

The Doctor of Chemistry (DChem) Program: Preparing Problem Solvers for Industry

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Proposition:

A doctoral degree is a vocational degree.

- All students pursuing a doctoral degree want to enhance their chances of getting a career position which makes use of doctoral skills.
- In chemistry, of the Ph.D's who graduated 10/96-9/97, 35% found career positions and 51% went into postdocs.
- For the 36 DChem graduates, all have career positions in R&D, and only 3 have ever held a postdoc.

Genesis of DChem

- UT-Dallas was young and not bound by tradition. Chemistry needed “something different” to gain approval from the Texas Coordinating Board.
- 1973 ACS Report, Chemistry in the Economy, Chapter 24, described feedback from industrial laboratory managers about the deficiencies of new Ph.D. hires.
- UT-Dallas asked industrial scientists “What are your jobs like?” and designed the DChem Program.

About UT-Dallas

- Founded in 1969 on the base of a private research institute;
- 9500 students, 45% graduate students
- Average age of undergraduates is 30+; average age of graduate students is 27+;
- 11 Chemistry faculty (10 research active) average \$180,000 per year in external research support (NSF, NIH, DOD, DOE, Welch, ACS, etc.)

1973 ACS Report, Chemistry in the Economy

Chapter 24, “Correlating Chemical Education with Industry Needs”

Five themes emerged:

- “a need for greater initiative and effort on the job and for greater attention to continuing self-improvement”. A complementary “need for modification of the structure of the Ph.D. research program “ was recognized;
- a need to move away from “excessive emphasis on theory and specialization”. The responses were summarized in the pithy quotation: “Send us chemists, not synthetic organic chemists, spectroscopists, theoretical physical chemists, etc., but chemists.”;
- a need for proficiency in basic laboratory skills including minor skills and “such profounder ones as ‘the proper design of experiments’”;
- a need for awareness of and “respect for economic constraints, commercial applicability, and social needs or implications”; and
- a need for significant improvement in communication skills, both verbal and written. Note: in the 1990’s add “people skills” and “teamwork”

Shaping the Future: The Chemical Research Environment in the Next Century ACS, 1994

“Objective: Develop more broadly trained and adaptable scientist and engineers, particularly those with graduate degrees, who are prepared to function in the multidisciplinary rapidly changing environment of the chemical research enterprise.”

Two Major Roles for Industrial Scientists

- Long Range R&D -- rather “academic” research and what most Ph.D. advisors know about.
Example: DuPont Experiment Station, Wilmington, DE. [Decreasing in 1990’s]
- Problem Solving -- meeting the needs of production, short term, diverse problems.
Example: DuPont Sabine River Works, 10 Ph.D.’s assigned to nylon intermediates plant. [Increasing in 1990’s]

Three Themes for Preparing Problem Solvers (and for the DChem)

- Problem Solvers need a broad background in chemistry. “You cannot say, “Sorry I’m a synthetic organotitanium chemist”.
- Problem Solvers need experience in starting and leaving problems. “Don’t, by the structure of your program, teach students that knowledge comes in three year chunks.”
- “If they are headed for industry, give them prior industrial experience”

The DChem Name

- The DChem is analogous to another well known “problem solving degree”, the M.D.
- When you go to an M.D., do you you want the doctor to develop new knowledge or to produce a timely and correct diagnosis and call on existing knowledge to treat or correct your problem?
- The DChem graduate has been trained to identify and solve chemical problems.

Structure of DChem

- Nine Core Courses (1 year)
- Problem Solving Examination is part of doctoral candidacy decision
- Research Divided into three Practica
 - Apprenticeship Practicum -- research associated with M.S degree (1 year) ;
 - Industrial Practicum -- student works full time in industrial R&D (1 year);
 - Fundamental Practicum -- student works on campus to produce a research paper (1.5-2 years).
- Four oral defenses of written reports

Industrial Practicum

- Student works on company's project at company's site.
- UT-Dallas and company technical manager identify a 9-12 month project which will benefit the company and push the student's growth as an "industrial problem solver"
- Company contract for students labor; student signs company's proprietary information agreement, and company owns all intellectual property.
- Company technical manager is a voting member of student's Supervisory Committee and is present at the oral defense of the Industrial Practicum.

Industrial Practicum and Proprietary Information

- The Industrial Practicum report is a public document, but sometimes it is necessary to disguise specific process details in order to satisfy University and company needs.
- Technical managers must think about proprietary information issues at the beginning of the project.
- UT-Dallas has done it successfully 50+ times.

DChem Statistics

- 50+ Industrial Practicum students placed; most at national companies; about 25% in DFW area;
- All DChem graduates have industrial R&D positions; 90+% have a job before graduation.
- 40-45% of Industrial Practicum students return to the IP company as career employees.

Some of our Industrial Friends

- Industrial Practicum Sponsors

ARCO, BASF, Dow, DuPont, Mallinkrodt, Merck (7), Rohm and Haas (3), Syntex, Texas Instruments (7), United Technologies (7)

- Career Hires

BASF, Dow, DuPont, Los Alamos National Laboratory, Mallinkrodt, Bayer, Merck, Motorola, Syntex, Texas Instruments, United Technologies

How can I get a DChem started?

Advice

- Come visit UT-Dallas
- Don't buy a "DChem Kit" -- you should take the DChem as "proof of concept" and re-solve the problem of effective preparation for industrial R&D in the 2000's, with attention to your strengths, constraints, and traditions.

Advice to Administrators and Policy Makers

- You cannot make it happen -- The DChem is hard work, and the faculty members must want to make it work or it will fail.
- You can stimulate faculty, assemble resources, and protect nascent “DChem” programs from internal and external naysayers.
- Continued ...

More Advice

- Count the right things and make the right decisions.
- Assess doctoral programs by counting the “Value Added as a Vocational Degree (VAVD).
- Use method given on next slides. Compute the average VAVD over all doctoral graduates from the program in a given time period.

VAVD Table

- Industrial R&D job at doctoral salary +5
- Other industrial job +3
- Academic job at research school (>\$50k individual grant funds per faculty member) +7
- Other stable academic position +5
- Postdoc/transient lecturer -1/year

VAVD Examples

- DChem

36 graduates, all in doctoral industrial R&D jobs, 3 of which had total of 6 years of postdoc.

$$\text{VAVD} = (33 \times 5 + 2 \times 4 + 1 \times 1)/36 = 4.83$$

VAVD Examples

- Average Chemistry Ph.D. Program

ACS survey (10/96-9/97)

35% full time permanent, 51% postdoc, 5% full time temporary, 5% not employed and not seeking, 4% other. Must make some reasonable assumptions.

$$\text{VAVD} = 3.82$$

VAVD Examples

- Worst Known to Melton
“Half our Ph.D. graduates go to M.S. type jobs and half go to postdocs.” [ouch!]

$$\text{VAVD} = (0.5 \times 2 + 0.5 \times 3) = 2.5$$

Units of VAVD are Years

- If VAVD is approximately the same as the length of time to Ph.D. degree, then the doctoral program is a fair deal for the student.
- If VAVD is significantly less than the length of time to Ph.D degree (6-7 years ??), then the doctoral program is not a fair deal for the student, and students will look for better opportunities.

The DChem is

- Research intensive
- Student oriented
- Adapted to current industrial R&D patterns (and continues to adapt)
- Successful (!!) in placing its students before they graduate
- Willing to share 15 years of “pilot plant” experience