

Recipients of the Master's Degree In Sanitary Engineering

By WALTER A. LYON, M.S.S.E., and ARTHUR P. MILLER, C.E.

TO PERMIT a quantitative assessment of the present and future supply of trained sanitary engineers, it is necessary to determine the number of graduates who follow the profession. In an earlier report (1), such data were provided concerning graduates from undergraduate curricula and options in sanitary engineering. The present study is designed to provide similar information about those who have completed graduate work in sanitary engineering at the master's level.

In order to throw additional light on the place of graduate work in sanitary engineering education, certain other statistical data are also discussed. These relate to the undergraduate background, the amount of experience prior to entering graduate school, and the employment distribution of the graduates. Particular attention is given to characteristics that the graduates from individual schools have in common with respect to prior experience and choice of employment.

Method and Data Used

Miller (2) showed that 44 universities and colleges in the United States at some time dur-

ing the period 1899-1951 granted the master's degree to individuals majoring in sanitary engineering. From these, a group of 28 institutions was drawn. These schools granted the master's degree in sanitary engineering to 1,023 nationals of the United States during the period 1900-1951. This number of graduates, constituting 86 percent of all United States nationals receiving a master's degree in sanitary engineering during those 52 years (1900-1951), was used as the basic material for this study.

The universities and colleges in the group were divided into two subgroups: one consisting of those schools which, in our study, were represented by 30 or more respondents who were United States nationals and the other by those which had fewer than 30. In this way, 7 "heavy producers" (Harvard University, Johns Hopkins University, Massachusetts Institute of Technology, University of Michigan, New York University, University of North Carolina, and University of Wisconsin) and 21 "light producers" were selected in order that data might be provided for both classes of institutions. Although the number of heavy producers was somewhat disproportionate, the number of light producers which are included assures their representation. Wherever there were statistically significant differences between the characteristics of schools or between "heavy and light producers," these will be indicated as significant.

In the analysis of the data, tests for significance were used where the need for such a test arose. Wherever, in this report, a difference is indicated as being "significant," this means that the difference was significant at a level of $P=.05$. The test employed was that described by Zubin (4) which by the use of nomographs determines the significance of the differences between

Mr. Lyon, formerly with the Division of Engineering Resources, Bureau of State Services, is now with the Division of International Health, Bureau of State Services, Public Health Service, and assigned to Bangkok as consultant in sanitation problems in Thailand. Mr. Miller is chief of the planning and development branch, Division of Engineering Resources.

the relative frequencies of events in two contrasted series or groups.

The colleges and universities included in the study provided lists of their graduates and the best available mailing address for each one. An explanatory letter with a reply post card was sent to each person and followup action was taken as long as it appeared to be productive of results. The information given by each respondent was edited, coded, and entered on punch cards for mechanical tabulation. Usable

data were obtained from 874 individuals or 85.4 percent of the group (1,023) to whom cards were mailed. Those who had also earned doctorate degrees in sanitary engineering were excluded.

Table 1 shows a summary of the total number of master's degrees in sanitary engineering granted by the 28 schools in the sample, the number of respondents from each institution, and other information concerning the composition of the sample.

Table 1. Summary, as of 1951, of information on recipients of the master's degree in sanitary engineering from 28 colleges and universities, 1900-1951

Institution	Total ¹	Recipients of the master's degree						
		Nationals of other countries	Nationals of the United States					
			Total	Dead	Ex-cluded ²	Respondents		
						Total	In profes-sion	Out of profes-sion
Total.....	1, 293	270	1, 023	21	128	874	763	111
Alabama Poly. Inst.....	3	0	3	0	1	2	1	1
California, Univ. of.....	31	1	30	0	8	22	18	4
Case Inst. of Tech.....	16	1	15	0	2	13	5	8
Cornell Univ.....	31	10	21	1	3	17	13	4
Florida, Univ. of.....	17	5	12	0	1	11	11	0
Harvard Univ.....	478	98	380	9	50	321	297	24
Illinois, Univ. of.....	13	2	11	0	1	10	10	0
Iowa State Col.....	11	1	10	0	2	8	5	3
Iowa, State Univ. of.....	18	6	12	0	0	12	10	2
Johns Hopkins Univ.....	48	8	40	0	3	37	36	1
Kentucky, Univ. of.....	3	0	3	0	0	3	3	0
Massachusetts Inst. of Tech.....	93	18	75	0	11	64	55	9
Michigan State Col.....	5	0	5	0	0	5	5	0
Michigan, Univ. of.....	200	67	133	6	11	116	99	17
New York Univ.....	102	1	101	1	13	87	75	12
North Carolina State Col.....	9	2	7	0	0	7	3	4
North Carolina, Univ. of.....	98	46	52	2	6	44	40	4
Northwestern Tech. Inst.....	3	0	3	0	1	2	1	1
Oklahoma Agri. and Mech. Col.....	3	0	3	0	0	3	3	0
Oregon State Col.....	5	0	5	0	1	4	3	1
Purdue Univ.....	16	1	15	0	3	12	11	1
Rensselaer Poly. Inst.....	3	0	3	0	1	2	2	0
Rutgers Univ.....	2	1	1	0	0	1	1	0
Tennessee, Univ. of.....	3	1	2	0	1	1	1	0
Texas, Univ. of.....	10	0	10	0	3	7	7	0
Virginia Poly. Inst.....	20	0	20	0	0	20	16	4
West Virginia Univ.....	3	0	3	0	0	3	3	0
Wisconsin, Univ. of.....	49	1	48	2	6	40	29	11

