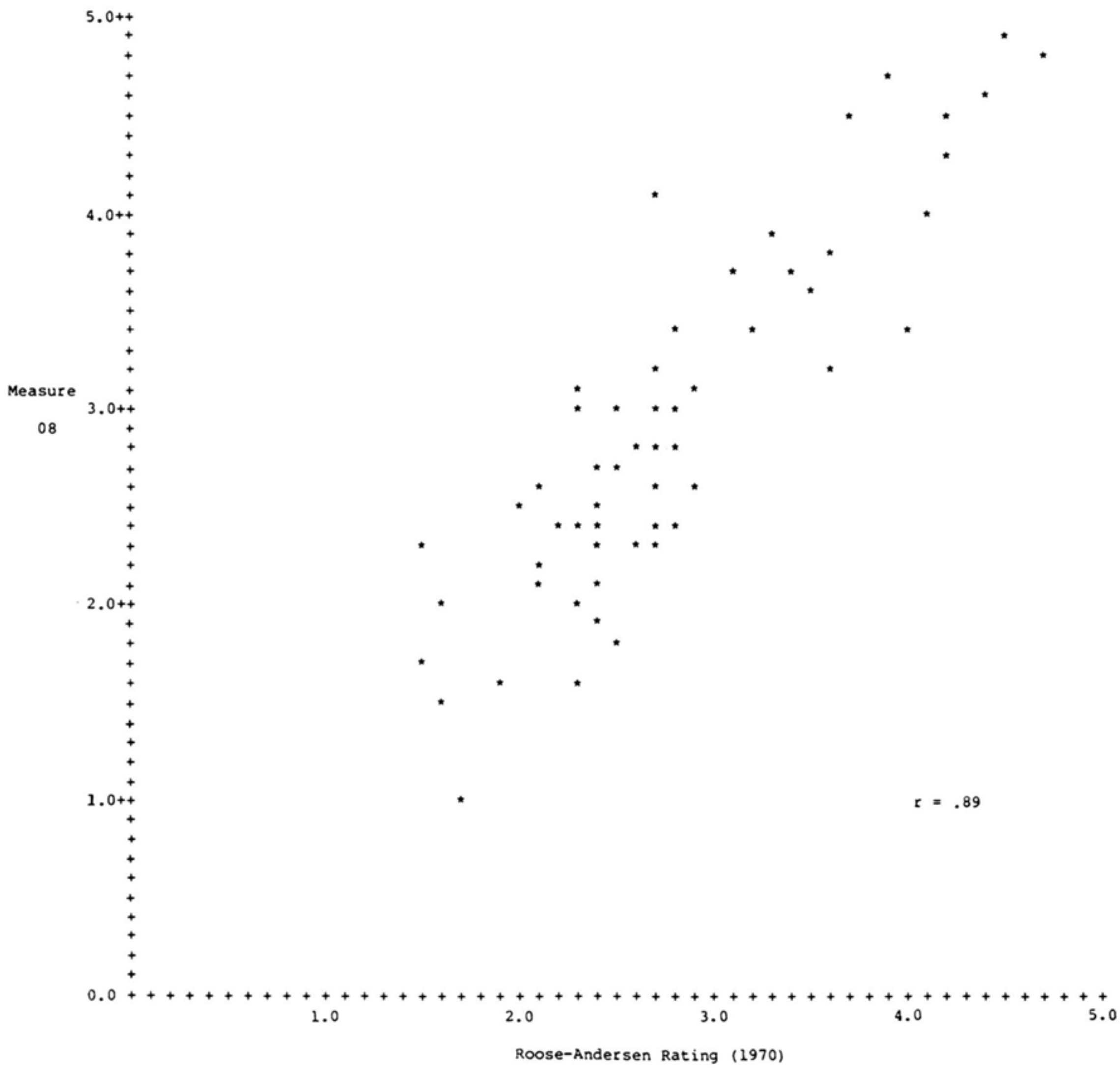

FIGURE 7.1 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--61 programs in chemical engineering.

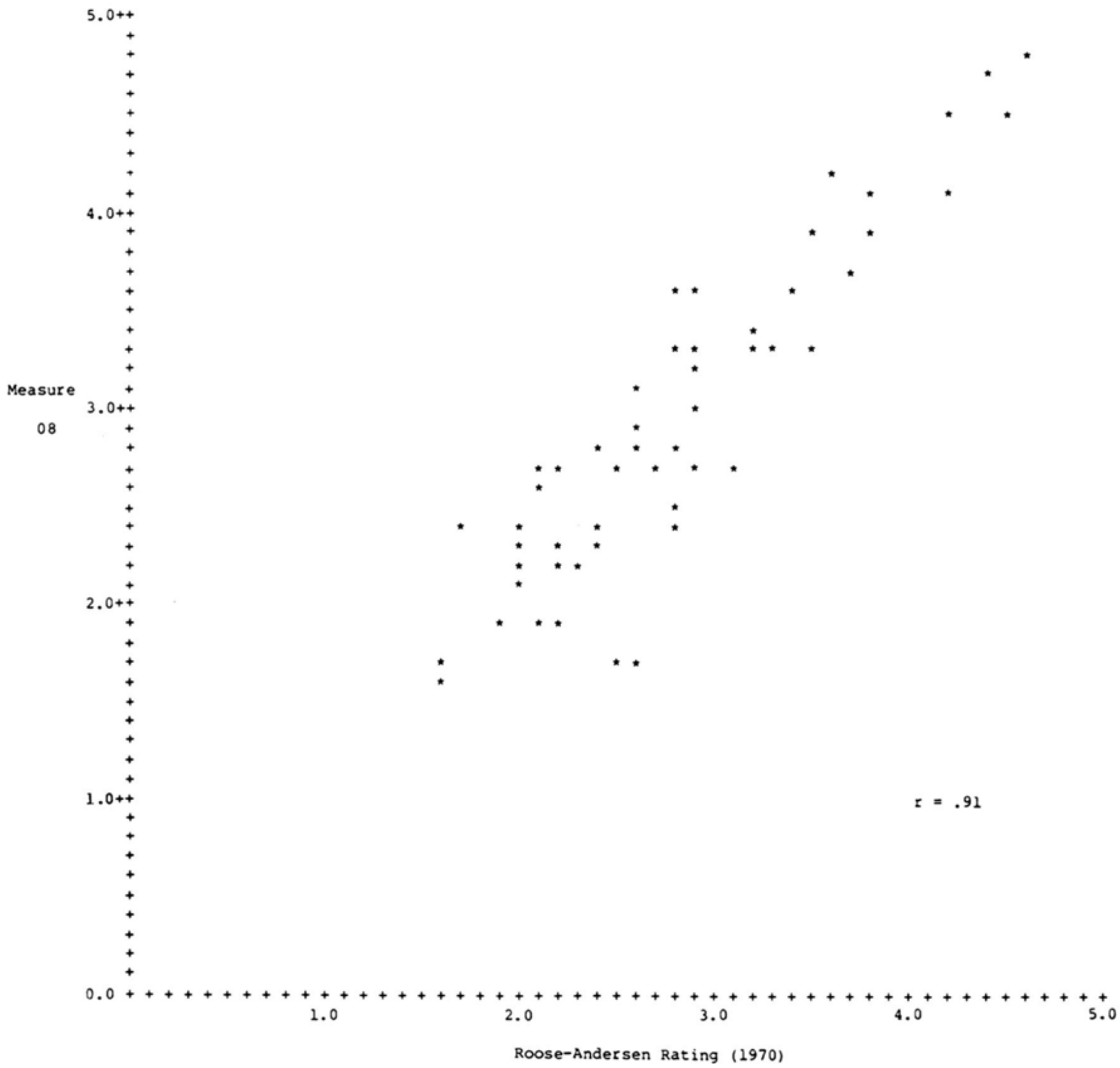

FIGURE 7.2 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--57 programs in civil engineering.

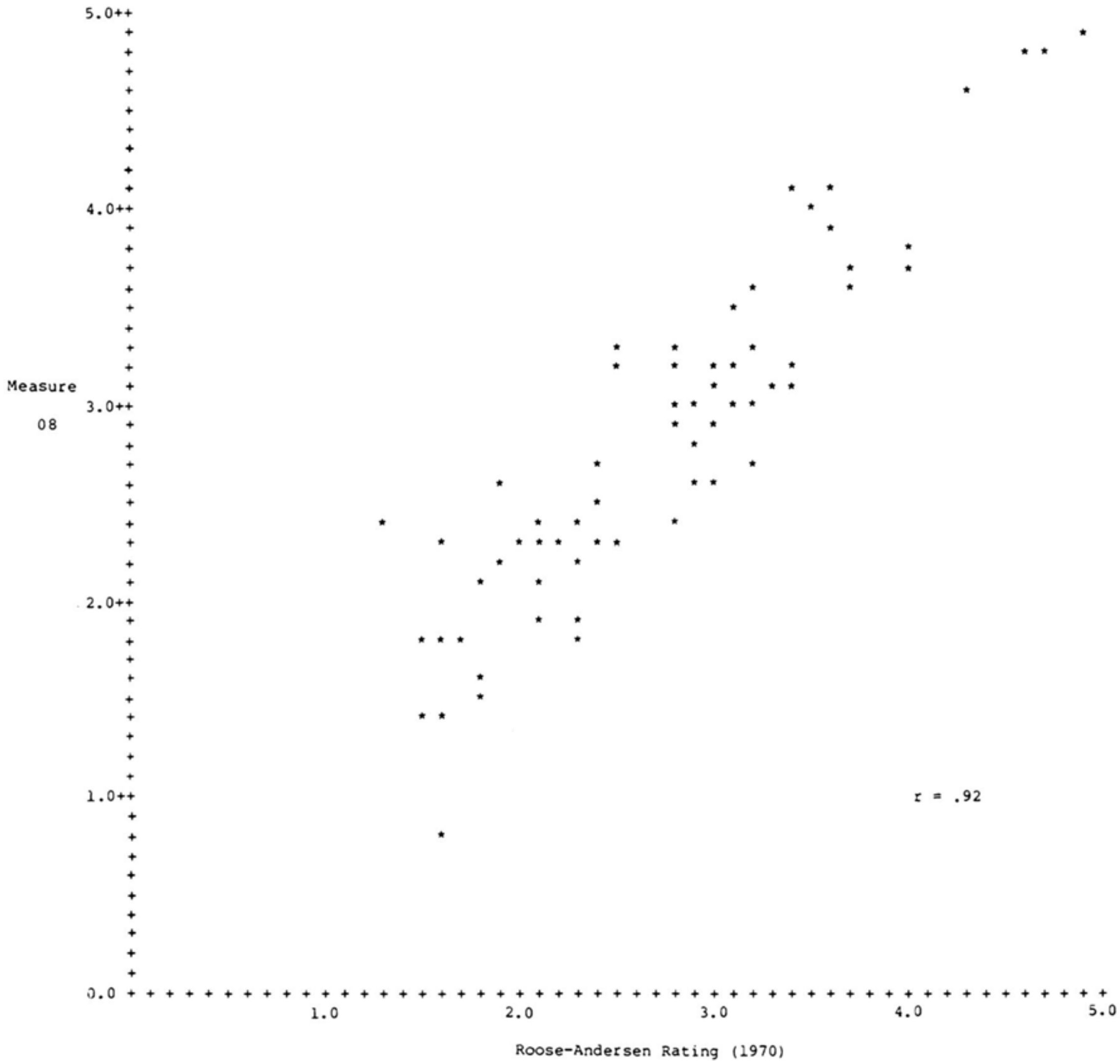

FIGURE 7.3 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--66 programs in electrical engineering.

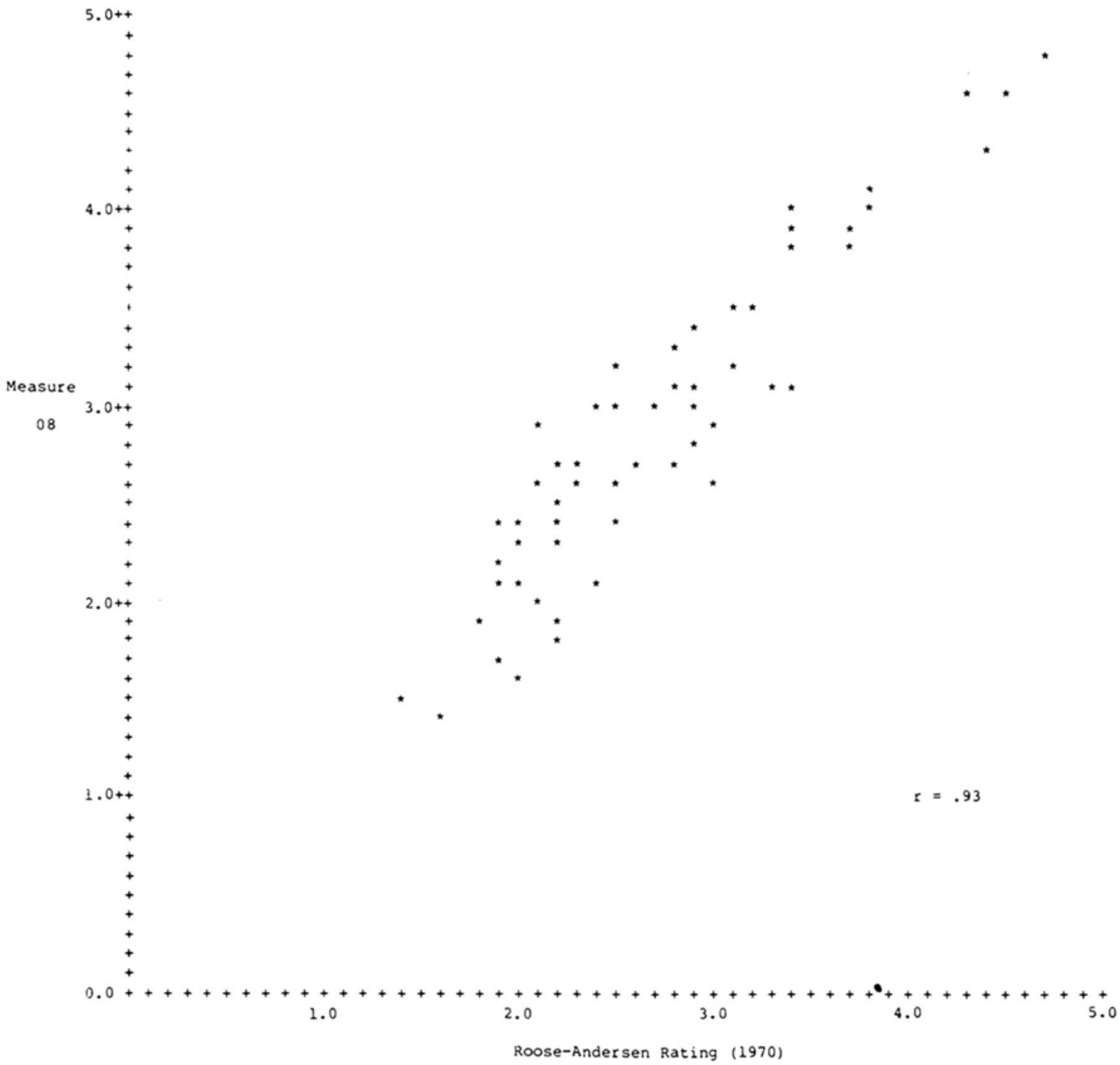

FIGURE 7.4 Mean rating of scholarly quality of faculty (measure 08) versus mean rating of faculty in the Roose-Andersen study--61 programs in mechanical engineering.

remember that the reported scores are based on the opinions of different groups of faculty members and were provided at different time periods. In 1969, when the Roose-Andersen survey was conducted, graduate departments in most universities were still expanding and not facing the enrollment and budget reductions that many departments have had to deal with in recent years. Consequently, a comparison of the overall findings from the two surveys tells us nothing about how much graduate education has improved (or declined) in the past decade. Nor should the reader place much stock in any small differences in the mean ratings that a particular program may have received in the two surveys. On the other hand, it is of particular interest to note the high correlations between the results of the evaluations. For programs in the four engineering disciplines the correlation coefficients range between .89 (chemical) and .93 (mechanical). The extraordinarily high correlations found in all four disciplines may suggest to some readers that reputational standings of programs in these disciplines have changed very little in the last decade. However, one must keep in mind that the correlations are based on the reputational ratings of only three-fourths of the programs evaluated in this assessment in these disciplines and do not take into account the emergence of many new programs that did not exist or were too small to be rated in the Roose-Andersen study.

