

Preparing Analytical Problem Solvers and Process Analytical Chemists

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Topics

- Overview of Doctor of Chemistry (DChem) Program
- Analytical Chemistry within the DChem Program
- Practical Aspects of Process Analytical Chemistry

Doctor of Chemistry (DChem)

- 70% of all doctoral chemists are employed in industry
- How should we prepare doctoral students for industrial careers?
- The DChem prepares students for roles as “industrial problem solvers”.

Doctor of Chemistry (DChem)

- In the late 1970's, we asked our industrial R&D friends, "What are your jobs like? What skills are needed?"
- Even in the 1970's, more than 50% of Ph.D. chemists worked as "problem solvers".
- The "problem solver" role has expanded in today's more competitive environment.

Doctor of Chemistry (DChem)

- Three themes emerged:
 - Problem solvers need a broad, fundamental background
 - Problem solvers need to change problems with rapid startup and little time spent on grieving.
 - Students need experience in industry as an integral part of their doctoral education.

Doctor of Chemistry (DChem)

- All students take the 9 core courses -- they do not become narrow specialists
- The same total research experience is divided into three sequential practica (Apprenticeship, Industrial, and Fundamental) in a structured 5 year degree
- All students spend 9-12 months working in industry, as “problem solvers in training”

Doctor of Chemistry (DChem)

- First two years (6 semesters)
 - 9 semester courses (2 organic, 1 inorganic, 1 thermodynamics, 1 communications, 2 analytical, 1 materials, 1 industrial chemistry)
 - 3 semesters full time research (Apprenticeship Practicum), problem solving examination
- ✓ M.S. degree \Leftrightarrow Industrial Practicum

Doctor of Chemistry (DChem)

■ Industrial Practicum

- Company pays, company chooses student, company owns intellectual property
- 9-12 month project which manager expects will push the student's growth as an industrial problem solver
- Company technical manager is a voting member of the committee at the student's defense of the Industrial Practicum report.

Doctor of Chemistry (DChem)

■ Fundamental Practicum

- On campus, ~ 18 months, judged on the basis of a “manuscript ready for submission to a good journal”
- Student works on project funded by faculty member’s competitive grant funds (NSF, DOD, NIH, ACS, Welch, industry)

Doctor of Chemistry (DChem) Results

- 40 - 45% of students take a career position with the IP company
- 90% of the students go directly from campus to career position -- no postdoc
- Salaries and career advancement match the Ph.D. numbers

Doctor of Chemistry (DChem) Industrial Practicum Placements

- BASF, Bayer, Dow, DuPont, Rohm & Haas, Mallinkrodt, Merck, Shell, Syntex, Texas Instruments, United Technologies -- national
- ARCO, Access Pharmaceuticals, Mannatech, Carrington Laboratories, Oryx, Mobil -- in Dallas-Fort Worth

Doctor of Chemistry (DChem)

Career Hires

- American Cyanamid, Bayer, Dow, DuPont, Huntsman Chemical, Lam Research, Los Alamos Nat'l. Lab, Mallinkrodt, Merck, Motorola, Phillips Petroleum, Sandoz-Agro, Shell, Sherwin-Williams, Syntex, Texas Instruments, United Technologies
- Access Pharamaceuticals, Carrington Laboratories

Analytical Chemistry in DChem

- “Analytical chemists” are chemists with an analytical thrust.
- First Course
 - Survey of Analytical Instruments (UV/Vis, IR, AA, Raman, MS, SEM, EXAFS, XPS, GC, LC)
Text - F.A. Settle, **Handbook of Instrumental Techniques for Analytical Chemistry**
 - Exams ask “For the analysis of ..., what instrumental techniques are (a) acceptable (b) preferred?”

Analytical Chemistry in DChem

- Second Course - "Problem Solving"
 - statistics (comparative tests, SPC, ANOVA, sampling, experimental design and optimization)
 - problem solving -- The goal is to become a detective with skilled access to many analytical techniques
 - Primary Analytical Chemistry Committee (from Conoco)

Analytical Chemistry in DChem

■ Problem Solving Examination

- Each student is given a (different) one page description of an ill-defined (often real) problem, and a week to learn, think, and present a 10 page report. The next week they have an oral defense of the approaches they proposed.
- Can the student learn rapidly and integrate that knowledge to produce effective solutions?

Analytical Chemistry in DChem

- Laboratory techniques
 - learned in the three research practica
 - many of the Industrial Practicum projects are primarily analytical
 - specific instrumental skills will vary depending upon the projects that the student has chosen

Practical Aspects of Process Analytical Chemistry

- Grew out of 1 week course offered at Dow Chemical Company, June 1999, to 9 DChem students (Melton was at Dow).
- Melton is reworking the course presentations (PowerPoint) to create a "companion text" for use by faculty at undergraduate and graduate level

Practical Aspects of Process Analytical Chemistry

- Project overview
- Process control
- Chromatography
- Electrochemistry
- Spectroscopy
- New technologies (NMR, Raman, MS)
- Sample conditioning and transport
- Analyzer systems integration
- Analyzer houses
- Overseas projects
- What is "success"?

Practical Aspects of Process Analytical Chemistry

- Three potential audiences
 - chemistry students
 - chemical engineering students
 - analytical chemists and chemical engineers already in industry
- Material will be on a CD-ROM
 - PowerPoint plus notes and/or commentary

Practical Aspects of Process Analytical Chemistry

- Current emphasis to increase knowledge of process analytical chemistry among analytical faculty and to encourage them
- PAPAC Workshop for faculty to be held January 7-12, 2001, at Dow Chemical Company site, Freeport, Texas (probable)

Practical Aspects of Process Analytical Chemistry

- Industry support is vital for PAPAC since very few academic chemists know about industrial analytical chemistry.
- We are seeking companies who could sponsor a faculty member AND provide technical friendship and support, as well as a site for field trips.
- Think about your supply chain for process analytical chemists!

The DChem Name

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