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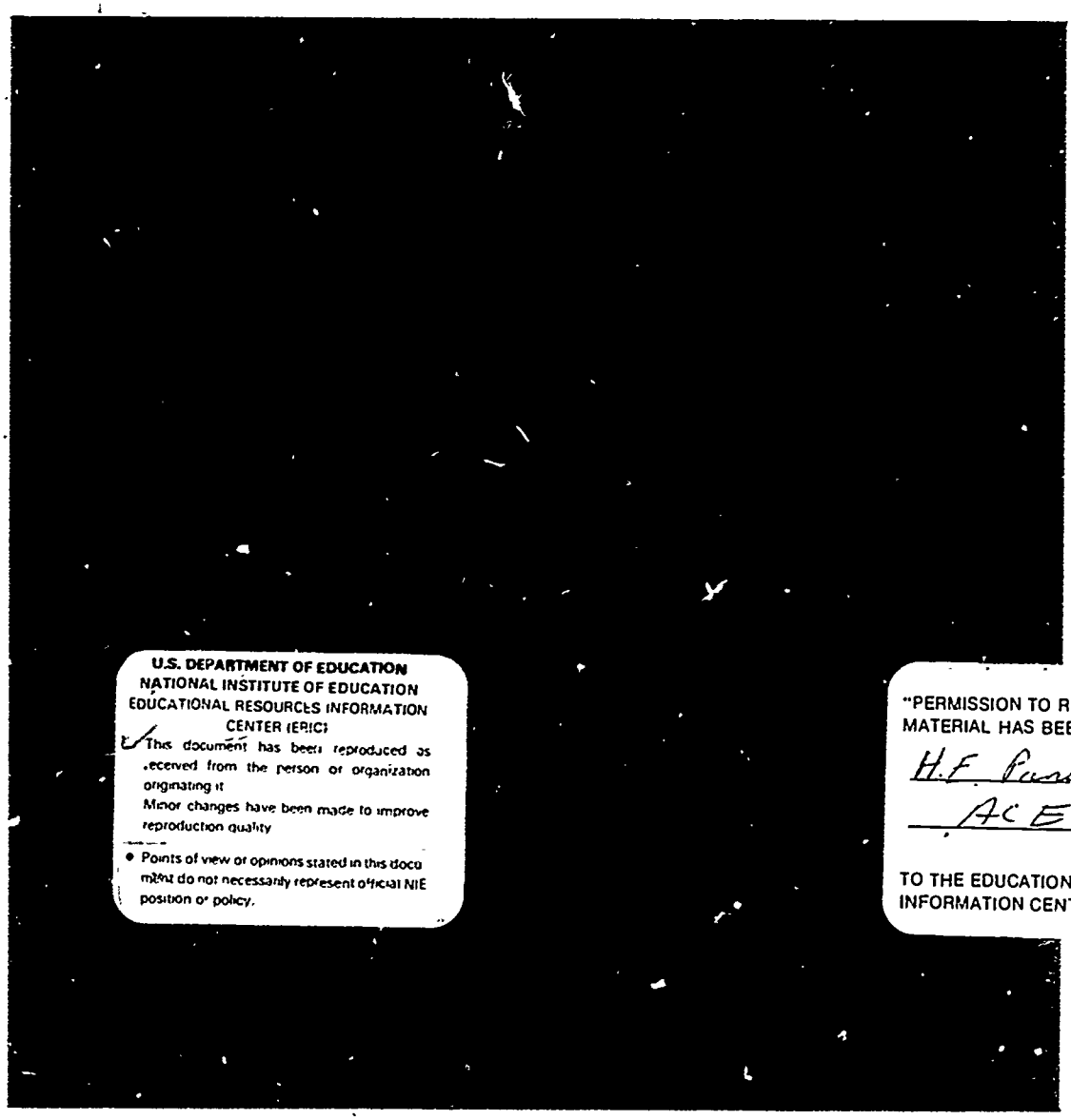
ABSTRACT

The extent of faculty vacancies in colleges of engineering, the effects of such vacancies upon research and instructional programs, and the nature of the competition between academia and industry in hiring engineering faculty were surveyed. The focus is on permanent full-time faculty positions in the following major engineering fields: aeronautical and astronautical, chemical, civil, computer science and computer engineering, electrical, industrial, and mechanical engineering. As of fall 1980, there were approximately 16,200 permanent full-time engineering faculty positions in the 244 institutions with at least one accredited engineering program. Additional findings include: the 50 institutions with the greatest engineering research and development (R & D) expenditures accounted for 45 percent of all permanent full-time engineering positions; almost 10 percent of full-time engineering faculty positions were unfilled at the beginning of the fall 1980 term, and of these, 45 percent had been vacant since fall 1979; the top 50 institutions in engineering R & D had a vancancy rate of 8 percent, compared with a rate of 11 percent at all other institutions; over half of all institutions reported a substantial decrease in their ability to recruit or retain engineering faculty over the past five years; that proportion was 64 percent at public institutions and 29 percent at private institutions; and during 1979-80, almost 400 full-time engineering faculty voluntarily left academia for full-time employment in industry, representing 2.7 percent of the permanent, employed faculty. Technical notes and a sample questionnaire are appended. (SW)

RECRUITMENT AND RETENTION OF FULL-TIME ENGINEERING FACULTY, FALL 1980

Frank J. Atelsek and Irene L. Gomberg



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AMERICAN COUNCIL ON EDUCATION

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AMERICAN COUNCIL ON EDUCATION

J. W. Peltason, *President*

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The Higher Education Panel is a survey research program established by the Council for the purpose of securing policy-related information quickly from representative samples of colleges and universities. *Higher Education Panel Reports* are designed to expedite communication of the Panel's survey findings to policy-makers in government, in the associations, and in educational institutions across the nation.

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Acknowledgments

This survey originated with the National Science Foundation's Division of Science Resources Studies. In particular, we would like to thank Charles H. Dickens and Larry Lacy of the Supply and Education Analysis Group within that Division for their help in developing the survey. The Higher Education Panel's Federal Advisory Board, its Technical Advisory Committee, and ACE's HEP Advisory Committee all contributed valuable guidance to this effort.

As ever we are indebted to our campus representatives who helped coordinate this survey effort and the deans and department heads who provided information or responded to it.