FUTURE STUDIES

One of the most important objectives in undertaking this assessment was to test new measures not used extensively in past evaluations of graduate programs. Although the committee believes that it has been successful in this effort, much more needs to be done. First and foremost, studies of this kind should be extended to cover other types of programs and other disciplines not included in this effort. As a consequence of budgeting limitations, the committee had to restrict its study to 32 disciplines, selected on the basis of the number of doctorates awarded in each. A multidimensional assessment of research-doctorate programs in many important disciplines not included among these 32 should be of great value to the academic community. Consideration should also be given to embarking on evaluations of programs offering other types of graduate and professional degrees. As a matter of fact, plans for including master's-degree programs in this assessment were originally contemplated, but because of a lack of available information about the resources and graduates of programs at the master's level, it was decided to focus on programs leading to the research doctorate.

Perhaps the most debated issue the committee has had to address concerned which measures should be reported in this assessment. In fact, there is still disagreement among some of its members about the relative merits of certain measures, and the committee fully recognizes a need for more reliable and valid indices of the quality of graduate programs. First on a list of needs is more precise and meaningful information about the product of research-doctorate programs--the graduates. For example, what fraction of the program graduates have gone on to be productive investigators--either in the academic setting or in government and industrial laboratories? What fraction have gone on to become outstanding investigators--as measured by receipt of major prizes, membership in academies, and other such distinctions? How do program graduates compare with regard to their publication records? Also desired might be measures of the quality of the students applying for admittance to a graduate program (e.g., Graduate Record Examination scores, undergraduate grade point averages). If reliable data of this sort were made available, they might provide a useful index of the reputational standings of programs, from the perspective of graduate students.

A number of alternative measures relevant to the quality of program faculty were considered by the committee but not included in the assessment because of the associated difficulties and costs of compiling the necessary data. For example, what fraction of the program faculty were invited to present papers at national meetings? What fraction had been elected to prestigious organizations/groups in their field? What fraction had received senior fellowships and other awards of distinction? In addition, it would be highly desirable to supplement the data presented on NSF, NIH, and ADAMHA research grant awards (measure 13) with data on awards from other federal agencies (e.g., Department of Defense, Department of Energy, National Aeronautics and Space Administration) as well as from major private foundations.

As described in the preceding pages, the committee was able to make several changes in the survey design and procedures, but further improvements could be made. Of highest priority in this regard is the expansion of the survey sample to include evaluators from outside the academic setting (in particular, those in government and industrial laboratories who regularly employ graduates of the programs to be evaluated). To add evaluators from these sectors would require a major effort in identifying the survey population from which a sample could be selected. Although such an effort is likely to involve considerable costs in both time and financial resources, the committee believes that the addition of evaluators from the government and industrial settings would be of value in providing a different perspective to the reputational assessment and that comparisons between the ratings supplied by academic and nonacademic evaluators would be of particular interest.

Minority Statement

The inclusion of several different and independent possible measures reflecting the quality of graduate education in this report seems to us a substantial addition and a significant improvement to previous such studies. However, we are concerned with the possibility that there are perhaps too many measures, some of which have little or no bearing on the objectives of the present study. In particular, measures 06 and 07 (on the employment plans of graduates) are not informative, have little or nothing to do with the quality of the program, and yield numbers that are not very dependable. Both measures come from data in the NRC's Survey of Earned Doctorates. Measure 06, the fraction of FY1975-79 program graduates with definite employment or study plans at time of doctorate, is vague because the “time of doctorate” may vary considerably from the time of year when, say, academic appointments are offered--and this in turn can vary substantially among institutions. This measure may be associated with the prosperity of the program, but its connection with quality is tenuous. Measure 07, the fraction of FY1975-79 program graduates planning to take positions in Ph.D.-granting universities, is even more nebulous. What is meant by “planning”? How firm are those plans? (We can't know; all there is is a check somewhere on a questionnaire.) What about the variation in quality among different Ph.D.-granting universities? It can be considerable, and such considerable differences are precisely those that the whole study is attempting to measure. Such data obscure the differences. Further, measure 07 betrays the inherent bias of the present study and previous ones in that the “program graduates planning to take positions in Ph.D.-granting universities” is tacitly offered as a measure of the “goodness” of the program. In the late 1970's and 1980's nothing can be farther from the truth. The kindest evaluation of measures 06 and 07 is that they are irrelevant.

These two measures do not result from careful plans made by the committee for this study in order to find other useful new measures. Such plans were considered, but for various good reasons could not be carried out. These two particular measures just happen to be available in the vast data collected and recorded (but not critically evaluated) over the years by the Commission on Human Resources of the National

Research Council. Their inclusion in this report might be explained by bureaucratic inertia, but this inclusion adds nothing to the report.

The inclusion of measure 07 in this volume on research doctorates in engineering is especially meaningless. In engineering, industrial experience is clearly very valuable, so that it makes little or no sense to ask engineering graduates whether they expect to go to a "Ph.D.-granting institution." The best industrial laboratories are not likely to be busy granting doctorates. To be sure, measure 07 is here qualified as a "program characteristic." The verbiage merely hides the fact that the inclusion of this meaningless measure serves only to clutter the report with added useless numbers.

SAUNDERS MAC LANE

C. K. N. PATEL

ERNEST S. KUH

Appendixes

APPENDIX A

LETTER TO INSTITUTIONAL COORDINATORS

COMMITTEE ON AN ASSESSMENT OF QUALITY-RELATED CHARACTERISTICS OF RESEARCH-DOCTORATE PROGRAMS IN THE UNITED STATES

Established by the Conference Board of Associated Research Councils

Office of the Staff Director /
National Research Council /
2101 Constitution Avenue, N.W. / Washington, D.C. 20418 (202) 389-6552

December 5, 1980

Dear

We are pleased to learn that you have been designated to coordinate the efforts of your institution in assisting our committee with an assessment of the characteristics and effectiveness of research-doctorate programs in U.S. universities. A prospectus describing the goals and procedures for this study has already been distributed to university presidents and graduate deans. The cooperation of universities and their faculties is essential for the assessment to be carried out in an objective and accurate fashion.

The study is being conducted under the aegis of the Conference Board of Associated Research Councils and is housed administratively within the National Research Council. Financial support has been provided by the Andrew W. Mellon Foundation, the Ford Foundation, the National Science Foundation, and the National Institutes of Health. The study will examine more than 2,600 programs in 31 fields in the physical sciences, engineering, life sciences, social sciences, and humanities. Approximately 10,000 faculty members will be asked to evaluate programs in their own fields. In addition to the reputational evaluations by faculty, information will be compiled from national data banks on the achievements of both the faculty involved in each program and the program graduates.

The product of this study will be a series of reports with descriptive data on institutional programs in each of 31 fields to be covered. These reports will present several different measures of the quality-related characteristics of each program being evaluated. Some of the measures will be adjusted for program size. With the cooperation of your institution and that of other universities, we plan to produce these reports by late spring of 1982. At that time the detailed data that have been compiled on research-doctorate programs within your institution will be made available to you for a nominal cost. These data should prove to be quite valuable for an assessment of the particular strengths and weaknesses of individual programs at your institution.

For the past three months the committee has deliberated over what fields are to be covered in the study and which programs within each field are to be evaluated. The financial resources available limit us to an assessment of approximately 2,600 programs in 31 fields. The fields to be included have been determined on the basis of the total number of doctorates awarded by U.S. universities during the FY1976-78 period and the feasibility of identifying and evaluating comparable programs in a particular field. Within each of the 31 fields, programs which awarded more than a specified number of doctorates during the period have been designated for inclusion in the study.

For each of the programs at your institution that are to be evaluated, we ask that you furnish the names and ranks of all faculty members who participate significantly in education toward the research doctorate, along with some basic information (as indicated) about the program itself. A set of instructions and a computer-printed roster (organized by field) are enclosed. In addition, you are given an opportunity to nominate other programs at your institution that are not on the roster, but that you believe have significant distinction and should be included in our evaluation. Any program you nominate must belong in one of the 31 fields covered by the study.

The information supplied by your institution will be used for two purposes. First, a sample of the faculty members identified with each program will be selected to evaluate research-doctorate programs in their fields at other universities. The selection will be made in such a way as to ensure that all institutional programs and faculty ranks are adequately represented in each field category. Secondly, a list of names of faculty and some of the program information you supply will be provided to evaluators selected from other institutions. Thus, it is important that you provide accurate and up-to-date information. You may wish to ask department chairmen or other appropriate persons at your institution to assist in providing the information requested. If you do so, we ask that your office coordinate the effort by collecting the information on each program and sending a single package to us in the envelope provided.

We hope that you will be able to complete this request by December 15. Should you have any questions regarding our request, please call (collect) Porter Coggeshall, the study director, at (202)389-6552. Thank you for your help in this effort.

Sincerely,

Lyle V. Jones
Co-Chairman

Gardner Lindzey
Co-Chairman

INSTRUCTIONS

General Instructions

- Provided on the first page of the accompanying roster is a list of the 31 program fields to be covered in this study. Those program fields for which you are requested to furnish information have been designated with an asterisk (*).
- For every designated field there is a separate set of roster pages. Please provide all of the information requested on these pages.
- If your institution offers more than one research-doctorate program in a designated field, we ask that you copy the roster pages furnished for that field category and provide a separate set of information for each program. For example, if your university offers one doctoral program in statistics and another in biostatistics, these should be listed separately. For this purpose, programs offered by different departments (or other administative units) that are advertised as distinct programs in your catalogues would be listed separately. Do not consider different specialty areas within a department to be separate programs.
- If your institution currently does not offer a research-doctorate program in an asterisked field or if, in your judgment, a doctoral program offered fails to fit the designated field category, please so indicate on the roster pages provided for that field.

List of Faculty Members (as of December 1, 1980)

- On each program roster please provide the names of faculty members who participate significantly in doctoral education.
- Included should be individuals who (a) are members of the regular academic faculty (typically holding the rank of assistant, associate, or full professor) and (b) regularly teach doctoral students and/or serve on doctoral committees.
- Members of the faculty who are currently on leave of absence but meet the above criteria should be included.
- Visiting faculty members should not be included.
- Emeritus or adjunct faculty members (or faculty with other comparable ranks) should also be excluded unless they currently participate significantly in doctoral education.
- Members of the faculty who participate significantly in doctoral education in more than one program should be listed on the roster for each program in which they participate.

- In many instances the list of faculty for a program may be identical to an institutional list of graduate faculty.
- Faculty names should be provided in the form in which they are most likely to be recognized by colleagues in the field. We prefer that, within each academic rank, you list faculty alphabetically by last name.

Nomination of Faculty to Serve as Program Evaluators (Column 3 of Faculty Roster)

- Please check the names of at least two faculty members in each academic rank within each program who would be available and, in your opinion, well-qualified to evaluate research-doctorate programs in their field.
- A sample of evaluators will be selected from the list of faculty you provide for each program. In selecting evaluators preference will be given to those whose names you have checked. If no names are checked, a random sample will be selected from the faculty list.

Faculty Who Do Not Hold Ph.D. Degrees From U.S. Universities (Column 4 of Faculty Roster)

- In order to help us match the faculty names you provide with records in the Doctorate Records File (maintained by the National Research Council), we ask that you identify those faculty members who do not hold a Ph.D. or equivalent research-doctorate from a university in the United States.
- This information will be used only for the purposes of collating records and will not be released to those who are selected to evaluate your institution's programs. Nor will this information affect in any way the selection of program evaluators from your institution's faculty.

Nomination of Additional Programs

- We recognize the possibility that we may have omitted one or more research-doctorate programs at your institution that belong to (non-asterisked) fields listed on the first page of the roster and that you believe should be included in this study.
- The last two pages of the accompanying roster are provided for the nomination of an additional program. You are asked to provide the names of faculty and other information about each program you nominate. Should you decide to nominate more than one program, it will be necessary to make additional copies of these two pages of the roster.
- Please restrict your nominations to programs in your institution that you consider to be of uncommon distinction and that have awarded no fewer than two doctorates during the past two years.
- Only programs which fall under one of the 31 field categories listed on the first page of the accompanying roster will be considered for inclusion in the study.

