Success in Graduate School

Graduate Recruiting Event

October 11, 2012

Questions

- Why are you studying to be a Chemical Engineer?
- What inspired you, and is inspiring to you?
- Where do you see yourself in 3 years? In 5 years? In 25 years?

You must get all of the education that you possibly can. Life has become so complex and competitive. You cannot assume that you have entitlements due you. You will be expected to put forth great effort and to use your best talents to make your way to the most wonderful future of which you are capable. Sacrifice a car; sacrifice anything that is needed to be sacrificed to qualify yourselves to do the work of the world. That world will in large measure pay you what it thinks you are worth, and your worth will increase as you gain education and proficiency in your chosen field. (Gordon B. Hinckley

We are all faced with a series of great opportunities brilliantly disguised as impossible situations (Charles Swindoll)

Opportunity is missed by most people because it is dressed in overalls and looks like work (Thomas Edison)

I was seldom able to see an opportunity until it had ceased to be one.
(Mark Twain)

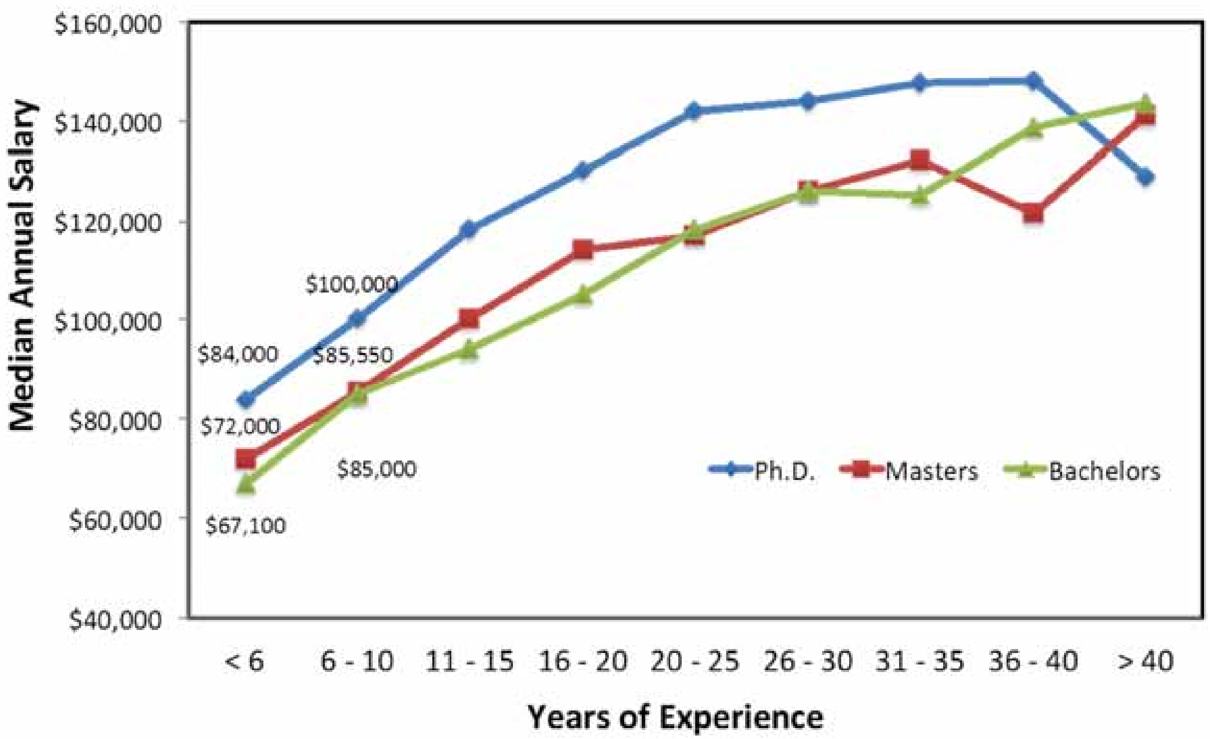
Why go to graduate school? (MS)

- Strengthen education
- Important degree for some companies
- Prepare for a “research” job
- “Stepping stone” to Ph.D.
- Asset for first job



Why go to graduate school? (Ph.D.)

- Necessary for most research positions
- Learn how to perform independent research
- Required for academic positions
- Increased earning potential



Source: Aug 2011 Chemical Engineering Progress, AIChE Publication

Some Facts

- Program Size
  - 15 full time faculty members, around 3 students per faculty
  - 35 PhD students
  - 12 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: Feb. 15 (apply in January, or earlier)
- Financial Aid
  - Tuition
    - Ph.D.—Department and advisor pay most tuition costs
    - M.S.—Pay own tuition
  - Stipend for students making good progress
    - $23,000/yr for PhD, $22,000/yr for MS
  - Many competitive fellowships available
    - NSF, DOD, DOE, EPA, NASA, Hertz, ExxonMobil, etc.