Highlights

Faculty Positions

- As of fall 1980, there were approximately 16,200 permanent full-time engineering faculty positions in the 244 institutions with at least one accredited engineering program.
- Public universities had an average of 20 faculty positions per engineering field; private universities had 15 per field; public four-year colleges, 10 per field; and private four-year colleges, 6 per field.
- The 50 institutions with the greatest engineering R & D expenditures accounted for 45 percent of all permanent full-time engineering positions.

Vacancies

- Almost 10 percent of full-time engineering faculty positions were unfilled at the beginning of the fall 1980 term; of these, 45 percent had been vacant since fall 1979.
- The top 50 institutions in engineering R & D spending had a vacancy rate of 8 percent, compared with a rate of 11 percent at all other institutions.

Recruiting and Retaining Faculty

- Over half of all institutions reported a substantial decrease in their ability to recruit or retain engineering faculty over the past five years; that proportion was 64 percent at public institutions and 29 percent at private institutions.
- Among institutions with decreased ability to recruit or retain engineering faculty, 80 percent reported that such staffing difficulties had led to increased teaching loads; 66 percent reported greater reliance on teaching assistants or part-time faculty; and 54 percent reported an inability to offer courses in certain subjects.
- Among institutions that reported decreased ability to recruit or retain engineering faculty, 76 percent reported a consequent decrease in the quality of research and 82 percent believed that the quality of instruction had declined.
- During 1979-80, almost 400 full-time engineering faculty voluntarily left academia for full-time employment in industry, representing 2.7 percent of the permanent, employed faculty.
- About 9 of every 10 deans thought that competition with industry for faculty had increased during the past five years.

ERRATA

On page 1, in the second paragraph, the first sentence, to the list of fields included in the survey should be added electrical engineering.

Background

In recent years education in engineering has taken some curious turns. Between 1975 and 1980, engineering baccalaureates increased by more than 50 percent while doctorate degree production fell by 12 percent. These trends pose a serious problem for the engineering colleges. The supply of new teachers continues to decrease at the very time student enrollments are continuing to set record levels. Academia's resulting difficulties in employing adequate numbers of faculty are aggravated by competition from industry which often pays engineering doctorates much more than do colleges and universities. The primary purpose of this survey is to assess the extent of faculty vacancies in colleges of engineering, the effects of such vacancies upon research and instructional programs, and the nature of the competition between academia and industry in hiring engineering faculty.

The survey's focus is on permanent full-time faculty positions in seven major engineering fields: aeronautical and astronautical, chemical, civil, computer science and computer engineering, industrial, and mechanical engineering. Institutions were asked to report the total number of faculty positions in each of these fields and the number that were unfilled at the beginning of the 1980 fall term, as well as those vacant since the start of the 1979 fall term. The deans also were asked for their assessments of the extent and effects of competition with industry upon their engineering colleges. The specific questionnaire items on which this survey report is based appear in Appendix A.

Methods Summary

The Higher Education Panel is an ongoing survey research program created in 1971 by the American Council on Education to conduct specialized surveys on topics of current policy interest to the higher education community and to government agencies.

The Panel is a stratified sample of 760 colleges and universities drawn from the population of more than 3,000 institutions listed in the National Center for Education Statistics' Education Directory. All institutions in this population are grouped in terms of the variables constituting the Panel's stratification design, which is based primarily on type (universities, four-year colleges, two-year colleges), control (public, private), and size (full-time equivalent enrollment). For any given survey either the entire Panel or an appropriate subgroup is used.

The survey instrument (see Appendix A) was mailed on October 15, 1980, to the 181 four-year colleges and universities in the Panel that in 1979 had at least one engineering program accredited by the Engineers' Council for Professional Development. Engineering deans were asked to provide, by specific engineering field, information on faculty vacancies, perceptions about competition with industry, and opinions regarding the effect of any difficulty in recruiting or retaining engineering faculty.

After mail and telephone follow-ups, usable responses were received from 159 institutions, for a response rate of 88 percent. Data from responding institutions were statistically adjusted to represent the national population of 244 colleges and universities with accredited engineering programs. The stratification design, weighting procedure, and comparison of respondents and nonrespondents are contained in Appendix B.

Findings

Faculty Positions

In the fall of 1980, the engineering fields covered by the survey had a total of 16,200 permanent, full-time faculty positions. As shown in Figure 1, the number of positions varied widely among the fields, ranging from a high of 3,570 full-time positions in electrical engineering to a low of 650 in aeronautical/astronautical engineering departments.

Almost 10 percent of full-time positions were unfilled, or filled with visiting or other temporary faculty, at the beginning of the 1980 fall term. Of these unfilled positions, 45 percent had been vacant since the fall of the previous year (1979). Figure 2 shows how each of the surveyed engineering fields fared in filling their available permanent faculty positions.

The aeronautical and astronautical engineering fields had only 4 percent of positions unfilled in fall 1980. In contrast, computer science and computer engineering reported vacancies of 16 percent in their permanent faculty positions, and more than half of these had been vacant at least since the fall of 1979. Industrial engineering departments also had an above average proportion of unfilled faculty positions. The other engineering fields in the survey--chemical, civil, electrical, and mechanical--had vacancy proportions near the overall level for all fields combined.

To determine whether the problems of recruiting and retaining engineering faculty were more acute in some institutional settings than others, separate tabulations were prepared for universities and four-year colleges, public and private institutions, and for the 50 institutions having the heaviest involvement in engineering R & D activity.

The top 50 institutions in terms of FY79 engineering R & D expenditures accounted for 45 percent of the approximately 16,200 permanent positions at the 244 institutions covered by the survey. The distribution of permanent faculty positions among the engineering fields at the top 50 institutions was roughly

Figure 1

Permanent Full-Time Engineering Faculty Positions, by Engineering Field, Fall 1980