¹ See reference 2.

² Excluded because of no or insufficient information. In this group, there are 30 who also obtained a doctorate degree.

Schools and Their Graduates

The number of schools granting the master's degree in sanitary engineering has kept pace with the rapid increase in the number of such degrees awarded. Ten colleges were awarding the master's degree to individuals majoring in sanitary engineering by 1925; by 1935 the number had risen to 22, by 1945 to 32, and by 1951 to 44 with an additional 13 schools prepared to do so if candidates presented themselves.

The student load carried by the schools is not equally distributed. For example, of all the degrees granted during the last decade (1942-51), almost two-thirds were awarded by one-eighth of the schools active during that period.

Loss From the Profession

For the purpose of this study, a graduate was considered to have remained in the profession if, during the year 1951, he was in an occupation in which he devoted all or part of his time to the application of engineering knowledge in the control of the environment in order to promote and protect the public health in administrative, promotional, operational, teaching, testing, design, or research activities.

In the bachelor's level study (1), all those who spent 50 percent or more of their time in sanitary engineering work were classified as being in the profession. In this study, all those who were practicing sanitary engineering any portion of their time were so classified. This change in definition accounts for 8 of the 35.8 percent difference between the "percents remaining in the profession" when the bachelor's and the master's groups are compared.

As stated before, the total number of students from the schools in the sample from whom usable information was received was 874; of these, 763 or 87.3 percent remained in the profession in 1951.

If we compare the percents remaining in the three educational levels, we find the following distribution:

Degree level of graduates	Percent of graduates remaining in the profession
Bachelor's.....	51.5
Master's.....	87.3
Doctorate.....	97.3

The figures above are based on degrees granted rather than on individuals. The same person may have been included twice or even three times. (The number of doctorate degrees earned in sanitary engineering to date is relatively small; therefore, data on them are used in this study only in this one comparison.) Most of those who received doctorates had also received the master's degree in sanitary engineering. This is not true, however, for those who earned degrees only to the master's level. Only about one-third of these had studied sanitary engineering at the undergraduate level.

The difference in percents remaining between the bachelor's and the master's degree levels even after taking into consideration the 8 percent accounted for through change in definition previously mentioned is about three times as great as the difference between the master's and the doctorate levels. The difference in percents remaining between the bachelor's and the master's levels is probably due in part to the fact that most of the master's degrees were granted more recently than most of the bachelor's degrees. The median master's degree in the sample used in this study (1900-1951) was granted in 1947. The median bachelor's degree in the undergraduate study (1) (1910-49) was granted in 1937. This means that the median bachelor's level graduate has had more time (that is, more of a chance) to leave the profession than has the median master's degree recipient.

In comparing the percents of graduates from each school who have remained in the profession, only the graduates during the 1942-51 period were considered, because a number of the schools in the study did not begin to grant the master's degree in sanitary engineering until some time during that period.

As shown in table 6, there were relatively small differences in the percents remaining among those from each school. In some cases, the number of graduates involved was too small to permit drawing significant conclusions.

When the heavy producers during the 1942-51 period were compared with the light producers, a significant difference in the percents remaining was found. (Since, for the 1942-51 period, the line of division between heavy and light producers was drawn at 15 respond-

ents, the University of California is included for this period only among the heavy producers.) For the heavy producers, the percent remaining was 93.5, whereas for the light producers it was 84.7. The reasons for this difference will become more obvious in the discussions of pregraduate-school experience and type of employment which follow.

Undergraduate Background

The undergraduate background of about half of the master's degree recipients in sanitary engineering was the civil engineering curriculum; somewhat more than a third completed the sanitary engineering option of civil engineering or the sanitary engineering curriculum; and about one-sixth completed some other type of engineering curriculum. Table 2 shows this, the percents remaining, and the percents which had pregraduate-school experience for each type of undergraduate work.