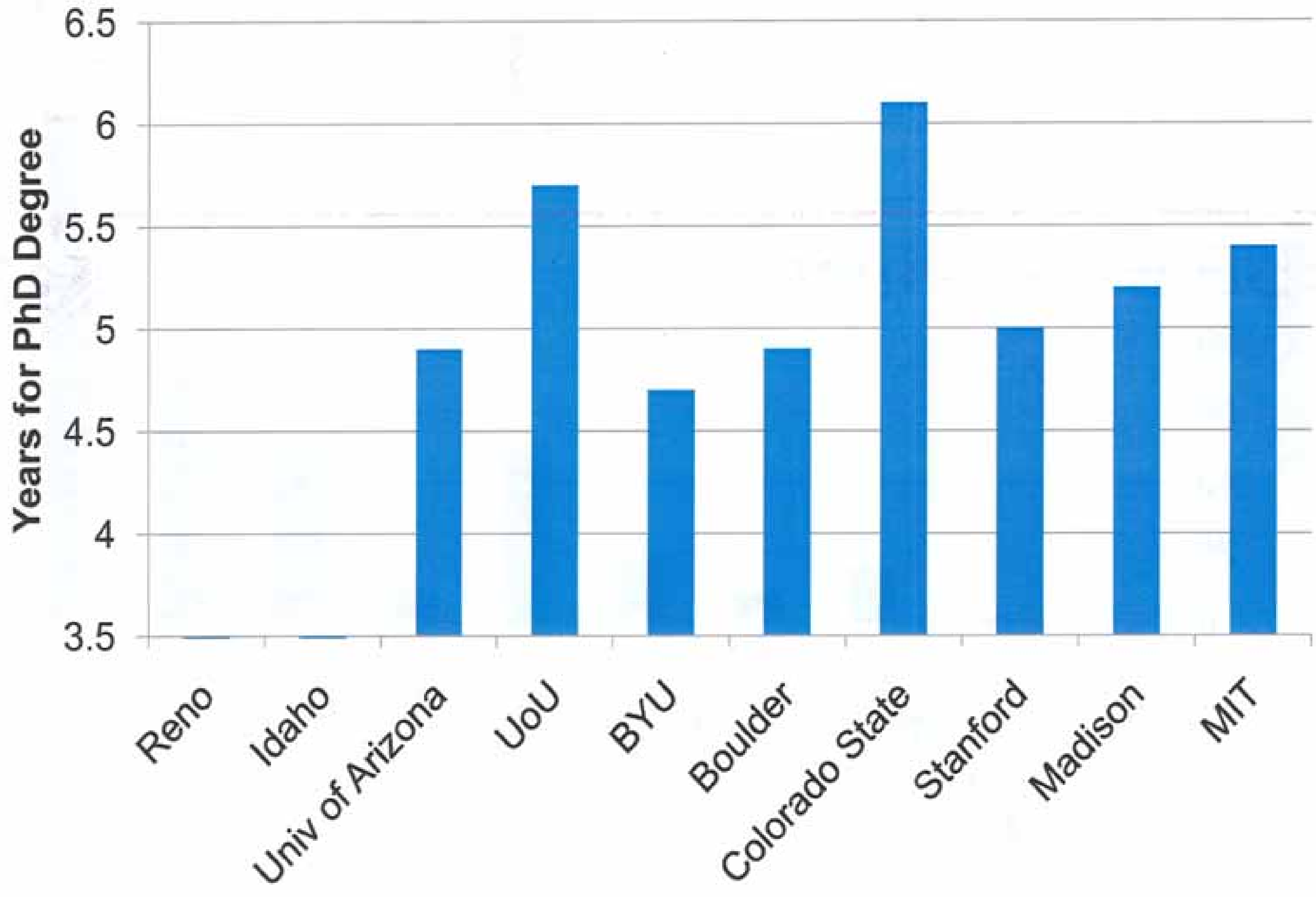
Some Facts

- 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 years

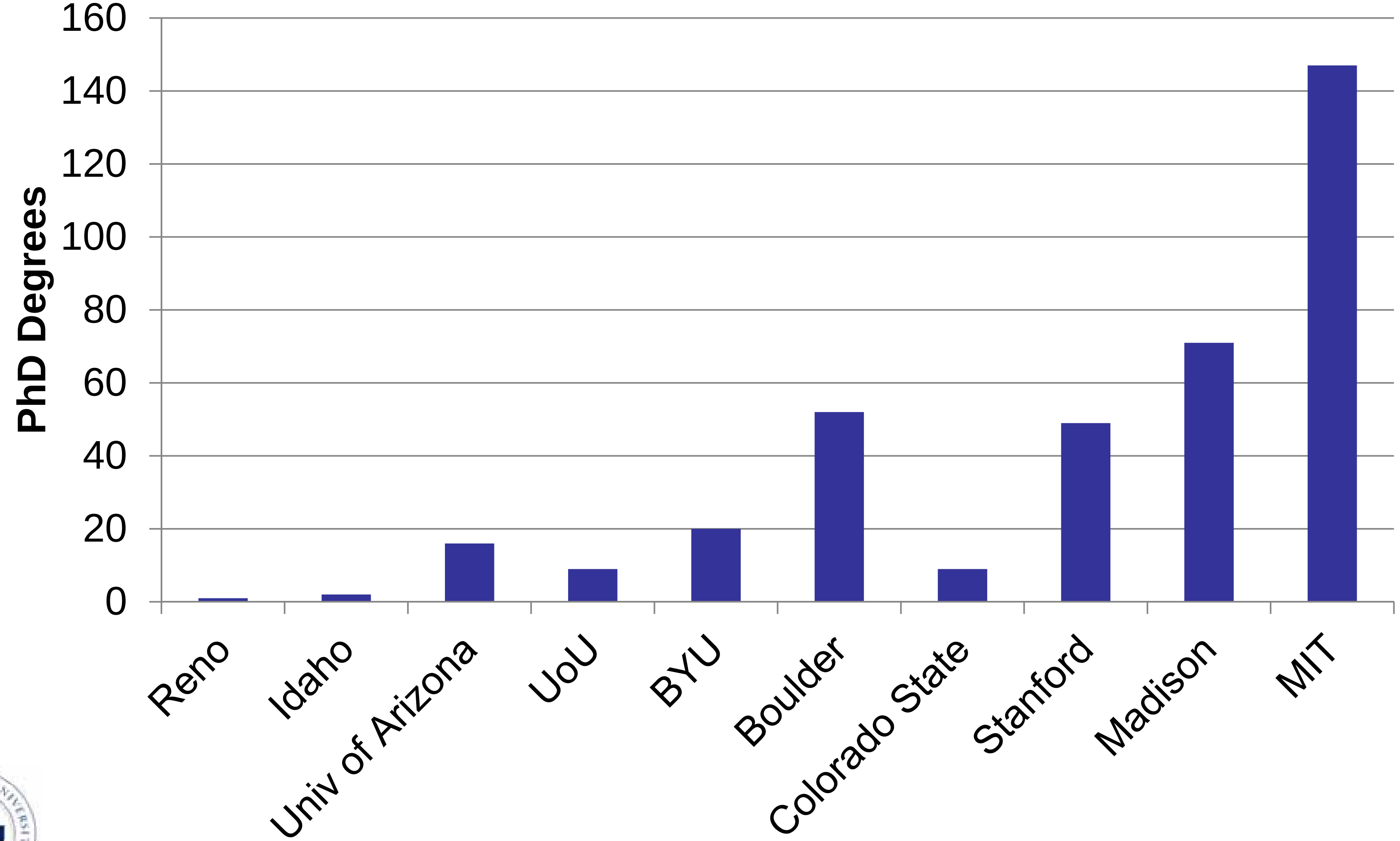
Why BYU ChemE?

- Active Research Programs
  - DIPPR
  - Combustion and energy
  - Biomedical engineering
  - Catalysis
  - Biochemical and molecular simulation
  - Electrochemical
  - ~$250,000/faculty per year for research
- Nearly all students in the program are funded
- Faculty are devoted to the students