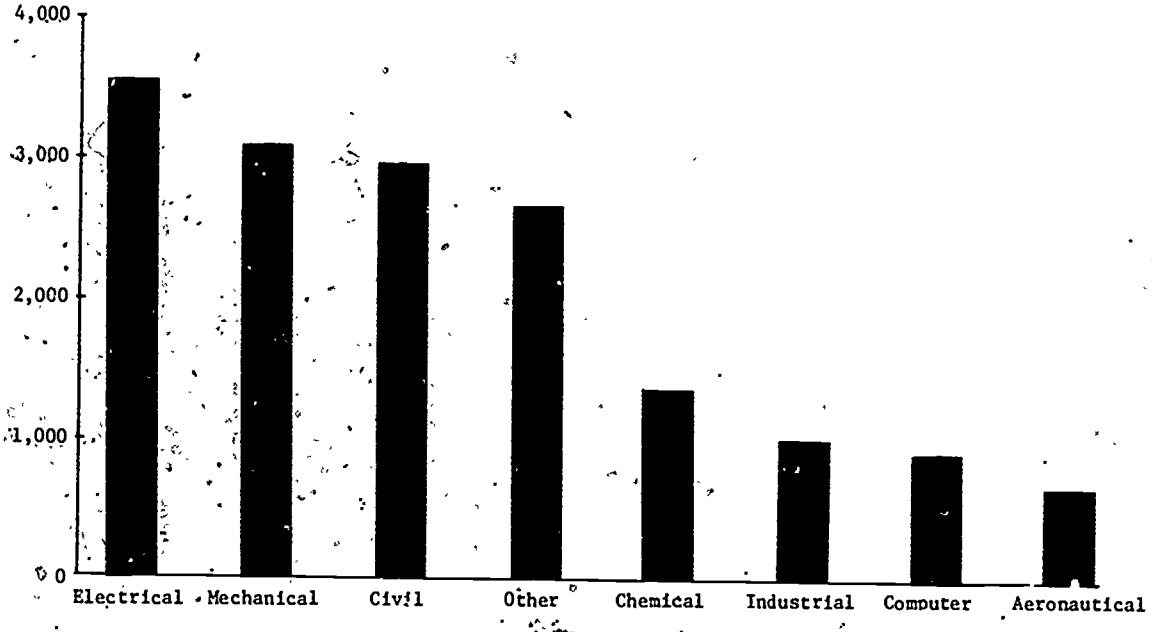
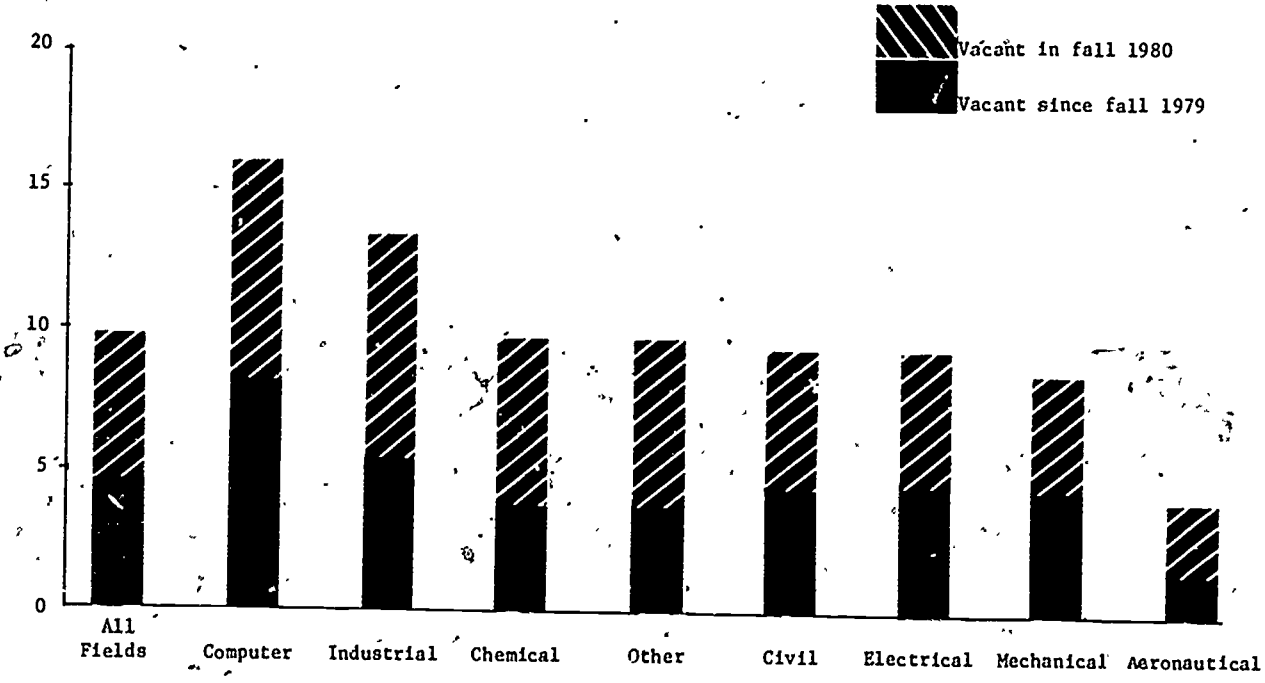


Figure 2

Engineering Faculty Vacancies as a Percentage of All Engineering Faculty Positions, Fall 1980



similar to that of other institutions, except that proportionately more top 50 positions were in aeronautical/astronautical engineering and "other" engineering fields which could not be readily classified under the specified engineering categories.

Overall, the top 50 institutions exhibited somewhat less difficulty in keeping their permanent full-time faculty positions filled. Vacancies accounted for 8 percent of their total positions, compared with a vacancy rate of over 11 percent at all other institutions. This pattern of lower vacancy rates at the top 50 institutions persisted in almost all the engineering fields listed. The difference was most notable in industrial engineering (9 percent vs. 17 percent). The top 50 institutions also had proportionately fewer long-term vacancies (i.e., unfilled since fall 1979).

Almost three-fourths (11,900) of the full-time engineering positions were at the 151 public institutions covered by the survey. Overall, vacancy rates at the beginning of the 1980 fall term were higher at public institutions, 11 percent vs. 8 percent for private institutions. This pattern of difference held in each of the surveyed engineering fields.

Since the mix of universities and four-year colleges offering engineering programs was different in the public and private sectors, it was advisable to separate and examine these elements in more detail. Table A[1] compares public and private institutions; detailed report tables show the data by field and by type and control of institution.

The proportion of positions that remained unfilled in fall 1980 was somewhat higher at public than at private universities in all fields but chemical and civil engineering. It is also notable that the public-private difference in vacancy rates was relatively small. In only one instance was the spread in vacancy rates greater than two percentage point.. industrial engineering vacancies were 2.5 percent greater at

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[1]Summary tables, identified by letters, appear throughout the text. Detailed report tables, identified by numerals, begin on page 14.

public universities. Moreover, the difference in the longer term vacancy percentages was even smaller, approaching two percentage points in only two instances.

