The Master's Degree in Chemistry
CPT Report: Spring 1998

The ACS Committee on Professional Training (CPT) is charged with examining education in chemistry at the postsecondary level. The ACS approval program for undergraduate departments of chemistry and the certification of bachelor's degree graduates is well known. In graduate education, the committee's most visible activity is the biennial production of *The ACS Directory of Graduate Research*. In addition, CPT has studied many facets of graduate training in chemistry and periodically has published reports of these studies. In the last few years, there has been an intense national debate about the Ph.D. training of scientists (1-3). CPT recently completed a survey of current practices in Ph.D. training, and reported the results in this *Newsletter*. Yet in focusing on the Ph.D., much of this recent attention has ignored a significant component of postgraduate training in chemistry in the U.S.: the master's degree.

Career opportunities in chemistry appear to be changing, particularly in industry and other non-academic positions. It is an often repeated statement that today's graduates must anticipate not one but several careers in their lifetimes. Employers seek graduates at all levels with stronger communication skills, more work experience, broader knowledge and greater flexibility than ever before, but look for this in addition to very sound and broad training in the chemical sciences. It is increasingly challenging to cover the expanding field of chemistry in a four-year program. Obtaining a Master's degree offers one attractive solution.

There are obvious indicators that the Master's degree in chemistry is alive and well. The numbers of Master's degrees awarded in chemistry are quite comparable to those for the PhD, and have showed an upturn in this decade (Table I). The annual salary survey conducted by the ACS shows a consistent and significant added value of the M.S. degree for professional chemists as they enter the workforce (Table II). Nevertheless, it sometimes appears that chemistry master's programs lack visibility.

The Committee on Professional Training recently conducted two brief surveys about the Master's program in chemistry. This report summarizes our findings. Both surveys were sent to department chairs of chemistry graduate programs. Survey I was mailed to 318 schools; of the 250 responses, 158 were from Ph.D. granting-institutions, and 92 were from institutions whose highest degree is the Master's.

Survey I questions are listed in Figure 1, and the results summarized in Table I. This survey was designed to learn about the structure of Master's programs. Survey II, which followed, was designed to learn more about educational goals. Survey II questions are listed in Figure 2, with results summarized in Table II. This follow-up survey was sent to chairs of all MS.-only and to 66 of the Ph.D.-granting departments which had returned the first survey. The latter were included in Survey II if they had awarded at least five Master's degrees in the most recent year, and if the number of Ph.D.s awarded did not exceed 50% more than the number of Master's. Our objective was to hear from the Ph.D. schools with more active Master's programs.

Master's programs in the U.S. differ widely in size. Many Ph.D. schools award more Master's degrees than the number of students they admit specifically for Master's programs. These frequently represent degrees awarded to students whose original objective was the Ph.D. Some are earned as a milepost, awarded to a student who is continuing to work toward the Ph.D. at the same school. The number of such degrees is difficult to ascertain. A quick review of any CPT Annual Report shows that many schools routinely award many more Ph.D.s than Master's, suggesting that many of their doctoral students do not first obtain an M.S. degree. The opportunity may not be offered; it also might require extra effort. At other places, depending on local customs and incentives, all Ph.D. candidates are awarded Master's degrees. A second

category of Master's has been called a consolation prize: a degree awarded to students who entered a program planning to obtain a Ph.D., but left before completing that degree. But these are only part of the picture. In Survey II, 63% of Ph.D. schools admit students specifically for Master's degree programs. A rough estimate, based on our overall data, is that more than three quarters of the Master's degrees awarded in chemistry in the U.S. go to students who entered graduate school seeking that degree.

Master's degree programs in American universities vary widely in some respects but are quite similar in others. The mean values of both the reported minimum time toward the degree (1.7 years) and the average time (2.5 years) are the same at Master's and doctoral universities. The average course credit hour requirement, (about 29), roughly equivalent to a year of course work, is quite common. Some schools require two years of coursework, and a few have no firm course requirement. Master's-only schools report a slightly higher proportion of students whose bachelor's degrees were earned outside the U.S. (39% as opposed to 33%). They also enroll a considerably higher proportion of students who are part-time (33% as opposed to 17%). However, even at M.S.-only schools, full-time study is the norm.

