# CBE Alumni Survey 2007 Results

This survey was distributed during the summer of 2007 to alumni from the calendar years 2002 and 2004 (5 and 3 years after graduation). The survey was patterned on the 2001 and 2004 Alumni Surveys, with slight modification of several questions. The survey questions are available separately on the department assessment web site. We used the SurveyMonkey web site, which provided a convenient format for asking predefined questions and also inviting free-format responses, and captured the responses to a spreadsheet as well as allowing limited online analysis of responses. This format resulted in collection of many helpful comments. All alumni were given code numbers to allow us to note responses and send reminders to those who did not respond. We did not identify individuals or connect names to responses.

From June through August, 2007, 74 if 171 alumni responded. The responses were equally divided between 20002 and 2004 graduates. The overall response of 43% is satisfactory for this type of survey, and is a distinct increase over the response rate seen in earlier years. In our previous alumni surveys, response rates were 34% in 2004, 35% in 2001 and 29% (of 3- and 5-year classes) in 1996. The gender balance among responses (30% female) was within three replies of the 34% female population of the two graduating cohorts.

## Continuing Education

Participation in graduate study, industrial short courses, or other continuing education activities was reported by 32 of 71 respondents (45%). This was a substantial decrease from the 79% level reported in 2004.

Degree programs completed or underway were:

| | |
|---|---|
| 8 | Graduate study in Chemical Engineering<br>most reported MS in ChE as well |
| 8 | MBA |
| 3 | Biomedical engineering or Bioengineering |
| 3 | Law school |
| 3 | MD or DDS |
| 1 each: | doctoral programs in Inorganic Chemistry, Materials Science, Pharmacy |
| 1 each: | master's programs in Computer Science, Materials Science, Biomedical, Biotechnology, Environmental Engineering |
| 1 | BS Biochemistry |

Chemical Engineering graduate schools mentioned were Minnesota (4), MIT (3), Illinois (2), Penn State U, UC-Davis, Georgia Tech, Case Western Reserve, and UW-Madison (Biomedical)

The free-form responses gave more detail on the educational needs and choices, and mentioned many continuing education activities on specialized topics. Prominent themes include Statisics and specific, hands-on topics.

> Chemical Plant commissioning; chemical plant design. This was required by my employer.
> Statistics, needed refresher and "highly encouraged" by management for all engineers.

Six Sigma - to learn statistical analysis and project management. Equipment Reliability - to learn how things wear out.

I studied chemical analysis including FTIR, thermal analysis and electron microscopy while employed as a chemist and later a product development engineer.

I am in the process of getting my MBA at UW-Oshkosh. I currently work as a project manager for the Georgia-Pacific Corporation and my main 'customer' is the sales and marketing department. I found it helpful to learn more business-lingo and learn more about how to analyze the financial aspects of project planning including budgeting and things like that. I am also taking several project management classes as part of my degree which are directly applicable to my job.

Economics, Statistics, Finance, Strategy, Accounting as part of MBA program. Wanted to get MBA in order to have the educational credentials to expand my career options move away from traditional engineering/science jobs.

Industrial Ammonia Refrigeration Short Courses Allen Bradley Ladder Logix Allen Bradley Short Courses.

Political science, chemistry, biology, chemical engineering, biochemistry, immunology, materials science. Because I find them interesting to study.

Materials Science due to interest in microelectronics processing.

Chemical Engineering, Chemistry I enjoyed both chemistry and mathematics in high school.

Theatre, Computer Science, English. Fun stuff.

Job related courses.

Various business subjects for work related development.

Coatings, rheology, web handling. They are immediately related to my current job function.

Chemical Engineering courses, Chemistry, Materials Science. They are all related to my present graduate work.

Biomaterials, polymers, and tissue engineering courses as part of my graduate work.

I completed the Master Brewers Program at UC-Davis in 2005 to gain entry into the brewing field.

Pumps and seals -- Learn more hands-on knowledge.

Biotechnology Technologies, Genome Science, Intellectual Property, Healthcare Management (Comparative Healthcare Systems), Risk Management and Environmental Analysis, Biochemistry, Molecular and Cell Biology, Statistics, part of my graduate degree.

Lean Manufacturing Operations Management Required for my management training program at GE.

Mechanical Engineering - applicable to current job.

Continuous Improvement Industry Specific Courses All were job required or improved job skills.

Medicine. It had been a strong interest of mine for a long time and something I wanted to pursue.

Environmental Engineering.

Molecular Biology and Chemical Engineering.

Coating Fundamentals at University of Minnesota - Twin Cities for my current position.

Bioengineering and biomaterials. I have decided to pursue a career in the biomedical device industry.

Food Science, to practice my ChE in a more specific field.

I studied geotechnical engineering subjects because they were related to my current job.

## Employment

Alumni reported that they hold positions at a wide variety of companies:

| Multiple posts |
|---|
| General Mills (7) |
| Cargill, Inc. (3) |
| 3M (2) |
| Curwood, Inc. (2) |
| General Electric (2) |

| One alumnus each | |
|---|---|
| A. Schulman, Inc. | Merck & Co., Inc. |
| Ampac Fine Chemicals | National Starch and Chemical |
| Cambridge Major Laboratories, Inc. | Nummelin Testing Services, Inc. |
| Caterpillar, Inc. | Oppenheimer Wolff & Donnelly LLP |
| Clorox | Oregon Fire and EMS |
| Covance Labs, NA | Procter & Gamble |
| Croda-Uniqema | Schlumberger |
| Ecolab Inc. | Shell |
| Electrotek Corp. | Sigma Environmental Services, Inc. |
| Epic Systems Corporation | Singapore Economic Development Board |
| Genzyme Corporation | TANN Corporation |
| Georgia-Pacific Corporation (Koch Industries) | Tekra Corporation |
| Hewlett-Packard | The Quikrete Companies |
| Hexion Specialty Chemicals | UC-Davis / Lawrence Livermore NL |
| ISS - Integrated Separation Solutions | United States Patent and Trademark Office |
| Jacob Leinenkugel Brewing Company | UTHSCSA |
| Johnson Diversey | W.L. Gore & Associates, Inc. |
| Kimberly-Clark | Walgreens |
| Lyondell | |

Most alumni work for larger companies. Their company sizes were characterized as:

| | | |
|---|---|---|
| fewer than 100 employees | 10.2% | 6 |
| 100 to 1000 employees | 15.3% | 9 |
| **greater than 1000 employees** | **74.6%** | **44** |

While 60 are currently employed, 13 said they were not (including some reponses from continuing students). Those not currently employed or in school explained:

> I recently quit my job to spend the next year or two traveling around the world.

> I am not employed in any capacity as a chemical engineer. I do web design and metadata work for the UW Digital Collections Center (amongst others).

Disability.

Work as an EMT-basic for the town of Oregon. I do it mostly for experience and also for some spare money.

Recently graduated - will be starting work in mid-July.

Moving soon with husband -- he has accepted a postdoctoral position.

What is your current job title or position?

Senior Research Engineer
Packaging Engineer
Senior Officer
Senior Chemical Engineer
Production Manager
Project Manager/Engineer
Department Manager - High Containment Manufacturing
Technical Service Engineer
Converting Technology Engineer
Safety Coordinator
Product Development Engineer
Project Manager
Senior Financial Analyst
Engineer - Product Development
Process/Project Engineer
Technical Coordinator
Scientist 2
Engineer II
Graduate Research Assistant
Process Development Engineer
QC Analyst
Research Assistant
Design Engineer
Product Development
Technical Service Representative
QA Process Engineer
Quality Engineer
Senior Engineer
Process Engineer
Research Assistant
Ph.D. Candidate
Operations Business Manager
Graduate Research Assistant
Plant Process Engineer
Research Assistant
Production Brewer
Production Engineer
Product Development Engineer
Student-Employee Graduate Researcher
Research
Patent Examiner
Technical Services Engineer
Maintenance Manager
Process Engineer
Graduate Student
Team Leader II
Senior Pharmacy Technician
EMT-Basic
Engineer
Design Engineer
Process Engineer
Graduate Student
Process Engineer II
Senior Field Engineer
Geotechnical Engineer
Project Manager
Applications Engineer
Manufacturing Team Leader
Commercial Operations
Temporary Production Scheduler (Sugar Free Department Head)

How would you describe your job activities over the past 2 years?: Which kinds of materials, substances, and products does your work involve

| **Consumer products** | **16** | **22%** |
|---|---|---|
| Polymers | 13 | 18% |
| Food products | 10 | 14% |
| Pharmaceuticals/biologicals | 10 | 14% |
| Specialty/fine chemicals | 8 | 11% |
| Electronic materials or devices | 7 | 9% |
| Petroleum, fuels, primary petrochemicals | 4 | 5% |
| Agriculture or bioprocess high volume materials | 3 | 4% |
| High volume chemicals | 3 | 4% |
| Pulp and paper products | 3 | 4% |

| | | |
|---|---|---|
| Metals/minerals | 0 | 0% |
| **Other** | **16** | **22%** |

"Other" included:

Law.
Adhesives.
Waste water treatment.
Biomass & biofuels.
Construction Equipment.
Concretes and Mortars.
Education.
Sol-gel synthesis.
Student, Administrative Assistant, and Clinical Investigator at Penn Law.
Reverse Osmosis Membrane Manufacturing.
Research and Development of Inorganic catalysts.
Service, health care.
Environmental compliance.
Soils, Building Foundations, Construction Materials Inspection/Testing.
Pollution controls and heat recovery systems.

Respondents indicated that their main job activities fell in the following categories: (multiple responses were invited)

| | | |
|---|---|---|
| Process operations: monitoring, improvement & troubleshooting | 37.7% | 23 |
| Product development | 32.8% | 20 |
| Laboratory research & development | 29.5% | 18 |
| Process and equipment design | 21.3% | 13 |
| Project engineering/management | 19.7% | 12 |
| Plant operations: scheduling and logistics | 18.0% | 11 |
| Business planning, managerial functions | 16.4% | 10 |
| Pilot plant process development | 11.5% | 7 |
| Economic evaluation | 11.5% | 7 |
| Marketing and product sales | 4.9% | 3 |
| Software development | 4.9% | 3 |
| Other (chemical engineering) | 3.3% | 2 |
| Other (not chemical engineering) | 19.7% | 12 |

Those who marked "other" included:

Packaging specifications, data system maintenance, cost savings project implementation.

Corporate transactional lawyer.

About 25% Business Planning/Managerial and 75% Plant Operations Management (logistics).

Product Development 60% Business Planning 20% Project Engineering 10% Sales & Marketing Stuff 10%.

Corporate Strategy (33%) 33% Business Planning 33% Economic/Financial Evaluation.

QC Analysis of Software Design Documentation 40%  Lab Research & Development 30%  Software Development 30%.

Lab R&D - 30%  Pilot Plant process development - 10%  Plant operations - 10%  Product Development - 30%  Customer visits/support - 20%.

Quality.

Review patent applications.

Customer support (50%),  Software development (25%),  Management (25%).

Project engineering 20%  35%  35%  10%.

Environmental compliance and reporting  Indoor air quality monitoring.

Geotechnical investigations/observations/reports 50%  Construction Materials Inspection/Testing 50.

Oilfield work.

"Do you supervise the work of other chemical engineers?"

Yes 8 (13%) No 53 (87%)

Respondents often provided a description of their job function and emphasis:

Develop processes for new food products.  Also, develop pilot plant systems to simulate plant production.

investment promotion activities

Corporate transactional lawyer

Process development - work with various unit operations to develop manufacturing processes to produce various types of liquid and solid cleaning products.  Unit operations include mix tanks, extruders, ribbon blenders, mills, heat exchangers, etc.

As the production manager my currently duties include overseeing the operations (incl. planning, production, maintenance, and process engineering) for the factory.  The daily focus is ensuring all products are made in specification ready for shipment and on-going projects including process optimization and project engineering management.

Manage capital projects: design, economics, construction, safety, and close out

I manage a department of 25 operators and two process engineers.  We produce highly toxic API's for cancer therapies.  My work includes improving all facets of the facility (safety, compliance, efficiency, etc..).  In addition I am responsible for all discipline, leveraging three "crew chiefs" or operators with additional responsibilities, ensuring facility compliance with FDA/OSHA standards, interfacing with Product Managers and working with multi-discipline teams to meet customer demand

Troubleshooting with customer's processes.  On site process improvement for plants and packaging applications.

Management of technology: bring in new equipment, improve old, work on cost savings projects to improve productivity, waste, etc.

Process development and pilot plant scale-up of active pharmaceutical ingredients.  Also all EHS&S duties.

Some process engineering to stay on top of market processes in the plant and ensure efficiencies and productivities are where they need to be.  Make appropriate process changes if they are not or if they can be improved.  Work with customers primarily in the food industry as packaging engineer responsibilities.  Product development responsibilities to evaluate new materials, develop new structures, incorporate resin additives and technologies.

I manage product development projects for new paper product dispensers.  Mostly electronic towel dispensers.  We outsource our EE/ME function so I manage outside design resources and internal packaging, art & sales resources to design & develop new products for market.  Then I manage the transition from design to manufacturing, which is 100% outsourced, mostly to Asia.

Calculate NPV of potential projects, and use Real Options analysis to help in decision making for the manufacturing division. Perform financial analyses in order to determine where to locate various steps of the production of pharmaceutical products.

I have 3 overall responsibilities: 1) Product Development: I design consumer tests for new/upstream products, sometimes using Design of Experiments, and then analyze the data. Learning from these data are then incorporated into design of the product. 2) Modeling: I create models that predict consumer perception of various product attributes as a function of technical parameters. This involves mostly linear regressions (multi-variable), but some non linear models too. These models are then used to accelerate product development. 3) Current Business. I interact with our manufacturing plant and work to resolve problems when they arise.

R&D, design, electrical and mechanical engineering, controls design, maintenance, software development, and lead the agricultural division of the company. We are developing equipment to take dairy manure and turn it into water using membrane technology.

Oversee & optimize the operations of 6 different production lines across 3 shifts. 3 Team Leaders directly report to me, with 120 operators reporting to me indirectly. Responsible for pushing Productivity efforts, Continuous Improvement efforts, Operational improvements, & building cross functional relationships.

I work in Process Development scaling processes up from lab scale to plant scale

I crystallize proteins of unknown structure and function with the aim of figure out what they look like and how they work.

Process development and sustaining for several unit processes in inkjet print-head R&D/manufacturing fab.

I aid in the development of software systems to aid in pharmaceutical product development. I also validate and run analytical methods for pharmaceutical product analysis.

Develop and carry out research plans for studying catalytic fuel reactions.

Mechanical engineering design work for a large construction equipment manufacturer.

Developing new additive masterbatch for film application.

I work with polymers (unsaturated polyester and vinyl ester resins) for fiberglass/carbon fiber/etc. composites I develop new products primarily for the marine and transportation markets I support our customers in applications technology (vacuum infusion, spray-up, resin-transfer molding, etc.) I coordinate new product runs in our pilot plant I also support our production facility

I manage a system in our facility and monitor and improve quality. I am also responsible for food safety and regulatory control.

I am a product and process developer

I am responsible for one of Gore's Fabrics lines. This includes the safety, quality, and production of this unit operation. Additionally, I am involved or the champion of a majority of Fabrics new product development opportunities. These opportunities are both local and global in nature.

Polymers research towards a Ph.D.

I am studying block copolymers. This work has involved the development of new anionic polymerization initiators, the synthesis of many block copolymers, and characterization of block copolymer morphological behavior using small-angle x-ray scattering, rheological measurements, and transmission electron microscopy. I have also supervised several undergraduate students working on research.

Liason between the plants and the business team at headquarters. I am the operations representative for marketing, finance, R&D, etc.

Graduate Student in Chemical Engineering at Georgia Tech.

Lean manufacturing, new capital specifications, misc. machine process improvements, and waste reduction

I'm a Research Assistant completing a thesis project

Work in all areas of the brewery--brew house, cellars and finishing and packaging

Troubleshoot and optimize a portion of a chemical process

Lab research and development. Some management.

I am a graduate student researcher. My thesis is related to synthesis of sol-gel materials which are being used as a scaffold for formation of lipid bilayers. I am mostly involved in the synthesis and characterization of the sol-gel material and the resulting bilayer

Review and examine patent application in the laboratory equipment area. Determine patentability of applications.