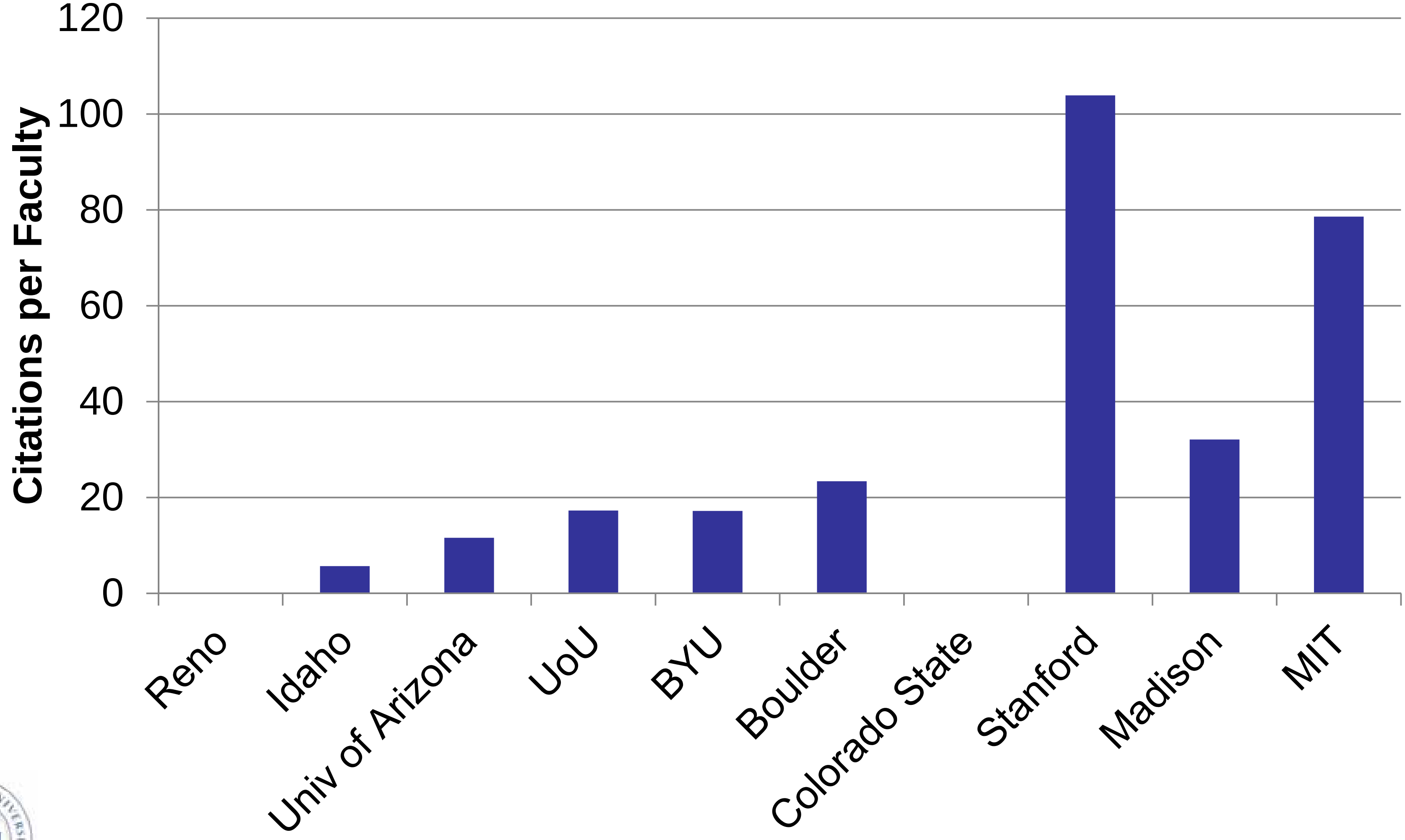
Consider the Time Commitment



PhD Degrees (2000-2004)