Table A

Unfilled Faculty Positions as a Percentage of All Full-time Engineering Faculty Positions

	All Institutions	Public Institutions	Private Institutions
Positions unfilled as of Fall 1980	9.8	10.5	7.7
Positions unfilled since Fall 1979	4.4	4.5	4.1

Recruiting and Retaining Faculty

The survey included a number of questions about how competition with industry has affected the colleges and universities. One question asked the engineering deans to assess how their ability to recruit and retain faculty had changed over the last five years. Table B summarizes their responses. Overall, half of the institutions reported there had been a substantial decrease in their ability to recruit and retain engineering faculty. An additional 37 percent reported a moderate or slight decrease in their ability to compete for faculty.

Table B

Perceived Change in Ability to Recruit and Retain Engineering Faculty, By Degree of Change

Degree of Change in Ability to Recruit	All Institutions	Public Institutions	Private Institutions
All degrees of change	100%	100%	100%
Substantial decrease	51	64	29
Slight or moderate increase	37	27	56
No change	5	1	12
Slight or moderate increase	3	3	3
Substantial increase	4	5	0

The deans' perceptions of their ability to compete differed markedly among public and private colleges and universities. Nearly two-thirds of those at public institutions said their ability was substantially decreased, compared with less than one-third of those at private institutions.

Effects of Staffing Problems

A follow-up question for institutions reporting a decrease in ability to obtain and hold full-time faculty asked about the specific effects of their staffing problems. Of the specific effects listed in the question, a preponderant majority (80 percent) pointed to a consequent increase in teaching loads (see table C). Two-thirds mentioned the necessity of greater reliance on graduate teaching assistants or part-time faculty, and

Table C

Effects of Decreased Ability to Recruit or Retain Full-time Engineering Faculty

	All Institutions
Increase in teaching loads	80%
Greater reliance on graduate teaching assistants or part-time faculty	66
Inability to offer courses in certain subjects	54
Reduction in faculty research	35
Other effects	21
No significant effects as yet	8

more than half (54 percent) were required to reduce their course offerings in certain subjects. About a third also pointed to a reduction in faculty research as an effect of their decreased competitive position.

Finally, about one-fifth of the institutions mentioned other effects that were not cataloged in our questionnaires. These included lowered morale, restraints in program development, longer student waiting lists, increases in foreign faculty with attendant language difficulties, reduced personal and academic guidance of students, and changes in the character and quality of instructional programs, particularly with respect to indi-

vidual instruction and small group interaction.

Another specific question asked whether the respondents believed that the quality of research and instruction in their engineering colleges had decreased because of the difficulty in recruiting or retaining full-time faculty. Overall, three-fourths of the deans who reported greater staffing problems saw resulting decreases in the quality of research, and four-fifths detected a decrease in the quality of instruction. (See table D.)

Table D

Perceived Change in Quality of Research and Instruction at Institutions Reporting Decreased Ability to Recruit Engineering Faculty

	Percentage Reporting Change of Quality in	
	Research	Instruction
All responses	100%	100%
Decrease in quality	75	82
Slight decrease	(40)	(41)
Moderate decrease	(29)	(31)
Great decrease	(6)	(10)
No decrease in quality	25	18

Another item asked what proportion of full-time junior faculty (assistant professors and instructors) who held permanent full-time positions in engineering colleges had not received their bachelor's degree in the United States. Table E shows that almost one-fourth of the junior faculty received their undergraduate degrees outside the United States. While not a direct indication of faculty shortages, the results do indicate that engineers from other countries have prevented shortages from becoming even more severe.

Table E

Full-time Junior Engineering Faculty
Who Did Not Receive Their Baccalaureates in the U.S.

	Total Junior Faculty	% With Bacc. From Outside U.S.
All institutions	3,400	24
Public institutions	2,400	25
Private institutions	1,000	20

Faculty Leaving for Industry

Another factor that contributes to vacancies among engineering faculty positions is the extent to which full-time faculty members shift from teaching careers to other assignments in industry. Table F shows the number of full-time engineering faculty who voluntarily left academia for full-time employment in industry during the 1979-80 school year. The question attempted to focus on faculty who were drawn away by the perceived benefits of employment in industry. Excluded from this count were those faculty who were denied reappointment for any reason, including failure to receive tenure. Those who left because they anticipated not receiving tenure also were excluded from this count.

Overall, almost 400 engineering faculty voluntarily left full-time academic positions at the 244 institutions under study for jobs in industry during 1979-80. For the year, these losses to industry represented about 2.7 percent of the 14,600 permanent faculty who were employed in fall 1980.

Table F

Full-time Engineering Faculty Who Left Voluntarily
For Full-time Employment in Industry

	Voluntary Departures	
	Number	As a % of Total Faculty
All Fields	37	2.7
Aeronatuical & astronautical engineering	12	1.9
Chemical	32	2.6
Civil	61	2.3
Computer science & computer engineering	43	5.6
Electrical	89	2.7
Industrial	24	2.8
Mechanical	78	2.7
Other engineering fields	58	2.4

Table F shows the extent of voluntary faculty departures to industry for each of the engineering fields covered in the survey. Notably, the computer science and computer engineering field lost the largest proportion of its faculty to industry (5.6 percent). This field also had the largest proportion of unfilled permanent positions (16 percent).

There was near unanimity in the respondents' views of the change in the degree of competition with industry over the past five years (table G). None believed that competition with industry had decreased at their college of engineering. Ninety percent reported an increase in competition and only 10 percent reported no change. Feelings that competition had increased were especially high at public universities (95 percent) and lowest among the private universities (82 percent).

Table G

Perceived Change Over the Past Five Years in the Degree of Competition With Industry for Engineering Faculty

	Competition Increased	No Change	Competition Decreased
Public			
Universities	95%	5%	0
Four-year colleges	88	12	0
Private			
Universities	82	18	0
Four-year colleges	92	8	0
Total	90	10	0

Institutions that reported increased competition with industry were asked to specify the chief reason for the increase. The distribution of responses is summarized in table H.

Superior salary and financial benefits in industry were cited as the chief reason by 76 percent of the institutions overall. An additional 15 percent attributed the increase in competition chiefly to declines in the production of new engineering doctorates during recent years. Only 5 percent cited better opportunities for advancement and recognition as the primary reason behind the increased competition.

