Graduate School in Chemical Engineering
Why get a ChemE MS degree?

- Strengthen education – opportunity to solidify core ChemE topics and enhance writing skills
- Increased credentials for a more design-oriented job
- Use as stepping stone to PhD
- Qualify for specific companies (e.g., Intel)
- Enhance qualifications for process engineering and other BS-level job openings?
Why get a ChemE PhD?

- Gain fundamental understanding necessary to solve cutting-edge engineering problems
- Learn to perform independent research
- Qualify for research-oriented industrial positions and academic positions
- Increase potential for managerial positions
- Establish credibility for consulting and entrepreneurial activities

Dr. Neville, I Am Legend

Doc, Back to the Future
Solve the Challenges Facing the World

- > 9 billion people (2050)
- Energy
- Clean water
- Infrastructure
- Transportation
- Food production
- Global warming
- Strategic Minerals
- Healthcare
- Terrorism
Value of Education: Education Pays

Earnings and unemployment rates by educational attainment

Unemployment rate in 2014 (%)

- Doctoral degree: 2.1%
- Professional degree: 1.9%
- Master's degree: 2.8%
- Bachelor's degree: 3.5%
- Associate's degree: 4.5%
- Some college, no degree: 6.0%
- High school diploma: 6.0%
- Less than a high school diploma: 9.0%

All workers: 5%

Median weekly earnings in 2014 ($)

- Doctoral degree: $1,591
- Professional degree: $1,639
- Master's degree: $1,326
- Bachelor's degree: $1,101
- Associate's degree: $792
- Some college, no degree: $741
- High school diploma: $668
- Less than a high school diploma: $488

All workers: $839

Note: Data are for persons age 25 and over. Earnings are for full-time wage and salary workers.
2015 Chemical Engineering Salaries

![Bar graph showing median salaries by work experience and degree level.](image)

**Figure 6.** Chemical engineers with PhDs earned more than those with lower-level degrees at most work-experience levels.

Source: June 2015 Chemical Engineering Progress, AIChE Publication
The bottom line

- There is a salary advantage to a higher degree, but the difference is probably not sufficient to justify graduate school (there are easier ways to maximize income).
- The career opportunities for engineers with advanced degrees are excellent.
- Increased earning power is probably not the best justification for a graduate degree.
Is Graduate School Right for Me?

- Lifelong career of learning and challenge
- Career extends beyond corporate goals
- Opportunities for major program and project leadership
- Increased opportunity to address the critical problems facing the world
- Opportunities to serve
Graduate School at BYU

Graduate School Information Dinner
Some Facts

• Program Size
  – 15 full time faculty members, around 3 students per faculty
  – 39 PhD students
  – 8 MS students

• Entrance Requirements
  – 3.0 GPA in upper division ChE classes and 3.3 overall GPA
  – GRE general exam (must do well on Quantitative section)
  – 3 letters of recommendation—research experience is a plus
  – Fall application deadline: Jan. 31

• Financial Aid
  – Tuition
    • Ph.D.—Paid by department and advisor (research grants)
    • M.S.—Sometimes tuition support
  – Student Stipend (does not include tuition)
    • $23,500/yr for PhD, $22,500/yr for MS
  – Many competitive fellowships available
    • NSF, DOD, DOE, EPA, NASA, ExxonMobil, etc.
Some Facts

• Select and work with an advisor

• M.S. Requirements
  – 30 credit hours = 23 lecture hours + 7 seminar/research
    • 8 regular classes (4 required)
  – TA for 1 semester (10 hrs/wk)
  – Publish 1 scientific paper,
    • Contributes to thesis
  – Target completion = 2 years

• Ph.D. Requirements
  – 54 credit hours = 34 lecture hours + 20 seminar/research
    • 12 classes (4 required)
  – TA for 2 semesters (10 hrs/wk)
  – Publish 3 scientific papers
    • Contributes to dissertation
  – Target completion = 4-5 years
Biochemical Eng. / Biotechnology

- Kinetic modeling of bioprocesses including fermentation (Lewis)
- Production of fuel and other products from biomass (Lewis)
- Rewriting the Genetic Code with Cell-free Synthetic Biotechnology (Bundy)
- Inventing new Cancer Therapeutics, Vaccines, Personalized Medicines, Biocatalysts (Bundy)
- Simulations of biomolecular systems including biosensors, DNA/protein micro-arrays (Knotts)
Biomedical/Tissue Engineering