Table 2 also shows that increasing percents of the master's degree recipients who had undergraduate work in civil engineering, the sanitary engineering option of civil engineering, sanitary or public health engineering, and other types of engineering curricula, remained in the profession. The percents who have had 1 year

or more of pregraduate-school experience vary in the same order. The differences in these percents are small, but they follow a pattern which suggests the general rule that the more a man is exposed to sanitary engineering either via experience or education, the more likely he is to remain in the profession.

Experience Prior to Graduate Work

Many of those who earned the master's degree in sanitary engineering had gained some experience in the field before beginning graduate work. In this study, we have assumed that only those who have had 1 year or more of such pregraduate-school sanitary engineering experience have had a significant amount of such experience. Table 3 indicates that more than half of the master's degree recipients fall into that category.

About 57 percent of those who remained in the profession after having completed graduate school work, had a year or more of pregraduate-school experience whereas only 24 percent of those who left the field had such experience. This is, of course, to be expected since an engineer who had some pregraduate-school experience has had more chance to decide whether or not he likes sanitary engineering than one who has not. Actually, of the 874 graduates in the sample, only 27 or 3 percent who had had pregraduate-school experience, left the profession at some time subsequent to the completion of graduate work.

When the graduates are grouped by the type of their 1951 employment, there are considerable differences in the proportions who had pregraduate-school experience. Table 4 demonstrates this.

The second column of this table shows the percents of all sanitary engineers in each type of employment who have reached the master's level of education. This could be considered as an indication of the extent of utilization of master's level men in each employment category. The fourth column shows the percents of graduates in each employment category who have had a year or more of pregraduate-school experience. This may be considered an index of the opportunity given by the employer, or taken by the student, to return to school for graduate work.

Table 2. Distribution of type of undergraduate curriculum completed by percent remaining in the profession in 1951 and pregraduate-school experience in sanitary engineering

Undergraduate curriculum completed	Recipients of the master's degree			
	Total		Percent remaining in the profession in 1951	Percent with 1 year or more of pregraduate-school experience
	Number	Percent		
Total.....	874	100.0	87.3	52.5
Civil engineering.....	421	48.2	86.2	46.3
Civil engineering-sanitary engineering option.....	266	30.4	86.8	53.8
Sanitary or public health engineering..	38	4.3	89.5	60.5
Other engineering....	149	17.1	90.6	65.8

Table 3. Distribution of years of sanitary engineering experience gained prior to entering graduate school and percent remaining in the profession in 1951

Years of pregraduate-school experience in sanitary engineering	Status of recipients of the master's degree in 1951						Percent remaining in the profession
	Total		In sanitary engineering work		Out of sanitary engineering work		
	Number	Percent	Number	Percent	Number	Percent	
Total.....	874	100.0	763	¹ 100.0	111	100.0	87.3
Less than 1.....	415	47.5	331	43.4	84	75.7	79.8
1 to 4.9.....	255	29.2	232	30.4	23	20.7	91.0
5 to 9.9.....	126	14.4	123	16.1	3	2.7	97.6
10 to 14.9.....	57	6.5	56	7.3	1	.9	98.3
15 to 19.9.....	17	1.9	17	2.2	0	-----	100.0
20 and over.....	4	.5	4	.5	0	-----	100.0

¹ Because of rounding, details may not add to totals in this and all subsequent tables.

Since the majority earned their degrees rather recently, it is assumed that most of the graduates have remained in the same employment category in which they were prior to their graduate studies.

As a general rule, in those employment categories where the greatest use of master's level men has been made, a greater proportion of the

men have returned to school to earn such a degree. However, there seem to be two exceptions to this rule. In the case of public works agencies where only a small proportion of sanitary engineers hold a master's degree, a high proportion have obtained them by returning to school after working in the field. With academic institutions, the opposite appears to be

Table 4. Relationship between type of employment and pregraduate-school experience in sanitary engineering

Type of employment	Percent of all practicing sanitary engineers with a master's degree of any type ¹	Recipients of the master's degree in sanitary engineering		
		Number	Percent with 1 year or more of pregraduate-school experience	Median number of years of pregraduate-school experience
Total.....	-----	874	52.5	1.35
In sanitary engineering work.....	21.3	763	56.6	1.88
Public health agency.....	35.8	345	68.1	3.32
Public works agency.....	11.2	66	59.1	2.33
Utility company.....	12.1	3	66.6	2.00
Academic institution.....	52.7	97	51.5	1.26
Special agency ²	24.4	40	50.0	1.00
Public administration.....	10.8	6	50.0	1.00
Construction firm.....	(³)	16	50.0	1.00
Industrial concern.....	18.6	69	42.0	.88
Consulting firm.....	12.9	107	34.6	.77
Other.....	11.7	14	64.3	2.14
Out of sanitary engineering work.....	-----	111	24.3	.66

¹ See reference 3.