Lead the technical support of health care software for a large hospital. Also manage 5 other technical services employees.

My main position is to manage the 9 person maintenance department at my membrane manufacturing plant. This involves managing PMs, projects, ergonomic projects, etc. I also am responsible as the process engineer for the rolling department. This include product engineering and managing cost out projects or productivity projects.

Process updates, install/qualify new equipment/chemistries

I am currently doing graduate research investigating the chemistry of inorganic catalysts and their activation of hydrogen.

I do lab work to develop new products.

I am developing a new process for producing ink jet inks.

Oilfield Wireline Engineer. Cell Leader, in charge of crew of 6-8 people, equipment, and operation while offshore. Gather downhole data to aide client's decisions in drilling and production of hydrocarbons.

I write geotechnical reports for roadways, bridges, and commercial buildings. I follow up the reports with inspection visits to those sites during the construction phase of the projects.

Managing a $85 MM soybean crush plant construction project.

Evaluate the feasibility/economics of different air pollution abatement systems and heat recovery systems. Assist sales department with technical proposals, project costing/pricing.

training to become a commercial oil trader

I am currently filling in for our Master Production Scheduler. This position involves monitoring sales orders on all of our Business Unit's products and SKUs. Prior to this and once the full time hiree is trained, my position title will be Sugar Free Department Head. In this role, I was (and will be) responsible for managing 14 hourly employees and 2 production lines. This entails everything from process improvements and efficiency monitoring to granting vacation requests.

## Feedback on individual curriculum topics

Ratings of how well the UW-Madison ChE undergraduate education prepared students in:

| Subject | Very prepared | Adequately prepared | Poorly prepared | Courses not taken |
|---|---|---|---|---|
| Mathematics (calculus, differential equations) | **51.6% (32)** | 48.4% (30) | 0.0% (0) | 0.0% (0) |
| Statistics | 17.7% (11) | **46.8% (29)** | 27.4% (17) | 8.1% (5) |
| Chemistry | 43.5% (27) | **56.5% (35)** | 0.0% (0) | 0.0% (0) |
| Physics | 24.2% (15) | **72.6% (45)** | 3.2% (2) | 0.0% (0) |
| Computer Science (CS 310) | 9.7% (6) | **58.1% (36)** | 25.8% (16) | 6.5% (4) |
| Electric circuits and electronics (ECE 376) | 8.1% (5) | **62.9% (39)** | 27.4% (17) | 1.6% (1) |
| Process Synthesis (CBE 250) | **55.7% (34)** | 44.3% (27) | 0.0% (0) | 0.0% (0) |
| Thermodynamics (CBE 211 or 311) | 41.0% (25) | **52.5% (32)** | 6.6% (4) | 0.0% (0) |
| Transport Phenomena (CBE 320) | **55.7% (34)** | 41.0% (25) | 3.3% (2) | 0.0% (0) |

| | | | | |
|---|---|---|---|---|
| Chemical engineering laboratories (CBE 324 and 424) | **59.0% (36)** | 37.7% (23) | 3.3% (2) | 0.0% (0) |
| Momentum and Heat Transfer Operations (CBE 326) | **49.2% (30)** | 47.5% (29) | 3.3% (2) | 0.0% (0) |
| Mass Transfer Operations (CBE 426) | 45.9% (28) | **50.8% (31)** | 1.6% (1) | 1.6% (1) |
| Reactor Engineering (CBE 430) | **47.5% (29)** | 45.9% (28) | 3.3% (2) | 3.3% (2) |
| Materials & Polymers (CBE 440 or 540) | 37.7% (23) | **52.5% (32)** | 3.3% (2) | 6.6% (4) |
| Process Control (CBE 470) | 29.5% (18) | **59.0% (36)** | 11.5% (7) | 0.0% (0) |
| Process Design (CBE 450) | 28.3% (17) | **65.0% (39)** | 6.7% (4) | 0.0% (0) |

In the comments, 10 students mentioned Statistics as problematic, 7 mentioned ECE 376 unfavorably ("a joke"), and 7 cited the Computer Science course as lacking. Comments were:

I feel the courses I marked as very prepared gave me a solid foundation to solve the problems I find in my daily work. I do not remember everything, but can look to my reference books and troubleshoot from there.

I ended up using a lot more **statistics** at my job than anything else and didn't feel like there was much of an emphasis on it in the curriculum beyond the one class.

I still retain much of the information I was taught in the classes that I rated "very prepared".

Great courses.

Most of what I learned in CS 310 is now obsolete. My ChE/CBE classes all did a great job of preparing me, and the work habits that I developed made law school a breeze!

The chemical engineering core courses were very good; however, some of the supporting sciences were not as good. **More training in statistics (practical applications) would have been useful** - process capability in particular). A chemical engineering **course focused on product development** would have been very useful as well - this is the area that I feel the **UW curriculum is the weakest** (other comparable schools have courses on product development).

I have felt well-prepared overall for my career as a process engineer and know a production manager. I particularly feel I was very well prepared for the basic fundamentals of chemical engineering such as mass/heat balances, process design, and hands-on type of projects/troubleshooting.

I thought several of the courses were either very well taught or just made more sense to me. These are courses that I intuitively remember well after a number of years. Although I do not use them every day - I feel more comfortable approaching these subjects with book in hand. Other courses, in particular the ECE course, do not seem to stick out as useful in my career. This may be because some courses were put in the curriculum as "survey" or "exposure" courses or just because I have never used the skills in that course since school.

The general process, transport, labs, etc. prepared me very well for the parts of my career that have required them. The **computer science class poorly prepared me** because it did not teach the relevant programs (databases, advanced excel techniques, presentations, Minitab, visual basic programming).

Thermo was way too theoretical. Needs more real world application. I work with adhesives, and so have found the understanding of materials and polymers very useful. **Statistics** use is very important in Six Sigma, so I had a very good background for that.

Very prepared in all ChE courses because they provided a broad, real-life knowledge that is applicable to life. **Poorly prepared in stats** because the course was not required and not adequately covered in ChE courses. Poorly prepared in physics because for ChE it was too in depth and didn't relate to how I would need to use it.

The only area that I really wish I would have had more information in was simple circuit board design in **ECE 376**. I know a lot of theory behind AC sine curves, but I needed to know how to layout a

simple board with a microcontroller, resistors, capacitors, and other components and really had to start at square 1.

I feel "very prepared" in math, chemistry, and physics mainly due to the intense concentration of classes in these areas. For the ChE classes, I feel "very prepared" because these classes were focused on real applications (real problems), and not just theory. Regarding the "poorly prepared" classes, I have the following comments: **1) Statistics: This class was a complete joke...**so focused on theory with hardly any application. Once I arrived at P&G, I took a 3 day training for JMP (stats software from SAS), and I honestly learned 10x more in this class than in the UW class. Since stats is used virtually everywhere in engineering, I find this to be a very critical outage for UW ChE's. 2) **ECE: The worst class I took at UW** (besides CS 110, which no longer exists). Very poorly organized, too much material crammed into 1 semester, and a very frustrating lab. I learned plenty about circuits in Physics...this class only confused me more. 3) ChE 450: I learned a little about design overall, but what I really disliked was how there were exams on material that we hardly even covered.

I believe that I take a little bit from all the classes that I have to use in my everyday occupation. I spent 1.5 years working as a refrigeration engineer and learned everything on the job. I only remember studying refrigeration for 2 days in CBE211. Otherwise, I believe I was very prepared for my job field and am very satisfied where I am at in my career.

I find I use **statistics** near daily, or at least weekly. I wish I would have had more learning in statistics. I also did not receive much in the way of **computer programming**. Visual Basic would have been more relevant for me. Also, I would have liked additional classes in **circuits**. The core Chemical Engineering classes, I believe, were taught extremely well.

**Computer science did not teach enough MatLab** or UNIX or Linux or code (i.e. FORTRAN, pearl, etc). All ChE classes were rigorous, thought provoking, well structured, had excellent TAs, and intense. I got a lot out of the classes.

I strongly recommend a class on **statistics as they relate to process control and design of experiments**. With the exception of the thermo series, which was too theoretical to be practically useful, I've used material I learned from the majority of the curriculum.

The core competencies in the sciences (math, stats, chemistry) were pivotal in being able effectively communicate with the various business units on an intellectual level. The computer science course allowed me to be competent with core computer programming and problem solving concepts. This allowed me to diversify my analytical validation skills into the CS area. Transport phenomena and CBE324, 424 both allowed me to develop well above average laboratory skills which also aided in method validation. Process control and design concepts are applicable to almost every area of signal acquisition and design for method validation.

After taking graduate level courses, I thought that the three courses that really stood out as good preparation for further course work were the intro course, the transport phenomena course, and the thermo courses.

Overall I think the preparation of most classes far exceeds what is actually necessary in corporate America. The **computer science class was inadequate**. More emphasis should be placed on analysis and the use of computer tools.

The thermo courses are far more intense than any other schools'. My graduate level thermo classes were dumbed down versions of what I had at UW. I took 2 computer science courses as an undergrad and took nothing away from them. It would have been very helpful to have a course that actually taught the students how to computer program. I felt that the instructors of the courses assumed we already knew about computer programming, which was false.

I do not use complex mathematics but the concept taken during undergraduate courses helps the logical thinking process.

To be honest, coming into my position I felt that I had had a much more rigorous ChE background than my peers from other schools. Most of the areas above I knew more than I needed for an entry position. This is a good thing.

I use a lot of statistics now and I only took the required course and it was not enough. **Computer science needs to be more relevant** to programs engineers are going to use and not making connect four games.

I perform a great deal of complicated designed experiments to troubleshoot process issues and design new products. Gore teaches a **very in depth class in DOE's that is offered at UW**, however it is not recommended or even mentioned by any advisor in my knowledge. Extra training in this area would have greatly jump started my career. With regards to Reactor Engineering/Kinetics and Materials & Polymers, the material presented and examined upon was more than adequate to provide the base knowledge needed to prepare me to apply the principles to the specific materials I currently use.

ChE 311, 320 and 540 provided a good head start for the graduate level courses I took at the University of Minnesota.

I took the graduate thermodynamics course at Minnesota and thought it was very easy. I was well ahead of my peers in terms of the amount of material I had seen before. I also took the graduate fluid mechanics course at Minnesota and felt well-prepared for it. I struggled with the computer programming aspects of some of the math courses I took at Minnesota. I did not feel prepared to program on my own.

The lab courses were extremely challenging, but provided good structure and practice for the work world. **ECE was a poorly run course with very little practical or valuable information**. Thermodynamics was far too theoretical and abstract. It could have been taught with better balance between practical and theoretical.

Much of what I learned in UW was relevant to my present graduate work.

Working in the polymer industry, those classes prepared me well for the processing of polymers. The **circuits class** did not interest me.

The depth and breadth of both mathematics and chemistry required in the program has been highly adaptable to many situations. **Statistics**, transport, and design courses, in retrospect, were too remedial to be helpful in my research.

I don't do much reactor design, only operations and optimization. Process control in the plant (with the advent of DMC and advanced control) is completely different. I would rather they would have spent more time on the application of what we were learning.

Computer science should teach at least one coding language instead of a little of everything. **ECE was not a well designed class** because it just focused on solving circuit problems. All the fundamental chemical engineering classes were good in preparation.

In general, the classes regarding operations and process could be improved by having an increased amount of hands-on real world information. Examples of this include bringing in more equipment, taking it apart, showing how things work. **More demonstrations**. This would connect the equations to how things actually work. There was some of this in the labs, particularly summer lab, but it should be more consistent and ongoing throughout the curriculum.

The very prepared topics are where I learned the most material that I felt like made a difference in my education and allowed me come to the realization what I was getting into at UW-Madison chemical engineering program. Also, Professor Charles Hill is an excellent teacher.

I don't directly use any of the knowledge that I gained in the classes I took. But the overall skill of problem solving that I honed through these classes has perfectly prepared me for my current job.

Comp Sci 310 should have included databases like Access. I use that more than any of the this class taught me. **ECE 376 was a waste of a class**. What I need to know is how to evaluate how much power I have and how much my new equipment will draw. I need to know what the difference between 480 voltage and 110 voltage is. I need more practical training....not imaginary numbers. 470 was useful to know how control devices provide feedback and use it, but the class was too theoretical.

Loved most of my classes, computer and electrical classes were too abstract to apply to my job.

**Statistics** was not emphasized in any classes besides the one statistics class required.

**Classes that required a design project** (250 and 326) were of greatest help. I didn't rate 450 very prepared despite the fact that it had a project because the instruction I received in that class was not very good. All the classes I rated poorly prepared were because they were too theory based. After working in an industrial environment, I feel that the program is more geared towards grad school than actual applications. For the labs, again too much theory and what is considered technical writing. A better lab would be problem solving or "how could we make" sort of labs. Not the cook book labs with a ton of calculations afterwards that need to be written within strict technical guidelines. I know the department is striving to improve communication skills among its graduates, but it should not be in that form. Often in the business world, communication about issues needs to be written for people with no technical background, or haven't used that technical background in a long time. I don't think that you should get rid of all technical writing, I feel it should be reduced and there should be a greater focus on presentation skills.

I think that integrating the CS and statistics course material into other CBE courses (i.e. process design, labs, etc.) would have better prepared me in those areas.

Core engineering classes except for 470 gave a very good background in which to draw from. **However, for me, 470 was very disappointing**, I have done a lot of work in process control, and I must say that what I learned in that class did not help much at all.

I deal with mass and energy balances daily, along with transport-type problems. I feel that those courses were well-organized and taught very useful material, in relation to my current job. **ECE 376 was a joke** - I retained absolutely nothing from that class, and I'm incapable of performing even basic calculations for power requirements, which has been a problem for me in my current position. The course is too broad, in my opinion, and should focus on relevant subjects in industry - 3 phase power, and include units on sizing and theory of basic industrial equipment (transformers, circuit breakers, electrical disconnects, etc.). And again, the materials courses should focus more heavily on practical issues for chemical engineers - corrosion, materials selection for piping/reactors, temperature/pressure ratings of different materials, etc. Most of us won't be making steel or polymers - but we would like to know how to use them properly.

Ratings of how useful these areas have been in the respondent's career:

| | Frequently used | Moderately used | Not used | Courses not taken |
|---|---|---|---|---|
| Mathematics (calculus, differential equations) | 18.0% (11) | **52.5% (32)** | 27.9% (17) | 1.6% (1) |
| Statistics | 34.4% (21) | **49.2% (30)** | 11.5% (7) | 4.9% (3) |
| Chemistry | 44.3% (27) | **47.5% (29)** | 6.6% (4) | 1.6% (1) |
| Physics | 20.3% (12) | **55.9% (33)** | 22.0% (13) | 1.7% (1) |
| Computer Science (CS 310) | 9.8% (6) | 39.3% (24) | **45.9% (28)** | 4.9% (3) |
| Electric circuits and electronics (ECE 376) | 1.7% (1) | 33.3% (20) | **61.7% (37)** | 3.3% (2) |
| Process Synthesis (CBE 250) | 15.0% (9) | **55.0% (33)** | 28.3% (17) | 1.7% (1) |
| Thermodynamics (CBE 211 or 311) | 13.3% (8) | 41.7% (25) | **43.3% (26)** | 1.7% (1) |
| Transport Phenomena (CBE 320) | 26.7% (16) | **40.0% (24)** | 31.7% (19) | 1.7% (1) |
| Chemical engineering laboratories (CBE 324 and 424) | 21.7% (13) | **50.0% (30)** | 26.7% (16) | 1.7% (1) |
| Momentum and Heat Transfer Operations (CBE 326) | 20.0% (12) | **43.3% (26)** | 35.0% (21) | 1.7% (1) |
| Mass Transfer Operations (CBE 426) | 21.7% (13) | **40.0% (24)** | 35.0% (21) | 3.3% (2) |
| Reactor Engineering (CBE 430) | 13.6% (8) | 35.6% (21) | **45.8% (27)** | 5.1% (3) |
| Materials & Polymers (CBE 440 or 540) | **35.0% (21)** | **35.0% (21)** | 23.3% (14) | 6.7% (4) |
| Process Control (CBE 470) | 10.0% (6) | **46.7% (28)** | 41.7% (25) | 1.7% (1) |

| | | | | |
|---|---|---|---|---|
| Process Design (CBE 450) | 10.2% (6) | **55.9% (33)** | 32.2% (19) | 1.7% (1) |

Followup comments singled out Statistics as being particularly important in 3 responses. Comments on items that stood out included:

Use momentum and heat balances in design work and also have had to do a lot of system design.