Requirements for the Master's degrees vary. It is not uncommon to have multiple tracks. Frequently, schools offer both a coursework-only Master's, and a research-based Master's. Coursework-only Master's degrees are offered at 25% of the Master's-level schools, and at 42% of the Ph.D. schools. Specific courses for Master's students and specific exams for Master's students are prevalent, but far from universal. A small percentage of the respondents to Survey I answered affirmatively that their program was specifically designed for employment with that degree only.

Brochures and other materials submitted with Survey I suggest a wide range of educational goals for Master's programs in Chemistry. The second survey was designed to obtain a clearer picture of that breadth. Although the response rate was good, the data remain a bit difficult to interpret. Like Ph.D. programs, most Master's programs are designed broadly to accomplish a variety of goals: preparing students for jobs in industry, in education, and to go on to further study. In some cases, there are separate tracks, with separate degree requirements, but that is not common. About one third of Master's programs report teacher-training as one of their goals. This number is about the same at Master's and Ph.D. schools. Special programs for in-service teachers seem to be more prevalent at non-Ph.D. schools. One interesting example is at Bucknell University, where high school teachers can earn a Master's degree in chemistry after three summers at Bucknell.

Preparation for work in industry is a common objective for Master's programs: 59% of Ph.D. schools and 89% of Master's schools reported this goal. But the number of programs with a specific industrial focus is small. About 4% of respondents described their program as preparing for a particular sector of industry, and 6% reported industry partnerships. While the numbers are small, Master's programs with a particular industrial emphasis or with specific connections to industry can be attractive to both students and to industry. Examples include a program in Coatings Technology and Polymer Chemistry at DePaul University, a program in Industrial Chemistry at the University of Central Florida, the Lehigh Educational Satellite Network, which allows Lehigh courses to be offered to employees at multiple corporate sites, and the University of Colorado Denver's program with an Environmental and Biotech-Pharmaceutical emphasis. Several schools offer combined B.S./M.S. degrees, including Idaho State and Vassar.

Today, one hears calls for the revitalization of the Master's degree, or at the least, an enhancement of its prestige. Prestige is a subjective matter, but visibility is less so, and often the former accompanies the latter. How can the ACS contribute to bringing better visibility to Master's programs? An ACS publication, the *ACS Directory of Graduate Research*, is always useful to students thinking about graduate study. The most prestigious Ph.D. programs are highly visible, but how does a student find a Master's program, perhaps one with a particular emphasis? Posters and brochures are ephemeral, and are easily buried in the next day's mail. Today's

technology suggests an attractive and cost-effective answer. A chemistry graduate study web page, accessible from the ACS ChemCenter, could list programs at various levels, including special emphases, with hypertext links to the schools. CPT is exploring this possibility and welcomes your advice and suggestions.

Table I											
CPT SURVEY I RESULTS	**ALL**	**MASTER'S SCHOOLS**					**DOCTORAL SCHOOLS**				
Question		**Replies**	**Mean**	**Min**	**Max**	**Total**	**Replies**	**Mean**	**Mean**	**Max**	**Total**
Surveys returned	250	92					158				
Q3a. MS students admitted	1257	90	6.8	1	30	611	155	4.2	0	90	646
Q3b. MS degrees	1195	91	5.0	1	25	452	150	5.0	0	20	743
Q4a. Minimum time	1.7	89	1.7	0	3		153	1.7	0	5	
Q4b. Typical time	2.5	91	2.5	1.3	4		156	2.5	0	5	
Q5. Semester hours	28.6	85	30.3	7	45		154	27.7	0	66	
Q6. % domestic BA	65	86	60.5	5	100		106	67.3	10	100	
Q7. % part time etc.	23	92	33.3	0	100		81	16.7	0	100	
Degree requirements	**%Y**	**#**	**%Y**	**Y**	**N**		**#**	**%Y**	**Y**	**N**	
Q8. Thesis	74	89	82	73	16		146	70	102	44	
Q9. If not, research	59	34	59	20	14		80	59	47	33	
Q10. Coursework only	35	92	25	23	69		151	42	63	88	
Q11a. Specific courses	65	91	85	77	14		155	54	83	72	
Q11b. If so, taken by others	34	61	70	43	18		106	13	14	92	
Q12a. Specific exams	52	91	66	60	31		154	44	68	86	
Q12b. If so: different	52	53	79	42	11		155	35	28	53	
Q13. For jobs at MS level	16	89	19	17	72		146	14	21	130	