² Includes professional associations, nongovernmental agencies, and military service.

³ Included under "Other."

the case. Although a high proportion of educators and researchers hold the master's degree, relatively fewer of them gained experience before earning their degree. In some of the employment categories, the numbers involved were too small to produce significant information.

Sanitary engineers who return to school to earn their master's degree after having gained some experience seem to favor certain schools. The data show that significantly greater percentages of graduates from Harvard University and the University of Michigan have had more than 1 year of pregraduate-school experience. This also appeared to be the case (although not statistically significant) for the Johns Hopkins University, New York University, and the University of North Carolina. Conversely, a significantly smaller percent of the graduates from the University of Wisconsin and the Massachusetts Institute of Technology have had such experience. When the heavy producers are compared to the light producers, 57 percent of the graduates from the former are found to have had more than 1 year of pregraduate-school experience as compared to 30 percent of the graduates from the latter. This difference is significant.

Time Spent in Sanitary Engineering

Because of the nature of sanitary engineering and particularly because of its relation to other types of public works, there are a number of graduates who spend only a portion of their time in sanitary engineering. This is particularly true for sanitary engineers who have reached a higher level of responsibility, such as the head of a large consulting firm, a city engineer, or the dean of a school of engineering. Table 5 shows this distribution, and compares it with that of the entire profession.

Four-fifths of the master's degree recipients in the sanitary engineering profession devoted most of their time to sanitary engineering work. When compared with the entire profession, the recipients of master's degrees in sanitary engineering devote considerably more of their time to work in sanitary engineering than do non-recipients. This is probably so in part because the master's group is younger and because a greater proportion of this group is in public

Table 5. Distribution of all sanitary engineers and of recipients of the master's degree by percent of time spent in sanitary engineering work

Group	Percent of time devoted to sanitary engineering work	All sanitary engineers ¹	Recipients of the master's degree in sanitary engineering	
		Percent	Number	Percent
	Total-----	100.0	763	100.0
I	More than 75-----	61.9	611	80.1
II	50 to 75-----	19.2	82	10.7
III	Less than 50-----	18.9	70	9.2

¹ See reference 3.

health work as compared with the profession as a whole.

When we study the graduates from chronologically selected groups of classes, we find noteworthy differences in the percents remaining in, and in the distribution of percent of time spent on, sanitary engineering work.

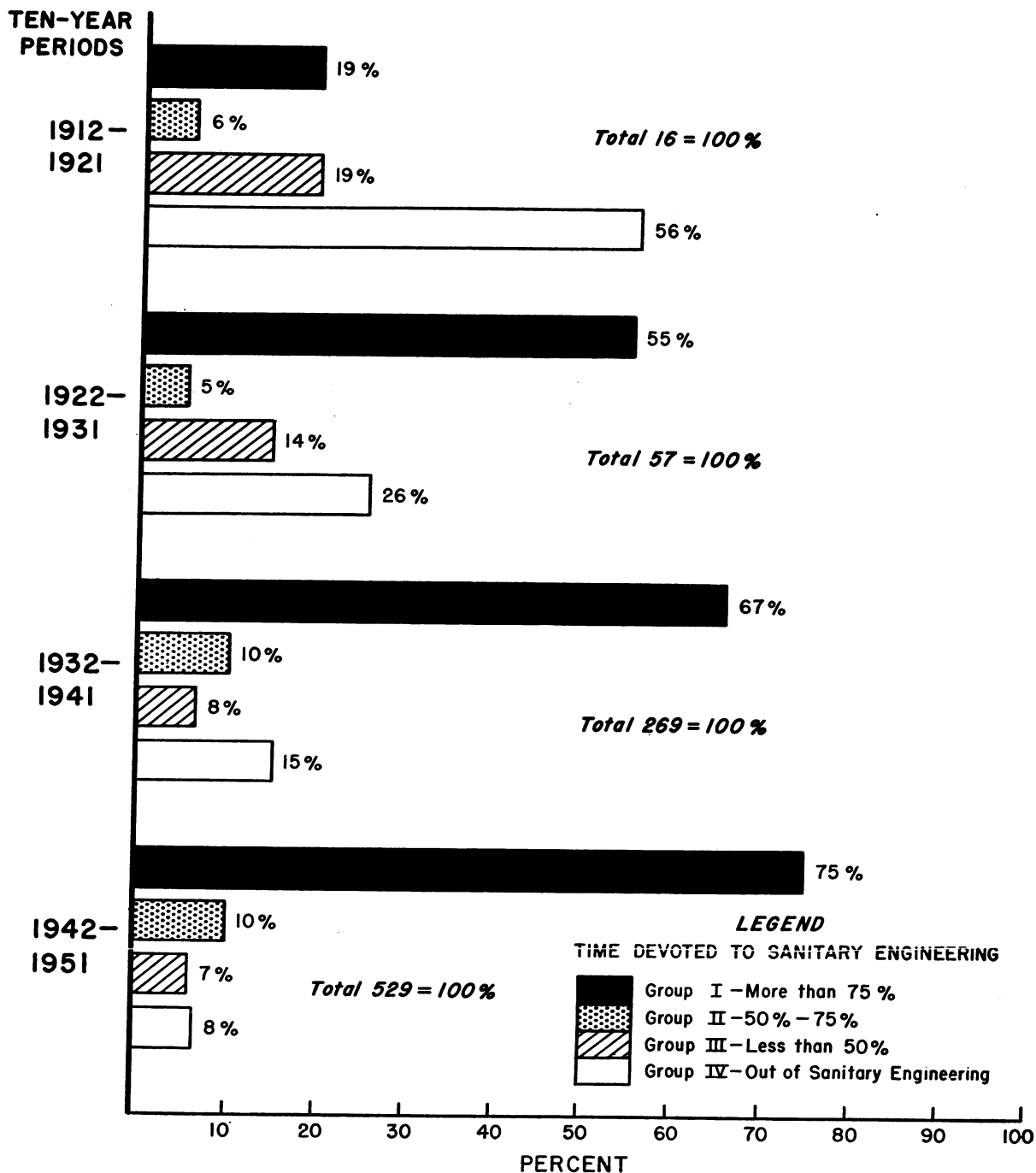
Figure 1 shows that the greater the time elapsed since graduation, the larger becomes the proportion of those who have left the profession. The high percentage of graduates from the 1912-21 classes who have left the profession is no doubt due in part to retirement. The progressive increase in the size of group I among the more recent graduates is probably due to the fact that younger men tend to work in more specialized areas and in part due to the recent expansion of environmental health activities in water pollution control and other fields.