The packaging field does not often call upon my chemical engineering background, thank goodness.

When I was working at Clorox formulating cleaning products, I did not use much of the information that I directly learned in class. Most was learned on the job.

While I was employed as a chemist I used those topics I rated as "frequently used" more often than the others.

Nature of job not related to chemical engineering.

Certain classes will be used more based on profession.

No occasion to use calculus, ECE or computer science in my previous job as a product developer at General Mills.

It is difficult to answer the questions above - the mindset/thought process that I was taught at while at UW was the most valuable part of my education (of course, without the courses this wouldn't have been possible). None of the courses taken have been directly applicable to work, but when taken as a whole, they are all necessary.

Typically the ones marked frequently used are needed for my job where computer software packages may not be available. Those marked not used are either not required or have software packages available through work.

For whatever reason I just have not had the experiences or maybe opportunities to apply a lot of the information that was part of the ChE curriculum in my professional career. Rarely do I actually do a calculation or utilize textbook principles. The courses marked "not used" are just the most glaring examples. Again, I feel a lot of that has to do with the industry and company that you end up working for.

I work with adhesives, and so have found the understanding of materials and polymers very useful. Statistics use is very important in Six Sigma, so I had a very good background for that. Calculus is used to develop the equations that are used on an every day basis, but not calculus itself. The other not used classes were very theoretical and so not very helpful day to day. I also don't need reactor engineering for my job, which is more mechanically focused.

Frequently used because my main job responsibilities require, and vice versa for not used.

I really don't use much of my ChE training. I have picked up most of what I needed from 440 and SPE (society of plastics engineers) seminars. I also have learned a lot on the job about project management. I don't work in a manufacturing or traditional research environment so unit operations has not been useful and the circuits I design need to cost less than $5 and run off a couple D cells to controls is too fancy for me.

I did not take a statistics class at UW (but have subsequently). Statistics is something I have had to use quite a bit, and I wish I had taken it as an undergrad.

I personally do not work with reactors, although I could in the future. Majority of my work is around process scale up, so I deal a lot with process design and control.

Laboratory experiments require me to draw on all my past knowledge in order for me to design good experiments, and analyze data properly.

I use a great deal of transport in my job to understand my unit processes. Statistics are crucial to understanding process control and capability.

The "frequently used" items above were pertinent to my graduate studies at Illinois, while the "not used" were not. Currently, I am not using any of the above (apart from my brief experience assisting ChE 250 library instruction at Wendt Library last semester).

For many of the same reasons I stated above, the various CBE concepts I learned allowed me to have the breadth of knowledge of scientific and engineering principles to apply the more ChE concepts in the pharmaceutical arena.

I use a lot of these topics for studying catalytic reactions as graduate level research.

I don't function in a traditional chemical engineering environment so most of the classes are never used. I think the core principles from any class I listed as frequently used are used by all engineers.

I used organic chemistry and thermodynamics every single day. I don't work in industry; therefore process design/control has no place in my work.

The company core business is polymer processing. Anything other than the knowledge about polymers are not specifically used, but the courses have definitely trained us in our logical thinking process.

Comp Sci - we do calculations in MS Excel, CS not needed. ECE - I do not work with electrical systems. Physics - pretty general, I really don't use it.

I use lots of food chemistry information and statistics for process control. Calculus is not used. I do not use 'typical' ChE tools like mass transfer, thermodynamics or heat transfer.

I currently do not specifically perform any CPU programming or deal with many problems relating to physics. Additionally, as with the remaining classed marked "not used," I currently do not perform tasks which directly relate to these principles. However, I am sure the basic principles taught are used in some manner or another. Most people take the knowledge they've accumulated for granted and apply it without knowing. As for the classes designated as "frequently used," my job function requires that I apply these principles on a regular basis.

My research deals with materials chemistry, most specifically with polymers.

I have not really dealt with electric circuits in my graduate work, although I know a number of graduate students who have. I do think the ECE 376 course was useful, however. The courses I marked as "frequently used" are all topics very closely related to my graduate studies.

Graduate School.

My job deals with polymers.

I use chemistry, statistics, transport, and materials frequently because they are fundamental to understanding and interpreting data I collect. Most of the other stuff I have no use for, since I'm not really using core Chemical Engineering systems or processes.

My research is very specialized and not industrial so most of the classes are not used (right now). My research mostly involves polymer chemistry and interfaces so those topics are frequently used.

Spending most of my time working on product development, consumer studies, project leadership, and packaging design does not often bring about the need to use chemical engineering principles. Hence the ratings above.

I just need to know the background of the applications presented before me. There is no need for me to use the knowledge I obtained in school. What counts is that I understand what is happening when something like mass transfer occurs. I rarely use theoretical information. This goes for the material that I was taught in graduate school.

My job is not in chemical engineering so I do not directly use any of the topics listed above.

Job does not involve chemistry.

I use chemistry, kinetics, and thermodynamic based material in my chemistry graduate research.

Always using mass/energy balance. I never use calculus or DiffEQs. I never do technical writing as we did in lab, nor do I use chemical reactors or polymer science.

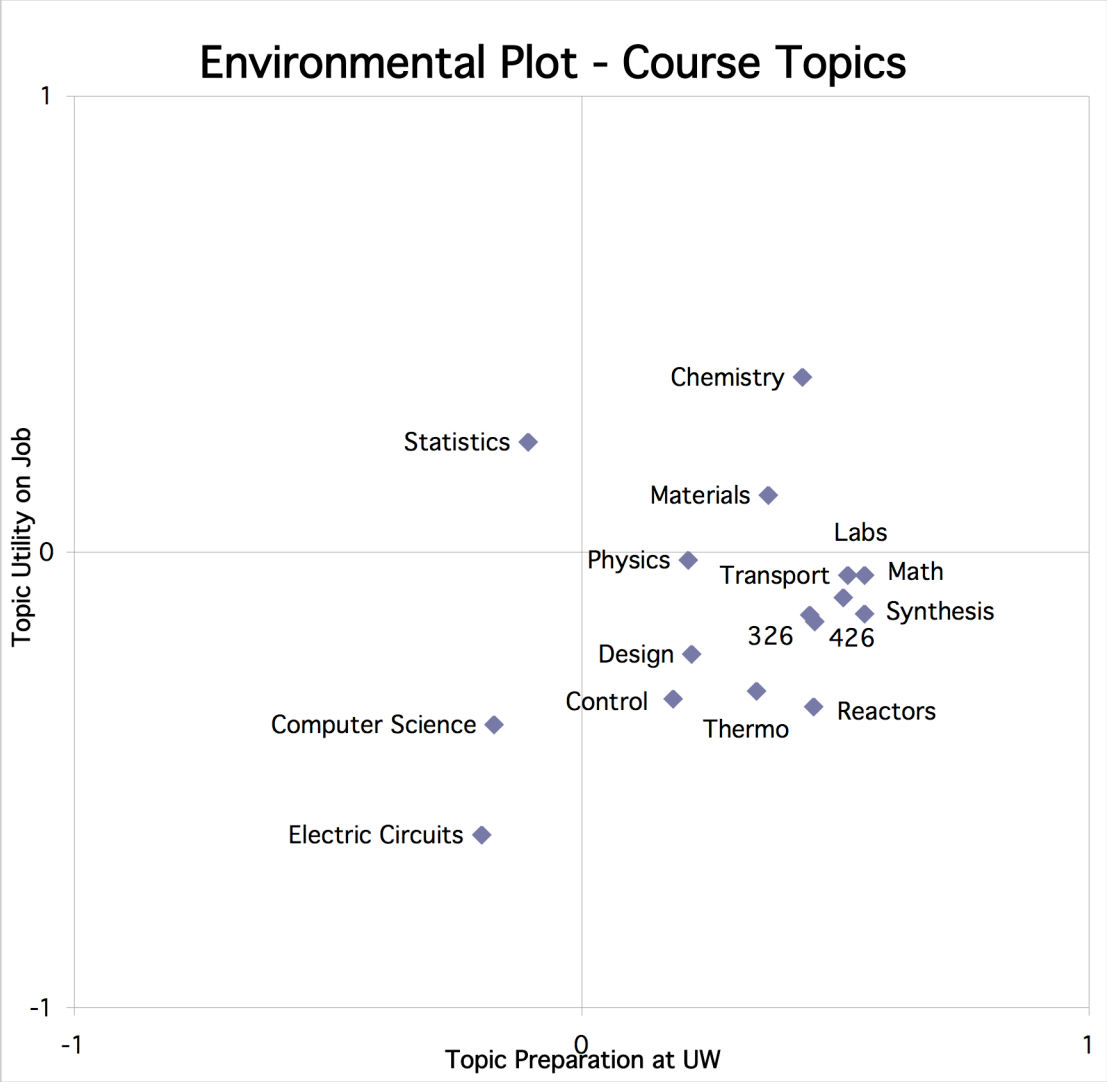
Now working in dental field.

I am now pursuing a field in biomaterials, which does not utilize some of the traditional CBE courses such as process control and design, etc.

These ratings for how much preparation students receive at the university and how important these topics are in their jobs can be compared in an "environmental" plot. Here, we calculate average ratings using the following scales:

| | | |
|---|---|---|
| Very prepared | +1 | Frequently used |
| Adequately prepared | 0 | Moderately used |
| Poorly prepared | -1 | Not used |

In such a plot, ideal results are that the most frequently used topics are those with the best preparation, and the topics not used are those with the least preparation. Thus, the ideal results would be spread from the upper right corner of the plot tailing down towards the lower left corner. Any topics above this ideal 45° line are more important than our preparation anticipates, and any topics far below this diagonal line may be receiving undue emphasis. With this scaling, the plot is seen to be:



The individual scores are

| Topic | Training | T rank | Utility | U rank |
|---|---|---|---|---|
| Mathematics (calculus, differential equations) | 0.52 | 4 | -0.10 | 7 |
| Statistics | -0.11 | 14 | 0.24 | 2 |
| Chemistry | 0.44 | 8 | 0.38 | 1 |
| Physics | 0.21 | 12 | -0.02 | 4 |
| Computer Science (CS 310) | -0.17 | 15 | -0.38 | 15 |
| Electric circuits and electronics (ECE 376) | -0.20 | 16 | -0.62 | 16 |
| Process Synthesis (CBE 250) | 0.56 | 1 | -0.14 | 8 |
| Thermodynamics (CBE 211 or 311) | 0.34 | 10 | -0.31 | 12 |
| Transport Phenomena (CBE 320) | 0.52 | 3 | -0.05 | 5 |
| Chemical engineering laboratories (CBE 324 and 424) | 0.56 | 1 | -0.05 | 5 |
| Momentum and Heat Transfer Operations (CBE 326) | 0.46 | 5 | -0.15 | 10 |
| Mass Transfer Operations (CBE 426) | 0.45 | 7 | -0.14 | 9 |
| Reactor Engineering (CBE 430) | 0.46 | 6 | -0.34 | 14 |
| Materials & Polymers (CBE 440 or 540) | 0.37 | 9 | 0.13 | 3 |
| Process Control (CBE 470) | 0.18 | 13 | -0.32 | 13 |
| Process Design (CBE 450) | 0.22 | 11 | -0.22 | 11 |

From these scores, we see that most of the "core" ChE topics are all perceived to be "overprepared" or "underused." All of these topics are rated between adequately and very prepared, as might be expected for topics that are chosen for the ChE curriculum. However, most of our curriculum topics fall below "moderately used" and have negative utility scores. In 2007, we began getting separate ratings of CBE 250, 450, and 470 rather than grouping them together. Although CBE 250 is rated higher than the two upper-level systems courses on both axes, none of these courses received positive utility scores.

Notable observations:

- This year **Materials** joined **Statistics** and **Chemistry** with positive utility scores.
- The **Electric Circuits** course was lowest in both training and utility scores

Several free-response questions followed this section of curriculum ratings.

"In your view, what deficiencies do entering Chemical Engineers have? (Consider your own start, or other new engineers you have known.)" Multiple mentions themes are **Statistics**, **Business Concepts**, **Oral Communications**, and **Hands-on Experiences**.

> For me in my career it is a lack of background in food science. If I had known I was going to be working in this industry, I would have taken more food science courses.
>
> I don't agree with the lack of emphasis placed on general business knowledge, i.e., how to participate in meetings, write a great e-mail, etc. The curriculum does not allow for enough Humanities credits.
>
> Statistics.
>
> Project management.
>
> Widely varying chemistry skills.
>
> Produce development background/experience and project management.

For engineers entering the workforce (e.g. factory experience) there is a large deficiencies around common problems experienced in these type of settings. For example, issues with pumps, heat exchangers, materials of construction, etc should have more of an emphasis.

One thing that I always felt would benefit all ChE's is to do more plant/hands on experiences. I worked for a while in an Ethanol plant and that experience put all the theoretical stuff together. Distillation, Fermentation, Molecular Sieves, Centrifuges, Dryers, etc... It never made that much sense to me in a book/classroom. The value in complementing the theoretical concepts of Mass Transfer with plant tours or "days in industry" would probably be the best way to directly improve the curriculum.

Applied statistical analyses. Being able to examine lots of data for trends rather than deriving phenomena from first principles is a key part of what I do on a daily basis.

Not enough mechanical based, should have some focus on how chemical engineering and engineering in general are used in industrial applications other than for reactors and oil companies.

Need more focus on polymers and materials in general.

1) Need a little more knowledge about circuits and how to interface with electrical engineers. I work with and understand ME lingo a lot more easily, and EE was tough to pick up. 2) Need to require some basic business stuff. Like accounting & finance 101 combined. I recall being in meetings and the word IFO is batted around a lot. No clue what it means (Income from Operations).

Lack of practical, common sense knowledge of manufacturing and trouble shooting of pumps, distillation, etc.

1) The lack of real-world statistical problem solving skills (mentioned above). 2) Not being well-rounded enough. The training in ChE was excellent overall, but I wish I had been REQUIRED to take some engineering-relevant business classes, such as econ, finance, etc. I took (and passed) the FE exam 6 months after graduating, but I was amazed at how I had learned nothing in regards engineering finance...everything that I know now came from the FE review manual and from first hand experience at P&G. Why not replace ECE 376 with 1 or 2 such classes? I'm sure the # of ChE's who work with project financials far exceeds the # of ChE's who design circuits!

I believe that the biggest disadvantage they have is experience and knowledge. I came into the program from growing up on a farm and have a good practical knowledge. I also spent time working as a chemist assistant in a chemical factory before college and had a good understanding of equipment and how process streams and variables are in a job setting.

Most really don't understand what a ChE is. We know it is a good career, but don't know what job options are out there.

I feel I am more deficient in skill areas away from chemical engineering...as in electrical circuits, statistics, and comp. sciences. Also, I wish I would have had more exposure to business economics.

Social skills, ability to empathize with people. I have definitely lost my ability to talk to people over the years.

Statistics, SPC, design of experiments.

Entering undergrad? No idea. Entering graduate school? Not enough undergrad research experience. Entering the work force? Not enough interviewing experience.

Primarily one thing: Experience. All the preparatory work necessary to establish a base of knowledge in CHE are necessary and good. However, nothing is a substitute for actually working in a corporate environment.

Lack of knowledge of the chemical industry including history and current status.

Oral Communication Skills and Corporate Politics.

Many are unable to do computer programming, which is a VERY useful skill.

We learned so much basic/fundamental aspect of chemical engineering but most of the time the work is so specialized. I would say if there's a more focused approach on specific area that would prepare us better.

What my supervisors tell me (not about me, specifically) is that current generation grads lack basic professionalism skills. Things like writing good reports, being willing to sacrifice to meet deadlines, interacting with professionals who have been in industry for 10+ years. I agree with them.

Not enough manufacturing knowledge. The summer lab takes the ability to get an additional good internship away from ChemE's. There should be more partnerships with manufacturing facilities in the area. Communication skills should also be improved, there should be some information on team building/improvement as I lead many teams.

