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”.
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.
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 ⇒ 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 Pharmaceuticals, 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?”
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.