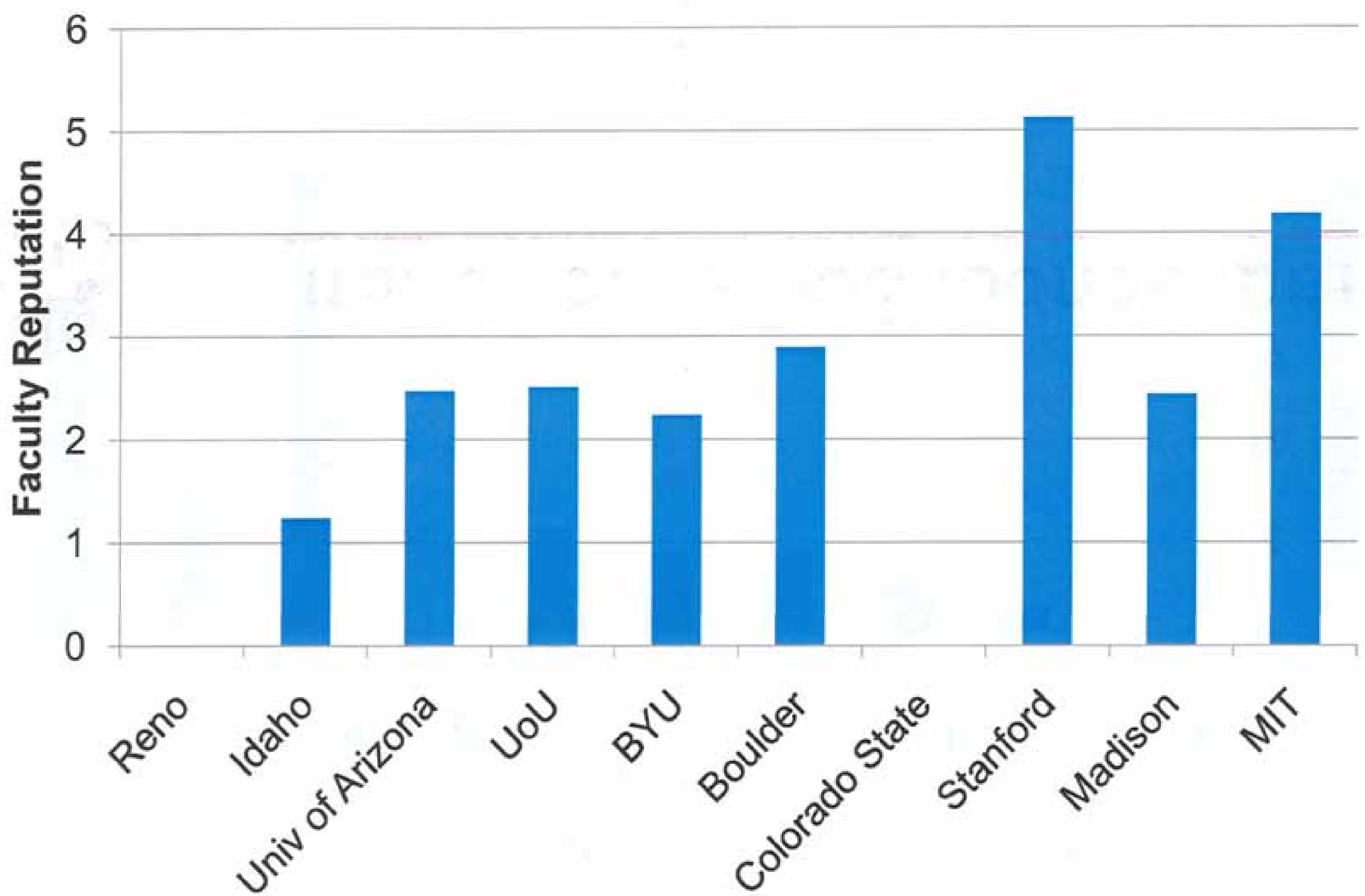


Citations

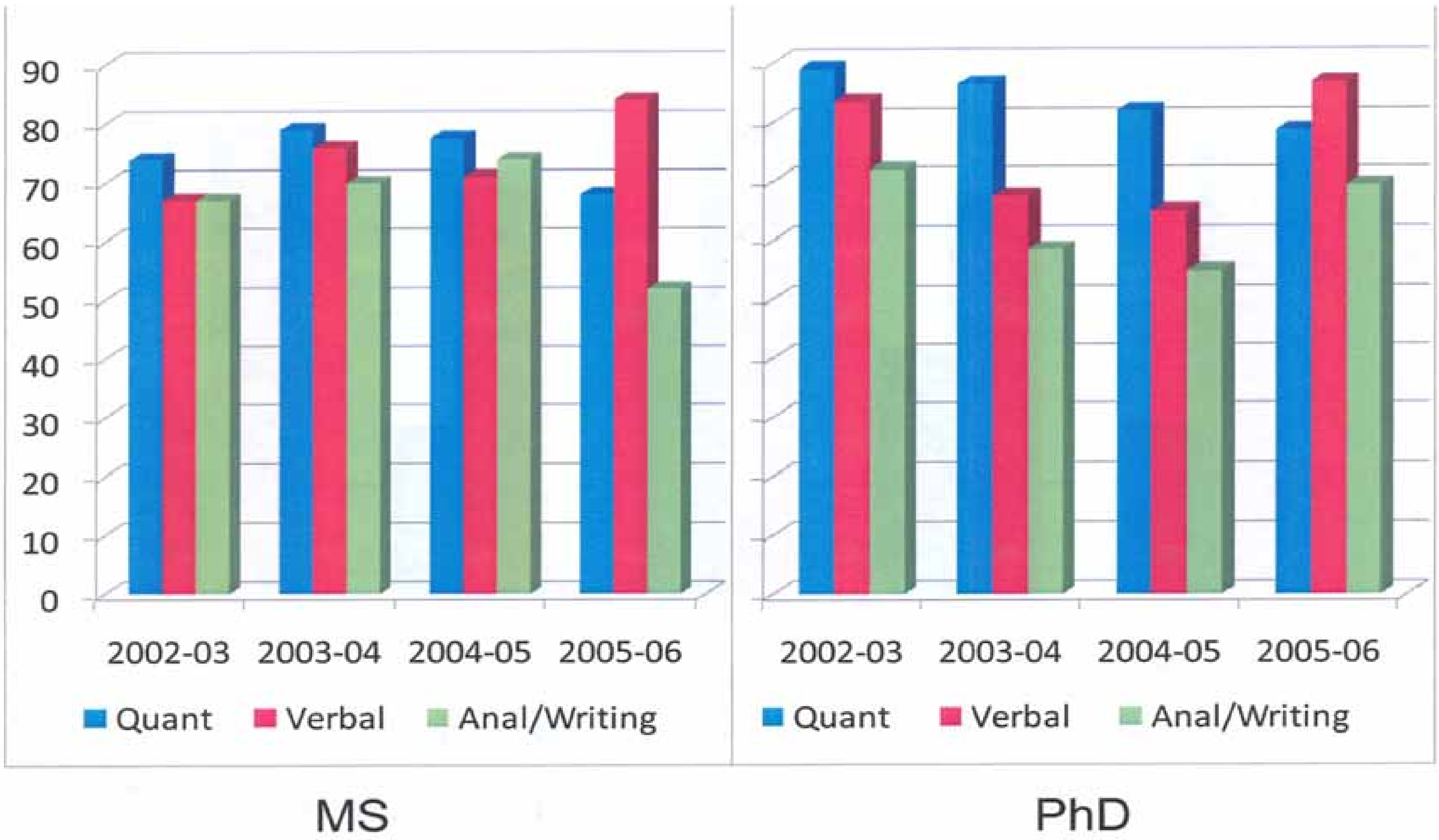


Citations per Faculty
120
100
80
60
40
20
0
Reno
Idaho
Univ of Arizona
UoU
BYU
Boulder
Colorado State
Stanford
Madison
MIT

Quality Research (Citations/Paper)



Quality Graduate Students



GRE Percentiles

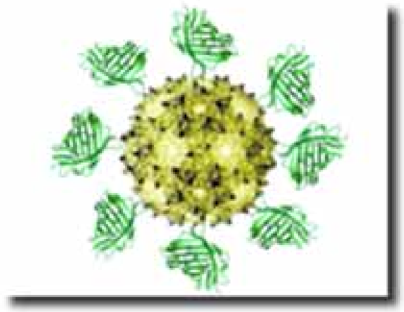
How To Prepare for Graduate School?

- 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

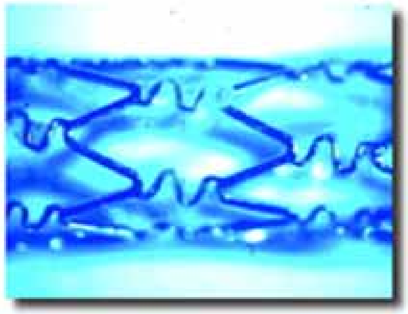
Conclusions

- Graduate work is rewarding and provides many opportunities
- Many important and interesting research areas in Chemical Engineering
- BYU Chemical Engineering is a great choice!