Besides internships and co-ops, it would be nice to have more formal practical application options.

I believe the education I received one of the best educations available at the University of Wisconsin and am very thankful for the opportunity. That being said, I also believe the CBE program is tailored to sending students to Grad. School. I believe the pendulum should be shifted back a little towards preparing students for industry. The majority of the class in which I graduated did not go on to pursue higher education immediately. That being said, I do not currently use any of the microscopic or macroscopic modeling that I learned in Thermodynamics, etc... Additionally, the industry in which I work is dominated by the use of statistics. While we learned some experimental statistics in various classes, the information presented dealt with the fit of models to data, not with the statistical design of experiments. I currently perform experiments on a weekly basis dealing with 5-25 variables/responses. Nothing in my formal UW education prepared me for dealing with this type of work.

Chemical engineers seem to still lack technical presentation skills and the ability to properly reference and cite sources.

For graduate work, I felt a bit unprepared in terms of mathematics and computer programming and I struggled in those course.

Presentation skills - more practice should be required in undergrad.

Computer Programming.

Communication, ability to interact with diverse populations, ability to apply theoretical coursework to real world situations.

I've said time and time again, not enough work with directly applying what you learn to real life. UW does not adequately prepare students to take on traditional plant role, but molds students more towards research. I believe this is short-sighted as the majority of undergrads do NOT go onto a graduate engineering degree.

Not much. Chemical Engineers from Madison are very well prepared. For my job I would have liked more knowledge of Inorganic Chemistry and solid state chemistry as well as some physics.

My biggest deficiency starting graduate school was my computer programming skills.

It would have been helpful to have more hands-on lab type work with reactors, pumps, all types of processing equipment to get a better feel for how these things work mechanically.

Not knowing what they are capable of doing other than plant work. There are so many chemical engineering job out there that do not require us to step onto the plant but still make a difference in the engineering or technology world. What is most important is the degree you get, not the work in the plant (which is just as important). Just because you are an ChE, this does not mean you are automatically in consumer type goods as an engineer. I am a patent examiner reading and examining about the newest technologies in the engineering and physical sciences world, which I think is much better than being out in the plant.

Communication.

We lack mechanical understanding. I feel very weak in electronics and what makes up all of the automation in the plants. PLC programming and how VFDs are used throughout industry. Those kinds of practical things.

Experience and ability to interact with current engineers and hourly workers.

Chemical engineers do not know chemistry! Upon pursuing a graduate degree in chemistry, I have realized how little chemistry a chemical engineer is exposed to during their undergraduate career,

especially in the world today involving a lot of catalysis. I feel that at least one semester of inorganic chemistry should be required and more chemistry lab classes. Incorporation of a research part to the curriculum besides summer lab would help in the development of independent thinking.

Oral communication skills Real process experience (hands on with common equipment such as pumps, blowers, etc.) One excellent example of that was my 426 lab partner. Both of us were taking the lab after our senior year (the last thing for us to do). One day in lab he pointed to something and asked what it was. It was a pump. He had gone through all the classes and didn't know what a larger real pump looked like (during humidity experiments).

Plasma properties.

I think more hands-on knowledge of polymer chemistry would be beneficial to most, if not all, chemical engineers.

For me, the co-op experience was just as valuable as the classroom experience. Had I just had the classroom experience I would have been very unprepared. I would make a co-op a mandatory part of the education.

Practical knowledge in materials selection and electrical equipment.

"What are the most important qualities or skills that a Chemical Engineer should have? Why? (For example: working independently, creative thinking, problem solving, time management, communication, working in a team, intellectual curiosity, confidence in field, ethical responsibility, etc.)"

Problem solving is huge. Working in a team setting is also critical to future success.

Analytical skills, problem solving, working on a team, communication.

Teamwork, business skill, problem solving.

Communication, communication, communication, creative thinking, problem solving.

Technical expertise, followed by a good sense of what makes sense in a business (product development). Communication and writing skills (email in particular) would also be extremely important.

Depending on the position it depends, however, interpersonal skills is important in any job. However, in general problems solving skills and working as a team is also important.

Ability to manage... In my experiences (and my friends), unless you go to work for a large company or a company specifically designated to engineering (i.e. a design company) there becomes little or brief opportunities to practice real ChE. That said, I understand the importance of educating all students on those principals. My experiences have really put me in positions where I not only needed to be a "general technical resource" but also needed to be able to leverage a diverse body of coworkers to accomplish goals. I am not sure if you can teach leadership/management in a classroom - or if it is the place of the ChE department to do it. However, the reality is that ChE's for whatever reason frequently rise to positions of leadership within companies. Maybe it would be possible to designate an "option" or "certificate" for those that know the direction of ChE they want to be in. In other words, maybe Junior year you could select a management option on the ChE curriculum. instead of taking Circuits or Polymer Science you would somehow use those credits to acquire skills more relevant to being a Production Supervisor. or Manager. Ultimately, the successful engineer needs to understand the responsibility of "just getting the job done" no matter what that takes. Sometimes technical, sometimes political.

Problem solving and project management skill are the most important in my opinion.

Problem solving, working in a team, leadership, communication, ethical responsibility.

Have initiative and intellectual curiosity so you can actually do some work. Have good social skills so you can effectively interact with operators and the plants, not to mention customers.

Time management, work independently, learn quickly, able to work professionally at all times (by that I mean not lose temper when teammate screws up, keep calm in stressful situation, etc.) Hard working, not a prima-donna (had a co-op who refused to do some menial shipping work saying a technician should do it) My department has 10 engineers, 2 technicians and 1 secretary. So the engineers need to be willing and able to do their own clerical work unless they are super busy.

Leadership ability, communication skills.

All the above are extremely important. For me, problem solving and communication have been very important to my success at P&G.

Willing to tackle any problem, no matter how big or small and to be creative to get to a solution.

Problem solving, time management, communication, & intellectual ability.

Problem solving, communication, time management, passion, team working.

Communication, adaptability/flexibility, decision making, team work.

Ability to communicate, think critically and analytically, be novel. Chemical engineers are often at the forefront of science, and in order to advance that front I believe they most need the qualities I listed above.

Communication and collaboration. Half of an engineer's job is to find the other engineer who already knows the answer to his/her problem. Risk-taking is important for bringing ideas into manufacturing.

Communication, working in a team, problem solving.

I would list three items: 1. Creative problem solving, 2. Confidence with subject material, 3. Being a self-starter.

A curiosity for natural processes.

Communication, problem solving, time management, working in a team.

Creative problem solving. Being able to work successfully individually as well as in a group. Most importantly is intellectual curiosity-without it, a person has no motivation to solve real problems and understand the solution.

All of above (working independently, creative thinking, problem solving, time management, communication, working in a team, intellectual curiosity, confidence in field, ethical responsibility) in balance.

The ability to work independently and solve problems are very important. Time management is probably the most important.

Problem solving, team work, creative thinking, influence skills and communication. I am never alone in making a decision, we always have a team. Problem solving is the most important skill.

Ability to problem solve.

Problem solving, creative thinking, team work, and communication. I believe "book smarts" only take you so far. I've seen members at the top of my class fail in the industry. Although classes don't teach communication and team work, these are some of the most important things my company looks for while recruiting. Furthermore, no matter what type of engineering one studies, college teaches you how to solve problems. Creativity and tenacity are great assets in the real world. Everything else can be learned.

Working in groups and general problem solving skills.

The ability to communicate, function either independently or on a team, and solve a diverse range of problems.

Well-rounded (don't just take engineering courses!), problem solving, creativity, written and oral communication (and ability to communicate technical information in a very basic non-technical way - important for business teams of various backgrounds), social skills, confidence without arrogance

Independent work, creative thinking, time management, teamwork, confidence in work.

The ability to know how to learn. You can't walk out of school and pick up at any job. You need to have the skills to be able to learn about your industry and position within that industry. Being able to learn and pick it up quickly is key to success.

Communication, ability to overcome adversity.

Problem Solving and Communication.

Team work, communication, confidence in the field, problem solving. Most work is done in teams where teamwork and good communication are required.

Problem solving and creative thinking.

Today, the most important qualities in industry are probably time management and ethical responsibility. Another one would be global impact.

Problem solving, communication.

Problem solving and working as a team, intellectual inquiry.

Problem solving, communication. If you have excellent communication skills and problem solving skills you can do any job well. Any job requirement can taught to a person with excellent communication and problem solving skills.

Working in a team. My job requires me to work with people 100% of the time. Without my people skills....I would not be as successful as I am. Creative thinking and problem solving are also required because no one is going to train you. You need to jump into the plant and figure out the problems on your own. Thinking outside the box (as Professor Hill always said) is a very valuable skill.

Communication and the ability to stand up for your decisions.

Creative thinking, problem solving, working in a team, independent thinking.

Creative thinking, communication and problem solving.

System engineering.

All of the above are important. I think that UW-Madison's CBE department does a great job in encouraging excellence in all of these areas.

For me it is the ability and willingness to learn. Which should be inherent if someone made it through the ChE program. Also, the ability to realize and admit that they don't it all. Too many engineers believe this and end up severely hurting their careers.

Communication and creative thinking are most important - new engineers will always have limited knowledge, but if they're willing to ask the right questions and can think creatively, they will gain respect from their superiors and get results.

## " Which skills would you like to see the ChE program encourage or improve on?"

Continue great problem solving skill set development. I would also encourage the program to help the students drive innovation in their fields.

Communication!

Business skills.

Oral and written communication can always use additional attention; the ability to do this well sets engineers apart from their peers in a substantial way.

Communicating in the real world (email, presentations, executive summaries) Product development activities

More hands on and real life problem solving.

As mentioned above, plant experiences/tours with real problems would be much more interesting than reading a problem from the back of the book.

Statistical analyses (not theory but application) and project management.

Leadership.

More knowledge of materials.

Business Knowledge. Maybe 1 class that would be a whirlwind of Marketing 101 & Finance 101 & Accounting 101 that would explain how a typical company is organized, what the roles of each department is and the terms for the math. The math for Finance & Accounting is very easy, but the terminology is foreign until you try to learn it.

Business/Financial skills.

Hand-on education.

Communication!

Time management and team working.

Decision making: how to weigh information and make decisions when there is no clear "right" or "wrong" answer.

Community outreach, breadth of education.

More practical thermo and a Stats requirement.

Communication.

Group problem solving and navigating the team dynamic. CBE424 does pretty well with this but incorporating a project in which 3-4 members must produce within a limited (1-2 days) timeframe would be realistic to the corporate environment for small process/product issues.

Advising undergraduate students - I thought this was an afterthought, and most people have no what their degree is good for.

Most people would benefit in a class that prepared an individual to work in a team environment similar to how a business is run.

More exposure to real world situations in momentum/mass/heat transfer and process design (senior year, 250 does a better job).

More hands on approach to emerging technologies. Our lab courses have trained us in traditional unit operations that are mostly automated nowadays so I think some aspects of it can be shortened. Sort of not trying to reinvent the wheel, I'd say.

Leadership. Globalization.

Statistical Design of Experiments and real world application.

Solving open-ended problems with no definitive right answer.

I thought the program was overall very good, with some deficiencies in math and computer programming.

Technical Writing and computer programming.

More design, perhaps a long term design project that spans multiple semesters.

Vanity.

Ethical responsibility -- this is becoming more of an issue lately.

None. The right skills are encouraged.

I think that the use of computer coding should be stressed and maybe the class should be taught within the department just to chemical engineers.

1. More lab work focused on understanding how things work. 2. Also within labs, the focus seemed more about doing calculations than increasing understanding of real-world equipment and processes. The equipment was often some very simple setup where we just were told what knobs to turn and buttons to push to get our data. Then we'd spend forever doing calculations in excel to analyze data. It is good to know how to do calculations, but I've found that process engineers often only do simple data analysis.

Prof Hill's ChE 430 class. This was well taught. Also encourage on non-typical chemical engineering jobs as this may not turn away many females if not in a predominant world.

Communication.

The UW ChE program provides a strong theoretical curriculum for its undergraduate students. While this is, no doubt, important for those students continuing on to Ph.D. programs, the undergraduate ChE program should enhance its offering of practical engineering skills/principles.

Electronics. Mechanical aptitude. EHS training.

working with others outside of the engineering field

Creative thinking along with problem solving, which might help with more unique ideas especially in process design independent thinking and learning how to find literature to help solve a problem.

Make sure all advisors know what they're doing from the start. It's not helpful to switch to a better advisor partway through when every potential employer starts their questions with "Why haven't you had an internship yet?" because your first advisor said you should wait until you've had a bunch of engineering classes.

Ethical responsibility and safety in the laboratories.

A course on project management would be great.

More focus on tangibles - case studies, for example. I'm an engineer and I've been asked to find an appropriate material to contain 1% HCl by volume (in air), at 1600°F and ambient pressure. I know that the costs for an exotic alloy would be prohibitive - what other options do I have, if any? Who would I ask for help, if my company doesn't have any Ph.D. materials scientists? That type of information would be very useful.

Clearly, management skills and statistics are both strongly recommended by the respondents.

## Advising

The next question asked for a rating of the quality of career advising.

| | |
|---|---|
| very adequate | 15 |
| **somewhat adequate** | **28** |
| somewhat inadequate | 12 |
| very inadequate | 4 |
| not applicable | 2 |

The average score falls in "somewhat adequate." While these scores are generally satisfactory, there continues to be a need to ensure that the minority of students who are strongly dissatisfied with their career advising are provided with alternatives or otherwise assisted. Advising quality still varies from advisor to advisor. More advice on long-term trends and non-traditional fields is proposed in some comments. One salient theme is that students perceived a strong orientation on preparing students for **graduate studies**, and slighting support for the majority of students headed directly to **industrial employment**. Respondents had a large number of suggestions on how career advising could be improved.

More focus on life after UW early on along with the focus on life at UW.

Loved the on-campus internship interviews, and also for full-time interviews. I've noticed that many schools now require an internship experience for graduation and I wonder if that's now a requirement at UW?

Provide more information on options earlier on in the curriculum. I might not have chosen ChE if I really knew what my job opportunities and the day-to-day work would be.

More senior students give career advise or mock interview for junior students.

Career Services was excellent.

Discussion should take place on the different types of careers to be had. Chemical engineering is a lot different than what I thought it would be.

I can not say enough about the ECS team at UW. I have spoke to many fellow ChE's from around the country and other major universities. Rarely do I come across someone who has had that good of a group behind them as they conduct a job search. Most do not even know what to ask for in a starting salary. From the department standpoint, I think it is important that they enlighten the ChE's when they come in that many of the positions they will enter the work force in do not always use a lot of textbook knowledge. I elaborated more on that earlier.

I had very poor career advising while at UW-Madison. My counselor was not concerned at all with counseling an undergraduate and visibly displayed this disinterest. Dedicated career counselors with job (non-academic) experience would be great.

I went in planning to finish in 4 years, and so had all of my courses mapped out before I got an engineering professor as an advisor. I only talked to him to get my schedule approved every semester.

I am unsure what you mean by career advising. If it means how well did they help me find a job, they were fantastic. Career fairs are great, the on-campus interview is excellent, and the connections they have with employers is outstanding. The online job postings are still accessible to alumni as well, which is great. If it means how well did they help me decide on my career, they didn't at all.

Focus more on companies outside of the Midwest, and on non-traditional industries that might hire engineers.

Bring in industry engineers to work with the students to give insight on what they wish they would have studied and learned.

Start during Freshman year already. Freshmen don't realize it is important to start thinking about that stuff right away.

A more personal interaction with your undergrad major advisor. If profs are too busy to do it, then outside mentors should be brought in who have experience in academia and industry.

I didn't get opportunities to visit companies, so I'm lucky I got into the right field for me.

The professors focused on grad school. And that's great. But the focus on finding an actual engineering job in industry was severely lacking. It may have just been the times, with a booming economy freshman year and a slumping economy senior year, but we all had the sense that jobs would just fall into our laps after graduation. That didn't happen.

More visibility. With the rigors of the CBE curriculum, it can sometimes be difficult for students to either remember or make the time for specific advising. While I realize it is not practical to provide individual support plans for everyone, it would be beneficial to have either in-class reminders/flyers available for students to realize what the advising could do for them.