PLEASE RETURN COMPLETED RCSTER IN THE ENCLOSED ENVELCPE TC:

CCMMITTEE ON AN ASSESSMENT OF QUALITY-RELATED CHARACTERISTICS OF RESEARCH-DCCTCRATE PRCGRAMS
NATIONAL RESEARCH CCUNCIL, JH-711
2101 CONSTITUTION AVENUE, N.W.
WASHINGTON, D.C. 2C418

FIELDS INCLUDED IN THE STUDY

ARTS AND HUMANITIES
* ART HISTORY
* CLASSICS
* ENGLISH LANGUAGE AND LITERATURE
* FRENCH LANGUAGE ANC LITERATURE
* GERMAN LANGUAGE AND LITERATURE
  LINGUISTICS
  MUSIC
* PHILOSOPHY
* SPANISH ANC PORTUGUESE LANGUAGE AND LITERATURE

BIOLOGICAL SCIENCES
* BICCHEMISTRY
  BOTANY (INCLUDING PLANT PHYSICLCGY, PLANT PATHCLOGY, MYCOLOGY)
* CELLULAR BICLOGY/MOLECULAR BIOLOGY
* MICROBIOLOGY (INCLUDING IMMUNCLOGY, BACTERIOLOGY, PARASITCLOGY, VIROLCGY)
* PHYSIOLOGY (ANIMAL, HUMAN)
  ZOOLOGY

ENGINEERING
* CHEMICAL ENGINEERING
* CIVIL ENGINEERING
* ELECTRICAL ENGINEERING
* MECHANICAL ENGINEERING

PHYSICAL SCIENCES
* CHEMISTRY
* COMPUTER SCIENCES
* GECSCIENCES (INCLUDING GEOLOGY, GECCHEMISTRY, GEOPHYSICS, GENL EARTH SCI)
* MATHEMATICS
* PHYSICS (EXCLUDING ASTRONCMY, ASTRCPHYSICS)
  STATISTICS (INCLUDING BIOSTATISTICS)

SOCIAL AND BEHAVIORAL SCIENCES
* ANTHROPOLOGY
* ECONOMICS
* HISTORY
* POLITICAL SCIENCE
* PSYCHOLOGY
* SOCICLOGY

* DESIGNATES FIELDS FOR WHICH YCU ARE RECUESTEC TO PROVICE INFCRMATION ON RESEARCH-DOCTORATE PRCGRAMS IN YOUR INSTITUTION. (SEE INSTRUCTION SHEET REGARDING NOMINATION OF ADCITIONAL PROGRAMS TO BE INCLUDED IN THE STUDY).

```
**************************************************
***                                - PART A   ***
**************************************************
```

PLEASE ANSWER EACH OF THE FOLLOWING QUESTIONS ABOUT THE RESEARCH-DOCTORATE PROGRAM

IN ______________________________

(1) WHAT IS THE NAME OF THE DEPARTMENT (OR EQUIVALENT ACADEMIC UNIT) IN WHICH THIS RESEARCH-DOCTORATE PROGRAM IS OFFERED ?

....

(2) HOW MANY PH.D.'S (OR EQUIVALENT RESEARCH-DOCTORATES) HAVE BEEN AWARDED IN THE PROGRAM IN EACH OF THE LAST FIVE ACADEMIC YEARS ?

1975-76 ....

1976-77 ....

1977-78 ....

1978-79 ....

1979-80 ....

(3) APPROXIMATELY HOW MANY FULL-TIME AND PART-TIME GRADUATE STUDENTS ENROLLED IN THE PROGRAM AT THE PRESENT TIME (FALL 1980) INTEND TO EARN DOCTORATES ?

FULL-TIME STUDENTS ....

PART-TIME STUDENTS ....

TOTAL ....

(4) IN APPROXIMATELY WHAT YEAR WAS THIS RESEARCH-DOCTORATE PROGRAM INITIATED ? (IF PROGRAM WAS DISCONTINUED AND SUBSEQUENTLY REINSTATED, PLEASE GIVE YEAR IT WAS REINSTATED) .

....

****
*** _ - PART B ***
****

(1) LIST BELOW ALL FACULTY WHO PARTICIPATE SIGNIFICANTLY IN DOCTORAL EDUCATION IN THIS PROGRAM (SEE INSTRUCTIONS SHEET). PLEASE PRINT OR TYPE NAMES IN FOLLOWING FORMAT: EXAMPLE: MARY A. JONES / A. B. SMITH, JR.	(2) INDICATE THE ACADEMIC RANK OF EACH FACULTY MEMBER (PROF., ASSOC. PROF., ASST. PROF., ETC.).	(3) CHECK BELOW AT LEAST 2 FACULTY IN EACH RANK AVAILABLE AND WELL-QUALIFIED TO EVALUATE OTHER PROGRAMS (SEE INSTRUCTIONS SHEET).	(4) CHECK BELOW ANY FACULTY WHO DO NOT HOLD A PH.D. OR OTHER RESEARCH-DOCTORATE FROM A UNIVERSITY IN THE U.S. (SEE INSTRUCTIONS SHEET).
01	..	( )	( )
02	..	( )	( )
03	..	( )	( )
04	..	( )	( )
05	..	( )	( )
06	..	( )	( )
07	..	( )	( )
08	..	( )	( )
09	..	( )	( )
10	..	( )	( )
11	..	( )	( )
12	..	( )	( )
13	..	( )	( )
14	..	( )	( )
15	..	( )	( )
16	..	( )	( )
17	..	( )	( )
18	..	( )	( )
19	..	( )	( )
20	..	( )	( )

APPENDIX B

SURVEY OF EARNED DOCTORATES

(Conducted by the National Research Council under the sponsorship of the National Science Foundation, the Department of Education, the National Institutes of Health, and the National Endowment for the Humanities.)

This annual survey of new recipients of Ph.D. or equivalent research doctorates in all fields of learning contains information describing their demographic characteristics, educational background, graduate training, and postgraduation plans. The source file includes nearly complete data from all 1958-81 doctorate recipients and partial information for all 1920-57 doctoral graduates.

NSF Form 558 1977
OMB No. 99-R0290
Approval Expires June 30, 1979

SURVEY OF EARNED DOCTORATES

This form is to be returned to the GRADUATE DEAN, for forwarding to .... Board on Human-Resource Data and Analyses
Commission on Human Resources
National Research Council
2101 Constitution Avenue, Washington, D. C. 20418

Please print or type.

A. Name in full: .... (Last Name) (First Name) (Middle Name) (9-30)

Cross Reference: Maiden name or former name legally changed .... (31)

B. Permanent address through which you could always be reached: (Care of, if applicable) ....

.... (Number) (Street) (City)

.... (State) (Zip Code) (Or Country if not U.S.)

C. U.S. Social Security Number: _ _ _ - _ _ - _ _ _ _ (32-40)

D. Date of birth: .... (41-45) (Month) (Day) (Year) Place of birth: .... (46-47) (State) (Or Country if not U.S.)

E. Sex: 1 ☐ Male 2 ☐ Female (48)

F. Marital status: 1 ☐ Married 2 ☐ Not married (including widowed, divorced) (49)

G. Citizenship: 0 ☐ U.S. native 2 ☐ Non U.S., Immigrant (Permanent Resident)
1 ☐ U.S. naturalized 3 ☐ Non-U.S., Non-Immigrant (Temporary Resident) (50)
If Non-U.S., indicate country of present citizenship .... (51-52)

H. Racial or ethnic group: (Check all that apply.) *A person having origins in* —
0 ☐ American Indian or Alaskan Native ..... any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.
1 ☐ Asian or Pacific Islander ..... any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands. This area includes, for example, China, Japan, Korea, the Philippine Islands, and Samoa.
2 ☐ Black, not of Hispanic Origin ..... any of the black racial groups of Africa.
3 ☐ White, not of Hispanic Origin ..... any of the original peoples of Europe, North Africa, or the Middle East.
4 ☐ Hispanic ..... Mexican, Puerto Rican, Central or South American, or other Spanish culture or origins, regardless of race. (53-55)

I. Number of dependents: Do not include yourself. (Dependent = someone receiving at least one half of his or her support from you) .... (56)

J. U.S. veteran status: 0 ☐ Veteran 1 ☐ On active duty 2 ☐ Non-veteran or not applicable (57)

EDUCATION

K. High school last attended: .... (School Name) (City) (State) (58-59)

Year of graduation from high school: .... (60-61)

L. List in the table below all collegiate and graduate institutions you have attended including 2-year colleges. List chronologically, and include your doctoral institution as the last entry.

Institution Name	Location	Years Attended		Major Field (Use Specialties List)		Minor Field	Degree (if any)		
		From	To	Name	Number	Number	Title of Degree	Granted Mo.	Granted Yr.

M. Enter below the title of your doctoral dissertation and the most appropriate classification number and field. If a project report or a musical or literary composition (not a dissertation) is a degree requirement, please check box. ☐ (44)

Title .... Classify using Specialties List
.... Number Name of field
....

N. Name the department (or interdisciplinary committee, center, institute, etc.) and school or college of the university which supervised your doctoral program: .... (Department/Institute/Committee/Program) (School)

O. Name of your dissertation adviser: .... (Last Name) (First Name) (Middle Initial)

SURVEY OF EARNED DOCTORATES, Cont.

P. Please enter a "1" beside your primary source of support during graduate study. Enter a "2" beside your secondary source of support during graduate study. Check all other sources from which support was received.

58 ___ NSF Fellowship
59 ___ NSF Traineeship
60 ___ NIH Fellowship
61 ___ NIH Traineeship
62 ___ NDEA Fellowship
63 ___ Other HEW
64 ___ AEC/ERDA Fellowship
65 ___ NASA Traineeship
66 ___ GI Bill
67 ___ Other Federal support (specify) ....
68 ___ Woodrow Wilson Fellowship
69 ___ Other U.S. national fellowship (specify) ....
70 ___ University Fellowship
71 ___ Teaching Assistantship
72 ___ Research Assistantship
73 ___ Educational fund of industrial or business firm
74 ___ Other institutional funds (specify) ....
75 ___ Own earnings
76 ___ Spouse's earnings
77 ___ Family contributions
78 ___ Loans (NDSL direct)
79 ___ Other loans
80 ___ Other (specify) ....

Q. Please check the space which most fully describes your status during the year immediately preceding the doctorate.

0 ☐ Held fellowship
1 ☐ Held assistantship
2 ☐ Held own research grant
3 ☐ Not employed
4 ☐ Part-time employed

Full-time Employed in: (Other than 0, 1, 2)
5 ☐ College or university, teaching
6 ☐ College or university, non-teaching
7 ☐ Elem. or sec. school, teaching
8 ☐ Elem. or sec. school, non-teaching
9 ☐ Industry or business
(11) ☐ Other (specify) ....

(12) ☐ Any other (specify) .... (9)

R. How many years (full-time equivalent basis) of professional work experience did you have prior to the doctorate? (include assistantships as professional experience) .... (10-11)

POSTGRADUATION PLANS

S. How well defined are your postgraduation plans?
0 ☐ Have signed contract or made definite commitment
1 ☐ Am negotiating with a specific organization, or more than one
2 ☐ Am seeking appointment but have no specific prospects
3 ☐ Other (specify) .... (12)

T. What are your immediate postgraduation plans?
0 ☐ Postdoctoral fellowship?
1 ☐ Postdoctoral research associateship?
2 ☐ Traineeship?
3 ☐ Other study (specify) ....
} Go to Item "U"
4 ☐ Employment (other than 0, 1, 2, 3)
5 ☐ Military service?
6 ☐ Other (specify).................. (13)
} Go to Item "V"

U. If you plan to be on a postdoctoral fellowship, associateship, traineeship or other study

What will be the field of your postdoctoral study?
Classify using Specialties List.
Number .... Field .... (14-16)

What will be the primary source of support?
0 ☐ U.S. Government
1 ☐ College or university
2 ☐ Private foundation
3 ☐ Nonprofit, other than private foundation
4 ☐ Other (specify) .... (17)
6 ☐ Unknown
Go to Item "W"

V. If you plan to be employed, enter military service, or other—What will be the type of employer?
0 ☐ 4-year college or university other than medical school
1 ☐ Medical school
2 ☐ Jr. or community college
3 ☐ Elem. or sec. school
4 ☐ Foreign government
5 ☐ U.S. Federal government
6 ☐ U.S. state government
7 ☐ U.S. local government
8 ☐ Nonprofit organization
9 ☐ Industry or business
(11) ☐ Self-employed
(12) ☐ Other (specify) .... (18)

Indicate *primary* work activity with "1" in appropriate box; *secondary* work activity (if any) with "2" in appropriate box.
0 ☐ Research and development
1 ☐ Teaching
2 ☐ Administration
3 ☐ Professional services to individuals
5 ☐ Other (specify).................. (19-20)

In what field will you be working?
Please enter number from Specialties List .... (21-23)

Go to Item "W"

W. What is the name and address of the organization with which you will be associated?

....
(Name of Organization)

....
(Street) (City, State) (Or Country if not U.S.) (24-29)

BACKGROUND INFORMATION

X. Please indicate, by circling the highest grade attained, the education of

		Elementary school	High school	College	Graduate		
your father:	none	1 2 3 4 5 6 7 8	9 10 11 12	1 2 3 4	MA, MD PhD	Postdoctoral	(30)
your mother	none	1 2 3 4 5 6 7 8	9 10 11 12	1 2 3 4	MA, MD PhD	Postdoctoral	(31)
	0	1 2 3	4 5	6 7	8 9	(11)	

Signature .... Date completed .... (32-34)

APPENDIX C

LETTER TO EVALUATORS

COMMITTEE ON AN ASSESSMENT OF QUALITY-RELATED CHARACTERISTICS OF RESEARCH-DOCTORATE PROGRAMS IN THE UNITED STATES

Established by the Conference Board of Associated Research Councils

Office of the Staff Director /
National Research Council /
2101 Constitution Avenue, N.W. / Washington, D.C. 20418

April 14, 1981

Dear

As you may already know, our committee has undertaken an assessment of research-doctorate programs in U.S. universities. The study is examining approximately 2,650 programs in 31 fields in the arts and humanities, biological sciences, engineering, physical and mathematical sciences, and social sciences. A study prospectus is provided on the reverse of this page. You have been selected from a faculty list furnished by your institution to evaluate programs offering research-doctorates in the field of Chemical Engineering.

On the first page of the attached form is a list of the 79 programs that are being evaluated in this field. These programs produce more than 90 percent of the doctorate recipients in the field. In order to keep the task manageable, you are being asked to consider a randomly selected subset of 50 of these programs. These are designated with an asterisk in the list on the next page and are presented in random sequence on the evaluation sheets that follow. Please read the accompanying instructions carefully before attempting your evaluations.