A number of respondents were reluctant to identify one primary reason. Some thought most or all of the listed reasons were important factors in the increased competition with industry. A few respondents referred to the better laboratory equipment and facili-

ties in industry. Others referred to a generally inadequate funding base in academia

Table H

Chief Reason for Increased Competition with Industry for Engineering Faculty

	All Institutions
All reasons	100%
Industry offers superior salaries and financial benefits	76
Fewer engineering doctorates have graduated in recent years	15
Industry offers better opportunities for advancement and recognition	5
Other	4

which they felt has eroded educational quality and, therefore, the morale necessary to remain in education despite compensation inducements offered by private industry. One respondent stated that the present survey was too narrowly conceived in that it "overlooks a very serious constraint to recruiting faculty, namely, legislative restrictions in hiring and position control. This is far more serious than competition from industry at this time."

Conclusions

The survey findings indicate that most institutions have been unable to recruit and retain a full complement of well-qualified faculty in many fields of engineering. In consequence, teaching loads have increased, greater reliance has been placed on teaching assistants and part-time faculty, and the range of course offerings has been reduced in certain subjects. Overall, many of the survey respondents believe that the quality of research and instruction in engineering colleges is on the decline.

Other commentators on the "crisis in engineering education" have pointed to additional aspects of the problem of faculty shortages:

-- New tenure-track faculty positions are not being authorized in many colleges, even where such additions could be justified by the growth in number of students enrolled.[2] Recent Panel surveys affirm that college and university administrators are reluctant to take actions that may lead to long-term financial commitments. Increasingly, current staff needs are being met by part-time arrangements outside the traditional tenure system.

-- There is some indication that present shortages of doctoral level engineering faculty are beginning to lead universities and colleges to limit undergraduate enrollments.[3]

-- Industrial salaries are significantly higher than academic salaries. In spite of continuing faculty shortages, the salary structure for engineers in academia has not responded to the normal rules of supply and demand. Colleges and universities often attempt to maintain a general correspondence of salary levels in all disciplines. Thus the short supply and high demand for engineering faculty do not necessarily result in salary levels much higher than in other disciplines where demand for faculty is lower and supply is higher.[4]

While this survey stressed the academic aspects of the engineering manpower problem, industry also suffers from its effects. Obviously, problems associated with shortages of doctoral level engineers are shared by government, industry, and the academic institutions, even if not always equally.

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[2]James G. Knudsen, American Institute of Chemical Engineers, The Crisis in Chemical Engineering Education, p. 2.

[3]Ibid., p. 3.

[4]American Association of Engineering Societies (AAES), Data Related to the Crisis in Engineering Education, March 1981.

Detailed Report Tables

Table 1

Permanent Full-time Engineering Faculty Positions, Fall 1980:
All Institutions (N=244)*

Engineering Fields	Number of Positions: Total	Number of Positions: Avg. Per Dept.	Positions Unfilled at Beginning of 1980 Fall Term: N	Positions Unfilled at Beginning of 1980 Fall Term: % of total	Positions Unfilled Since Beginning of 1979 Fall Term: N	Positions Unfilled Since Beginning of 1979 Fall Term: % of total
Aeronautical and astronautical	649	15	26	4.0	10	1.5
Chemical	1,382	11	136	9.8	53	3.8
Civil	2,907	15	276	9.5	124	4.3
Computer science and computer engineering	914	9	146	16.0	75	8.2
Electrical	3,570	16	333	9.3	168	4.7
Industrial	1,007	10	135	13.4	54	5.4
Mechanical	3,121	15	275	8.8	135	4.3
Other engineering fields	2,658	20	257	9.7	101	3.8
Total positions	16,208	14	1,583	9.8	720	4.4

*Included in this survey were only institutions with at least one engineering program accredited by the Engineers' Council for Professional Development, 1979.

Note: On this and subsequent tables, totals may not add exactly because of weighting and rounding.

Table 2

Permanent Full-time Engineering Faculty Positions, Fall 1980:
Top 50 Institutions*

Engineering Fields	Total Number of Positions	Positions Unfilled at Beginning of 1980 Fall Term: N	Positions Unfilled at Beginning of 1980 Fall Term: % of total	Positions Unfilled Since Beginning of 1979 Fall Term: N	Positions Unfilled Since Beginning of 1979 Fall Term: % of total
Aeronautical and astronautical	384	16	4.2	5	1.3
Chemical	680	51	7.5	23	3.4
Civil	1,279	93	7.3	39	3.0
Computer science and computer engineering	369	51	13.8	31	8.4
Electrical	1,443	116	8.0	55	3.8
Industrial	433	39	9.0	9	2.1
Mechanical	1,170	93	7.9	50	4.3
Other engineering fields	1,600	119	7.4	53	3.3
Total positions	7,356	578	7.9	264	3.6

*In level of engineering R & D expenditures, FY79

Table 3

Permanent Full-time Engineering Faculty Positions, Fall 1980:
Public Institutions (N=151)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% total	N	% of total
Aeronautical and astronautical	502	16	22	4.4	7	1.4
Chemical	1,008	11	100	9.9	37	3.7
Civil	2,219	18	211	9.5	83	3.7
Computer science and computer engineering	679	10	115	16.9	58	8.5
Electrical	2,480	19	255	10.3	131	5.3
Industrial	790	11	109	13.8	41	5.2
Mechanical	2,209	17	226	10.2	105	4.8
Other engineering fields	2,028	20	213	10.5	80	3.9
Total positions	11,915	16	1,251	10.5	542	4.5

Table 4

Permanent Full-time Engineering Faculty Positions. Fall 1980:
Private Institutions (N=93)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% of total	N	% of total
Aeronautical and astronautical	147	15	5	3.4	2	1.4
Chemical	374	11	35	9.4	15	4.0
Civil	688	10	65	9.4	41	6.0
Computer science and computer engineering	234	7	31	13.2	18	7.7
Electrical	1,090	13	77	7.1	37	3.4
Industrial	217	7	25	11.5	13	6.0
Mechanical	912	12	48	5.3	31	3.4
Other engineering fields	629	21	44	7.0	21	3.3
Total positions	4,291	12	330	7.7	178	4.1

Table 5

Permanent Full-time Engineering Faculty Positions, Fall 1980: Public Universities (N=86)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% of total	N	% of total
Aeronautical and astronautical	367	15	20	5.4	7	1.9
Chemical	854	13	74	8.7	37	4.3
Civil	1,718	22	131	7.6	59	3.4
Computer science and computer engineering	436	12	68	15.6	44	10.1
Electrical	1,778	23	160	9.0	84	4.7
Industrial	593	14	68	11.5	24	4.0
Mechanical	1,642	21	142	8.6	71	4.3
Other engineering fields	1,611	25	153	9.4	70	4.3
Total positions	8,999	20	817	9.1	396	4.4