Require both the student and professor to set aside 30 min a year or semester to meet and discuss whatever is on the students mind. I think forcing the professor to set aside the time, and then remember the event will be the most difficult task.

More focus on potential career paths and what first positions at companies would actually entail.

The bulk of the companies represented at career fairs and for interviews are the big ones - the Cargills, the Dows, etc. Which is great if you want to go to a ChE mill and be a process engineer. But I did a process engineering co-op at Cargill and hated it. I had to use other resources (monster.com) in this case to find a ChE position that wasn't simply one where you grind out 5-10 years running a department in a plant. I think it would help if the career advising services did more to find a broader range of employers so that not every ChE thinks they have to go into process engineering.

They need to stress internships and co-ops. These were vital to getting a job.

My personal faculty advisor didn't care much for the job and did little to help.

I'm not sure what career advising we received. While in college, students are happy just to have received a job offer.

Require all faculty to be available for advising.

The professors didn't seem to care much about advising. They often didn't know course requirements or anything about courses not in chemical engineering. The professors that were actually willing to meet with students (i.e. those not named Juan de Pablo) typically read from lists that we already had and didn't offer much insight.

I had the overwhelming suspicion that my advisor didn't care whether I succeeded or failed.

No one, save Prof. Root was supportive of someone's want to go into a traditional production engineer job.

I don't really remember getting any career advise except from a few professors that I spoke to.

More non-plant jobs. At Penn, career advising is more on the business/intellectual property aspect of engineering, not theoretical use jobs.

Place more of an emphasis on finding the right job for each person - not necessarily just finding a chemical engineering job. Focus more on companies that higher any major - chemical engineers are typically very bright motivated people that will succeed in many different arenas. They should realize this and be encouraged to learn more about positions that do not require a chemical engineering degree.

Provide better ideas of what is out there. Design, manufacturing, management, consulting, EHS, sourcing, product management, technology.

More interaction with employers and workers in the field and in Wisconsin.

Career Services was excellent.

As above, also encourage employers to only interview candidates if they actually have positions available. "We might have something available a year from now next May" is pretty useless to someone who has to pay rent.

Nothing comes to mind. I thought the career advising at UW-Madison College of Engineering was outstanding. Other colleges should use UW's program as a model. In addition, the career fairs and on-site interviews were very helpful.

It was really a joke for me.

More focus on the younger students - entering the program, my initial vision was to work in a lab somewhere. I didn't know that a master's degree would essentially be required for that, or that I would have been better served with a chemistry or biochemistry degree. Young students need to be aware that the vast majority of B.S. ChE's end up in a factory, working on process improvements/capital projects and things of that nature, and that R&D basically requires an advanced degree.

"How well prepared do you believe you are to compete within your field or current area of employment?"

| | |
|---|---|
| **very adequate** | **48** |
| somewhat adequate | 10 |
| somewhat inadequate | 1 |
| very inadequate | 1 |
| not applicable | 1 |

Comments:

I feel my education is a key contributor to my current success.

Despite not entering the chemical engineering profession, I must confess that the working attitude adopted during the stint at UW has helped me to face the various challenges at work.

The quality of engineering education from UW-Madison is world class.

I think that my problem solving skills and ability to quickly synthesize information has been invaluable.

I feel I could get most jobs I want - both because of the foundation I gained while at UW and the experience I have from working for almost 3 years. My ability to negotiate an above average compensation my work, however is lacking.

Based upon my experience and knowledge of the marketplace, I truly feel I have had great career experiences to make me competitive in the marketplace.

I believe the department did a very thorough job of introducing the tools necessary to have a basic understanding of many industries. However, I felt that I would be more of a "technical expert" coming out as an undergrad. That is not the case. I see now how it takes a few years in an industry and with a company to really learn the nuts and bolts.

Problem solving and communication are some of my stronger qualities, which have helped me in any situation I have come across so far even if I didn't have a lot of knowledge about a subject.

I have over 4.5 years of very hands on experience so I am very confident of the work I do and am not afraid to take on new adventures.

I think my education helped me learn how to think on my feet and be a leader in stressful situations. It helped build confidence when facing a tall task and I know I learned the theories, but the other stuff was more important.

I graduated about 2.5 years ago and I run a division and lead the team in my company. I design and operate new technology.

Madison has a great reputation for being a tough school for ChE & it is true. I am more prepared than most others.

Even though I believe there are areas of improvement, I think that UW Madison has prepared me much better than most other schools.

I believe I received a top rate undergraduate education, which provided me with the skills and credibility to compete within my current area of employment. Additionally, summer internship experience and my current job responsibilities/accomplishments allow me to compete in my field.

The Madison ChE program was sink or swim, and I fit in well in that learning environment, I decided to swim.

I work with a few other UW engineers, all of whom are successful.

In the world of library and information studies, I am incredibly well prepared.

The skills I learned in the CBE program and the degree I attained place me in the forerunners for problem solving, time management, and responsibility in any company. I use those skills to actively engage and solve problems in the company and, thus, I advance without too much additional effort or obstacle.

I felt like I could outperform my peers.

The educational opportunity provided by the ChE department at Wisconsin is very intense. I believe if an individual can handle the program they will be very well prepared employment.

The program was more rigorous that any others, (almost) all of the graduates were brilliant people who pushed each other to work harder. As a result, we are more prepared than many other graduates.

It’s more a matter of how smart you are and how confident you are, not a matter of where you get the degree from.

We had a broad exposure and were challenged in every ChE class. I could have used more food knowledge, but I gained the ability to learn and that has been crucial.

Based upon what I've learned in college and the formal/informal instruction I've received while in the work force, I've found myself adequately prepared to deal with most of the projects or issues I've come across.

My undergraduate background provided more than adequate preparation for a top level graduate program.

I feel I've had a successful graduate career up to this point.

UW ChE is a highly regarded degree and well-known as a strenuous program. Holding that degree is very meaningful to employers.

I've learned a lot of new skills in my position. I feel I have a lot of good experience and examples to support my growth as an engineer.

ChE at the UW was so challenging, that most other things seem easy in comparison.

I have all the knowledge. I just haven't had a chance to apply it.

I believe chemical engineers are the best candidates for most jobs. I believe they are the smartest, hardest working, and best problem solvers and can fit in many areas. A broad knowledge is provided to help enable this.

In graduate school, just the fact that I received my BS in chemical engineering at Madison puts me ahead of others. Whether that reputation remains will be up to me and I think I am in a good position to compete.

Could have more: 1. Finance courses, 2. Project management courses.

I come from one of the best engineering schools in the nation and an ex boyfriend's dad that is a Ph.D. in ChE, not from Wisconsin, speaks very highly of the school and BSL, still. Everyone knows the Wisconsin Chemical Engineering program, even here on the East Coast and is extremely well respected.

My job requires excellent problem solving skills - this the core skill taught to chemical engineers at UW. In addition, my job requires good communication skills - something that I have always been strong in but don't think was focused on during my education.

No experience in current job, feel that women are not respected by older engineers.

I continuously use my chemistry and chemical engineering background everyday in the chemistry research I am doing.

Despite the deficiencies, the department is still one of the best and companies recognize that.

Grades suffer significantly by not working on homework sets with 15 other people, copying homework, having a years worth of past exams, etc. The wall I hit with this in 320 or so kind of hurts everything else and the resulting cynicism hurts it even more.

My current field isn't highly technical, so I'm slightly over-qualified in that respect. My knowledge of chemistry is my biggest asset in my current position, as I'm one of very few people here with any significant education in chemistry. If I had taken a job with one of the more traditional employers for this major (petrochemical, food, etc.), I'd probably be in a better position to comment on the "competition".

## "How does your undergraduate education compare with that of peers in your field from other schools? (Example: advantages, disadvantages)"

I think there is a level of parody [or *parity*?] compared to others in my field; I do feel that I was probably ready to make a difference at work faster than they were.

Great advantage.

Seems comparable.

I was fortunate that the Chemical Engineering department stressed the quality of the work product, especially in the 470 and 424 classes. The quality of the writing that was demanded in those classes prepared me for the writing I now perform in my training to be an attorney.

Advantage: analytical skills, Disadvantage: Economics, finance, business knowledge.

**As good as my engineering peers; far superior to my law school peers.** With regard to my law school peers, I won two awards for my writing skills, and I believe that part of that was due to the writing and editing in the CBE program.

Very competitive. My company mostly hires from UW and the University of Minnesota (Twin Cities) - a few engineers come from other large programs. I feel that UW offers a few advantages, mostly the lab courses - it seems like UW engineers are more capable when it comes to actually conducting an experiment and doing things in a lab setting. **UW engineers, however, don't**

**seem to be as educated when it comes to conducting business -** all companies need to make money, choose what projects to work on (and which ones cannot be resourced).

I find my problem solving skills to be better.

I think it compares favorably. A large part of that, in my experience, is the diverse and robust experience of going to school in Madison. Those, 4, 5+ years shaped my adult life and who I am. They taught me about all the different things I could be exposed to and allowed me to step into new places very easily. The rigors/demands of the book work prepared me for similar types of challenges at work. It is much easier to deal with pressure after having survived the UW ChE program.

I am definitely more prepared from a theoretical standpoint. Some of my peers have better leadership backgrounds and project management capabilities.

Advantages: more stressful, so stress on job was easy to handle Disadvantages: too theoretical, too many credits required so if I wanted to get done in 4 years I couldn't take additional classes.

I feel **UW-Madison ChE's are at a material and chemistry knowledge disadvantage** compared to other schools. As a general hands-on knowledge and ChE knowledge we are more experienced. Depends on the person too.

Adv: More theory, more homework, more stressful tests. Disadvantages: less knowledge of business, co-oping less typical, less connection to the manufacturing industry.

Major disadvantage is what I said above...I was not well rounded enough compared to my peers. My **boss, for example, graduated from Cornell and took many classes in business/finance**. At P&G, it's the norm to interact with people from finance, marketing, etc on a regular basis.

I am told everyday that the engineers I work with can't believe the knowledge I have already and what I am capable of doing.

Tougher than others, so it was better for me in the long run!

I believe my undergraduate education is comparable or superior to that of peers in my field. Advantages include excellence in engineering principals and application, solid technical skills, and strong work ethic.

I believe my undergraduate education is comparable or superior to that of peers in my field. Advantages include excellence in engineering principals and application, solid technical skills, and strong work ethic.

Similar. **Lacking in Stats** but ChE 424 was a huge plus.

Better than most.

I do not work with many chemical engineers. However, the few that I do work with seem to work with me on a similar level. I would rate the project based classes a little higher than other institutions on average. However, a deficiency I noted was the relatively small amount of internships available at UW-Madison.

**Far more rigorous**. I do believe some schools focus on a more practical education which could be somewhat beneficial in the workplace.

It was much more difficult that most others. The time required to complete the home work was too much. I chose to graduate in 4 years, I now wish I would have taken an extra year and had a least a little time for fun. I spent four years killing myself. College should be difficult, but there should be time for fun, too.

We are better prepared to think harder, work harder, and work under pressure/time constraints.

See above answer. From what I've seen, the UW-Madison ChE education is more rigorous than most schools.

I work with ChEs from different institutions and General Mills continues to recruit from UW Madison because of the quality of the recruits.

I've found out that most other universities do not "force" students to endure classes such as CBE 424 (Summer Lab). I think this is a great disadvantage to those universities as 424 teaches one how to deal with real life scenarios. While I've done much more rigorous work since then, 424 was a great "break-in" to the life as I currently know it.

I believe UW offers a major advantage in thermodynamics and design of experiments. The courses in Physical Chemistry were lacking.

Vastly better than others in thermodynamics. On par or better in nearly everything else, with the exception of math and computer programming.

Similar to other top schools; few other young engineers I know feel they had a MORE challenging or thorough program.

Breadth of knowledge, mathematical ability.

UW-Madison is highly regarded as a top university and it gives you a certain level of respect.

Advantages: Course rigor and opportunities to work in many labs across campus. Disadvantages: Very much stuck in tradition and impersonal, especially considering the relatively small size of the department.

Generally superior to that of others. Only a small percentage of people employed in the brewing field have such a rigorous educational background.

Excellent academically, poorly for hands on time.

I think Madison is harder than the other schools, but it may not be recognized as such. Job placement is a big key.

I think that in many subjects I retained more knowledge and my grasp of mathematics related to chemical engineering problems is a big advantage.

Similar.

Wisconsin classes are extremely well taught from the best and seems like I understand material better than others from non-top of the nation programs.

I think my undergraduate education has better prepared me - I am a better problem solver than my peers which has enabled me to be very successful so far.

I feel I am above and beyond peers from other schools....even schools like Michigan, Purdue, and U Mass. I feel I didn't just learn topics for an exam...I still remember when I learned in college....which is just the way I learn though.

My undergraduate education is stronger than most of my peers, mostly due to the fact that I had graduate level classes available which I did take during my undergraduate career.

High ranking school so people assume I know things.

Among my peers, I had one of the best educations.

I took similar classes, but I felt that we had more hands-on training through the CBE labs. We also had more training in transport phenomena than other colleges, which I think is a bonus. The only disadvantages I see are that CBE was only just starting to offer more biological classes when I was attending. That may not be the case anymore.

I believe my education compares well. However, it does appear to me that UW is more focused on producing graduate student engineers than ones ready for industry.

I don't deal with peers from other schools on a regular basis. Only customers and they're always in an entirely different field.

## " During your undergraduate study, what subject areas, if any, would you have liked to study more? Why?"

For me, food science would have been very helpful.

Literature, economics, general business acumen.

Finance.

Product development, statistics, and some type of course that would educate me about some of the basics all businesses face (what to expect - what the real world is like, financial analysis).

Operations.

I personally would have enjoyed an opportunity to branch out a little more in the core discipline. Although I understand there is a lot of ChE to learn and be introduced to, there was often a feeling with other students at UW that I could not relate to them because of the rigorous Engineering life. This does create a neat bond between other engineers - but sometimes there was a desire to break away and see some new faces once in a while.

Applied Statistics and Business Finance.

Converting processes, more mechanical engineering courses, design of experiments.

**Materials, polymers** because that is what I need the most knowledge on in my job, and in any ChE job you need that knowledge.

**Business/Finance**. More variety of subjects that were not engineering. Not enough broad education requirements, and too many required engineering classes.

**Business/finance** (mentioned above).

More electrical courses. I believe that engineers work with more electrical concepts and areas than what is taught in school.

**Statistics**. I use that more than anything.

Food engineering and/or food science classes since I work as a product developer on consumer food products.

Biochemistry, immunology, music. Because I want to be a doctor and more well-rounded.

Stats, stats, stats.

Catalyst sciences would have interested me. As the world grows hungry for additional power with diminished resources, the need for energy cost reduction in large scale processes will become more and more important; not to mention the ability of catalyst science to allow for viable fuel cells and other alternate energy sources. It would've been my goal to specialize in those areas if more were available undergraduate level courses.

I would have liked a course on surface science. Surface science seems to be relevant to so many subjects, and I felt like an intro course would have been useful.

Cutting edge technologies.

Another 1 or 2 liberal arts course would have been fantastic! Because of the 133 credit requirement, it is nearly impossible to fit them in 4 years.

I wish I had had more time to explore interests in the liberal arts. The ChE program is extremely focused on ChE - which it should be, I suppose - but even though I took 5 years to graduate, I still wish I could have taken more liberal arts classes just for enjoyment.

Statistics - This is the most important area of math in manufacturing. Management of teams - A good team can accomplish more than any individual.

During my study, I would have loved to study more polymers and polymer labs but they were not offered. Additionally, I was extremely interested in materials and kinetics. Now that I am out of school, I wished I had spent more time in Stats.

I would have liked to study polymers more, because I find the properties of macromolecules interesting. This is one of the reasons I chose to attend graduate school in polymer science.

Since I ended up studying polymers in graduate school, it would have been useful for me to take a polymers course.

**Industrial engineering and statistics** - very practical skills that can be valuable in all areas.

**Biology**, as I am dabbling in quite a bit of biology for my graduate course of study.

All of them. There's always room for improvement.

Biology, biochemistry, statistics, professional development.

Biochemical Engineering--Applicable to brewing science and technology.