How much of this change is due to program growth and how much of it can be attributed to the natural broadening of individual responsibility that comes with advancing professional experience can only be determined by periodic studies of this kind which will compare future observations with present findings.

Employment Distribution

The types of employment favored by graduates of different colleges and universities appear to differ. To determine the extent of these differences, the graduates who have remained in

Figure 1. Percentage distribution of recipients of a master's degree for selected 10-year periods, by time devoted to sanitary engineering work in 1951.



the profession from each heavy producer school were compared in each case with the graduates from all the remaining schools combined by the type of employment in which they were found in 1951. It was possible to make these comparisons only for the heavy producers, as only they

had graduates in sufficient numbers to justify significant conclusions.

Table 6 gives the employment information as of 1951 for the graduates of each of the 28 schools in the sample who were then in the profession.

Table 6. Recipients of the master's degree in the profession in 1951, by institution and type of employment; and the percent remaining in the profession of the class group of 1942-51

Institution at which the master's degree was earned	Classes of 1900-1951											
	Total		Public health agency		Public works agency		Utility company		Consulting firm		Industrial concern	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total.....	763	100	345	45.2	66	8.7	3	0.4	107	14.0	69	9.0
Alabama Poly. Inst.....	1	100	0	-----	0	-----	0	-----	0	-----	0	-----
California, Univ. of.....	18	100	10	55.6	1	5.6	0	-----	1	5.6	1	5.6
Case Inst. of Tech.....	5	100	1	20.0	0	-----	0	-----	3	60.0	1	20.0
Cornell Univ.....	13	100	5	38.5	1	7.7	0	-----	2	15.4	1	7.7
Florida, Univ. of.....	11	100	5	45.5	1	9.1	0	-----	0	-----	0	-----
Harvard Univ.....	297	100	160	53.9	17	5.7	0	-----	38	12.8	30	10.1
Illinois, Univ. of.....	10	100	3	30.0	0	-----	0	-----	1	10.0	1	10.0
Iowa State Col.....	5	100	0	-----	0	-----	0	-----	1	20.0	1	20.0
Iowa, State Univ. of.....	10	100	2	20.0	2	20.0	0	-----	1	10.0	2	20.0
Johns Hopkins Univ.....	36	100	16	44.4	6	16.7	0	-----	1	2.8	1	2.8
Kentucky, Univ. of.....	3	100	1	33.3	0	-----	0	-----	2	66.6	0	-----
Massachusetts Inst. of Tech.....	55	100	13	23.6	3	5.5	0	-----	15	27.3	6	10.9
Michigan State Col.....	5	100	0	-----	0	-----	0	-----	0	-----	1	20.0
Michigan, Univ. of.....	99	100	69	69.7	10	10.1	1	1.0	6	6.1	2	2.0
New York Univ.....	75	100	15	20.0	15	20.0	1	1.3	18	24.0	15	20.0
North Carolina State Col.....	3	100	1	33.3	0	-----	1	33.3	0	-----	0	-----
North Carolina, Univ. of.....	40	100	18	45.0	2	5.0	0	-----	8	20.0	2	5.0
Northwestern Tech. Inst.....	1	100	0	-----	0	-----	0	-----	1	100.0	0	-----
Oklahoma Agri. and Mech. Col.....	3	100	1	33.3	0	-----	0	-----	0	-----	1	33.3
Oregon State Col.....	3	100	0	-----	1	33.3	0	-----	0	-----	0	-----
Purdue Univ.....	11	100	5	45.5	2	18.2	0	-----	1	9.1	0	-----
Rensselaer Poly. Inst.....	2	100	1	50.0	0	-----	0	-----	0	-----	0	-----
Rutgers Univ.....	1	100	0	-----	0	-----	0	-----	0	-----	0	-----
Tennessee, Univ. of.....	1	100	0	-----	1	100.0	0	-----	0	-----	0	-----
Texas, Univ. of.....	7	100	3	42.9	2	28.6	0	-----	1	14.3	0	-----
Virginia Poly. Inst.....	16	100	5	31.3	1	6.3	0	-----	2	12.5	1	6.3
West Virginia Univ.....	3	100	1	33.3	0	-----	0	-----	0	-----	0	-----
Wisconsin, Univ. of.....	29	100	10	34.5	1	3.4	0	-----	5	17.2	3	10.3