BYU Research Areas



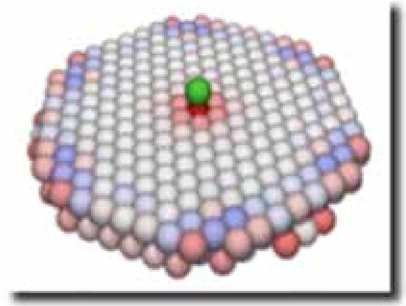
Biochemical Engineering



Biomedical Engineering

Catalysis

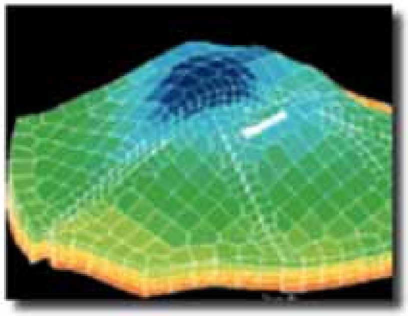
Combustion



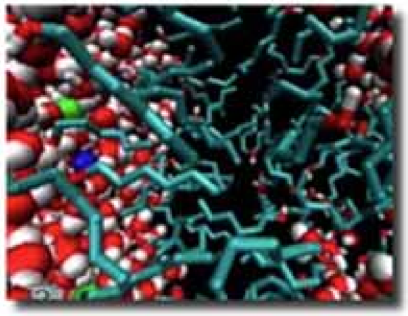
Electrochemical Systems

Molecular Simulations

Sustainable Energy



The International Reservoir Simulation Research Institute



Thermophysical Properties

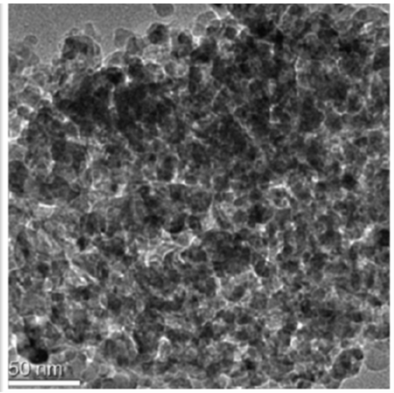
Catalysis and Kinetics

Bill Hecker

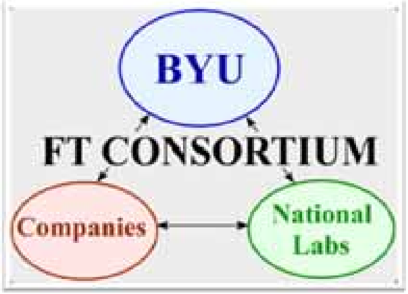
Morris Argyle

- Preparation, characterization, and testing of sophisticated nanomaterials
- Kinetic and modeling studies of catalytic reactions
- Reactor design
- Applications include Fischer-Tropsch synthesis and water-gas shift reaction