Thermodynamics -- but I really liked thermo. I could have spent a whole semester getting that distillation tower to run.

Same as above. Solid state chem., inorganic chem., physics, polymers.

Computer science - I have no programming skills.

More PE classes. Those were really fun and I didn't start taking them until junior year. 2. More finance classes to better understand top-line growth, bottom line growth, expense, capital, etc.

Kinetics and Reactor Design.

Computer programming - I find this interesting. I don't think this would be too useful for most chemical engineers though. I think the curriculum is very good the way it is. It doesn't really matter what subjects are taught as long as the problem solving process is emphasized.

Biochemistry because it is a growing field and will have higher demands in the future.

More biochemistry, hands on learning, more labs.

I would have liked to see additional **polymer chemistry/engineering courses** as well as courses in **biomaterials** and/or **surface analysis**. The surface chemistry course offered was great, but didn't have any information on biomaterials. Since this is a vastly growing field, I think the CBE dept should focus some resources in that area. I also think **a course/lab in sustainable energy** would have been really interesting. This is also a growing field and will definitely become very important in the next few years.

Materials of construction (see reasons above).

"The ChE degree requires 10 credits of laboratory courses involving Chemistry and Chemical Engineering. Please rate the value of this laboratory experience to your career and comment on why you rated it this way."

| | |
|---|---|
| **very valuable** | **39** |
| somewhat valuable | 15 |
| of limited value | 6 |
| not valuable | 1 |

Over half of the students chose "very valuable." Comments range from constructive to scathing. In particular, the Control Lab got several unfavorable comments.

These provide a student the hands-on experience needed for successful career in industry.

Any job in a food, medical, or pharmaceutical field will require large amounts of documentation and strict use of design of experiments. Labs require these things, along with a lot of technical writing.

I think some of the experiments were dated. The methods and process are the most important and the biggest takeaway from the labs.

I have often worked in the lab and have been required to write reports, though not nearly as intensive as when I was in college!

My laboratory work on the job was very different than the lab classes.

Lab work provides the opportunity to hone analytical skills and allows the realization of textbook theory.

The Chemistry lab has little use. The Chemical Engineering labs are very useful.

Lab experience is extremely valuable - I would not recommend reducing the amount of lab experience.

It is good to have solid lab technique, but it got quite repetitive after a while. There is a lot of value in all the report writing. I have always felt much better prepared to create technical reports than my peers.

Application of the theory is very valuable.

They were a lot of work and at times stressful courses at the time but it prepares a person well for the "real world" and gives UW-Madison more confidence for entering the real world.

I think Summer Lab is very valuable to see how to set up a complex experiment, and O - chem. & P - chem. labs were pretty standard. 324 lab (I think that's the number) does not really stand out to me.

I rarely analyze samples or do lab size experiments. Mine are large scale and we use labs to analyze all our samples.

I work daily in a laboratory environment.

Laboratory experience taught valuable technical, documentation, and report writing skills.

The labs were great for me because I was a visual learner, so the labs brought the concepts full circle for me. I think summer lab should be taken sooner, perhaps after junior year, not senior.

The engineering labs are much more valuable than the chemistry or physics labs.

In grad school, I did simulation work. My laboratory experiences made for some good stories, but weren't particularly valuable to me.

Lab experience is essential to the CHE field. You need to know how to conduct a valid experiment and how to document the results of that experiment in a way that is clear and concise to other members of the engineering community. The lab classes provide that base of knowledge.

The writing was valuable experience, even though I hated it.

Lab work and understanding how data is obtained from a laboratory situation is essential to the everyday function of an engineer.

I found process control lab to be totally useless. The 8 hours a week of analytical chem. lab was too much. 4 hours per week would be plenty.

Need more hands on experience on new technologies. This could be due to the fact that most of the time the lab was too tedious (e.g. collecting too much data instead of just getting the concept understood). It's a waste of time and too many details can make people miss the bigger picture.

ChE 424 (summer lab) is the best class I have ever taken. It was brutally demanding. It required all the ChE knowledge gained from previous courses. Most importantly, it required an enormous amount of effort to be able to complete professional reports and meet deadlines.

The labs were a better way to get hands on experience. There were some older labs and equipment that were not as useful.

I use everything I've learned in both chemical engineering and chemistry labs on a regular basis. While I have been introduced to new types of chemical analysis since then, the areas that I received instruction on have been extremely valuable.

I found ChE 324 and 424 very valuable. I did not see much value in the 470 lab.

I need the laboratory and communication skills I learned in lab courses in my graduate work.

Helps develop problem solving skills, data analysis, and written communications.

Prepared me well for Grad school.

Saying something will work, and actually making it work are two completely different things. Discovering why it didn't go as planned is just as important to developing problem solving skills.

While the experience is very important, I feel that too much emphasis was placed on the amount of material covered (10 reports in 5 weeks in Summer Lab). As a result, I feel key aspects of lab work - proper design, data acquisition and analysis - suffered as student tried to crank out one report after another.

Lab experience is always good.

Some of the labs did not add any value and were taken to fulfill a requirement.

In graduate school, any lab experience is beneficial.

As stated, I think lab work is very beneficial and should be increased significantly.

Summer lab (I forget the number) was of a lot of value. We actually got a chance to be creative and problem solve - no defined steps. Other labs were not valuable since it was just following outlined steps.

I learned better in my lab classes than in most lectures.

I feel that the laboratory courses were very beneficial in understanding the material. I felt that 10 or more credits would be a good number of credits to include in the program.

My previous comments about cook book labs followed by extensive calculations and very strict technical writing. None of that is used in industry. They are geared more towards future grad school students.

Summer lab was great. It was great to see my grades up with other people's when they couldn't work 20 people together splitting up a homework assignment and copying.

I do a lot of lab work in my job. Instrumentation class was the most useful.

I think that the chemistry and CBE labs were extremely important in solidifying concepts learned in the classroom. I still frequently use techniques I learned in the laboratories at UW-Madison.

Only reason I rank this way is the 470 lab could be the most valuable lab taken. However, for me, none of the equipment ever worked and was presented poorly.

Most of the laboratory experiments provided some practical experience.

"Please rate the value of the summer laboratory course in particular."

| | |
|---|---|
| **very valuable** | **43** |
| somewhat valuable | 12 |
| of limited value | 4 |
| not valuable | 2 |

Comments showed strong opinions. Many students highlighted time-management skills. Others praised the overseas options. The main suggestion for improvement (beyond dropping the lab course) was to modernize experiments. Generally, the positive:negative ratio is 4:1.

While it really was a time sink and also a very demanding course, I felt it was very valuable development tool. Once you accomplish this course, you can get through almost anything.

Pure torture and I was not mentally connected to it.

It was very hard work, but it was enriching in reinforcing textbook knowledge and building time management skills.

Good for writing experience and for problem solving skills.

This course gave practicality to the other course work (book stuff). It also gave confidence to conduct useful real world experiments.

It was a great experience...however, more for the interpersonal skill development with the course abroad.

This course simulated real work more than any other. It was very focused and allowed the student to consume themselves in something for a period of time. Although multi tasking skills learned in a normal semester are valuable, this was an opportunity for those of us who like to dive deep into things to shine. The experiments themselves were also very "real world". I think they presented very open ended challenges that often were not entirely technically difficult, but needed resolution. This is similar to any challenge I have faced in work up to this point. I would say that teamwork was another aspect that was learned, but my unique experience allowed for a little less teamwork than others experienced. That said - it did prepare me for the array of people that you have to form teams with in the professional world.

Good experience with working on larger projects, lots of technical writing. I took mine in Oviedo and really enjoyed the chance to study and live temporarily in a foreign country and still study in English.

Same comments as above and also helped develop initiative and intellectual curiosity and intelligence.

I think learning how to solve the problem was pretty cool. The frustration I had with the course was the difficulty in building things. I do similar things all the time in my job, but I have a well stocked storeroom with nuts & bolts & screws & fasteners of all types plus I can order anything I need on the internet, while summer lab was an exercise in scavenging. I know there is a limited budget, but building things was rough. That is my main memory.

Was not very useful to me because I am very hands on and creative and was able to apply what I know from theory and paper to real life.

Very difficult & draining, but worth it. Very proud that I completed it.

This helped to prepare me to work quickly and efficiently.

Summer lab offered the most "real world" experience in terms of problem-solving, experimental design, and project management. The writing and communication required in the class were very valuable. I believe communication is a vital, but often overlooked, part of working in the "real world".

Definitely gave me lots of experience in designing experiments, which was key in job interviews.

Its only value was as a personal test of endurance.

While very intensive, to say the least, that class alone provided enough practical application of the CHE concepts I learned to, and I quote, "stun" various interviewers. They were very impressed that independent projects, especially 9 of them in 5 weeks with write-ups, were undertaken in undergraduate courses. Speaking from personal experience, I also really enjoyed the hands-on experience and seeing the tangible results of understanding the various chemical and physical systems with which we worked.

The summer lab course was a confidence builder.

I took this class abroad so I saw this as valuable on two fronts. One, it allowed me to see a part of the world that I had never seen before and two it provided a very challenging final capstone to the entire program.

I took the course in Spain. I found the Spanish professors to be inadequate.

See above - more thoughts on ChE 424: As of your first day on the job, employers don't care what school you went to, how your grades were or how smart you think you are. They care that you are able to work on a team, solve problems and finish projects quickly and well. They also care that you bring a professional attitude to work. ChE 424 demanded all of these things - maybe even demanded a bit more than my current job does. ChE 424 wasn't always pleasant, but like I said it has been the best class I've ever taken.

It would have been more valuable in the year. I hated summer lab because I already had a job and did not want to waste 6 more weeks including summer tuition to get my degree. This was the biggest waste of time of my five years.

The time when each person takes it should be standardized.

Please see my response above.

The informal labs were very beneficial in preparing my own experiments after graduation.

It was beneficial to be exposed to a variety of pieces of laboratory equipment.

A bit over the top in terms of workload - not sure how much I retained. Though I must admit, there's some sense of pride that comes in finishing it, as well as some sense of "you should have to do it since I did!"

Teaches me time management and to perform under pressure.

See above. In addition completion of the very challenging summer lab makes one feel like they can accomplish anything.

Provides first hand experience on many topics, and encourages problem solving.

This was the only time to really do hands on experimentation.

Good experience for a lot of reasons. Most like a real job except internship.

Good experience. It helped put some things together. I think you could do labs like this throughout the year, so that people get familiar with all the common equipment. To make it more manageable on people's time you could do the following. 1. Don't have so many calculations at the end. The benefit is spending time understanding how it works. 2. Don't insist on the super long drawn out lab reports for everything. For example, O-chem. lab was a lot of time in the lab (8 hr/wk) but we could do the lab write-up in an hour. Whereas ChE write-ups would end up being like 5 - 15 hours depending who you were.

Very hands on and met awesome people from Clemson in Vienna, Summer 2004. I am still friends with them and one is my boyfriend. The material was well thought-out and written despite we were in another country.

This focused on problem solving, and is invaluable in the development this skill.

It gave a good hands on approach to things, but I don't really do that kind of work anymore.

The pace of the class was a great prep for the workplace. Working with professors was a big plus.

I really enjoyed summer lab, and I felt that it gave individuals a feel into what real R & D is like, especially the special projects. I was very glad that this class with the curriculum presented was offered.

The lab reports were rough, but the lab work was fun and interesting. As stated above, because everyone had to work on their lab reports alone for once, I could actually compete.

I have to admit that this was by far the most painful of all the required CBE courses, but it was extremely helpful. It was a great chance to combine all of the knowledge I had learned over the past 4-5 years. I also loved that we could be creative with the experiments we designed. We weren't given solid instructions to follow. This is something that I do now in graduate school. The communications training in this course was especially helpful. I still use much of the advice I received on technical writing and presentations.

Great course.

The course was somewhat similar to a real-world situation (creative thinking and communication were stressed), but required an incredible amount of time and effort. For a low-income student like myself, it was impossible to maintain a job, because I was forced to spend 16-20 hours per day on the coursework (8 hours in the lab, and 8-12 additional hours analyzing data and writing reports). It also became much more difficult to find employment for the remainder of the summer, because employers generally don't let the summer help take a three-week vacation. I was forced into a nearly-insurmountable amount of credit card debt as a result of this. Additional student loans weren't available, either, due to my parents' poor credit history. I don't feel it's fair to those students who need a steady income to keep from ruining their credit rating. A commitment of 8-10 hours per day would be reasonable, while still allowing a student to work part time.

## Independent Study – ChE 599

Of the 60 responses, 38 students (63%) took an independent study semester as part of their courses. This level is unchanged from 3 years ago. The most frequent rating was "very valuable."

| | |
|---|---|
| very valuable | 22 |
| somewhat valuable | 12 |
| of limited value | 3 |
| not valuable | 2 |

Many had comments to the follow-up questions.

"Why do you rate it this way?"

It turned out to be one of the only course areas that is very applicable to my current job. I was able to draw on that experience during my interviews and also my first few months on the job.

It was just busy work for one of the professors.

Independent study provided the wonderful opportunity of a self-planned and organized work.

It is very practical topic.

Allowed me an opportunity to explore some different aspects of engineering, and to interact with people in some unique circumstances.

The independent study was very researchy and upstream, but I ended up in a career that is more focused on today - actually making a product and producing it. So, in my situation, it wasn't very valuable because I took a different path after graduating.

I learned about the research side of chemical engineering.

I don't really even remember much other than running some enzymes and a variety of temps and then seeing how effective they were. Just a lab experiment that took a long time.

I worked on something that was only used in university setting and I never plan to work in that environment.

It allowed me to try a few different things.

It opened my views to other areas of chemical engineering.

Because I learned what it was like to do real research and write real papers.

A chance to do independent research.

Didn't accomplish as much as I'd have liked due to lack of supervision or access to advice.

I wrote a paper on chemotherapy-embedded, biodegradable polymers. It turns out that in the pharmaceutical field, it is very helpful to understand the mechanics of drug delivery in the human body.

Exposure to undergraduate research helped me decide that I was definitely interested in graduate school, but not in the field that I was initially interested in.

I learned a lot about how to do independent research. Also, it is the only way a student gets to know a professor at all; therefore, it is important for letters of recommendation for grad school applications.

It just happen that the field I was working on was not what I eventually pursued. Difficulties to find advisor/independent project limited our options.

I only needed one credit and it was a literature search. It was good because of the one on one interaction with a professor. I didn't have that kind of personal contact with another professor.

I received numerous credits for independent study. These credits were research and application based on real problems. While performing to a deadline we were forced to be creative, think out of the box, and basically just get the job done. There is no substitute for this type of experience. I believe these experiences separated me from the rest of my classmates while recruiting for jobs. My GPA was probably middle of the road for my class, my experiences (both internships/co-ops and research) were really a big advantage.

The course provided a nice glimpse into what graduate-level research is like.

Experience I never could have got in a traditional classroom setting.

Undergraduate research with Dr Abbott - Prepares me for the rigors of Grad School research in the lab.

You learn how to problem solve. You learn how to work independently and with others. It's a good mentoring program.

It was the only window into graduate life and what it meant to be a professor.

One of the best learning experiences I had. Very beneficial for resumes/experience, and experience prepares well for real work environment.

Again, it was good preparation for graduate work.

Interesting to listen to the outside speakers come in and present their research. Gave a good idea what grad school or a PhD program would be like.

I taught for Prof Murphy. I learned that I am not a teacher. Loved the idea to educating kids that were not able to comprehend simple science concepts. Was able to use hands-on materials from UW to excite their interest and show them what they can accomplish if they put their mind to it.

It made me realize that research was not for me. I didn't like being in a lab all day. I like the fast pace of manufacturing. I like the pressure and staying busy.

I took Chem. 599, not CBE 599, where I did independent chemistry research. The hands on experience I had, caused me to decide to go to graduate school in chemistry instead of chemical engineering.

I have to clarify that I didn't sign up for CBE 599 on my transcript, but I performed paid independent research with Dr. Paul Nealey for ~1 year. My research in the Nealey lab was the reason I decided to go on to graduate school. I loved the work I was doing and also that I could take an independent role in his lab performing exciting research. I also loved that I could work with both engineers and biologists and learn new techniques in both disciplines. This experience couldn't have been more valuable to me.

