

# Preparing for Careers in Chemical R&D: B.S. , M.S., and Ph.D.



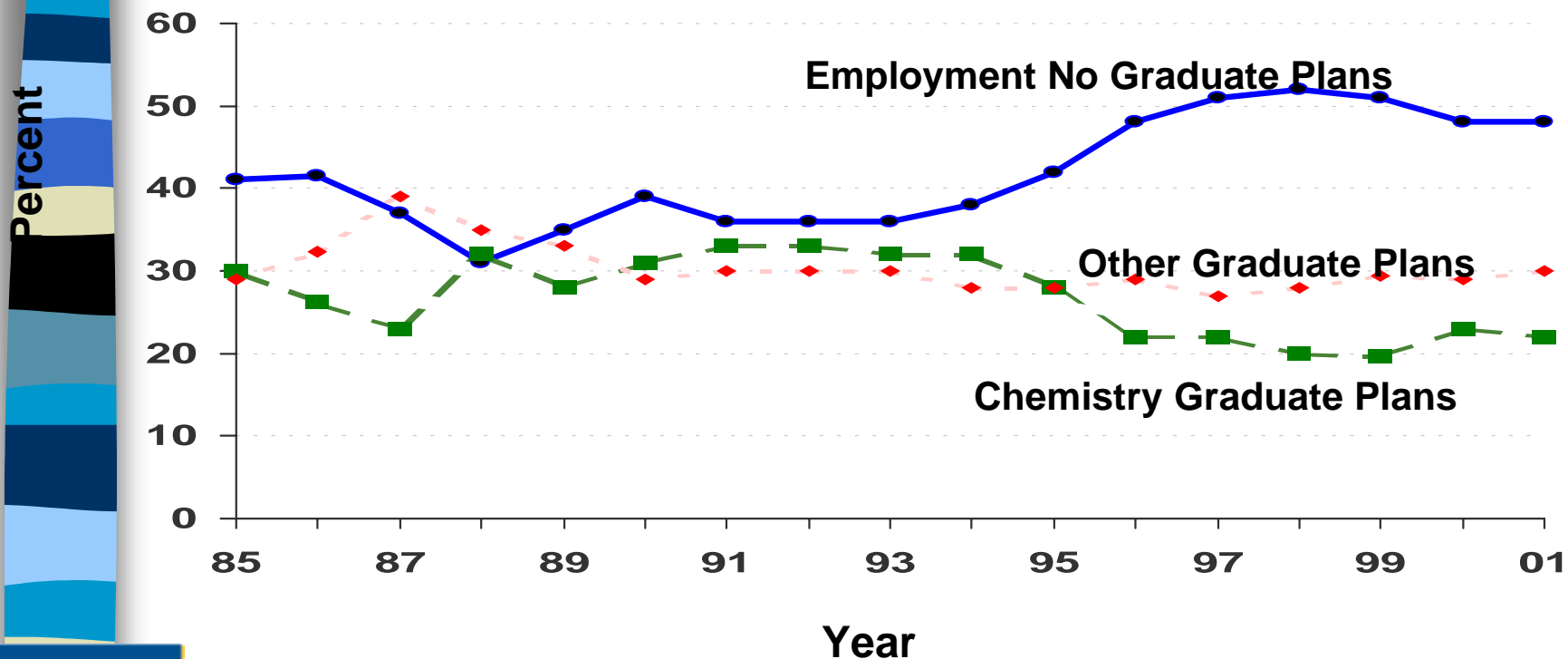
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# About the next slide...

- The next slide is the one which Jura Viesulas (ACS Career Services) wanted to show at BCCE, but the power failure prevented her from using the overhead projector.
- Slide 3 and beyond is the Melton talk.

# Post-Graduation Plans of BS / BA Chemistry Graduates



Source: ACS New Graduate Surveys  
ACS Department of Career Services



# Industry needs chemists...

- “A chemist receives a problem described in macro language, understands and solves the problem with atomic level ideas, and returns the solution to the customer in macro language.”  
--after M. Panar



# BS Chemists vis-à-vis BS Chemical Engineers

- Starting salaries for BS ChemE's are 40% higher than for BS Chemists.
- “BS ChemE's are ready to solve problems; BS Chemists are ready for graduate school.”