See footnotes at end of table.

Harvard University, when compared to all other schools combined, has a significantly greater proportion of its graduates working for public health agencies and a significantly smaller proportion employed in public works agencies. Harvard also appears to have a smaller proportion of its graduates who have reached only the master's level serving as university teachers, although more than half of the Harvard doctorate recipients are now working in academic institutions.

Graduates from the University of Michigan also seem to choose, in smaller proportions

than do graduates from the other schools combined, employment with consulting firms, industrial concerns, and academic institutions.

The picture among the graduates from New York University is somewhat reversed from that of the University of Michigan. Significantly smaller proportions are in public health and academic work, while significantly greater proportions are in public works agencies, consulting firms, and industrial concerns.

When the Massachusetts Institute of Technology was compared with all the other schools, it was found that a significantly small percent

Table 6. Recipients of the master's degree in the profession in 1951, by institution and type of employment; and the percent remaining in the profession of the class group of 1942-51—Continued

Institution at which the master's degree was earned	Classes of 1900-1951										Classes of 1942-51
	Academic institution		Special agency ¹		Public administration		Construction firm		Other		Remaining in the profession in 1951
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Percent
Total	97	12.7	40	5.2	6	0.8	16	2.1	14	1.8	91.9
Alabama Poly. Inst.....	0		0		0		1	100.0	0		100.0
California, Univ. of.....	4	22.2	0		0		1	5.6	0		90.0
Case Inst. of Tech.....	0		0		0		0		0		36.4
Cornell Univ.....	3	23.1	0		0		1	7.7	0		85.7
Florida, Univ. of.....	4	36.4	1	9.1	0		0		0		100.0
Harvard Univ.....	24	8.1	10	3.4	1	.3	5	1.7	12	4.0	94.4
Illinois, Univ. of.....	4	40.0	1	10.0	0		0		0		100.0
Iowa State Col.....	3	60.0	0		0		0		0		66.7
Iowa, State Univ. of.....	3	30.0	0		0		0		0		80.0
Johns Hopkins Univ.....	3	8.3	8	22.2	0		1	2.8	0		97.2
Kentucky, Univ. of.....	0		0		0		0		0		100.0
Massachusetts Inst. of Tech.....	11	20.0	3	5.5	2	3.6	1	1.8	1	1.8	97.6
Michigan State Col.....	4	80.0	0		0		0		0		100.0
Michigan, Univ. of.....	5	5.1	4	4.0	0		2	2.0	0		95.2
New York Univ.....	3	4.0	7	9.3	0		1	1.3	0		87.9
North Carolina State Col.....	1	33.3	0		0		0		0		66.7
North Carolina, Univ. of.....	5	12.5	3	7.5	1	2.5	0		1	2.5	96.7
Northwestern Tech. Inst.....	0		0		0		0		0		50.0
Oklahoma Agri. and Mech. Col.....	1	33.3	0		0		0		0		100.0
Oregon State Col.....	2	66.6	0		0		0		0		100.0
Purdue Univ.....	1	9.1	2	18.2	0		0		0		91.7
Rensselaer Poly. Inst.....	1	50.0	0		0		0		0		100.0
Rutgers Univ.....	1	100.0	0		0		0		0		(²)
Tennessee, Univ. of.....	0		0		0		0		0		100.0
Texas, Univ. of.....	1	14.3	0		0		0		0		100.0
Virginia Poly. Inst.....	4	25.0	1	6.3	1	6.3	1	6.3	0		83.3
West Virginia Univ.....	1	33.3	0		1	33.3	0		0		(²)
Wisconsin, Univ. of.....	8	27.6	0		0		2	6.9	0		77.8

¹ Includes professional associations, nongovernmental agencies, and military service.