I was allowed to follow up on a previous project, which was the basis for a student's Master's thesis. This allowed me to gain an intimate understanding of the typical duties and responsibilities of an M.S. candidate - and allowed me to make a clear decision regarding my direction after obtaining my B.S. (I decided not to pursue an advanced degree).

"How, if at all, could it have been improved? Be as specific as you can."

I think it was properly tailored to my interests.

More guidance from professor. Many undergraduate students were left without enough guidance.

A little more structure could have been offered, as well as a larger challenge. Make sure they don't turn into lab tech positions.

Boy, hard to recall. I think if I would have known more about the context of it.

There wasn't much participation when I took it. I think with more enrollment it would be better.

A more successful project! A nature paper perhaps.

Be assigned to a grad student and have regular meetings.

More guidance on the topic would've been nice. However, I believe that independent study courses are designed to challenge your resourcefulness. So, perhaps just providing examples of other independent study courses would be beneficial.

1.) Make research seminars available to undergrads, and stress their importance. 2.) Try to develop very defined and simple projects.

It's fine.

More announcement on what the available projects are.

The vast majority of our work was unsupervised by any university figure forcing us to work as a team and find solutions to our own issues.

More interaction with the Professor in charge.

None, very good.

A little more exposure to different labs would have been better.

If I had joined a group which had more graduate students or a more hands on professor, I could have learned more.

The University of Washington Dept. of BioE has a similar class, but it is a year-long senior project. The students write a paper and present research findings through presentations and posters. I think the CBE independent research could be more structured in that the students meet to discuss research topics and also give a presentation at the end of the term. I believe it will help them be more confident in their work and abilities. It would also be helpful if the advisors would

give written evaluations to the students periodically throughout their studies so that the students know what areas they can improve upon.

It was perfect - no complaints at all.

"In what ways, if any, did your independent study experience influence your choice of career?"

I am not sure it pushed me into Food, but it was a great experience to have and sure did give me an idea of what I could be getting myself into with a food company.

No influence.

I work in the area directly related to my independent study.

It didn't influence my choice of career.

I don't think it had much effect on my choice of career (neither good nor bad).

It hasn't influenced my career choice.

It made me never want to go to grad school. I would go crazy doing the same experiment at 50 different concentrations and temperatures. I also decided I did not want to work in research, but that development was a better fit for me. So in that sense, it was valuable.

None.

Not really.

None.

Well I have been a PhD student for 3 years and I am just starting another PhD.

Helped me decide to go to graduate school.

Steered me away from research and more toward process development and manufacturing.

It did not influence my choice of career.

See above.

I would not have gone to grad school had I not participated in it.

None. It was too short for a life-changing experience.

My experience helped me to decide what type of role I wanted after college (R&D, Laboratory, Process, Hands On/Off).

The course helped confirm that graduate school was the right career choice after UW.

Graduate school.

My professor was very into polymers and polymer science. I became interested and chose a related industry.

None, my decision to take 599 came after I decided to attend grad school.

Ensured I enjoyed my work/field.

One of the reasons I went to graduate school.

I did not become a teacher. I was debating at one point to work towards my PhD in Chemical Education at Georgetown.

It made me realize that manufacturing was the right choice for me! It was too slow....and I was trying to prove something that we already anticipated happening.

It dramatically affected my career; it made me realize that I like the more hands on approach to chemistry and that I wanted to go to graduate school in chemistry not chemical engineering.

I had thought of pursuing a career in the biomaterials field in the past, but after doing research in Dr. Nealey's laboratory, the idea was completely solidified. My CBE independent research experience played a very large role in influencing my career path.

" If you went to graduate school, in what ways, if any, was your graduate school experience influenced by the independent study?"

The course offered a chance to do independent research with other graduate students. I enjoyed this and ChE 599 helped me make my decision to go to graduate school.

I liked what I was doing in my ChE 599 lab research, and decided to continue on to Grad school.

No.

No.

No influence.

Graduate school was no adjustment for me because of the independent study experience I had at UW.

Helped me to get into top tier programs. Gave me initial experience in doing research and writing journal articles.

None.

I did not attend graduate school.

The independent study convinced me that graduate school would be interesting.

It was helpful to see the social dynamics of the graduate students. I had a better idea of what I was in for as a grad student.

None.

I was more familiar with lab techniques and dynamics.

I liked being independent and not having to work at set times.

I worked more in IP law rather than teaching. IP/Patents is what I extremely interested in now.

It was largely influenced by my independent study. My independent study as an undergrad involved a professor that was very hands off, which meant that I had to come up with most of the ideas for my research. This aided in me learning how to find things in the scientific literature and to learn how to solve scientific problems on my own, which I feel is one of the reasons of the success of my graduate career.

I am currently enrolled in a Ph.D. program in Bioengineering to further study biomaterials. I wouldn't have done this if I hadn't been so motivated by the biomaterials work I was able to perform in Dr. Nealey's lab.

## Feedback on individual soft-skills topics

Ratings of how well the UW-Madison ChE undergraduate education prepared students in:

| | Very prepared | Adequately prepared | Poorly prepared |
|---|---|---|---|
| Ability to function on teams | **49.2% (30)** | 47.5% (29) | 3.3% (2) |
| Ability to communicate effectively | 45.9% (28) | **54.1% (33)** | 0.0% (0) |
| Knowledge of contemporary issues | 18.0% (11) | **67.2% (41)** | 14.8% (9) |
| Understanding of professional and ethical responsibility | 27.9% (17) | **62.3% (38)** | 9.8% (6) |
| Understanding of impact of engineering solutions in a global and societal context | 25.0% (15) | **58.3% (35)** | 16.7% (10) |
| Ability to engage in lifelong learning, and recognition of its necessity | **50.8% (30)** | 44.1% (26) | 5.1% (3) |

Comments on standouts included:

I feel college helped me to get where I am today. It instilled a desire to learn more and also how you need to rely on others to get work done at times.

The UW curriculum seems very technical (a good thing to me), but lacked a connection to the real world - most of which the above questions were asking about.

I feel the ChE department instilled a good sense of drive and need for continued learning. I'm not quite sure how it was done...but it made students feel like the ChE career is a good one and one that could make a difference.

I think one of UW's greatest strengths is to create more "worldly" graduates. This even exists in the Engineering building. Working with a wide variety of people in many different situations is one of my greatest assets. A lot of the teamwork at UW helped force me out of that shell and realize that my ability to facilitate progress is something I have always been good at. One area of improvement may be for the staff to put some consideration into the teams. In my experience it was just "whoever you picked" was your team. Although this strategy does exist in the professional world, often times managers are *very* cognizant of who they put on teams and why. Taking the time to learn the students' strengths a little more would allow the faculty to put more organization into these teams. This may bring out skills that students never knew they had.

UW Madison fostered a "lifelong learning" ethic that I still draw on today.

The only class that really covered contemporary issues was CBE 450 w/ Dr. Murphy.

Contemporary issues was never focused on in coursework in general.

I gave a lot of presentations & got a lot of feedback on them. Learned to write a lot of reports. I think it would be valuable to work on a team with MEs or EEs on a big project. That would be very life-like, as rarely do ChEs work in a vacuum in my organization.

No curriculum on universal engineering fundamentals.

I don't remember talking about ethics or broader societal issues very much.

Effective communication: This is essential in any scientific field. You could be the most brilliant engineer alive but if you could not communicate your ideas, your value would be diminished. Ethical responsibility: It's truly amazing that even the smallest good decision in the realm of ethics can have broad reaching benefits for a career. News of good ethics spreads like wildfire through most companies because it is in such high demand. On various occasions, the CHE program highlighted the need for professional ethics. Engineering solutions in a global and societal context: Keeping the environment in which a system is designed in mind while designing it is a commonly overlooked concept. Environmental impact was addressed in the project oriented courses. Good coverage on this topic. Lifelong learning: IF there is one thing you take away from the CBE program at UW-Madison it's this: You don't know everything. The ability to stay current with what you work with is integral in staying an effective problem solving force in any corporation.

We had a lot of communication "writing" experience that I found very valuable.

I think some of these are inherent skills that I already possessed.

The difficult problem sets forced us to work in teams and communicate our ideas effectively. I don't feel ethics was covered at all or any current issues. Only math and science were discussed.

Not so much discussion about professional/ethical responsibility. I don't think it's necessary either before you start your career.

ChE 424 in particular (also ChE 450) was an excellent environment for learning how to complete projects on a team. Same for communicate effectively - 424 and 450 required both excellent written and oral reports.

The transport laboratory and summer lab courses were integral in developing communication skills. I functioned on teams in pretty much every course I took at Madison, either formally (e.g. ChE 450 group) or through informal study groups. I feel I learned how to investigate a wide range of issues and that skill has helped me in my graduate studies.

I believe the department focused too much on learning what is in the books and not enough on using what is in the books to improve the world. And I never once heard any professor use the word ethics. Also we rarely spoke about recent journal publications commenting on the state of the art.

I think the professors concentrated on issue that were important to them and ignored other areas (i.e. MTBE/ethanol debate was never covered, but it was a huge deal while I was in school).

I think that we learned to communicate well because of the summer lab course primarily and the process design class. We could have had a little more exposure to global chemical engineering context. We mostly focused on current research in academia instead of looking at what kinds of research different companies are currently doing.

Learning about many topics was great in the various classes.

Didn't get into a clique back in chem. 110 so didn't work on homework sets in large groups, etc. While I don't like how much copying people did, I then didn't have the social structure to ask other people for help when I needed it.

Ratings of how useful these areas have been in the respondent's career:

| | Frequently used | Moderately used | Not used |
|---|---|---|---|
| Ability to function on teams | **83.6% (51)** | 16.4% (10) | 0.0% (0) |
| Ability to communicate effectively | **90.2% (55)** | 9.8% (6) | 0.0% (0) |
| Knowledge of contemporary issues | 39.3% (24) | **57.4% (35)** | 3.3% (2) |
| Understanding of professional and ethical responsibility | **49.2% (30)** | **49.2% (30)** | 1.6% (1) |
| Understanding of impact of engineering solutions in a global and societal context | 41.0% (25) | **54.1% (33)** | 4.9% (3) |
| Ability to engage in lifelong learning, and recognition of its necessity | **62.3% (38)** | 37.7% (23) | 0.0% (0) |

Comments on standouts included:

We use almost all of these skills daily here. All projects are team orientated, you always need to communicate your progress and understand your impact on your peers and customers.

Working with coworkers is required on a daily basis. Many societal issues facing the country and the world today is impacted by many industries (e.g. energy). This is a daily topic at work regarding the use of energy at the plant as well as marketing opportunities with new industries such as biofuel.

The ability to communicate and function on teams has allowed me in a brief time to realize a lot of success within my company. Executives are continuously impressed by the ability to speak, lead, and take control of meetings/teams that is so often missing from many others. The bottom line is you need to understand then to get others to see your vision if you want to become a key player in your company. This takes great interaction ability.

All of the above topics come in to play on a daily level except for the impact on a global and societal context. The most important is the ability to function on teams.

Ability to function and communicate in a group setting is important in almost any job, so that there are fewer misunderstandings, and overlaps or gaps in what is being done. Communication of failures and accomplishments to supervisors/management is important, since nothing should be coming as a surprise at deadline or yearly review time.

I am on a team of engineers, marketers, designers, etc. for every project I do. I write agendas, project schedules, resource allocations for most of them and it is important to be able to communicate technical concepts to non technical people in my job. The ethics thing is important for me too as I deal with a lot of vendors, both design vendors and outsourced manufacturers and learning what I can and cannot say to them has been a process.

90% of my job is teamwork and communication. I also work for an environmentally-conscious company.

Again, not a practicing engineer, but continuing education, teamwork, and communication are vital in the library setting.

See above. The reasons these are frequently used in my career stem back to my answers for why I considered myself prepared for them when I left college.

Absolutely necessary for a corporate work environment.

In corporate world, every work is a team work; therefore communication skill is very important.

I use each of these of a regular basis. In my current global environment, one could not survive without any of the values listed above.

I work on a program with collaborators in industry and at another university.

I collaborate with others in my graduate studies, write papers for scientific journals, and am engaging in lifelong learning by being a graduate student.

Teamwork and communication is everything. Nobody wants a genius hermit. Knowledge of contemporary issues is especially important in grad school, where I am trying to have a contemporary impact.

In grad school it is always necessary to keep learning as well as communicate to different segments of education levels.

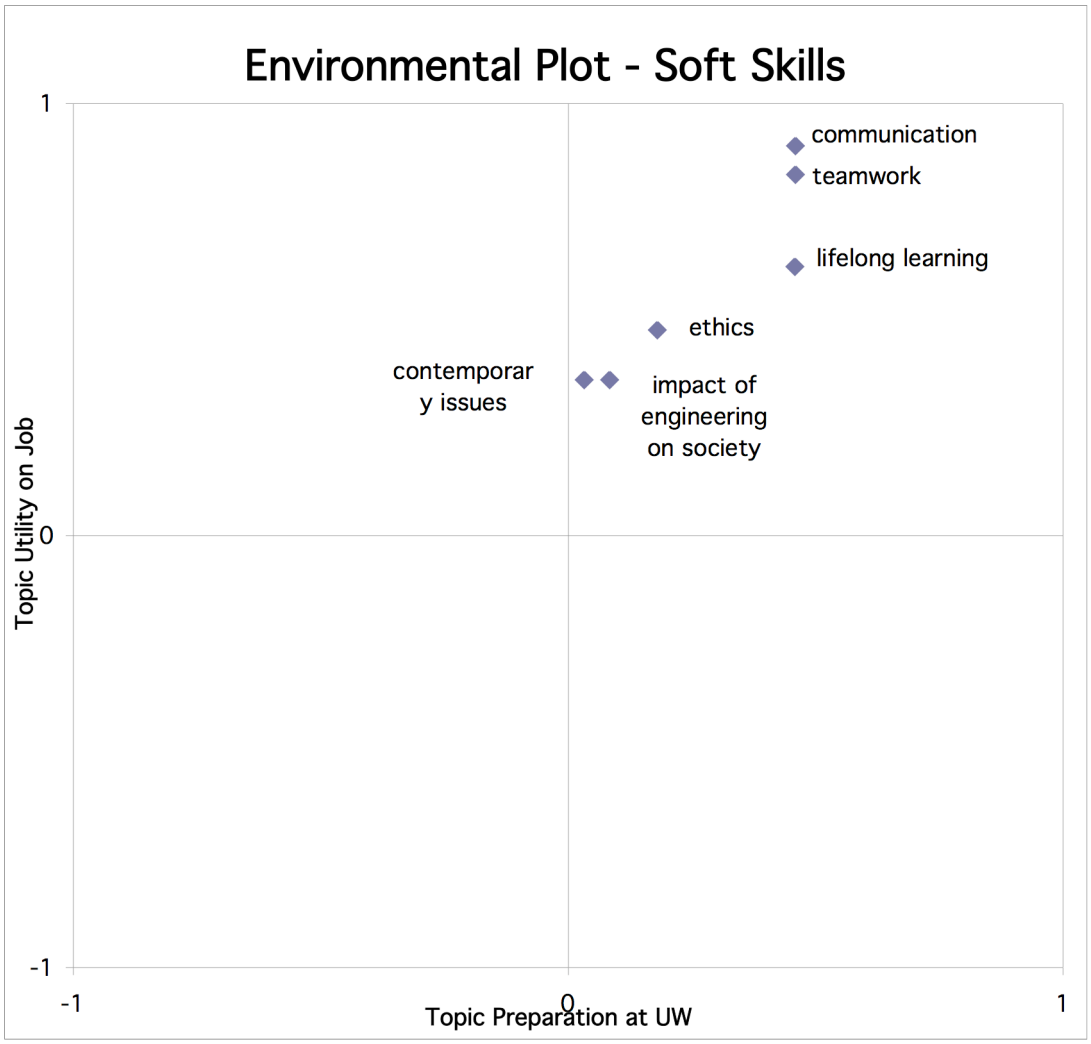
Particularly teamwork and communication skills are used constantly.

My career requires excellent communication skills - I am on the phone with customers nearly every day. Learning is also emphasized - there is always more to learn.