We ask that you complete the attached survey form and return it in the enclosed envelope within the next three weeks. The evaluations you and your colleagues render will constitute an important component of this study. Your prompt attention to this request will be very much appreciated by our committee.

Sincerely,

Gardner Lindzey

Lyle Jones
For the Study Committee

Enclosures

COMMITTEE MEMBERS
Lyle V. Jones, Co-Chairman
Gardner Lindzey, Co-Chairman
Paul A. Albrecht
Marcus Alexis
Robert M. Bock
Philip E. Converse
James H. M. Henderson
Ernest S. Kuh
Winfred P. Lehmann
Saunders Mac Lane
Nancy S. Milburn
Lincoln E. Moses
James C. Olson
Kumar Patel
Michael J. Pelczar, Jr.
Jerome B. Schneewind
Duane C. Spriestersbach
Harriet A. Zuckerman

RESEARCH-DOCTORATE PROGRAMS IN THE FIELD OF CHEMICAL ENGINEERING

(* DESIGNATES THE PROGRAMS WHICH YOU ARE ASKED TO EVALUATE ON THE FOLLOWING PAGES.)

INSTITUTION - DEPARTMENT/ACADEMIC UNIT

UNIVERSITY OF AKRON - CHEMICAL ENGINEERING
* AUBURN UNIVERSITY - CHEMICAL ENGINEERING
* BRIGHAM YOUNG UNIVERSITY - CHEMICAL ENGINEERING
CALIFORNIA INSTITUTE OF TECHNOLOGY - CHEMICAL ENGINEERING
* UNIVERSITY OF CALIFORNIA, BERKELEY - CHEMICAL ENGINEERING
* UNIVERSITY OF CALIFORNIA, LOS ANGELES - ENGINEERING AND APPLIED SCIENCE
* CARNEGIE-MELLON UNIVERSITY - CHEMICAL ENGINEERING
CASE WESTERN RESERVE UNIVERSITY - CHEMICAL ENGINEERING
CATHOLIC UNIVERSITY OF AMERICA - CHEMICAL ENGINEERING
UNIVERSITY OF CINCINNATI - CHEMICAL ENGINEERING
CUNY, THE GRADUATE SCHOOL - ENGINEERING
CLARKSON COLLEGE OF TECHNOLOGY - CHEMICAL ENGINEERING
* CLEMSON UNIVERSITY - CHEMICAL ENGINEERING
UNIVERSITY OF COLORADO, BOULDER - CHEMICAL ENGINEERING
* COLUMBIA UNIV-GRAD SCHOOL OF ARTS & SCI - CHEMICAL ENGINEERING AND APPLIED CHEMISTRY
* UNIVERSITY OF CONNECTICUT, STORRS - CHEMICAL ENGINEERING
* CORNELL UNIVERSITY, ITHACA - CHEMICAL ENGINEERING
* UNIVERSITY OF DELAWARE, NEWARK - CHEMICAL ENGINEERING
* GEORGIA INSTITUTE OF TECHNOLOGY - CHEMICAL ENGINEERING
* UNIVERSITY OF HOUSTON - CHEMICAL ENGINEERING
* UNIVERSITY OF IDAHO, MOSCOW - CHEMICAL ENGINEERING
* ILLINOIS INSTITUTE OF TECHNOLOGY - CHEMICAL ENGINEERING
* UNIV OF ILLINOIS AT URBANA-CHAMPAIGN - CHEMICAL ENGINEERING
IOWA STATE UNIVERSITY, AMES - CHEMICAL ENGINEERING
* KANSAS STATE UNIVERSITY, MANHATTAN - CHEMICAL ENGINEERING
* UNIVERSITY OF KANSAS - CHEMICAL AND PETROLEUM ENGINEERING
* UNIVERSITY OF KENTUCKY - CHEMICAL ENGINEERING
LEHIGH UNIVERSITY - CHEMICAL ENGINEERING
* LOUISIANA STATE UNIVERSITY, BATON ROUGE - CHEMICAL ENGINEERING
* UNIVERSITY OF MARYLAND, COLLEGE PARK - CHEMICAL AND NUCLEAR ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY - CHEMICAL ENGINEERING
* UNIVERSITY OF MASSACHUSETTS, AMHERST - CHEMICAL ENGINEERING
* MICHIGAN STATE UNIVERSITY, EAST LANSING - CHEMICAL ENGINEERING
* UNIVERSITY OF MICHIGAN, ANN ARBOR - CHEMICAL ENGINEERING
* UNIVERSITY OF MINNESOTA - CHEMICAL ENGINEERING AND MATERIALS SCIENCE
* UNIVERSITY OF MISSOURI, COLUMBIA - CHEMICAL ENGINEERING
* UNIVERSITY OF MISSOURI, ROLLA - CHEMICAL ENGINEERING
MONTANA STATE UNIVERSITY, BOZEMAN - CHEMICAL ENGINEERING
* NEW JERSEY INSTITUTE OF TECHNOLOGY - CHEMISTRY AND CHEMICAL ENGINEERING
NORTH CAROLINA STATE UNIVERSITY, RALEIGH - CHEMICAL ENGINEERING
* NORTHWESTERN UNIVERSITY - CHEMICAL ENGINEERING
* UNIVERSITY OF NOTRE DAME - CHEMICAL ENGINEERING
* OHIO STATE UNIVERSITY - CHEMICAL ENGINEERING
* OKLAHOMA STATE UNIVERSITY, STILLWATER - CHEMICAL ENGINEERING
* UNIVERSITY OF OKLAHOMA - CHEMICAL ENGINEERING AND MATERIALS SCIENCE
* OREGON STATE UNIVERSITY, COVALLIS - CHEMICAL ENGINEERING
* PENNSYLVANIA STATE UNIVERSITY - CHEMICAL ENGINEERING
* UNIVERSITY OF PENNSYLVANIA - CHEMICAL ENGINEERING
* UNIVERSITY OF PITTSBURGH - CHEMICAL AND PETROLEUM ENGINEERING
POLYTECHNIC INSTITUTE OF NEW YORK - CHEMICAL ENGINEERING

PRINCETON UNIVERSITY - CHEMICAL ENGINEERING
PURDUE UNIVERSITY, WEST LAFAYETTE - CHEMICAL ENGINEERING
RENSSELAER POLYTECHNIC INSTITUTE - CHEMICAL AND ENVIRONMENTAL ENGINEERING
* UNIVERSITY OF RHODE ISLAND - CHEMICAL ENGINEERING
RICE UNIVERSITY - CHEMICAL ENGINEERING
* UNIVERSITY OF ROCHESTER - CHEMICAL ENGINEERING
* RUTGERS UNIVERSITY, NEW BRUNSWICK - CHEMICAL AND BIOCHEMICAL ENGINEERING
UNIVERSITY OF SOUTHERN CALIFORNIA - CHEMICAL ENGINEERING
STANFORD UNIVERSITY - CHEMICAL ENGINEERING
UNIVERSITY OF FLORIDA, GAINESVILLE - CHEMICAL ENGINEERING
* SUNY AT BUFFALO - CHEMICAL ENGINEERING
* STEVENS INSTITUTE OF TECHNOLOGY - CHEMISTRY/CHEMICAL ENGINEERING
SYRACUSE UNIVERSITY - CHEMICAL ENGINEERING AND MATERIALS SCIENCE
* SUNY, COL OF ENVIR SCI & FORESTRY (SYRACUSE) - PAPER SCIENCE AND ENGINEERING
* UNIVERSITY OF TENNESSEE, KNOXVILLE - CHEMICAL, METALLURGICAL, AND POLYMER ENGINEERING
TEXAS A&M UNIVERSITY - CHEMICAL ENGINEERING
UNIVERSITY OF TEXAS, AUSTIN - CHEMICAL ENGINEERING
* TULANE UNIVERSITY - CHEMICAL ENGINEERING
* UNIVERSITY OF TULSA - CHEMICAL ENGINEERING
* UNIVERSITY OF UTAH, SALT LAKE CITY - CHEMICAL ENGINEERING
VANDERBILT UNIVERSITY - CHEMICAL ENGINEERING
UNIVERSITY OF VIRGINIA - CHEMICAL ENGINEERING
* WASHINGTON UNIVERSITY (ST LOUIS) - CHEMICAL ENGINEERING
* UNIVERSITY OF WASHINGTON, SEATTLE - CHEMICAL ENGINEERING
* WAYNE STATE UNIVERSITY - CHEMICAL ENGINEERING
* WEST VIRGINIA UNIVERSITY - CHEMICAL ENGINEERING
* UNIVERSITY OF WISCONSIN, MADISON - CHEMICAL ENGINEERING
* WORCESTER POLYTECHNIC INSTITUTE - CHEMICAL ENGINEERING
YALE UNIVERSITY - ENGINEERING AND APPLIED SCIENCE

INSTRUCTIONS

At the top of the next page please provide the information requested on the highest degree you hold and your current field of specialization. You may be assured that all information you furnish on the survey form is to be used for purposes of statistical description only and that the confidentiality of your responses will be protected.

On the pages that follow you are asked to judge 50 programs (presented in random sequence) that offer the research-doctorate. Each program is to be evaluated in terms of: (1) scholarly quality of program faculty: (2) effectiveness of program in educating research scholars/scientists: and (3) change in program quality in the last five years (see below). Although the assessment is limited to these factors, our committee recognizes that other factors are relevant to the quality of doctoral programs, and that graduate programs serve important purposes in addition to that of educating doctoral candidates.

A list of the faculty members signficantly involved in each program, the name of the academic unit in which the program is offered, and the number of doctorates awarded in that program during the last five years have been printed on the survey form (whenever available). Although this information has been furnished to us by the institution and is believed to be accurate, it has not been verified by our study committee and may have a few omissions, misspellings, or other errors.

Before marking your responses on the survey form, you may find it helpful to look over the full set of programs you are being asked to evaluate. In making your judgments about each program, please keep in mind the following instructions:

(1) Scholarly Quality of Program Faculty. Check the box next to the term that most closely corresponds to your judgment of the quality of faculty in the research-doctorate program described. Consider only the scholarly competence and achievements of the faculty. It is suggested that no more than five programs be designated “distinguished.”

(2) Effectiveness of Program in Educating Research Scholars/Scientists. Check the box next to the term that most closely corresponds to your judgment of the doctoral program's effectiveness in educating research scholars/scientists. Consider the accessibility of the faculty, the curricula, the instructional and research facilities, the quality of graduate students, the performance of the graduates, and other factors that contribute to the effectiveness of the research-doctorate program.

(3) Change in Program Quality in Last Five Years. Check the box next to the term that most closely corresponds to your estimate of the change that has taken place in the research-doctorate program in the last five years. Consider both the scholarly quality of the program faculty and the effectiveness of the program in educating research scholars/scientists. Compare the quality of the program today with its quality five years ago--not the change in the program's relative standing among other programs in the field.

In assessing each of these factors, mark the category “Don't know well enough to evaluate” if you are unfamiliar with that aspect of the program. It is quite possible that for some programs you may be knowledgeable about the scholarly quality of the faculty, but not about the effectiveness of the program or change in program quality.

For each of the programs identified, you are also asked to indicate the extent to which you are familiar with the work of members of the program faculty. For example, if you recognize only a very small fraction of the faculty, you should mark the category “Little or no familiarity.”

Please be certain that you have provided a set of responses for each of the programs identified on the following pages. The fully completed survey form should be returned in the enclosed envelope to:

Committee on an Assessment of Quality-Related Characteristics of Research-Doctorate Programs

National Research Council, JH-638

2101 Constitution Avenue, N.W.

Washington, D.C. 20418

Our committee will be most appreciative of your thoughtful assessment of these research-doctorate programs. We welcome any comments you may wish to append to the completed survey form.

PLEASE PROVIDE THE FOLLOWING INFORMATION: **FORM NO. 3606-75**

HIGHEST DEGREE YOU HOLD: ( ) PH.D. ( ) OTHER (PLEASE SPECIFY): ____________

YEAR OF HIGHEST DEGREE: ________

INSTITUTION OF HIGHEST DEGREE: ____________

YOUR CURRENT FIELD OF SPECIALIZATION (CHECK ONLY ONE):

A. ( ) AERO-/ASTRONAUTICAL ENGR.	K. ( ) MATERIALS SCIENCE
B. ( ) AGRICULTURAL ENGINEERING	L. ( ) MECHANICAL ENGINEERING
C. ( ) BIOMEDICAL ENGINEERING	M. ( ) METALLURGY
D. ( ) CHEMICAL ENGINEERING	N. ( ) NUCLEAR ENGINEERING
E. ( ) CIVIL ENGINEERING	O. ( ) OPERATIONS RESEARCH
F. ( ) COMPUTER ENGINEERING	P. ( ) PETROLEUM ENGINEERING
G. ( ) ELECTRICAL ENGINEERING	Q. ( ) SANITARY/ENVIRONMENTAL ENGR.
H. ( ) ELECTRONICS	R. ( ) SYSTEMS DESIGN/SYSTEMS SCIENCE
I. ( ) ENGINEERING MECHANICS	S. ( ) ENGINEERING, GENERAL
J. ( ) INDUSTRIAL ENGINEERING	T. ( ) OTHER (PLEASE SPECIFY): ____________

INSTITUTION: **UNIVERSITY OF MISSOURI, ROLLA** **FORM NO. 3606-01**
DEPARTMENT/ACADEMIC UNIT: **CHEMICAL ENGINEERING**
TOTAL DOCTORATES AWARDED 1976-80: 15

PROFESSORS: David AZBEL, Orrin K. CROSSER, Marshall E. FINDLEY, James W. JOHNSON, Gary K. PATTERSON, X. B. REED Jr, Raymond C. WAGGONER, H. K. YASUDA

ASSOCIATE PROFESSORS: A. I. LIAPIS, David B. MANLEY, Robert A. MOLLENKAMP, Bruce E. POLING

ASSISTANT PROFESSORS: Neil L. BOOK, Partho NEOGI, Oliver C. SITTON

SCHOLARLY QUALITY OF PROGRAM FACULTY

1. ( ) DISTINGUISHED
2. ( ) STRONG
3. ( ) GOOD
4. ( ) ADEQUATE
5. ( ) MARGINAL
6. ( ) NOT SUFFICIENT FOR DOCTORAL EDUCATION