Table 6

Permanent Full-time Engineering Faculty Positions, Fall, 1980: Private Universities (N=45)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% of total	N	% of total
Aeronautical and astronautical	147	15	5	3.4	2	1.4
Chemical	338	11	35	10.4	15	4.4
Civil	522	15	43	8.2	27	5.2
Computer science and computer engineering	214	10	31	14.5	18	8.4
Electrical	769	20	66	8.6	30	3.9
Industrial	134	9	12	9.0	7	5.2
Mechanical	587	16	41	7.0	24	4.1
Other engineering fields	629	21	44	7.0	21	3.3
Total positions	3,341	15	278	8.3	144	4.3

Table 7

Permanent Full-time Engineering Faculty Positions, Fall 1980:
Public Four-Year Colleges (N=65)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% of total	N	% of total
Aeronautical and astronautical	135	20[a]	2	1.5	0	0
Chemical	154	5	26	16.9	0	0
Civil	501	10	80	16.0	24	4.8
Computer science and computer engineering	243	8	47	19.3	14	5.8
Electrical	702	13	95	13.5	47	6.7
Industrial	197	6	41	20.8	17	8.6
Mechanical	567	11	84	14.8	34	6.0
Other engineering fields	417	10	60	14.4	10	2.4
Total positions	2,916	10	434	14.9	146	5.0

[a]Distorted somewhat due to the inclusion of faculty from a U.S. Service School.

Table 8

Permanent Full-time Engineering Faculty Positions, Fall, 1980:
Private Four-Year Colleges (N=48)

Engineering Fields	Number of Positions		Positions Unfilled at Beginning of 1980 Fall Term		Positions Unfilled Since Beginning of 1979 Fall Term	
	Total	Avg. Per Dept.	N	% of total	N	% of total
Aeronautical and astronautical	0	0	0	0	0	0
Chemical	36	7	0	0	0	0
Civil	166	5	22	13.3	14	8.4
Computer science and computer engineering	20	2	0	0	0	0
Electrical	321	7	11	3.4	7	2.2
Industrial	83	6	13	15.7	6	7.2
Mechanical	325	8	7	2.2	7	2.2
Other engineering fields	0	0	0	0	0	0
Total positions	951	6	53	5.6	34	3.6

Table 9

Perceived Change Within the Past Five Years in the Ability to Recruit or Retain Permanent Full-time Engineering Faculty

Change	Percentage of Institutions Reporting Change						
	Total Institutions (N=244)	Public			Private		
		Total (N=151)	Universities (N=86)	Four-Year (N=65)	Total (N=93)	Universities (N=45)	Four-Year (N=48)
There has been a substantial increase in our ability to recruit or retain full-time engineering faculty.	3.7	5.3	2.4	9.1	0	0	0
There has been a slight or moderate increase in our ability to recruit full-time engineering faculty.	3.3	3.3	1.2	6.1	3.3	6.7	0
There has been no change in our ability to recruit or retain full-time engineering faculty.	4.9	.7	1.2	0	12.0	15.6	8.5
There has been a slight or moderate decrease in our ability to recruit or retain full-time engineering faculty.	37.3	27.2	28.2	25.8	55.4	57.8	53.2
There has been a substantial decrease in our ability to retain full-time engineering faculty.	50.8	63.5	67.0	59.0	29.3	20.0	38.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 10

Effects Upon Engineering Colleges of the Difficulty in Recruiting or Retaining Full-time Faculty

Effects	Percentage of Institutions Reporting Effect						
	All Institutions	Public			Private		
		Total	Universities	Four-Year	Total	Universities	Four-Year
Number of institutions that reported decreased ability to recruit or retain full-time engineering faculty	*215*	*137*	*81*	*56*	*78*	*35*	*43*
There has been a reduction in faculty research.	34.8	36.7	38.5	34.0	29.6	25.0	33.3
There has been an increase in teaching loads.	80.3	80.5	85.9	72.0	78.9	53.1	100.0
There is greater reliance on graduate teaching assistants or part-time faculty.	65.7	77.3	80.8	72.0	42.3	62.5	25.6
We have been unable to offer courses in certain subjects.	53.5	54.7	53.8	6.0	50.7	37.5	61.5
Other	21.2	18.0	16.7	20.0	23.9	9.4	35.9
There has been no significant effect as yet.	8.1	6.2	3.8	10.0	9.9	9.4	10.3

Table 11

Extent of Decrease in Quality of Research and Instruction in Engineering Colleges Resulting from Difficulty in Recruiting or Retaining Full-time Faculty

Extent of Decrease in Quality	Percentage of Institutions Rating Quality						
	All Institutions	Public			Private		
		Total	Universities	Four-Year	Total	Universities	Four-Year
Number of institutions that reported decreased ability to recruit or retain full-time engineering faculty	*215*	*137*	*81*	*56*	*78*	*35*	*43*
Research							
No decrease	24.5	24.1	29.3	15.7	26.3	45.5	0
Yes, to a slight degree	40.1	35.3	32.9	39.2	52.6	30.3	83.3
Yes, to a moderate degree	29.2	33.1	31.7	35.3	19.3	21.2	16.7
Yes, to a great degree	6.2	7.5	6.1	9.8	1.8	3.0	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Instruction							
No decrease	18.4	17.0	15.9	18.9	20.8	17.6	23.3
Yes, to a slight degree	40.6	33.3	34.1	32.1	55.8	61.8	51.2
Yes, to a moderate degree	31.1	36.3	40.2	30.1	20.8	14.7	25.5
Yes, to a great degree	9.9	13.3	9.8	18.9	2.6	5.9	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 12

Full-time Junior Engineering Faculty Who Did Not Receive Their Baccalaureates in the United States

Institutional Category	Total Junior Faculty	Percentage with Baccalaureate Outside the U.S.
Total	3,397	23.7
Top 50 institutions*	1,400	22.1
Public institutions	2,416	25.0
Private institutions	981	20.5
Public universities	1,768	22.3
Private universities	683	19.2
Public four-year colleges	648	32.4
Private four-year colleges	298	23.5

*In level of engineering R & D expenditures, FY79

Table 13

Full-time Engineering Faculty Who Voluntarily Left Academia for Full-time Employment in Industry, 1979-80