TABLE II					
CPT SURVEY II RESULTS	**TOTAL**	**MASTERS**		**DOCTORAL**	
Surveys # received	130		74		56
Surveys # sent	158		92		66
Survey response	82%	80%		85%	
Admit for MA/MS?				63%	35
Goals	**%Y**	**%Y**	**Y**	**%Y**	**Y**
Q1. Industry	76.2	89	66	59	33
a. partnership	6.2	3	2	11	6
b. sector	3.8	5	4	2	1
c. general	63.8	82	61	39	22
Q2. Teacher training	30.8	32	24	29	16
a. in-service	11.5	16	12	5	3
b. preservice	8.5	9	7	7	4
c. both	19.2	20	15	18	10
Q3. Further study	73.1	91	67	50	28
Q4. General	50.0	65	48	30	17
Q5. BS/MS Combined	17.7	19	14	16	9
Q6. Other	6.2	5	4	7	4

Survey I

[The order of the questions has been changed.]

1. What Master's degree(s) does your department offer?
2. Does your department also offer a Ph.D.?

3a How many students are admitted annually specifically for study in the Master's program?
b. How many Master's degrees are awarded annually as a final degree?

4a. What is the minimum time required to earn a Master's degree (years)?
b. What is the typical time required?

5. What number of semester hours is required?

6. What is the Bachelor's origin of your Master's students?
Domestic _____% Foreign _____%
7. What percentage of your Master's degree students fall in the overall category of part-time/continuing education/employer-supported?
8. Is a thesis required for the Master's degree?
9. If not, is research required?
10. Can a Master's degree be earned solely on the basis of courses taken?
11a. Are there specific courses required for the Master's degree students?
b. If so, do they differ from those taken by other degree candidates?
12a. Are there specific exams required for Master's degree students?
b. If so, do they differ from those taken by other degree candidates?
13. Is your Master's degree program specifically designed to prepare students for employment with that degree only? If so, please elaborate.
14. The CPT is interested in innovative or nontraditional Master's degree programs and welcomes your submission of degree descriptions and other literature.

Figure 1 .

Survey II

[Asked of Ph.D. schools only]

Do you regularly admit students whose stated objective is obtaining a Master's degree, not a Ph.D. degree?

Yes [ ] No [ ]

If the answer is yes, please complete the following:

[Asked of all surveyed]

Which of the following best describes your goals for your Master's program(s)?
(You may check more than one answer):

1. Preparation for industry	Yes [ ]	No [ ]
If so, is it:		
a. a partnership with a specific employer	a. [ ]	
b. focused on a particular sector (e.g., polymers):	b. [ ]	
c. general	c. [ ]	
2. Teacher training		
If so, is it:	Yes [ ]	No [ ]
a. for in-service teachers	a. [ ]	
b. for preservice teachers	b. [ ]	
c. general	c. [ ]	
3. Preparation for more advanced study	Yes [ ]	No [ ]
4. General	Yes [ ]	No [ ]
5. Combined BS/MS program	Yes [ ]	No [ ]
6. Other: _____	Yes [ ]	No [ ]

Figure 2.

(end of special report)