# Job Description for a B.S. Chemist

- **B.S., Process Analytical Chemistry**
- Activities:
  - Works as a Development Chemist together with a Team Manager to prioritize, among multiple projects, the daily maintenance activities of process analyzer instrumentation analysts



# Job Description for a B.S. Chemist

- Interacts with chemical plant operators, process improvement engineers, and research and development personnel to assess potential opportunities and applications for the use of on-line analytical instrumentation based on cost and feasibility
- Interacts with chemical plant electrical, safety, and maintenance personnel to schedule and resolve issues involving installation of analyzer instrumentation



# Job Description for a B.S. Chemist

- Monitors analyzer performance, maintains statistical records, assists in training process instrument analysts and aids in troubleshooting.
- Documents process analyzer installation details for training.



# Job Description for a B.S. Chemist

## ■ Proficiencies

- Working knowledge of on-line chromatography, spectroscopy, and electrochemistry
- Design of sample handling systems
- Familiarity with conventional (pressure, temperature, flow) instrumentation as well as manufacturing unit operations
- Effective technical writing and PC skills



# Roles for B.S. and M.S. Chemists

## ■ Big Companies

- typically not given projects which provide growth/promotion opportunities
- limited to 1-2 grade promotions
- B.S. chemists are often viewed as “technicians”, and there are skills standards for technicians.
- “A B.S.hire requires 18 months to become useful.”
- “An M.S. is often a failed Ph.D.”



# Roles for B.S. and M.S. Chemists

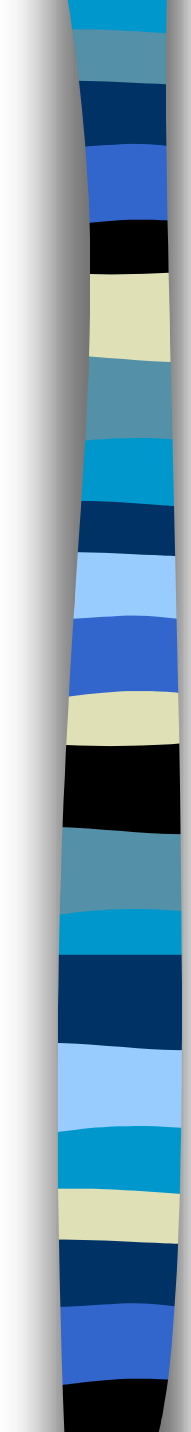
## ■ Small Companies

- typically not given projects which provide growth/promotion opportunities
- but they can't maintain the pigeon hole!
- small companies can go out of business!
- more opportunities for growth and greater risk



# Roles for Doctoral Chemists

- They are expected to work on the hardest problems the company has.
- The opportunities for growth and rewards are greatest for doctoral chemists.



# Where do doctoral chemists get jobs? (career positions, not postdocs)

- 65% Industry
- 10% Government
- 18% Colleges and Universities
- 7% Other



## In industry, what do doctoral chemists do?

- Long term chemical R&D (<50%)
  - new knowledge for eventual use
  - labs have “academic” flavor
  - academic consultants visit
- Problem solving (>50%)
  - short term response to commercial problems
  - academics don't see this part



## Industrial Example: DuPont

- Academic side: Experimental Station, Wilmington, DE
- Problem solving side: Sabine River Laboratory, Orange, TX



# I've made my decision...

- I want to have the opportunities available to a doctoral chemist.
- I want to work in industry (otherwise I might end up teaching students like me).
- So how do I get there...



# UTD's Proposition:

Why not adapt the doctoral experience to assist students in becoming better innovators and industrial problem solvers?