Engineering Fields	Total Institutions	Top 50*	Public			Private		
			Total	Universities	Four-Year	Total	Universities	Four-Year
Aeronautical and astronautical	3.0	2.1	1.4	1.8	0	7.7	11.6	0
Chemical	8.1	9.8	9.5	8.9	11.9	3.9	5.8	0
Civil	15.4	15.4	17.1	17.3	16.4	10.6	5.8	20.0
Computer science and computer engineering	10.8	9.7	11.9	11.9	11.9	7.7	11.6	0
Electrical	22.4	23.1	21.2	19.0	28.4	26.0	17.4	42.9
Industrial	6.0	6.3	5.1	6.2	1.5	8.6	2.9	20.0
Mechanical	19.7	15.4	17.1	19.0	10.5	26.9	31.9	17.1
Other engineering fields	14.6	18.2	16.7	15.9	19.4	8.6	13.0	0
Total faculty	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	(N=397)	(N=143)	(N=293)	(N=226)	(N=67)	(N=104)	(N=69)	(N=35)

*In level of engineering and R & D expenditures, FY79

Table 14

Perceived Change over the Past Five Years in the Degree of Competition with Industry in the Recruitment and Retention of Full-time Engineering Faculty

Change in Degree of Competition	Percentage of Institutions Reporting Change						
	Total Institutions (N=244)	Public			Private		
		Total (N=151)	Universities (N=86)	Four-Year (N=65)	Total (N=93)	Universities (N=45)	Four-Year (N=48)
Competition has decreased.	0	0	0	0	0	0	0
Competition has not changed.	10.2	7.9	4.7	12.1	12.9	17.8	8.3
Competition has increased.	89.8	92.1	95.3	87.9	87.1	82.2	91.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 15

Chief Reason for Increased Competition with Industry in the Recruitment and Retention of Full-time Engineering Faculty

Chief Reason	Total Institutions	Public			Private		
		Total	Universities Four-Year		Total	Universities Four-Year	
Number of institutions that reported increased competition with industry	*219*	*139*	*81*	*58*	*80*	*36*	*44*
Salaries and financial benefits in industry are perceived as superior.	76.2	73.2	77.5	67.2	82.5	77.8	86.4
Industry allows concentration upon research free from the demands of teaching.	.9	1.4	1.3	1.7	0	0	0
Industry is perceived to offer better opportunities for advancement and recognition.	4.6	3.6	3.7	3.5	5.0	11.1	0
Fewer new engineering doctorates have graduated in recent years than in the past.	15.1	17.4	13.8	22.4	11.3	8.3	13.6
Other	3.2	4.4	3.7	5.2	1.2	2.8	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

APPENDIX A: Survey Instrument

AMERICAN COUNCIL ON EDUCATION
ONE DUPONT CIRCLE
WASHINGTON, D. C. 20036

HIGHER EDUCATION PANEL
(202) 833-4757

October 15, 1980

Dear Higher Education Panel Representative:

Enclosed is Higher Education Panel survey #52, "Recruitment and Retention of Full-Time Engineering Faculty, Fall 1980." Sponsored by the National Science Foundation, the survey seeks to determine the extent of competition for qualified engineering personnel and the impact of competition upon an institution's ability to maintain its level of research and instruction.

There is some anecdotal evidence that strong competition from industry is having an adverse effect on higher education's ability to recruit and retain engineering faculty, largely because of the employment advantages perceived to lie in industry. At present, there is insufficient information to enable the Foundation to determine whether or how this concern should be addressed. It is hoped that the findings from this survey will fill part of that need.

The questionnaire should be completed by the dean of the college of engineering (or other organizational unit designated as engineering).

Please understand that responses from your institution will be held in strictest confidence. As with other surveys, the data you provide will be reported in summary fashion only and will not be identifiable with your institution. This survey is authorized by the National Science Foundation Act of 1950, as amended. Although you are not required to respond, your cooperation is needed to make the results comprehensive, reliable, and timely.

Please return the completed questionnaire to us by November 10, 1980. A prepaid envelope has been enclosed for your convenience. If you have any problems or questions, please do not hesitate to telephone us collect at 202-833-4757.

Thank you for your continued assistance.

Sincerely,

Frank J. Atelsek
Panel Director

OMB No. 099-R0265
Exp. 6/81

American Council on Education
Higher Education Panel Survey No. 52:
Recruitment and Retention of Full-Time Engineering Faculty, Fall 1980

1. Please supply the following position information for the college of engineering as of fall 1980. (SEE INSTRUCTIONS ON THE OPPOSITE PAGE.)

Engineering Fields	Permanent Full-Time Faculty Positions		
	Total number of positions (filled and unfilled)	Number in A which were unfilled at the beginning of the 1980 fall term	Number in B which have been unfilled since the beginning of the 1979 fall term
	A	B	C
Aeronautical and astronautical			
Chemical			
Civil			
Computer science and computer engineering			
Electrical			
Industrial			
Mechanical			
Other engineering fields			
Total positions			

Do not include engineering technology

2. Has there been any change within the past five years in the ability of your engineering college to recruit or retain permanent full-time faculty?

( ) a. There has been a substantial increase in our ability to recruit or retain full-time engineering faculty.

( ) b. There has been a slight or moderate increase in our ability to recruit or retain full-time engineering faculty.

( ) c. There has been no change in our ability to recruit or retain full-time engineering faculty.

( ) d. There has been a slight or moderate decrease in our ability to recruit or retain full-time engineering faculty.

( ) e. There has been a substantial decrease in our ability to recruit or retain full-time engineering faculty.

If you checked "a", "b", or "c", please skip question 3 and 4 and go straight to question 5.

3. How has the overall difficulty in recruiting or retaining full-time faculty affected your engineering college?

CHECK ALL THAT APPLY.

( ) There has been a reduction in faculty research.
( ) There has been an increase in teaching loads.
( ) There is greater reliance on graduate teaching assistants or part-time faculty.
( ) We have been unable to offer courses in certain subjects.
( ) Other (specify) _____.
( ) There has been no significant effect as yet.

4. Do you believe that the quality of research and instruction in your engineering college has decreased because of the difficulty in recruiting or retaining full-time faculty?

CHECK ONE IN EACH COLUMN

	Research	*Instruction*
No	( )	( )
Yes, to a slight degree	( )	( )
Yes, to a moderate degree	( )	( )
Yes, to a great degree	( )	( )

(over)

5. **Of the full-time junior faculty (instructors and assistant professors) in permanent positions in your engineering college, how many *did not* receive their bachelor's degree in the United States?**

_____ total number of junior engineering faculty

_____ number who received bachelor's degree outside the United States

6. **Of the full-time faculty in permanent positions during the 1979-80 school year, how many voluntarily left your engineering college to work full-time *in industry* because of its perceived superior employment advantages?**

Engineering Fields	Faculty Who Voluntarily Left for Industry
Aeronautical and astronautical	
Chemical	
Civil	
Computer science and computer engineering	
Electrical	
Industrial	
Mechanical	
Other engineering fields	
Total faculty	

Do not count those who were denied reappointment by your institution for any reason, including failure to receive tenure. Also *do not* include those who left because they anticipated failure to receive tenure.