Supervisor does not encourage thinking outside the box.

UW-Madison CBE dept did a great job in preparing me in each of these areas. I frequently use all of these skills in my current field.

These ratings for how much preparation students receive at the university and how important these topics are in their jobs can be compared in an "environmental" plot. In such a plot, ideal results are that the most frequently used topics are those with the best preparation, and the topics not used are those with the least preparation. Thus, the ideal results would be spread from the upper right corner of the plot tailing down towards the lower left corner. Any topics above this ideal 45° line are more important than our preparation anticipates, and any topics far below this diagonal line may be receiving undue emphasis. With this scaling, the plot is seen to be:




From these scores, we see that the training intensity and level of need or use on the job again are strongly correlated. Unlike the comparison of the academic (curricular) topics above, this time the utility levels are consistently 0.2-0.5 units higher than the UW preparation levels. Teamwork and communication skills again finish as the top two, with Communication rated higher in this survey.

At the bottom of both training and utility lists we find "knowledge of contemporary issues" and "understanding impact of engineering solutions in a global and societal context." These topics are not perceived as receiving much emphasis, but they are still found to be needed at a substantially higher level (above "moderately used").

## Co-op or intern program

Among those answering this question, 32 of 64 of the alumni respondents participated in the organized COE co-op or internship program. This level of 50% is a decrease from the 69% of 2004 survey respondents who had co-op experience. Of current respondents, the overwhelming majority rated this as "very valuable", and none described it as "of limited value." Those who did have co-ops were asked a series of supplemental questions:

"How, if at all, could it have been improved?"

One internship I had ended up turning into a lab tech role - something that shouldn't happen.

Nothing. This was **the most influential part of my education for my career**. I had several experiences which put me in the right path for a good career.

My first internship, I finished my project in 2 weeks, so for a while all they had me do was file papers. Having more items to work on would have been good.

My co-op position was not taken seriously by the company I worked for. It was a new position and nobody knew how to make use of a co-op or plan little projects out. I was left with way, way, way too much time on my hands and did not have the experience to plan out projects for myself or find enough work to do.

Wish I would have been able to know that many companies only hire their co-ops. I worked for Dow Chemical. A good company to learn the trade from, but not one I wanted to work for.

I wanted to try several companies but did not have the opportunity.

I did not enjoy my co-op experience. This has more to do with the particular employer than the program itself.

I had a great time and learned a lot about what I wanted to do after graduation.

It did exactly what it was supposed to; help financially and expose me to the corporate world.

I think I could have handled more challenging, open-ended projects on my co-ops. I did an alternating term co-op and felt that only during one term did I have a challenging experience.

None. It was EXCELLENT!!!!

It would be helpful for the company mentor to be adequately prepared for the student's arrival. Creating a meaningful and challenging project is key. However, I'm not sure if CBE can do much in this aspect.

"In what ways, if any, did your co-op experience influence your choice of career?"

I knew that I was comfortable working within a research and development for a consumer products company, and that I did not have to work in a plant!

Absolutely!

It reinforced my interest in R&D activities.

I really liked the people at my second internship, and this influenced me to take a job with that company.

I was able to see where I excelled and where my weaknesses were. I also was able to see what type of people were in the workplace and what I had to do to set myself apart - knowing most of the time that I wasn't going to be one of the strongest engineers academically.

It helped me realize that I didn't want to work in a lab, or in an environment with many PhD's, I realized that I wanted to work for one of the companies I had an internship with, and it gave me an "in" for interviews.

I certainly did not want to work for that company!!! It also helped me decide that I did not want a 100% plant/manufacturing focused position.

I learned I did not want to be a run-plant engineer in a chemical factory or have a job where I was on-call on nights & weekends.

I co-opted at Kimberly Clark, another consumer products company. I realized that I liked consumer products, but preferred P&G as it has a broader range of products, many of which are more applicable to ChE (liquid products for example).

Helped me decide to take a job in R&D. But, after 2 years there, I decided to switch to Operations.

I realized I did not want to work in a plant setting.

I found most of the work of full-time employees to be boring, because it was just solving problems from an old process.

Opened my eyes to non-traditional chemical engineering opportunities in the workplace.

It showed me that I did not enjoy process engineering. It also showed me that I preferred working for either a smaller company or in a small group with some autonomy in a large company.

I wanted to stay in manufacturing but not in chemicals after the experience. I went in to food instead.

My co-op/internship experiences solidified my design to become a process engineer.

Stayed with this company!

Did not influence.

Yes. Completely.

I decided to not work for a company after my BS because of my co-op experience.

I realized I did not want to do chemical engineering for a career (or at least be very picky about the career I chose). I was offered several chemical engineering positions but turned them down because they were not the right fit.

It gave me an idea of what a manufacturing/process/production engineer did! It made me realize that all the work I was doing in school was a foundation for problem solving....not necessarily something I will use daily.

After completing my co-op in process engineering, I realized that this was not the career path for me. I think that this experience was just as important as participating in a the independent research in CBE.

My co-op was a good introduction into the engineering working world. It helped me decided what type of work I wished to go into. I did not enjoy the type of work that my co-op introduced; however it helped me distinguish what I preferred to do and not do.

I worked for the company I co-oped for so it very much influenced my career.

It showed me that I didn't want to work for a large company in a big city - my personal preference is to live in a smaller town, and be able to talk to the company owner on a daily basis. Through my co-op experience with the larger company, however, I had contact with my current employer - which contact led directly to my hiring in January of 2005.

"If you went to graduate school, in what ways, if any, was your graduate school experience influenced by your co-op experience?"

Yes.

Not influenced.

The co-op experience helped me understand that I would have to go to graduate school to be creative and original.

I realized I didn't need a masters in engineering to do the job. It would not provide any added benefit. A masters in management may help, but is also not needed.

Only influence was going to grad school.

My graduate school experience was completely influenced by my co-op experience. I decided that the career path I saw during my co-op experience was not for me and decided that I would like to continue my education in a specialized area within CBE/BioE. I may not have decided to go on to graduate school if I had not participated in a co-op.

## Overall Preparation for Career

Overall rating of how well the UW undergraduate education prepared the responding students for their careers:

| | |
|---|---|
| **very good** | **37** |
| good | 22 |
| fair | 1 |
| poor | 1 |

Comments supporting individual ratings:

I feel I was challenged and also forced into situations where I was not comfortable, but I was able to find a way to succeed. Those skills are what have enabled me to be very successful in my field.

I was employed as a chemist when I completed my BS. Although the position was different than my BS degree, I found that I learned a sufficiently large amount of chemistry to run a chemistry lab independently at the company. I also knew engineering that enabled me to transfer into product development.

It definitely provided the confidence.

I consider the education and the school reputation.

The rigor of the undergraduate program helped prepare me both for work and for law school. Everything seems easy by comparison after going through the UW ChE program.

I loved UW and the education I received. It is a very competitive program, despite having areas that could be improved. The education is also what each student makes of it, and I think I made the most of it.

I am happy with my education and thus far my career.

I think the UW did a great job preparing me for all the different things I would see/experience in the professional world. I feel that I was exposed to a number of different things that helped accomplish this goal. I am disappointed that I never really had the opportunity to stretch myself technically and see what I was capable of. Unfortunately, that is probably because of the competition I faced interviewing on campus. For good or bad, the path I am on probably best suits my skills.

I was very well prepared from a theoretical standpoint. I could have been more prepared from an application standpoint. Specifically, interpretation of statistical data would have been beneficial.

I enjoyed my years at UW-Madison, and think that I learned more a way of thinking than practical knowledge that has helped me more than textbooks can or have.

You are as prepared as you force yourself to be. UW-Madison provided good course work, etc, but the fact that it was a reputable institution forced me to try harder.

I thought I got a great education, but overall it was geared a little more toward theory & grad school and I ended up being a more practical & industrial/business guy.

You learn a lot from experience in the field. College can only prepare you with the knowledge; how you apply it you need to learn from experience.

My degree helped me get a job with a great company, where I have been challenged, achieved great results, made great relationships, & continue to be challenged.

I feel I am a step above students from other schools.

My undergraduate education provided me with a solid understanding of scientific and engineering principals and applications. I believe the requirements and rigor of the ChE degree gave me a robust set of skills to use in my current position, as well as the confidence to succeed.

The only thing lacking was a manufacturing focus.

I feel incredibly well prepared for this particular course of grad school and career. It's not engineering, though.

As I said before, college coursework can only get you to "good". Beyond that, you need experience. You could be a 4.0 student and still be blind-sided by the bureaucracy of large corporations or the various social skills needed to effectively navigate in the corporate environment. Having the experience in a corporate environment, in CBE topics or otherwise, will allow you to avoid complications. College alone will not allow you to experience that.

I felt well prepared all around.

The Wisconsin chemical engineering program is very highly regarded. The difficulty level is such that there is no way you could not be prepared for a career in corporate America. Day to day work is almost easier in many ways than the work completed during my undergraduate program.

It was a challenging experience that prepared me well for graduate school.

In terms of engineering knowledge/coursework - UW-Madison over prepared me. In terms of project management/teamwork, ChE 424 and 450 were both excellent representations of how I am expected to function in my current position.

My undergraduate education provided a very good base for my graduate studies.

I felt very prepared for my graduate courses, as I've previously discussed. I also felt my communication skills were better than many of my peers and I had learned how to work effectively in teams.

Thorough, challenging, dedicated professors, high caliber classmates.

I felt prepared in my ability to learn what was necessary, and then apply other skills such as problem solving, to be able to make an impact as soon as possible.

I am basically an over-educated brewer--which is exactly what I wanted to be.

Not enough hands on experience. Check out Texas A&M's program. Too much emphasis on research.

There are a couple reasons which I mentioned above that require me to give a "good" rating instead of a "very good" rating. Another aspect which was not really covered was the interactions that the students had with the professors. My particular experience with professors was very good. I got some good career advice as well as some useful personal advice. Some professors were better teachers than others but overall professors were very good.

Overall it was very challenging and provided the problem solving and learning skills to be successful in almost any area.

If I didn't go to Wisconsin and studied what I did, I don't know where I would be. My undergraduate degree allows me to explore the biotech field and IP world. I will be starting law school next fall, 2008.

My career stresses problem solving, and my undergraduate education taught this to me very well.

Wisconsin prepared me VERY well. It taught me to not give up when hitting a road block. It taught me to work in teams. It taught me pretty strong fundamentals that I use to base every decision I make.

I feel that the program allowed me to challenge myself and allowed for a student to take classes that wouldn't be offered at any other university (i.e. grad level classes).

My military experience and Co-op prepared me equally for my role in industry as my education did.

Besides gaining great training in all CBE courses, I also had the opportunity to participate in extracurricular research/work experiences. Both of these experiences greatly influenced my career path and allowed me to gain more confidence in my abilities. I also felt well-prepared to communicate with colleagues and to work both independently and as a team.

There was a good balance - some of the courses were geared toward preparation for industry (CBE 250, 424), while others were geared toward graduate study/research (CBE 440, 311). The balance seemed a bit heavy on the research/grad study side, but that's probably because I wasn't interested in those things.

The final free-format input requested any other input that might be helpful in improving our undergraduate curriculum, with the following responses:

Keep the admission standards high. It is a great program and I am very proud to have been a part of its history.

I feel the **ChE department at Madison is truly one of the best** based upon what I have seen from coworkers in many parts of the country and world. I do feel that more classes could be offered around operations that focus on equipment mechanics. This however is just my opinion based upon my career experiences.

It would be great to find a way to teach people that in industry or maybe academia, you can have a great idea, but you need to be able to get your project funded by a non-engineer, so you need to be able to communicate to a non engineer and be a salesman or your great idea will go to the bottom of the pile. :)

Alright, I know I've said it a million times, but **STATS**, SPC, and **DOE**.

Two semesters of thermodynamics was excessive. Also, I realize it's a function of the job market, but it would've been nice if co-ops and internships would've been more readily available.

A **more in-depth course on solving math problems** (differential equations) that are relevant to chemical engineering would be useful. I believe we were required to take a course over in the CAE, but it could have covered a lot more material.

I think **the professors often forget that students are people**, not just math and science machines. I was a senior in the fall of 2001. While the rest of the country was watching the events unfolding on 9/11 the chemical engineering students were at the library doing their homework. At times like those, being a human is more important than being an engineer. It would have been extraordinarily helpful if in at least once class we would have had the opportunity to discuss what happened, even if it had been for just 10 minutes. Instead, in every class, it was business as usual.

I think **the philosophies of 424 and 450 should extend into earlier classes** - more **team projects**, more demanding deadlines, more requirements of **holistic knowledge** rather than focused knowledge. **Being able to work a spreadsheet (Excel) is critically important** for doing any sort of good data analysis. I knew a lot on my own; a lot of my peers didn't. I would suggest that most courses (further) require good data manipulation in Excel, maybe even offer a 1 or 2 credit course in how to use a computer effectively. A professional development class should be required. I took EPD 101 and it was good, but as I said in an earlier comment my employer sees current grads as lacking professionalism. My **co-op did help but not everybody takes a co-op**. Within current classes - good reports and strict deadlines on projects should be stressed more.

Advising could definitely be improved. I also think the switch to the biology course requirement was foolish, as there are many topics besides biology that are useful to investigate.

I feel like the department is focusing too much on traditional ways of teaching chemical engineering. I feel that the two thermo courses could be condensed into one, same with the transfer operations courses. Those two sets of courses are only used by a subset of individuals, so depth is not a necessity. Get some more diversity, among both the students and the faculty. Have the students present in more forums.

Keep it similar, but don't totally kill the kids with homework.

The department should **have a computer course just for the specific issues that chemical engineers would have**. The software that can be encountered in industry and maybe some coding and the electronic basics could be covered as well. The ECE class is useless and should be replaced by some other class...maybe an elective in the biological sciences. I personally wish that I had had **more exposure to materials science**. My research is more materials science than chemical engineering but in many ways the fields are similar except for terminology. It would have been helpful to have a better class than the 540 class that I took. It was too limited to phase diagrams instead of properties of materials and a lab in that class would have been very good as well.

1. Connecting the program more to the current job prospects for graduates. This is why a little more finance, project management, and product development coursework would be helpful. It really wouldn't take much. That IE 313 (something like that...maybe 413) was a good start and maybe one more finance course. 2. Make sure professors are doing a good job actually teaching students rather than writing equations on the board. I had Kathleen Pittman for about 4 courses of my ChE curriculum and she was a very poor teacher. She did not provide a sense that she understood the subject beyond the text in the book and did not extend the subject to practical real-world examples. I would go on but I don't believe she is on staff any longer, which is for the best. If a professor does not want to teach, or does not do a good job teaching they should not be given that responsibility. A number of **professors did a very good job**; most professors now that I think about it (Yin, Root, Swaney, Hill, Palecek, Cortright were all very good). I am just jaded by having Pittman for so many classes. There should be some kind of audit program to pick up on poor instructors. 3. Connect statistics to class-work and lab-work. Stats is actually a class that comes in very handy. However in a ChE rich curriculum it gets lost as an easy side-class. Enforcing the key statistics topics (t-test, P-values) in ChE classes would be beneficial.

An emphasis on undergraduates exploring undergraduate research and exploring graduate level classes should be included in the curriculum or discussed with advisors.

**Internships and Co-ops** should be more strongly encouraged, they are the best learning experiences.

As important as teamwork and such is to the engineering profession as a whole, I wish there would be more independent work to try to reduce the amount of copying on homework assignments. But since many of those people whom I know did not approach schoolwork ethically at all (copying homework, cheating on exams, etc) are successfully employed, the problem must be with me.

Add some structure to group work in the first couple class to **encourage team work**.

I think the CBE program at UW-Madison is outstanding. I would love to see more courses/labs **focused on upcoming fields (biomaterials, sustainable energy, innovative polymers**, etc.).

It might be useful to have two different "paths" for students - one for industry preparation, and one for academic preparation. That way, students who are not interested in research can learn more about equipment and processes in specific applications.

Several recurring themes are seen:

- More statistics, more applicable statistics
- Better preparation for applying computer tools to ChE problems
- Emphasize internships and co-ops
- More awareness of business issues
- More coursework on modern applications
- Continue updating laboratory experiments
- Opportunities for teamwork and oral communications