0. ( ) DON'T KNOW WELL ENOUGH TO EVALUATE

FAMILIARITY WITH WORK OF PROGRAM FACULTY

1. ( ) CONSIDERABLE FAMILIARITY
2. ( ) SOME FAMILIARITY
3. ( ) LITTLE OR NO FAMILIARITY

EFFECTIVENESS OF PROGRAM IN EDUCATING RESEARCH SCHOLARS/SCIENTISTS

1. ( ) EXTREMELY EFFECTIVE
2. ( ) REASONABLY EFFECTIVE
3. ( ) MINIMALLY EFFECTIVE
4. ( ) NOT EFFECTIVE

0. ( ) DON'T KNOW WELL ENOUGH TO EVALUATE

CHANGE IN PROGRAM QUALITY IN LAST FIVE YEARS

1. ( ) BETTER THAN FIVE YEARS AGO
2. ( ) LITTLE OR NO CHANGE IN LAST FIVE YEAR
3. ( ) POORER THAN FIVE YEARS AGO

0. ( ) DON'T KNOW WELL ENOUGH TO EVALUATE

INSTITUTION: UNIVERSITY OF OKLAHOMA **FORM NO. 3606-02**
DEPARTMENT/ACADEMIC UNIT: CHEMICAL ENGINEERING AND MATERIALS SCIENCE
TOTAL DOCTORATES AWARDED 1976-80: 16

PROFESSORS: Arthur William ALDAG Jr, Robert Jay BLOCK, Alfred CLARK, Raymond Deweitt DANIELS, Carl Edwin LOCKE, Cedomir M. SLIEPCEVICH, Kenneth Earl STARLING, Francis Mark TOWNSEND, William Reid UPTHEGROVE

ASSOCIATE PROFESSORS: John Michael RADOVICH, Samir Salim SOFER

ASSISTANT PROFESSORS: Lloyd L. LEE

SCHOLARLY QUALITY OF PROGRAM FACULTY

1. ( ) *DISTINGUISHED*
2. ( ) *STRONG*
3. ( ) *GOOD*
4. ( ) *ADEQUATE*
5. ( ) *MARGINAL*
6. ( ) *NOT SUFFICIENT FOR DOCTORAL EDUCATION*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

FAMILIARITY WITH WORK OF PROGRAM FACULTY

1. ( ) *CONSIDERABLE FAMILIARITY*
2. ( ) *SOME FAMILIARITY*
3. ( ) *LITTLE OR NO FAMILIARITY*

EFFECTIVENESS OF PROGRAM IN EDUCATING RESEARCH SCHOLARS/SCIENTISTS

1. ( ) *EXTREMELY EFFECTIVE*
2. ( ) *REASONABLY EFFECTIVE*
3. ( ) *MINIMALLY EFFECTIVE*
4. ( ) *NOT EFFECTIVE*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

CHANGE IN PROGRAM QUALITY IN LAST FIVE YEARS

1. ( ) *BETTER THAN FIVE YEARS AGO*
2. ( ) *LITTLE OR NO CHANGE IN LAST FIVE YEAR*
3. ( ) *POORER THAN FIVE YEARS AGO*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

INSTITUTION: OKLAHOMA STATE UNIVERSITY, STILLWATER **FORM NO. 3606-03**
DEPARTMENT/ACADEMIC UNIT: CHEMICAL ENGINEERING
TOTAL DOCTORATES AWARDED 1976-80: 15

PROFESSORS: K. J. BELL, B. L. CRYNES, J. H. ERBAR, R. N. MADDOX, R. L. ROBINSON

ASSISTANT PROFESSORS: G. L. FOUTCH, A. G. HILL, M. T. JAHANGIRIANS, J. WAGNER

SCHOLARLY QUALITY OF PROGRAM FACULTY

1. ( ) *DISTINGUISHED*
2. ( ) *STRONG*
3. ( ) *GOOD*
4. ( ) *ADEQUATE*
5. ( ) *MARGINAL*
6. ( ) *NOT SUFFICIENT FOR DOCTORAL EDUCATION*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

FAMILIARITY WITH WORK OF PROGRAM FACULTY

1. ( ) *CONSIDERABLE FAMILIARITY*
2. ( ) *SOME FAMILIARITY*
3. ( ) *LITTLE OR NO FAMILIARITY*

EFFECTIVENESS OF PROGRAM IN EDUCATING RESEARCH SCHOLARS/SCIENTISTS

1. ( ) *EXTREMELY EFFECTIVE*
2. ( ) *REASONABLY EFFECTIVE*
3. ( ) *MINIMALLY EFFECTIVE*
4. ( ) *NOT EFFECTIVE*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

CHANGE IN PROGRAM QUALITY IN LAST FIVE YEARS

1. ( ) *BETTER THAN FIVE YEARS AGO*
2. ( ) *LITTLE OR NO CHANGE IN LAST FIVE YEAR*
3. ( ) *POORER THAN FIVE YEARS AGO*

0. ( ) *DON'T KNOW WELL ENOUGH TO EVALUATE*

APPENDIX D

THE ARL LIBRARY INDEX

(SOURCE: Mandel, Carol A., and Mary P. Johnson, ARL Statistics 1979-80, Association of Research Libraries, Washington, D.C., 1980, pp. 23-24.)

The data tables at the beginning of the ARL Statistics display figures reported by ARL member libraries in 22 categories that, with the exception of the measures of interlibrary loan activity, describe the size of ARL libraries in terms of holdings, expenditures, and personnel. The rank order tables provide an overview of the ranges, and medians for 14 of these categories, or variables, among ARL academic libraries as well as quantitatively comparing each library with other ARL member institutions. However, none of the 22 variables provides a summary measure of a library's relative size within ARL or characterizes the ARL libraries as a whole.

The ARL Library Index has been derived as a means of providing this summary characterization, permitting quantitative comparisons of ARL academic libraries, singly and as a group, with other academic libraries. Through the use of statistical techniques known as factor analysis, it can be determined that 15 of the variables reported to ARL are more closely correlated with each other than with other categories. Within this group of 15 variables, some are subsets or combinations of materials. When the subsets and combinations are eliminated, 10 variables emerge as characteristic of ARL libary size. These are: volumes held, volumes added (gross), microform units held, current serials received, expenditures for library materials, expenditures for binding, total salary and wage expenditures, other operating expenditures, number of professional staff, and number of nonprofessional staff.

These 10 categories delineate an underlying dimension, or factor, of library size. By means of principal component analysis, a technique that is a variant of factor analysis, it is possible to calculate the correlations of each of the variables with this hypothetical factor of library size. From this analysis a weight for each variable can be determined based on how closely that variable is correlated with the overall dimension of library size defined by all 10 categories. A high correlation indicates that much of the variation in ARL library size is accounted for by the variable in question, implying a characteristic in which ARL libraries are relatively alike. The component score coefficients, or weights, for the 1979-80 ARL academic library data are as follows:

Volumes held	.12108
Volumes added (gross)	.11940
Microforms held	.07509
Current serials received	.12253
Expenditures for library materials	.12553
Expenditures for binding	.11266
Expenditures for salaries and wages	.12581
Other operating expenditures	.10592
Number of professional staff	.12347
Number of nonprofessional staff	.11297

From these weights an individual library can compute an index score that will indicate its relative position among ARL libraries with respect to the overall factor of library size. The data for each of the 10 variables are converted to standard normal form and multiplied by the appropriate weight. The resulting scores are expressed in terms of the number of standard deviations above or below the mean index score for ARL academic libraries. Thus, the formula* for calculating a library's 1979-80 index score is as follows:

.12108	(log of volumes held - 6.2916)/.2172
+.11940	(log of volumes added gross - 4.8412)/.2025
+.07509	(log of microforms - 6.0950)/.1763
+.12253	(log of current serials - 4.3432)/.2341
+.12553	(log of expenditures for materials - 6.2333)/.1636
+.11266	(log of expenditures for binding - 5.0480)/.2475
+.12581	(log of total salaries - 6.4675)/.2103
+.10592	(log of operating expenditures - 5.6773)/.2635
+.12347	(log of professional staff - 1.8281)/.1968
+.11297	(log of nonprofessional staff - 2.1512)/.2046

The index scores for the 99 academic libraries that were members of ARL during 1979-80 are shown on the following page. It is important to emphasize that these scores are only a summary description of library size, distributing ARL libraries along a normal curve, based on 10 quantitative measures that are positively correlated with one another in ARL libraries. The scores are in no way a qualitative assessment of the collections, services, or operations of these libraries.

*For calculation on a hand calculator, the formula can be mathematically simplified to: (.55746 x log of volumes held) + (.58963 x log of volumes added gross) + (.42592 x log of microforms) + (.52341 x log of current serials) + (.76730 x log of expenditures for materials) + (.45519 x log of expenditures for binding) + (.59824 x log of total salries) + (.40197 x log of operating expenditures) + (.62739 x log of professional staff) + (.55215 x log of nonprofessional staff) -26.79765.

APPENDIX E

FACULTY RESEARCH SUPPORT

The names of National Science Foundation (NSF) research grant awardees were obtained from a file maintained by the NSF Division of Information Systems. The file provided to the committee covered all research grant awards made in FY1978, FY1979, and FY1980 and included the names of the principal investigator and co-principal investigators for each award. Also available from this file was information concerning the field of science/engineering of the research grant and the institution with which the investigator was affiliated. This information was used in identifying which research grant recipients were on the program faculty lists provided by institutional coordinators.

The names of National Institutes of Health (NIH) and Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) research grant recipients (principal investigators only) were obtained from the NIH Information for Management Planning, Analysis, and Coordination System. This system contains a detailed record of all applications and awards in the various training and research support programs of these agencies. For the purposes of this study, information analogous to that available from the NSF file was extended for FY1978-80 research grant awardees and their records were matched with the program faculty lists. Measure 13 constitutes the fraction of program faculty members who had received one or more research grant awards from NSF (including both principal investigators and co-principal investigators), NIH, or ADAMHA during the FY1978-80 period.

R&D EXPENDITURES

Total university expenditures for R&D activities are available from the NSF Survey of Scientific and Engineering Expenditures at Universities and Colleges. A copy of the survey form appears on the following pages.

NSF FORM 411 (Dec. 1979)

FORM APPROVED
OMB No. 99-R0279

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

SURVEY OF SCIENTIFIC AND ENGINEERING EXPENDITURES AT UNIVERSITIES AND COLLEGES, FY 1979

(Current and Capital Expenditures for Research, Development, and Instruction in the Sciences and Engineering)

Organizations are requested to complete and return this form to:

NATIONAL SCIENCE FOUNDATION
1800 G Street, N.W.
Washington, D.C. 20550
Attn: UNISG

This form should be returned by February 1, 1980. Your cooperation in returning the survey questionnaire promptly is very important.

Financial data are requested for your institution's 1979 fiscal year.

This information is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information you provide will be used for statistical purposes only. Your response is entirely voluntary and your failure to provide some or all of the information will in no way adversely affect your institution.

All financial data requested on this form should be reported in thousands of dollars; for example, an expenditure of $25,342 should be rounded to the nearest thousand dollars and reported as $25.

Where exact data are not available, estimates are acceptable. Your estimates will be better than ours.

Please correct if name or address has changed

(Includes aggregate data from 567 universities and colleges but excludes 19 university-administered FFRDC's)

Include data for branches and all organizational units of your institution, such as medical schools and agricultural experiment stations. Also include hospitals or clinics owned, operated, or controlled by universities, and integrated operationally with the clinical programs of your medical schools. Exclude data for federally funded research and development centers (FFRDC's). A separate questionnaire is included in this package if your institution administers an FFRDC. **If you have any questions please contact Jim Hoehn (202-634-4674).**

Please enter the beginning and ending dates of your institution's fiscal year for which you are reporting on this form:

_______________ through _______________

Please note in space below:
(1) Any suggestions to improve the design of the survey questionnaire, (2) any suggestions to improve the instructions, or (3) any comments on significant change in R&D in your institution.

(Attach additional sheets, if necessary.)

PLEASE TYPE OR PRINT NAME OF PERSON SUBMITTING THIS FORM	TITLE	AREA CODE	EXCH	NO.	EXT
NAME OF PERSON WHO PREPARED THIS SUBMISSION (If different from above)	TITLE	AREA CODE	EXCH	NO.	EXT

Please check and correct if necessary the name and address of your institution shown on the mailing label.	DATE

ITEM 1. CURRENT EXPENDITURES FOR SEPARATELY BUDGETED RESEARCH AND DEVELOPMENT (R&D) IN THE SCIENCES AND ENGINEERING, BY SOURCE OF FUNDS AND BASIC RESEARCH, FY 1979 (Include indirect costs)

ITEMS 1. & 2. INSTRUCTIONS

Separately budgeted research and development (R&D) includes all funds expended for activities specifically organized to produce research outcomes and commissioned by an agency either external to the institution or separately budgeted by an organizational unit within the institution. **Include** equipment purchased under research project awards as part of "current funds." Research funds subcontracted to outside organizations should also be included. **Exclude** training grants, public service grants, demonstration projects, etc.

Under a. **Federal Government.** Report grants and contracts for R&D by all agencies of the Federal Government including indirect costs from these sources.

Under b. **State and local governments.** Include funds for R&D from State, county, municipal, or other local governments and their agencies. Include here State funds which support R&D at agricultural experiment stations.

Under c. **Industry.** Include all grants and contracts for R&D from profitmaking organizations, whether engaged in production, distribution, research, service, or other activities. Do not include grants and contracts from nonprofit foundations financed by industry, which should be reported under **All other sources.**

Under d. **Institutional funds.** Report funds which your institution spent for R&D activities including indirect costs from the following sources: (1) General-purpose State or local government appropriations; (2) general-purpose grants from industry, foundations, or other outside sources; (3) tuition and fees; (4) endowment income. In addition, estimate your institution's contribution to unreimbursed indirect costs incurred in association with R&D projects financed by outside organizations, and mandatory cost sharing on Federal and other grants. To estimate unreimbursed indirect costs, many institutions use a university-wide negotiated indirect cost rate multiplied by the base (e.g., direct salaries and wages, etc.) minus actual indirect cost recoveries. If your institution now separately budgets what was previously classified as departmental research, these data should be included in line d.