Tissue Engineering

Growing Hearts in a Bioreactor

Human Ear on Back of Mouse

Theranostic Drug & Gene Delivery

Bacteria-Blood for Sepsis Diagnosis
• Preparation, characterization, and testing of sophisticated nanomaterials
• Detailed kinetic measurements and kinetic modeling of catalytic reactions
• Reactor design and optimization
• Current research includes Fischer-Tropsch synthesis and hydroisomerization catalysts
• Biocatalysis optimization/immobilization
85% of world’s energy comes from fossil fuels!

- Clean coal, oil shale, and biomass energy conversion
- Exa-scale simulation advanced industrial-scale coal-fired boiler
- Advanced turbulent reacting flow simulation approaches: ODT/DNS/LES
- Advanced diagnostics for combustion and gasification
- Chemistry and reaction rates of live shrubs in wildland fires
- Biomass combustion/gasification and co-firing

Wildland fires

ODT and DNS

Oil shale

Tom Fletcher

David Lignell

Larry Baxter

Andrew Fry
Electrochemical Systems

- 3D modeling for the development of next generation devices and the mitigation of technology limiting factors
- Fabrication and optimization of high-performance electrodes and batteries
- Advanced diagnostic techniques for electrochemical devices
- Nano-scale device fabrication with use of self-assembling biological templates
Process Control and Optimization

BYU PRISM
MODEL OPTIMIZE CONTROL

• Energy Systems
• Upstream Oil & Gas
  – Drilling Automation
  – Reservoir Optimization
• Optimization Technology
• Graduate Internships

John Hedengren
Sustainable Energy

- Carbon capture process capable of CO₂ capture at 2-3 ¢/kwh – less than half of other systems
- Large, efficient, rapidly responding energy storage processes
- Biomass thermal and biological conversion to useful energy
- Advanced diagnostics for combustion and gasification
- Energy for developing countries

Larry Baxter
Randy Lewis
John Harb

Biofuel Cell

Syngas conversion to biofuels and chemicals

Biomass cookstove development

Cryogenic Carbon Capture™ Hardware
Nuclear Power / Reactor Safety

- Design of advanced nuclear reactor systems
- Integration of nuclear power with other energy systems
- Development of safer and cheaper nuclear fuels
- Development of passive safety systems to cool down nuclear core without operator action or electricity
- Hybrid Nuclear-Chemical Systems

New Nuclear Reactors (I²S-LWR)

New fuels: annular Fuel rod (20% higher power)

New core designs $U_3Si_2$, $ThO_2$, etc.

Matthew Memmott

Safety Analysis
Thermophysical Properties

- Thermophysical property measurement and estimation
- Development and management of DIPPR database of properties of industrially important chemicals
- Molecular simulations and quantum chemical calculations

Vincent Wilding

Tommy Knotts
How To Prepare for Graduate School

• GRE exam
  – Study: especially the verbal and analytical sections
  – Can take online, Take early

• Application
  – January application deadlines (vary by university)
  – Letters of recommendation, written statements, transcripts.

• Can take grad classes as an undergrad
  – prepare for grad school somewhere else,
  – early start on research

• Integrated Masters Program
Prestigious National Graduate Fellowships

**GRADUATE RESEARCH FELLOWSHIPS**

Winners typically go to top U.S. graduate schools
Worth $30,000–60,000 per year

Aim for 3.8 GPA or higher
Participate in undergraduate research
Apply in the fall of your senior year
Generally reserved for U.S. citizens or U.S. persons
BYU’s engineering program has a good track record of successful candidates

Oct. 27  
National Science Foundation  
Nov. 5  
NASA

Dec. 18  
Department of Defense  
Dec. 1  
SMART

Jan. 19  
Department of Energy  
Apr. or May  
STAR

CSGF  
STAR
Why BYU for Graduate School?
Conclusions

• Graduate work is rewarding and opens doors to an exciting career
• Great time to be an engineer with opportunities to address technical issues with global impact
• BYU Chemical Engineering is a great choice!