7. **Considering your college of engineering as a whole, how has the degree of competition *WITH INDUSTRY* changed over the past five years in the recruitment and retention of full-time faculty for permanent positions?**

( ) a. Competition with industry decreased.
( ) b. Competition with industry has not changed.
( ) c. Competition with industry has increased.

***If you checked* "a" or "b" stop here. Thank you for your help.**

8. **What do you think is the chief reason for the increased competition with industry?**

CHECK ONLY ONE.

( ) Salaries and financial benefits in industry are perceived as superior to those in your engineering college.
( ) Employment security in industry is perceived as better than that in your engineering college.
( ) Industry allows concentration upon research free from the demands of teaching.
( ) Industry is perceived to offer better opportunities for advancement and recognition.
( ) Industry is perceived to provide better laboratory equipment and facilities.
( ) Fewer new engineering doctorates have graduated in recent years than in the past.
( ) Other (specify) _____

Thank you for your assistance.
Please return this form by November 10, 1980 to:
Higher Education Panel
American Council on Education
One Dupont Circle, N.W.
Washington, D.C. 20036

Please keep a copy of this survey for your records.
Person completing form
Name _____
Dept. _____
Phone _____

If you have any questions or problems, please call the HEP staff collect at 202-833-4757.

Instructions

Please provide information on all full-time engineering faculty with appointments in the college of engineering (or other organizational unit designated as engineering) at your institution. Also include other engineering faculty outside the engineering college if they belong to departments specifically designated as being in a field of engineering.

Please exclude faculty in nonengineering departments (e.g., physics, mathematics) which may be part of the college of engineering. Also exclude engineering technology faculty.

Please allocate faculty and positions according to the most closely corresponding fields listed. Include under "other" those engineering positions which do not closely correspond to the listed fields.

Definitions

Full-time faculty - Include instructors, assistant professors, associate professors, full professors, and other equivalent ranks.

If a faculty appointment is split between two colleges, it should be included if 50 percent or more of the appointment is in the college of engineering.

Permanent positions - Include all tenure-track positions and other positions which have been designated for full-time faculty eligible for permanent employment. Do not include positions which are designated for faculty with a temporary appointment or who are otherwise ineligible for tenure.

If your college has a fixed budget, rather than a specific number of positions available, please report in question 1 the total number of full-time faculty who would be employed if qualified candidates were available for all positions.

Unfilled permanent positions - Please include in question 1 all permanent positions for which you have attempted to recruit full-time faculty but which remain unfilled by full-time faculty as of the time specified.

Also consider unfilled all those permanent positions for which you have attempted to recruit full-time faculty but which you were able to fill only with visiting or other temporary faculty.

Appendix B: Technical Notes

The survey instrument was mailed to all four-year colleges and universities in the Panel that had at least one engineering program accredited by the Engineers' Council for Professional Development in 1979. Usable responses were received from 88 percent of the 181 eligible Panel members.

Weighting

The usual HEP weighting process was not designed to deal with colleges of engineering. To adjust this process for the engineering faculty survey, a two-stage procedure was employed. The first stage used the standard HEP stratification whereas the second considered numbers of engineering degrees conferred.

I. HEP Stratification Design

	Cell	Population (N=244)	Respondents (N=159)
1	Public universities	86	75
2	Private universities	45	40
3	Public four-year FTE > 8,750	41	30
4	Private four-year FTE > 8,750	4	1
5	Public four-year FTE 3,700-8,750	10	5
6	Public four-year FTE < 3,700	15	2
7	Private four-year FTE 2,000-8,750	26	5
8	Private four-year FTE < 2,000	17	1

II. Revised Stratification Design

	Cell	Population (N=244)	Respondents (N=159)
1	Public universities > 300 (engineering degrees conferred in 1978)	46	38
2	Public universities < 300	40	37
3	Private universities > 300	16	13
4	Private universities < 300	29	27
5	Public four-year > 100	37	23
6	Public four-year < 100	29	14
7	Private four-year > 100	20	3
8	Private four-year < 100	27	4

This two-stage weighting was completed in the following steps:

Stage I: Using the HEP design (collapsed into 8 cells), an institutional weight was created by the ratio of the number of population institutions to the number of responding institutions, separately for each cell.

$$w_i = \frac{N_i \text{ population}}{n_i \text{ respondents}} \quad \text{for each HEP stratification cell } i$$

Stage II. A second ratio was formed according to the respondent's position in the new stratification design partly based on degrees conferred in engineering. For each cell, the number of institutions in the population was divided by the sum of the weights the responding institutions acquired from their respective positions in the initial HEP design.

$$w_j = \frac{N_j \text{ population}}{\Sigma w_i n_i} \quad \text{for each new stratification cell } j$$

Then the two ratios were multiplied together to form the final institutional weight.

$$W = w_i \times w_j$$

Because 74 percent of the survey population are Panel members, and 72 percent of of the population are in the certainty (self-representing) cells, no estimates of sampling error were computed.

Respondents

Among the 159 institutions that responded to the survey, private four-year colleges had a lower than average response rate (78 percent). The highest response rates were recorded for institutions in the South (97 percent), private universities-

and institutions that awarded between 150 and 300 engineering degrees in 1978 (93 percent each).

Comparison of Respondents and Nonrespondents

Characteristic	Respondents (N=159)	Nonrespondents (N=22)	Response Rate
Total	100.0	100.0	88.3
Type and control			
Public universities	47.1	47.6	88.2
Private universities	25.2	14.3	93.0
Public four-year	23.3	28.6	85.4
Private four-year	4.4	9.5	77.8*
Census region			
East	21.4	23.8	87.2
Midwest	22.0	28.6	87.5
South	35.8	9.5	96.6
West	20.8	38.1	80.5
Degrees conferred in engineering (1978)			
Less than 150	28.9	38.1	85.2
150 - 300	34.0	19.0	93.1
301 - 450	16.4	23.8	83.9
More than 450	20.8	19.0	89.2

*Response rate falls more than ten percent below the average.

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