Under e. **All other sources.** Include foundations and voluntary health agencies grants for R&D, as well as all other sources not elsewhere classified. Funds from foundations which are affiliated with or grant solely to your institution should be included under d. Institutional funds. Funds for R&D received from a health agency that is a unit of a State or local government should be reported under State and local governments. Also include gifts from individuals that are restricted by the donor to research.

Please exclude from your response any R&D expenditures in the fields of education, law, humanities, music, the arts, physical education, library science, and all other nonscience fields.

Source of funds		(1) Total R&D expenditures (Dollars in thousands)	(2) Basic research (Percent of column 1)
a. Federal Government	1110	$ 3,431,538	73.4 %
•b. State and local governments	1125	467,311	
c. Industry	1150	193,794	
d. Institutional funds	1160	716,241	
(1) Separately budgeted	1161	357,926	
(2) Underrecovery of indirect costs and cost sharing	1162	358,315	
•e. All other sources	1175	373,845	
f. TOTAL (sum of a through e)	1100	$ 5,182,729	68.5 %

Basic research is directed toward an increase of knowledge; it is research where the primary aim of the **investigator** is a fuller knowledge or understanding of the subject under study rather than a practical application thereof.

CONFIDENTIALITY

Information received from individual institutions in lines 1161 and 1162, or estimates for basic research expenditures, will **not** be published or released; only aggregate totals will appear in publications.

•Combined data cell (See instructions for b and e).

Total R&D expenditures reported in line 1100 column (1) and line 1400 column (1) should be the same.
Federally financed R&D expenditures reported in line 1100 column (1) and line 1400 column (2) should be the same.

ITEM 2. TOTAL AND FEDERALLY FINANCED EXPENDITURES FOR SEPARATELY BUDGETED RESEARCH AND DEVELOPMENT, BY FIELD OF SCIENCE, FY 1979 (Include indirect costs and equipment).

Field of science	Illustrative disciplines		(Dollars in thousands) (1) Total	(2) Federal
a. ENGINEERING (TOTAL)	Aeronautical, agricultural, chemical, civil, electrical, industrial, mechanical, metallurgical, mining, nuclear, petroleum, bio- and biomedical, energy, textile, architecture	1410	$ 715,454	$ 474,866
b. PHYSICAL SCIENCES (TOTAL)		1420	559,566	448,992
(1) Astronomy	Astrophysics, optical and radio, x-ray, gamma-ray, neutrino	1421	39,026	26,862
(2) Chemistry	Inorganic, organo-metallic, organic, physical, analytical, pharmaceutical, polymer science (exclude biochemistry)	1422	204,062	154,031
(3) Physics	Acoustics, atomic and molecular, condensed matter, elementary particles, nuclear structure, optics, plasma	1423	275,680	236,872
(4) Other	Used for multidisciplinary projects within physical sciences and for disciplines not requested separately	1424	40,798	31,227
c. ENVIRONMENTAL SCIENCES (TOTAL)	ATMOSPHERIC SCIENCES: Aeronomy, solar weather modification, meteorology, extra-terrestrial atmospheres GEOLOGICAL SCIENCES: Engineering geophysics, geology, geodesy, geomagnetism, hydrology, geochemistry, paleomagnetism, paleontology, physical geography, cartography, seismology, soil sciences OCEANOGRAPHY: Chemical, geological, physical, marine geophysics, marine biology, biological oceanography	1430	429,129	307,493
d. MATHEMATICAL AND COMPUTER SCIENCES (TOTAL)		1440	145,087	94,534
(1) Mathematics	Algebra, analysis, applied mathematics, foundations and logic, geometry, numerical analysis, statistics, topology	1441	65,637	49,043
(2) Computer sciences	Design, development, and application of computer capabilities to data storage and manipulation, information science	1442	79,450	45,491
e. LIFE SCIENCES (TOTAL)		1450	2,814,824	1,810,729
(1) Biological sciences	Anatomy, biochemistry, biophysics, biogeography, ecology, embryology, entomology, genetics, immunology, microbiology, nutrition, parasitology, pathology, pharmacology, physical anthropology, physiology, botany, zoology	1451	949,993	690,805
(2) Agricultural	Agricultural chemistry, agronomy, animal science, conservation, dairy science, plant science, range science, wildlife	1452	565,697	168,849
(3) Medical	Anesthesiology, cardiology, endocrinology, gastroenterology, hematology, neurology, obstetrics, opthalmology, preventive medicine and community health, psychiatry, radiology, surgery, veterinary medicine, dentistry, pharmacy	1453	1,214,442	890,612
(4) Other	Used for multidisciplinary projects within life sciences	1454	84,692	60,463
f. PSYCHOLOGY (TOTAL)	Animal behavior, clinical, educational, experimental, human development and personality, social	1460	99,732	72,256
g. SOCIAL SCIENCES (TOTAL)		1470	290,057	153,674
(1) Economics	Econometrics, international, industrial, labor, agricultural, public finance and fiscal policy	1471	85,415	40,641
(2) Political science	Regional studies, comparative government, international relations, legal systems, political theory, public administration	1472	39,029	18,452
(3) Sociology	Comparative and historical, complex organizations, culture and social structure, demography, group interactions, social problems and welfare, theory	1473	72,669	46,739
(4) Other	History of science, cultural anthropology, linguistics, socio-economic geography	1474	92,944	47,842
h. OTHER SCIENCES, n.e.c. (TOTAL)*	To be used when the multidisciplinary and interdisciplinary aspects make the classification under one primary field impossible	1480	128,880	68,994
i. TOTAL (SUM of a through h) Check to insure that column totals are identical with data reported in item 1.		1400	5,182,729	3,431,538

*PLEASE EXCLUDE FROM YOUR RESPONSE ANY R&D EXPENDITURES IN THE FIELDS OF EDUCATION, LAW, HUMANITIES, MUSIC, THE ARTS, PHYSICAL EDUCATION, LIBRARY SCIENCE, AND ALL OTHER NONSCIENCE FIELDS.

ITEM 3. CAPITAL EXPENDITURES FOR SCIENTIFIC AND ENGINEERING FACILITIES AND EQUIPMENT FOR RESEARCH, DEVELOPMENT, AND INSTRUCTION, BY FIELD OF SCIENCE AND SOURCE OF FUNDS, FY 1979

ITEM 3. INSTRUCTIONS

Report funds for facilities which were in process or completed during FY 1979. Expenditures for administration buildings, steam plants, residence halls, and other such facilities should be excluded unless utilized principally for research, development, or instruction in engineering or in the sciences. Land costs should be **excluded.** Exclude small equipment items in your current fund account costing approximately **$300** or less per unit or as recommended by the Joint Accounting Group (JAG) or as determined by your institutional policy; these are to be reported under items 1 and 2.

Facilities and equipment expenditures **include** the following: (a) Fixed equipment such as built-in equipment and furnishings; (b) movable scientific equipment such as oscilloscopes and pulse-height analyzers; (c) movable furnishings such as desk; (d) architect's fees, site work, extension of utilities, and the building costs of service functions such as integral cafeterias and bookstores of a facility; (e) facilities constructed to house separate components such as medical schools and teaching hospitals; and (f) special separate facilities used to house scientific apparatus such as accelerators, oceanographic vessels, and computers.

Field of science		(Dollars in thousands)		
Total (1)	Federal (2)	All other sources (3)		
a. Engineering.	1710	$ 95,399	$ 22,060	$ 73,339
b. Physical sciences.	1720	64,551	32,439	32,112
c. Environmental sciences	1730	25,293	8,970	16,323
d. Mathematical and computer sciences	1740	27,465	3,049	24,416
e. Life sciences	1750	456,477	92,567	363,910
f. Psychology	1760	7,803	1,767	6,036
g. Social sciences	1770	20,932	2,069	18,863
h. Other sciences, n.e.c.	1780	31,984	5,054	26,930
i. **Total (sum of a through h)**.	**1700**	$ 729,904	$ 167,975	$ 561,929

APPENDIX F

DATA ON PUBLICATION RECORDS

Data for these measures were provided by a subcontractor, Computer Horizons, Inc. A detailed description of the derivation of these measures and examples of their use is given in:

Francis Narin, Evaluative Bibliometrics: The Use of Publications and Citations Analysis in the Evaluation of Scientific Activity, Report to the National Science Foundation, March 1976.

The following pages have been excerpted from Chapter VI and Chapter VII of this report and describe operational considerations in compiling the publication records included here (measure 15) and the methodology used in determining the "influence" of published articles (measure 16).

VI. OPERATIONAL CONSIDERATIONS

A. Basics of Publication and Citation Analysis

The first section of this chapter discusses the major stages of publication and citation analysis techniques in evaluative bibliometrics. Later sections of the chapter consider publication and citation count parameters in further detail, including discussions of data bases, of field-dependent characteristics of the literature, and of some cautions and hazards in performing citation analyses for individual scientists.

The basic stages which must be kept in mind when doing a publication or citation analysis are briefly summarized in Figure 6-1.

1. Type of Publication

For a publication analysis the fundamental decision is which type of publication to count. A basic count will include all regular scientific articles. However, notes are often counted since some engineering and other journals often contain notes with significant technical content. Reviews may be included. Letters-to-the-editor must also be considered as a possible category for inclusion, since some important journals are sometimes classified as letter journals. For example, publications in Physical Review Letters were classified as letters by the Science Citation Index prior to 1970, although they are now classified as articles.

For most counts in the central core of the scientific literature, articles, notes and reviews are used as a measure of scientific output. When dealing with engineering fields, where many papers are presented at meetings accompanied by reprints and published proceedings, meeting presentations must also be considered. In some applied fields, i.e., agriculture, aero-space and nuclear engineering, where government support has been particularly comprehensive, the report literature may also be important. Unfortunately, reports generally contain few references, and citations to them are limited so they are not amenable to the normal citation analyses.

Books, of course, are a major type of publication, especially in the social sciences where they are often used instead of a series of journal articles. In bibliometrics a weighting of n articles equal to one book is frequently used; no uniformly acceptable value of n is available. A few of the papers discussed in Chapter V contain such measures.

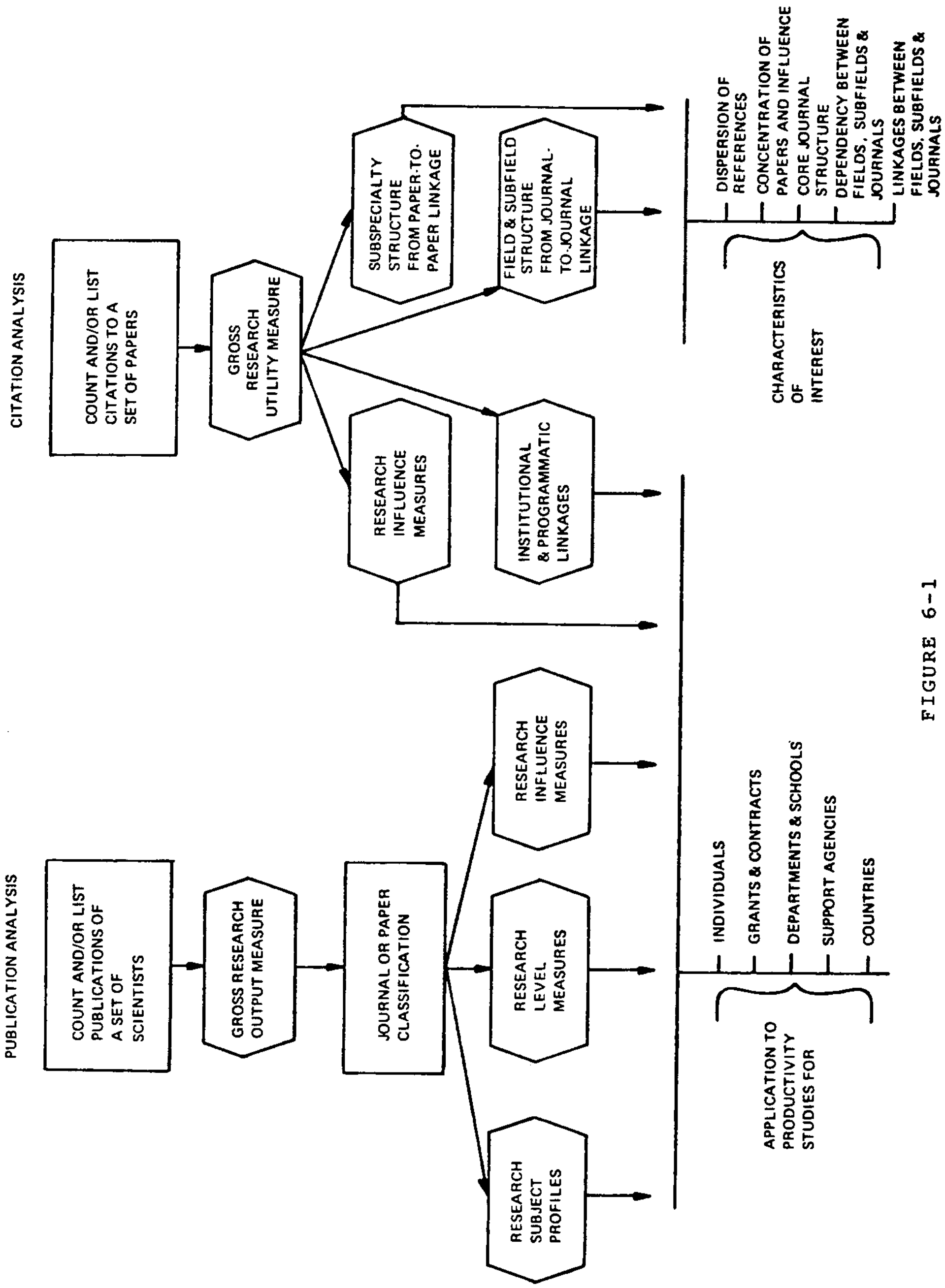

FIGURE 6-1

STAGES OF PUBLICATION AND CITATION ANALYSIS

2. Time Spans

A second important decision in making a publication count is to select the time span of interest. In the analysis of the publications of an institution a fixed time span, usually one year or more, is most appropriate. In comparing publication histories of groups of scientists, their professional ages (normally defined as years since attaining the PhD degree) must be comparable so that the build-up of publications at the beginning of a career or the decline at the end will not complicate the results. A typical scientist's first publication appears soon after his dissertation; if he continued working as a scientist, his publications may continue for thirty or more years.