² No master's degree in sanitary engineering granted in the 1942-51 period.

of its graduates are in public health agencies and a significantly greater percent with consulting firms. MIT graduates also appear to favor employment in academic institutions.

The employment distribution of the graduates from the University of North Carolina appears to fall closer to the average than that of the other heavy producers. There were no significant differences in the employment distribution of its graduates when they were compared with those of the other schools.

Graduates from the Johns Hopkins University showed an employment distribution fairly

close to the average except that they favor public works agencies somewhat and are represented in a significantly smaller proportion in consulting firms.

The University of Wisconsin is the only school which has a significantly higher proportion of its graduates employed in academic institutions.

When heavy and light producers were compared, a few differences were found in the employment distribution of the graduates from the two groups of schools. The heavy producers had a significantly higher proportion of their

graduates employed in public health agencies and the light producers had almost three times as great a proportion of their graduates employed in academic institutions as did the heavy producers. As a matter of fact, more than half of those employed in the academic field came from the light producers and, interestingly enough, the University of Wisconsin, which produced the least number of graduates among the heavy producers, also had a high percentage of its graduates teaching.

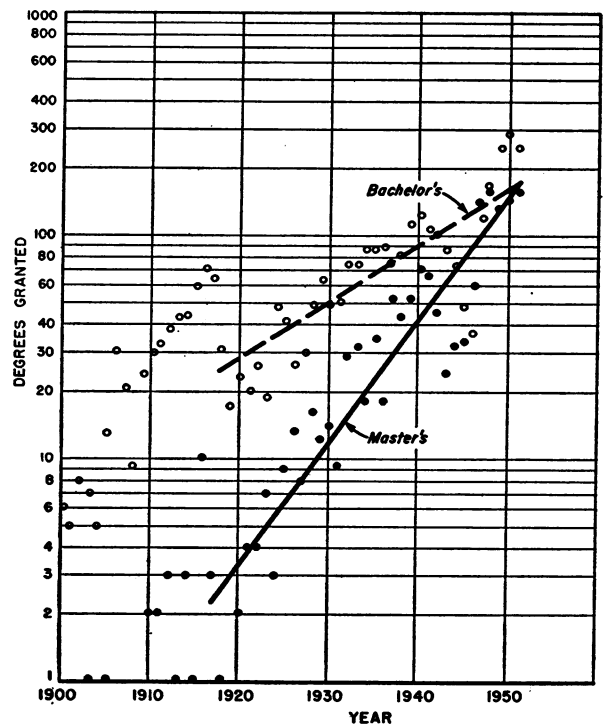
If these data are pursued further, it becomes evident that only a small proportion (15.3 percent) of the master's degree recipients from the heavy producers who are now in the academic field, are teaching at the same institution that awarded them their master's degrees. But of more importance, these data also reveal that the light producers not only turn out a disproportionate share of teachers, but that the majority of these teachers (64.3 percent) have remained with the same institution from which they earned graduate degrees. It is likely that the Engineer's Council for Professional Development (see its 19th annual report, 1951) had this in mind when it wrote: "As schools grow, the pressure for staff expansion led to recruiting by the simple process of keeping on recent graduates, and then allowing them to do their graduate work, if any, while teaching. In this way, there was a subtle influence of continuity of curriculum with little urge for reevaluation or vitality of concept of objectives."

Growing Importance of the Master's Degree

While there has been a considerable increase in the number of sanitary engineering degrees granted on all levels, the number of master's degrees has increased at a greater rate than the number of bachelor's degrees.

The total number of master's and bachelor's degrees granted to students majoring in sanitary engineering in the United States each year during the period 1900-1951 are shown in figure 2. The points on this figure have been plotted on a logarithmic vertical scale in order to facilitate the comparison of relative differences. Between the years 1917 and 1941, the data appear to assume a certain degree of linearity (see note on page 727).

Figure 2. Total number of bachelor's degrees and of master's degrees granted upon completion of study in sanitary engineering in the United States each year, 1900-1951.



The figure shows that the average rate of increase in the annual number of master's degrees granted has been considerably greater than that of the bachelor's degrees. The two curves intersect during 1951. This is, of course, not true for the entire engineering field.

Although there is no evidence that sanitary engineering education on the undergraduate level is on the decline, there is a definite shift of emphasis toward graduate level education in this field. Educational opportunities for veterans have undoubtedly been partly responsible for this shift.