## UTD's Approach:

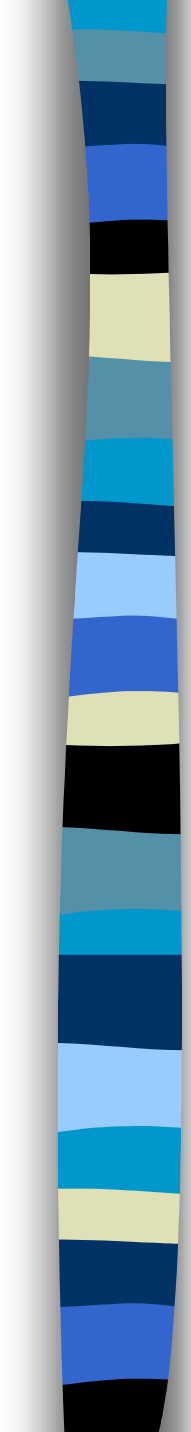
We asked our industrial friends what skills were needed for their jobs. They gave us these themes:

- Broad course background
- Expectation of changing problems
- Prior industrial experience



# The Doctor of Chemistry (DChem) Program ( $\approx$ 5 years)

- eight courses (2 semesters)
- problem solving examination
- research spans three Practica
  - Apprenticeship Practicum -- learn research methods, earn M.S. (4 semesters)
  - Industrial Practicum -- work for 9-12 months as a “problem solver in training” at a company site (3 semesters)
  - Fundamental Practicum --produce paper for submission to a journal (5 semesters)



# Problem Solving Examination (part of doctoral candidacy process)

- After coursework completed
- Applied chemistry focus
- One week to develop solution to problem
- Written and oral defense of solution
- Gateway to pursuing the DChem degree



# Apprenticeship Practicum

- Relatively closely supervised
- Written report and oral defense
  - Similar to Master's thesis
  - Shows growth toward DChem potential
- Gateway to Industrial Practicum placement



# Industrial Practicum

- 9 to 12 months in industry
- Grow as problem solver
- Experience industrial research
- Help solve meaningful problems
- Team participant experience
- Improve communication skills
- Prepare and defend report of work



# Industrial Practicum Partners

- United Technologies
- Merck
- DuPont
- Dow Chemical
- Mannatech
- Corning
- Shell R&D
- EG&G Rocky Flats
- Mobil R&D
- Carrington Labs
- ARCO R&D
- Texas Instruments
- Syntex
- Mallinkrodt
- Rohm & Haas
- Bunsen Rush



# Fundamental Practicum

- Similar to classical Ph. D. research
- High level of independence
- A new advisor, if desired
- Thesis presented for oral defense
- Results acceptable for refereed publication



## Faculty Research

- Successful in attracting C&G funds:  
NSF, DOE, DOD, NIH, Welch
- Average research funding per faculty member: (approx) \$180K/year



## DChem Results

- 90% of DChem graduates go to career industrial position straight from campus (45% for Ph.D. graduates).
- Starting salaries and advancement are same as Ph.D. graduates.
- 40-45% of DChem graduates take a career position at the Industrial Practicum company.



# Employers of DChem Graduates

- American Cyanamid
- BASF
- Bayer
- Carrington Labs
- Dow Chemical
- Sandoz-Agro
- Sherwin-Williams
- United Technologies
- DuPont
- Huntsman Chemical
- Los Alamos Nat'l. Lab
- Merck
- Motorola
- Phillips Petroleum
- Syntex
- Texas Instruments



# Changes in the DChem

- Industrial Practicum is no longer mandatory; thus a student can stay on campus.
  - provides a dual track capability.
  - relieves parts of IP placement stress
- Name will (almost certainly) become Ph.D.



# What is the right path?

- Where do you want to be in ten years?
- Do you have the opportunity to invest five lean years to achieve a Ph.D?
- Do you want to do a two year postdoc on top of a Ph.D. in order to get a good academic job?



# Acknowledgements

- UTD Chemistry faculty
  - We designed and brought the DChem to maturity.
- American Chemical Society
  - They invited me to BCCE, and they have provided information and counsel for many years.
- Many Industrial Friends
  - They taught me their culture.



# Advertisements

- I organize workshops on Process Analytical Chemistry for college faculty. Please contact me.
- I would love to talk to faculty about the DChem and its advantages for their students.
- [melton@utdallas.edu](mailto:melton@utdallas.edu)
- <http://www.utdallas.edu/~melton>