The accurate control of the time span of a count is not as trivial as it might seem. Normally, the publication count is made from secondary sources (abstracting or indexing services) rather than from scanning the publications individually. Since most abstracting and indexing sources have been expanding their coverage over time, any publication count covering more than a few years must give careful consideration to changes in coverage. Furthermore, the timeliness of the secondary sources varies widely, with sources dependent on outside abstractors lagging months or even years behind. Since these abstracting lags may depend upon language, field and country of origin, they are a particular problem in international publication counts.

The Science Citation Index is one of the most current secondary sources, with some 80% to 90% of a given year's publications in the SCI for that year.

Of course, no abstracting or indexing service can be perfect, since some journals are actually published months after their listed publication dates. Nevertheless, variations in timeliness are large from one service to another.

3. Comprehensiveness of Source Coverage

An important consideration in making a publication count is the comprehensiveness of the source coverage. Most abstracting and indexing sources cover some journals completely, cover other journals selectively, and omit some journals in their field of interest. The Science Citation Index is an exception in that it indexes each and every important entry from any journal it covers. This is one of the major advantages in using the SCI as a data base. Chemical Abstracts and Biological Abstracts have a group of journals which they abstract completely, coupled with a much larger set of journals from which they abstract selectively, based upon the appropriateness of the article to the subject coverage. In some cases the abstractor or indexer may make a quality judgment, based on his estimate of the importance or the quality of the article or upon his knowledge of whether similar information has appeared elsewhere; Excerpta Medica is a comprehensive abstracting service for which articles are included only if they meet the indexers' quality criteria.

Some data on the extent of coverage of the major secondary sources is presented in Section D of this chapter.

4. Multiple Authorships and Affiliations

Attributing credits for multiple authorships and affiliations is a significant problem in publication and citation analysis. In some scientific papers the authors are listed alphabetically; in others the first author is the primary author; still others use different conventions. These conventions have been been discussed by Crane[1] and by other social scientists.[2] There does not seem to be any reasonable way to deal with the attribution problem, except to attribute a fraction of a publication to each of the authors. For example, an article which has three authors would have one-third of an article attributed to each author. The amount of multiple authorship unfortunately differs from country to country and from field to field. Several studies have investigated the problem, but no comprehensive data exists.[3]

Multiple authorship takes on particular importance when counting an individual's publications since membership on a large research team may lead to a single scientist being a coauthor of ten or more publications per year. This number of publications is far in excess of the normal publication rate of one to two articles per year per scientist.

Multiple authorship problems arise less often in institutional publication counts since there are seldom more than one or two institutions involved in one publication.

A particularly vexing aspect of multiple authorship is the first author citation problem: almost all citations are to the first author in a multi-authored publication. As a result, a researcher who is second author of five papers may receive no

[1] Diana Crane, “Social Structure in a Group of Scientists: A Test of the ‘Invisible College' Hypothesis,” American Sociological Review 34 (June 1969):335-352.

[2] James E. McCauly, “Multiple Authorship,” Science 141 (August 1963):579. Beverly L. Clark, “Multiple Authorship Trends in Scientific Papers,” Science 143 (February 1964):822-824.

[3] Harriet Zuckerman, “Nobel Laureates in Science: Patterns of Productivity, Collaboration, and Authorship,” American Sociolgoical Review 32 (June 1967):391-403.

citations under his own name, even though the papers he co-authored may be highly cited. Because of this, a citation count for a person must account for the citations which appear under the names of the first authors of publications for which the author of interest was a secondary author. This can lead to a substantial amount of tedious additional work, since a list of first authors must be generated for all of the subjects' multi-authored papers. Citations to each of these first authors must then be found, the citations of interest noted, and these citations fractionally attributed to the original author. Since multiple years of the Citation Index are often involved, the amount of clerical work searching from volume to volume and from author to author, and citation to citation can be quite large.

A note of caution about the handling of multiple authorship in the Corporate Index of the Science Citation Index: SCI lists a publication giving all the corporate affiliations, but always with the first author's name. Thus a publication by Jones and Smith where Jones is at Harvard and Smith is at Yale would be listed in the Corporate Index under Harvard with the name Jones and also under Yale with the name Jones. To find the organization with which the various authors are affiliated, the original article must be obtained.

Although the publisher of the Science Citation Index, the Institute for Scientific Information, tries to maintain a consistent policy in attributing institutional affiliations, when authors have multiple affiliations the number of possible variants is large. In the SCI data base on magnetic tape, sufficient information is included to assign a publication with authors from a number of different institutions in a reasonably fair way to those institutions; however, in the printed Corporate Index, one has to refer to the Source Index to find the actual number of authors, or to the paper itself to find the affiliations of each of the authors.

5. Completeness of Available Data

Another consideration in a publication analysis is the completeness of data available in the secondary source, since looking up hundreds or thousands of publications individually is tedious and expensive. One difficulty here is that most of the abstracting and indexing sources are designed for retrieval and not for analysis. As a result, some of the parameters which are of greatest analytical importance, such as the affiliation of the author and his source of financial support, are often omitted. Furthermore, some of the abstracting sources are cross-indexed in complex ways, so that a publication may only be partially described at any one point, and reference must be made to a companion volume to find even such essential data as the author's name. While intellectually trivial, these searches can be exceedingly time consuming when analyzing large numbers of publications.

The specific data which are consistently available in the secondary sources are the basic bibliographic information: i.e., authors' name, journal or report title, volume, page, etc. This information is the basic data used for retrieval, and since the abstracting and indexing services are retrieval oriented, this bibliographic information is always included.

Data which are less consistently available in the secondary source are the authors' affiliation and the authors' rank or title. Both of these are of interest in analysis. For example, the ranking of universities based on publication in a given subject area is often of interest. This ranking can be tabulated only from a secondary source which gives the authors' university affiliation.

6. Support Acknowledgements

The source of the authors' financial support is seldom given in any secondary source, although it is now being added to the MEDLARS data base. Since this financial data can be used to define the fraction of a subject literature which is being supported by a particular corporate body such as a governmental agency, the data are of substantial evaluative interest.

The amount of acknowledgement of agency support in the scientific literature has changed over time. In a Computer Horizons study completed in 1973 the amount of agency support acknowledgement was tabulated in twenty major journals from five different fields.[4] Table 6-1 summarizes those support acknowledgements for 1969 and 1972.

In 1969, only 67% of the articles in 20 major journals acknowledged financial support. By 1972, the percentage of articles acknowledging financial support had risen to approximately 85%. The table shows that the sources of support differ from one field to another and also shows that the fields of interest to these sources differ as well. For example, the National Science Foundation is the major source of acknowledged support in mathematics, while the National Institutes of Health clearly dominate the support of biology. Chemistry is the field with the largest amount of non-government (private sector) support in the U.S.

Note also that the 20 journals used were major journals in their fields; as less prestigious journals are examined, the amount of support acknowledgement generally decreases.

[4]Computer Horizons, Inc., Evaluation of Research in the Physical Sciences Based on Publications and Citations, Washington, D.C., National Science Foundation, Contract No. NSF-C627, November, 1973.

TABLE 6-1 AGENCY SUPPORT ACKNOWLEDGEMENTS IN 20 LEADING JOURNALS FROM 5 MAJOR FIELDS - 1969 and 1972

Agency	Mathematics		Physics		Chemistry		Biochemistry		Biology		All Fields	
Acknowledged	1969	1972	1969	1972	1969	1972	1969	1972	1969	1972	1969	1972
NSF	18%	37%	14%	19%	18%	21%	8%	8%	8%	8%	13%	16%
NIH	2	1	1	1	11	10	37	39	23	32	13	16
AEC	1	1	21	15	10	8	3	2	3	2	11	8
DOD	15	7	19	15	10	10	1	1	2	3	10	9
Other U.S. Government	1	2	1	2	2	2	1	1	1	3	1	2
Other U.S.	3	10	3	14	8	21	10	10	9	13	7	14
Foreign	5	4	5	15	7	8	16	25	10	24	8	16
Unacknowledged	55	37	31	11	32	18	25	13	42	14	33	15

In an attempt to account for the 15% of unacknowledged papers, a questionnaire was sent to all U.S. authors in the 1972 sample who did not acknowledge agency support. Almost 70% of the authors who had not listed sources of support responded to the questionnaire. Of the authors who responded, over two-thirds were supported by their institutions as part of their regular duties; approximately 20% of the respondents cited specific governmental agencies as sources of support, even though they had not acknowledged these in the article itself. Twelve percent of the respondents listed no agency or institutional support; research done as fulfillment of graduate studies was included in this category.

Overall, the 1972 tabulation and survey showed that 88% of the research reported in these prestigious journals was externally supported, and that 97% of the externally supported work was acknowledged as such.

7. Subject Classification

Having constructed a basic list of publications, the next step in analysis is normally to subject classify the publications. Either the journals or the papers themselves may be classified. When a large number of papers is to be analyzed, classification of the papers by the field of the journal can be very convenient. Such a classification implies, of course, a degree of homogeneity of publication which is normally adequate when analyzing hundreds of papers. Such a classification may not be sufficient for the analysis of the scientific publications of one or a few individuals.

Subject classification schemes differ from one abstracting and indexing service to another. Therefore, a comparison of a collection of papers based on the classification schemes of more than one abstracting and indexing service is almost hopeless. A classification of papers at the journal level has been used in the influence methodology discussed in Chapters VII through X.

8. Citation Counts

Citation counts are a tool in evaluative bibliometrics second in importance only to the counting and classification of publications. Citation counts may be used directly as a measure of the utilization or influence of a single publication or of all the publications of an individual, a grant, contract, department, university, funding agency or country. Citation counts may be used to link individuals, institutions, and programs, since they show how one publication relates to another publication.

In addition to these evaluative uses, citations also have important bibliometric uses, since the references from one paper to another define the structure of the scientific literature. Chapter III discusses how this type of analysis may be carried out at a detailed, micro-level to define closely related papers through bibliographic coupling and co-citation. That chapter also describes how citation analysis may be used at a macro-level to link fields and subfields through journal-to-journal mapping. The bibliometric characteristics of the literature also provide a numeric base against which evaluative parameters may be normalized.

Some of the characteristics of the literature which are revealed by citation analysis are noted on Figure 6-1. These characteristics include:

The dispersion of references: a measure of scientific "hardness", since in fields that are structured and have a central core of accepted knowledge, literature references tend to be quite concentrated.

The concentration of papers and influence: another measure of centrality in a field, dependent upon whether or not a field has a core journal structure.

The hierarchic dependency relationships between field, subfield and journals, including the comparison of numbers of references from field A to field B, compared with number of references from field B to field A: this comparison provides a major justification for the pursuit of basic research as a foundation of knowledge utilized by more applied areas.

The linkages between fields, subfields and journals: a measure of the flow of information, and of the importance of one sector of the scientific mosaic to another.

VII. THE INFLUENCE METHODOLOGY

A. Introduction

In this chapter an influence methodology will be described which allows advanced publication and citation techniques to be applied to institutional aggregates of publications, such as those of departments, schools, programs, support agencies and countries, without performing an individual citation count. In essence, the influence procedure ascribes a weighted average set of properties to a collection of papers, such as the papers in a journal, rather than determining the citation rate for the papers on an individual basis.

The influence methodology is completely general, and can be applied to journals, subfields, fields, institutions or countries.

There are three separate aspects of the influence methodology which are particularly pertinent to journals. These are

1. A subject classification for each journal
2. A research type (level) classification for the biomedical journals, and
3. Citation influence measures for each journal.

It is the third of these, the citation influence measures, which add a quality or utilization aspect to the analysis. The influence methodology assumes that, although citations to papers vary within a given journal, aggregates of publications can be characterized by the influence measures of the journals in which they appear. Chapter IX discusses this assumption in some detail.

Older measures of influence all suffer from some defect which limits their use as evaluative measures.

The total number of publications of an individual, school or country is a measure of total activity only; no inferences concerning importance may be drawn.

The total number of citations to a set of publications, while incorporating a measure of peer group recognition, depends on the size of the set involved and has no meaning on an absolute scale.

The journal "impact factor" introduced by Garfield is a size-independent measure, since it is defined as the ratio of the number of citations the journal receives to the number of publications in a specified earlier time period.[1] This

[1]Eugene Garfield, "Citation Analysis As a Tool in Journal Evaluation," Science 178 (November 3, 1972):471.

measure, like the total number of citations, has no meaning on an absolute scale. In addition the impact factor suffers from three more significant limitations. Although the size of the journal, as reflected in the number of publications, is corrected for, the average length of individual papers appearing in the journal is not. Thus, journals which publish longer papers, namely review journals, tend to have higher impact factors. In fact the nine highest impact factors obtained by Garfield were for review journals. This measure can therefore not be used to establish a "pecking order" for journal prestige.

The second limitation is that the citations are unweighted, all citations being counted with equal weight, regardless of the citing journal. It seems more reasonable to give higher weight to a citation from a prestigious journal than to a citation from a peripheral one. The idea of counting a reference from a more prestigious journal more heavily has also been suggested by Kochen.[2]

A third limitation is that there is no normalization for the different referencing characteristics of different segments of the literature: a citation received by a biochemistry journal, in a field noted for its large numbers of references and short citation times, may be quite different in value from a citation in astronomy, where the overall citation density is much lower and the citation time lag much longer.

In this section three related influence measures are developed, each of which measures one aspect of a journal's influence,with explicit recognition of the size factor. These measures are:

(1) The influence weight of the journal: a size-independent measure of the weighted number of citations a journal receives from other journals, normalized by the number of references the journal gives to other journals.
(2) The influence per publication for the journals: the weighted number of citations each article, note or review in a journal receives from other journals.
(3) The total influence of the journal: the influence per publication times the total number of publications.

[2]M. Kochen, Principles of Information Retrieval, (New York: John Wiley & Sons, Inc. 1974), 83.

B. Development of the Weighting Scheme

1. The Citation Matrix

A citation matrix may be used to describe the interactions among members of a set of publishing entities. These entities may, for example, be journals, institutions, individuals, fields of research, geographical subdivisions or levels of research methodology. The formalism to be developed is completely general in that it may be applied to any such set. To emphasize this generality, a member of a set will be referred to as a unit rather than as a specific type of unit such as a journal.

The citation matrix is the fundamental entity which contains the information describing the flow of influence among units.

The matrix has the form

$$C = \begin{pmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \vdots & \vdots & & \vdots \\ c_{n1} & c_{n2} & \cdots & c_{nn} \end{pmatrix}$$

A distinction is made between the use of the terms “reference” and “citation” depending on whether the issuing or receiving unit is being discussed. Thus, a term C_{ij} in the citation matrix indicates both the number of references unit i gives to unit j and the number of citations unit j receives from unit i.