Future trends in a field as small as this are difficult to predict. Recent estimates (1) of the expected number of graduates from the bachelor's level appear now to have been somewhat low. This is because the estimates of future production of all engineering graduates were recently raised, presumably because of the effect of the recent publicity on the shortage of engineering manpower. It looks now as though we might expect between 500 and 600 sanitary engineering graduates at the bachelor's level

NOTE: When a straight line is fitted to the points by the method of least squares for the period 1917-51 (see fig. 2 and p. 726 of text), the mathematical expressions for the best fitting lines became:

$$\text{Log } Y_{cb} = 1.77780 + .02777x \text{ for the bachelor's degrees and}$$
$$\text{Log } Y_{cm} = 1.28388 + .05654x \text{ for the master's degrees.}$$

x equals the year minus 1934 during which Y_c degrees were granted. The year 1934 was chosen as the origin for the x -axis.

during the 4-year period, 1953-56. Figure 2 indicates that if the 34-year (1918-51) trend continues, the annual number of master's degrees granted may be expected to exceed the number of bachelor's degrees.

The availability of public, philanthropic, and other funds for graduate education, as well as selective service policies and general economic trends, are each likely to have an impact upon the number of men who will be able to earn master's degrees in sanitary engineering in the years to come. No matter what outside forces might introduce unexpected change, the record of the past 34 years clearly shows the profession's increasing preference for graduate training in the structure of sanitary engineering education.

Summary

A quantitative study has been made of those who received master's degrees in sanitary engineering during the 52-year period 1900-1951. Twenty-eight colleges and universities, whose graduates represent 86 percent of all the United States nationals who received master's degrees in sanitary engineering during that period, were included in the study. Upon inquiry, 85.4 percent of these graduates responded with usable data.

It was found that 87.3 percent of the master's degree recipients were in the profession in 1951.

The median master's degree recipient gained 1.35 years of sanitary engineering experience after receiving his bachelor's degree and before beginning his graduate studies. Of the entire group, only 3 percent who had had pregraduate-school experience, left the profession at some-time subsequent to doing graduate work.

Among the master's degree recipients reporting, 83.6 percent earned their degrees at 7 of the schools (heavy producers) and 16.4 percent, at the other 21 schools (light producers). A significantly greater proportion of graduates from the heavy producers than from the light producers were practicing sanitary engineering in 1951.

The patterns of employment distribution of the graduates from certain individual schools and from the heavy and the light producer groups differ in part significantly from each other. Particularly outstanding is the fact that more than half of those in the academic field have received their degrees from the light producers and almost two-thirds of them are employed at the institution in which they received their master's degree.

Slightly more than one-third of those who received the master's degree in sanitary engineering had a sanitary engineering undergraduate education. About half took the civil engineering curriculum and one-sixth had completed undergraduate work in one of the other branches of engineering.

The relative trends in the production of bachelor's and master's level graduates in sanitary engineering over the past 34 years suggest that the point has been reached at which the annual production of master's level graduates can be expected to exceed that of the bachelor's level graduates. This observation, together with the fact that roughly 8 out of 10 master's degree recipients as compared with 5 out of 10 bachelor's degree recipients, stay in the profession for which they received their schooling suggests that the educational needs of the profession are being more successfully met by graduate-level education.

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Public Health Service Staff Announcements

Dr. Russell M. Wilder, first director of the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Public Health Service, retired July 1, 1953. Dr. Wilder, internationally known for his work in metabolic diseases and nutrition, came to the Public Health Service in January 1951 shortly after his retirement from the Mayo Foundation where he was professor of medicine and chief of the department of medicine. He will continue as a member of the Board of Editors of *Public Health Reports*. Dr. Wilder will make his home at Rochester, Minn.

Dr. Eddie M. Gordon has been appointed medical officer in charge of the Public Health Service Hospital (National Leprosarium), Carville, La., to succeed Dr. Frederick A. Johansen. Dr. Gordon has been in charge of the Public Health Service Hospital in Chicago. He has also held clinical positions at the Service medical facilities in San Francisco, Boston, Seattle, and

San Pedro, and has been assigned medical officer in the U. S. Consulates at Hong Kong, China, and Manila, P. I.

Dr. Frederick A. Johansen, who retired June 1 after 29 years of service at Carville, participated actively in the evolution of the modern sulfone therapy. Later he guided the installation and organization of the community activities and rehabilitation services at the National Leprosarium. He is widely recognized as an authority on Hansen's disease.

Octavia Heistad, Public Health Service nurse officer, has been assigned to the Point IV technical aid program in Libya where she will work with Libyan nurses and other health aides in extending public health nursing. Miss Heistad, who has done public health nursing in Chicago and Detroit for the past 4 years, will join Bertha Tiber, assigned to Libya as chief nurse under Point IV.