The time frame of a citation matrix must be clearly understood in order that a measure derived from it be given its proper interpretation. Suppose that the citation data are based on references issued in 1973. The citations received may be to papers in any year up through 1973. In general, the papers issuing the references will not be the same as those receiving the citations. Thus, any conclusions drawn from such a matrix assume an on-going, relatively constant nature for each of the units. For instance, if the units of study are journals, it is assumed that they have not changed in size relative to each other and represent a constant subject area. Journals in rapidly changing fields and new journals would therefore have to be treated with caution.

A citation matrix for a specific time lag may also be formulated. This would link publications in one time period with publications in some specified earlier time period.

2. Influence Weights

For each unit in the set a measure of the influence of that unit will be extracted from the citation matrix. Because total influence is clearly a size-dependent quantity, it is essential to distinguish between a size-independent measure of influence, to be called the influence weight, and the size-dependent total influence.

To make the idea of a size-independent measure more precise, the following property of such a measure may be specified: if a journal were randomly subdivided into smaller entities, each entity would have the same measure as the parent journal.

The citation matrix may be thought of as an "input-output" matrix with the medium of exchange being the citation. Each unit gives out references and receives citations; it is above average if it has a "positive citation balance", i.e., receives more than it gives out. This reasoning provides a first order approximation to the weight of each unit, which is

$$W_i^{(1)} = \frac{\text{total number of citations to the ith unit from other units}}{\text{total number of references from the ith unit to other units}}.$$

This is the starting point for the iterative procedure for the calculation of the influence weights to be described below.

The denominator of this expression is the row sum

$$S_i = \sum_{j=1}^{n} C_{ij}$$

corresponding to the ith unit of the citation matrix; it may be thought of as the "target size" which this unit presents to the referencing world.

The influence weight, W_i, of the ith unit is defined as

$$W_i = \sum_{k=1}^{n} \frac{W_k \; C_{ki}}{S_i}$$

In the sum, the number of cites to the ith unit from the kth unit is weighted by the weight of kth (referencing) unit. The number of cites is also divided by the target size S_i of the unit i being cited. The n equations, one for each unit, provide a self consistent "bootstrap" set of relations in which each unit plays a role in determining the weight of every other unit. The following summarizes the derivation of those weights.

The equations defining the weights,

$$W_i = \sum_{k=1}^{n} \frac{W_k \; C_{ki}}{S_i}, \quad i = 1,..,n \qquad 1$$

are a special case of a more general system of equations which may be written in the form

$$\left\{ \sum_{k=1}^{n} W_k \; \gamma_{ki} \right\} - \lambda W_i = 0, \quad i = 1,..,n \qquad 2$$

Here $\gamma_{ki} = \frac{C_{ki}}{S_i}$ and Equation 1 is shown to be

a special case of Equation 2 corresponding to $\lambda = 1$. As will be explained shortly the system of equations given in (1) will not, in general, possess a non-zero solution; only for certain values of λ called the eigenvalues of the system, will there be non-zero solutions.

With the choice of target size Si, the value $\lambda = 1$ is in fact an eigenvalue so that Equation 1 itself does possess a solution.

Using the rotation γ^T for the transpose of γ,

$\gamma^T_{ik} = \gamma_{ki}$; introducing the Kronecker delta

symbol defined by $\delta_{ik} = \begin{cases} 1 & i = k \\ 0 & i \neq k \end{cases}$

the equation can then be written

$$\sum_{k=1}^{n} \left(\gamma^{T}_{ik} - \lambda \delta_{ik} \right) w_k = 0 \qquad 3$$

This is a system of n homogeneous equations for the weights. In order that a solution for such a system exists, the determinant of the coefficients must vanish. This gives an nth order equation for the eigenvalues

$$\begin{vmatrix} \gamma_{11}-\lambda & \gamma_{21} \; .\;.\;.\;. & \gamma_{n1} \\ \gamma_{12} & \gamma_{22}-\lambda \; .\;.\;. & \gamma_{n2} \\ \vdots & \vdots & \vdots \\ \gamma_{1n} & \gamma_{2n} \; .\;.\;.\;. & \gamma_{nn}-\lambda \end{vmatrix} = 0 \qquad 4$$

called the characteristic equation.

Only for values of λ which satisfy this equation, does a non-zero solution for the W's exist. Moreover, Equation 3 does not determine the values of the W_k themselves, but at best determines their ratios. Equivalently the eigenvalue equation may be thought of as a vector equation for the vector unknown

$$\underline{W} = \{ w_1, \ldots, w_n \}$$

$$\underline{\underline{\gamma}}^{T} \cdot \underline{W} = \lambda \underline{W} \qquad 5$$

from which it is clear that only the direction of $\underline{W}$ is determined.

The normalization or scale factor is then fixed by the condition that the size-weighted average of the weights is 1, or

$$\frac{\sum_{1}^{n} s_k \; w_k}{\sum_{1}^{n} s_k} = 1 \quad (6)$$

This normalization assures that the weight values have an absolute as well as a relative meaning, with the value 1 representing an average value.

Each root of the characteristic equation determines a solution vector or eigenvector of the equation, but the weight vector being sought is the eigenvector corresponding to the largest eigenvalue. This can be seen from the consideration of an alternative procedure for solving the system of equations, a procedure which also leads to the algorithm of choice.

Consider an iterative process starting with equal weights for all units. The values $w_i^{(0)} = 1$ can be thought of as zeroth order approximations to the weights. The first order weights are then

$$w_i^{(1)} = \frac{\sum_{k=1}^{n} c_{ki}}{s_i}$$

This ratio (total cites to a unit divided by the target size of the unit) is the simplest size-corrected citation measure and, in fact, corresponds to the impact measure used by Garfield. These values are then substituted into the right hand side of Equation 1 to obtain the next order of approximation. In general, the mth order approximation is

$$W_i^{(m)} = \sum_{k=1}^{n} \frac{W_k^{(m-1)} \quad C_{ki}}{S_i} = \sum_{k=1}^{n} W_k^{(m-1)} \times \gamma_{ki} = \sum_{j=1}^{n} (\gamma)^m_{ji}$$

The exact weights are therefore

$$W_i = W_i^{(\infty)} = \sum_{j=1}^{n} \left(\lim_{m \to \infty} \gamma^m \right)_{ji}$$

This provides the most convenient numerical procedure for finding the weights, the whole iteration procedure being reduced to successive squarings of the γ matrix.

This procedure is closely related to the standard method for finding the dominant eigenvalue of a matrix. Since $\lambda = 1$ is the largest eigenvalue, repeated squarings are all that is needed. If the largest eigenvalue had a value other than 1, the normalization condition, Equation 6, would have to be reimposed with each squaring. Convergence to three decimal places usually occurs with six squarings, corresponding to raising γ to the 64th power.

APPENDIX G

CONFERENCE ON THE ASSESSMENT OF QUALITY OF GRADUATE EDUCATION PROGRAMS

September 27-29, 1976

Woods Hole, Massachusetts

Participants

Robert A. ALBERTY	Dean of Science, Massachusetts Institute of Technology
Charles ANDERSEN	Coordinator, Education Statistics, American Council on Education
Richard C. ATKINSON	Acting Director, National Science Foundation
R. H. BING	Chairman, Department of Mathematics, University of Texas at Austin
David W. BRENEMAN	Senior Fellow, The Brookings Institution
John E. CANTLON	Vice-President for Research and Graduate Studies, Michigan State University
Henry E. COBB	Professor, Courant Institute of Mathematical Sciences, New York University
Monroe D. DONSKER	Professor, Department of History, Southern University
David E. DREW	Senior Scientist, Rand Corporation
E. Alden DUNHAM	Program Officer, Carnegie Corporation of New York
David A. GOSLIN	Executive Director, Assembly of Behavioral and Social Sciences, National Research Council
Hanna H. GRAY	Provost, Yale University
Norman HACKERMAN	President, Rice University
Philip HANDLER	President, National Academy of Sciences
David D. HENRY	President Emeritus, University of Illinois
Roger W. HEYNS	President, American Council on Education
Lyle V. JONES	Vice Chancellor and Dean, Graduate School, University of North Carolina at Chapel Hill
Charles V. KIDD	Executive Secretary, Association of American Universities
Winfred P. LEHMANN	Professor, Department of Linguistics, University of Texas at Austin
Charles T. LESTER	Vice-President of Arts and Sciences, Emory University

Gardner LINDZEY	Director, Center for Advanced Study in the Behavioral Sciences (Chairman)
Raymond P. MARIELLA	Dean of the Graduate School, Loyola University
Cora B. MARRETT	Center for Advanced Study in the Behavioral Sciences
Peter S. McKINNEY	Acting Dean, Graduate School of Arts and Sciences, Harvard University
Doris H. MERRITT	Dean, Research and Sponsored Programs, Indiana University/Purdue University
John Perry MILLER	Corporation Officer for Institutional Development, The Campaign for Yale
Lincoln E. MOSES	Professor, Department of Family, Community and Preventive Medicine, Stanford University Medical Center
Frederick W. MOTE	Professor, Department of East Asian Studies, Princeton University
Thomas A. NOBLE	Executive Associate, American Council of Learned Societies
J. Boyd PAGE	President, The Council of Graduate Schools in the United States
C. K. N. PATEL	Director, Physical Research Laboratory, Bell Laboratories
Michael J. PELCZAR, Jr.	Vice-President for Graduate Studies and Research, University of Maryland, College Park
Frank PRESS	Chairman, Department of Earth and Planetary Sciences, Massachusetts Institute of Technology
John J. PRUIS	President, Ball State University
Lorene L. ROGERS	President, University of Texas at Austin
John SAWYER	President, The Andrew W. Mellon Foundation
Robert L. SPROULL	President, University of Rochester
Eliot STELLAR	Provost, University of Pennsylvania
Alfred S. SUSSMAN	Dean, Horace H. Rackham School of Graduate Studies, University of Michigan
Donald C. SWAIN	Academic Vice-President, University of California System
Mack E. THOMPSON	Executive Director, American Historical Association
Charles V. WILLIE	Professor of Education and Urban Studies, The Graduate School of Education, Harvard University
H. Edwin YOUNG	Chancellor, University of Wisconsin, Madison
Harriet A. ZUCKERMAN	Associate Professor, Department of Sociology, Columbia University

SUMMARY

September 27-29, 1976, Woods Hole, Massachusetts

Report of the Conference

A substantial majority of the Conference believes that the earlier assessments of graduate education have received wide and important use: by students and their advisors, by the institutions of higher education as aids to planning and the allocation of educational functions, as a check of unwarranted claims of excellence, and in social science research.

The recommendations which follow attempt to distill the main points of consensus within the conference. This report does not in any sense adequately represent the rich diversity of points of view revealed during the Conference nor the deep and real differences in belief among the participants.

Recommendations

1. A new assessment of graduate programs is needed, and we believe that the Conference Board is an appropriate sponsor. While we do not propose to specify the details of this assessment, we are prepared to suggest the following guidelines.
2. The assessment should include a modified replication of the Roose-Andersen study, with the addition of some fields and the subdivision of others.
3. It is important to provide additional indices relevant to program assessment such as some of those cited by Breneman, Drew, and Page. The Conference directs specific attention to the CGS/ETS Study currently nearing completion and urges that the results of that study be carefully examined and used to the fullest possible extent.
4. The initial assessment study should be one of surveying the quality of scholarship and research and the effectiveness of Ph.D. programs in the fields selected for inclusion.

a. It is intended that the study be carried forward on a continuing basis to provide valuable longitudinal data. This should be implemented along the lines suggested by Moses, involving annual assessment of subsets of programs.
b. Every eligible institution should be given the choice of whether to be included in the study.
c. Each program is to be characterized by a set of scores, one for each selected index. The presentation of scores for all

reported indices should be accompanied by a discussion of their substantive meaning. In addition, appropriate measures of uncertainty should accompany all tables of results.

5. We propose a simultaneous study exploring ways of reviewing goals of graduate education other than research and scholarship. This would involve review of other doctoral programs and selected master's programs.

APPENDIX H

PLANNING COMMITTEE FOR THE STUDY OF THE QUALITY OF RESEARCH-DOCTORATE PROGRAMS

September 1978

Robert M. Bock
Dean of the Graduate School
University of Wisconsin at Madison
Philip E. Converse
Institute for Social Research
University of Michigan
Richard A. Goldsby
Department of Genetics
Stanford University
Hugh Holman
Department of English
University of North Carolina at Chapel Hill
Lyle V. Jones
Vice Chancellor and Dean, Graduate School
University of North Carolina at Chapel Hill
Gardner Lindzey, Co-Chairman
Director
Center for Advanced Study in the Behavioral Sciences
Stanford, California
Sterling McMurrin
Dean of the Graduate School
University of Utah
Lincoln E. Moses
Administrator
Energy Information Administration
Washington, D.C.
George Pake
Xerox Corporation
Palo Alto, California
C. K. N. Patel
Director, Physical Research
Bell Laboratories
Cornelius Pings
Dean of the Graduate School
California Institute of Technology
Gordon Ray
President
The John Simon Guggenheim Memorial Foundation
Harriet A. Zuckerman, Co-Chairman
Department of Sociology
Columbia University

APPENDIX I

REGION AND STATE CODES FOR THE UNITED STATES AND POSSESSIONS (and U.S. Government)

11 Maine
12 New Hampshire
13 Vermont
14 Massachusetts
15 Rhode Island
16 Connecticut

21 New York
22 New Jersey
23 Pennsylvania

31 Ohio
32 Indiana
33 Illinois
34 Michigan
35 Wisconsin

41 Minnesota
42 Iowa
43 Missouri
44 North Dakota
45 South Dakota
46 Nebraska
47 Kansas

51 Delaware
52 Maryland
53 District of Columbia
54 Virginia
55 West Virginia
56 North Carolina
57 South Carolina
58 Georgia
59 Florida

61 Kentucky
62 Tennessee
63 Alabama
64 Mississippi

71 Arkansas
72 Louisiana
73 Oklahoma
74 Texas

81 Montana
82 Idaho
83 Wyoming
84 Colorado
85 New Mexico
86 Arizona
87 Utah
88 Nevada

90 Guam
91 Washington
92 Oregon
93 California
94 Alaska
95 Hawaii
96 Virgin Islands
97 Panama Canal Zone
98 Puerto Rico