Preparation of FT Cobalt Catalyst



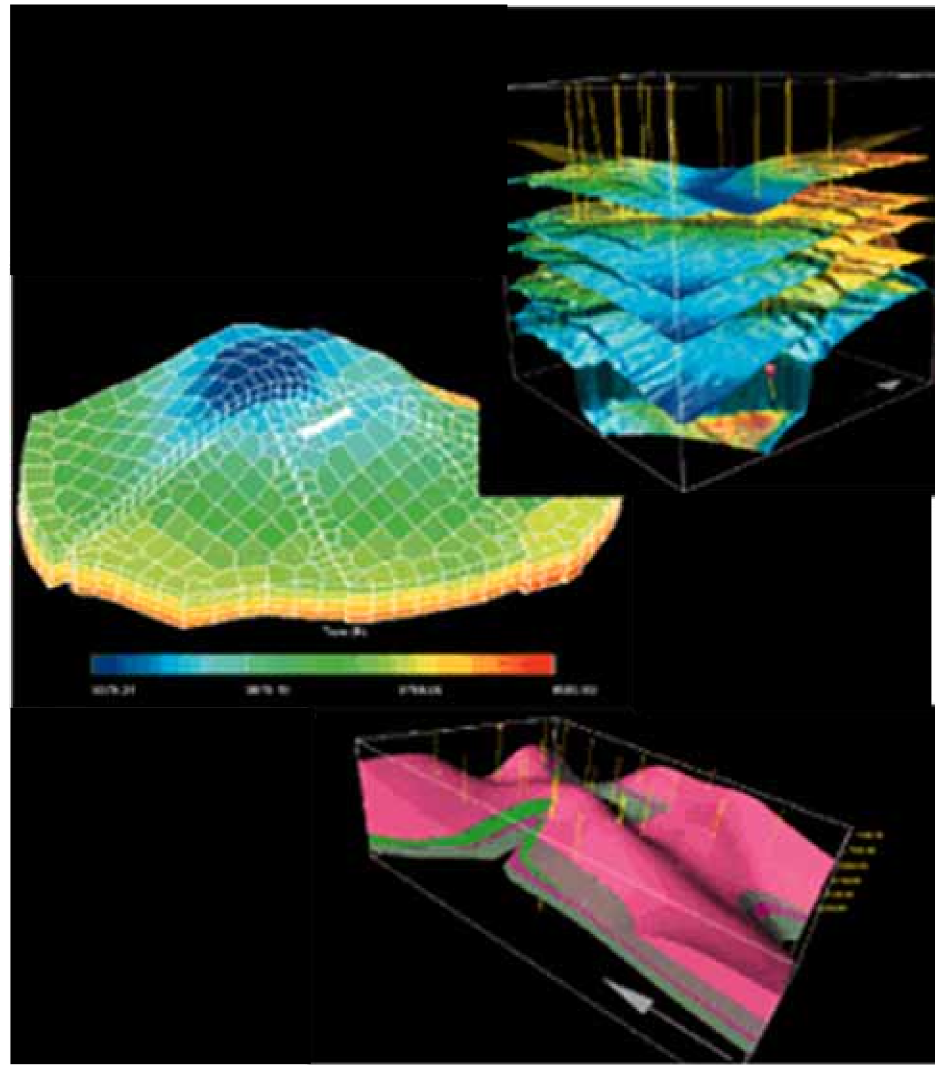
TEM image of FT Fe Catalyst



Fixed-Bed Reactor

Reservoir Simulation Research

Hugh Hales

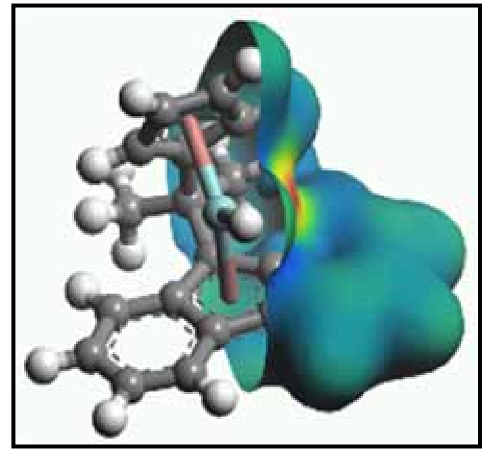


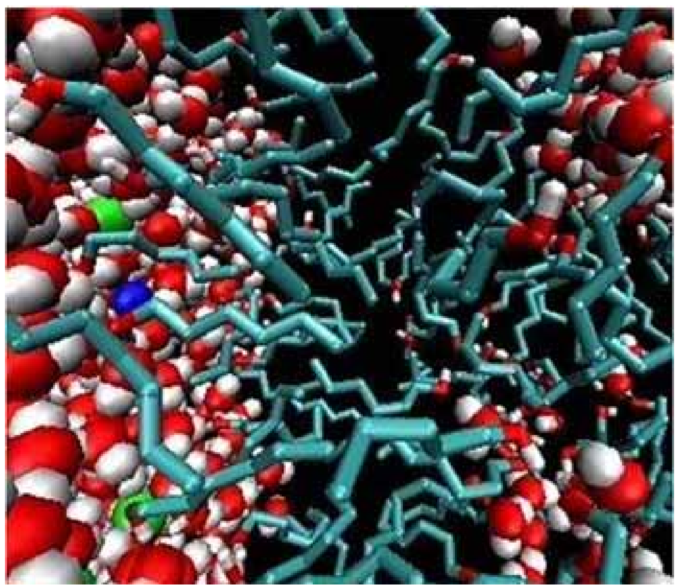
- Reservoir simulation is used to optimize the production of oil and gas.
- To adequately describe reservoir heterogeneities, immense models are required. (10^6 - 10^9 equations).
- Research at BYU involves:
  - Faster methods for linear algebra.
  - Faster and more accurate solutions of partial differential equations.
  - Treatment of complex well and reservoir geometries

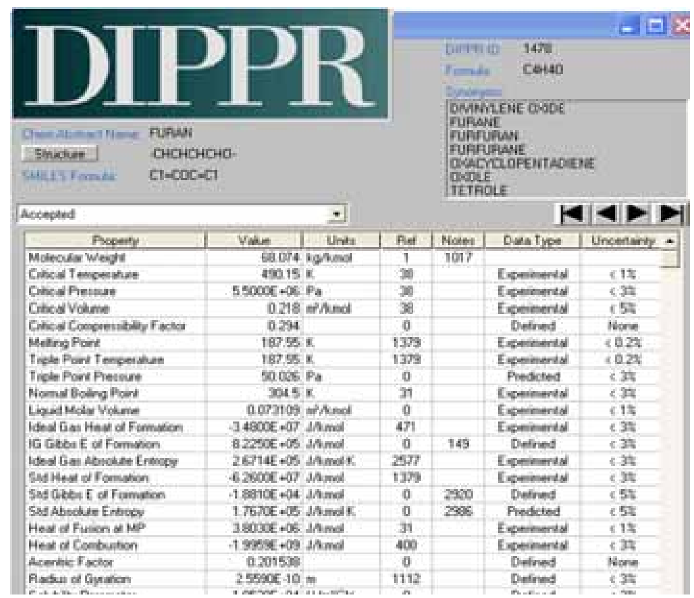
Thermophysical Properties

Vince Wilding

- Molecular simulations and quantum chemical calculations
- Thermophysical properties estimation and measurement
- Manage DIPPR database







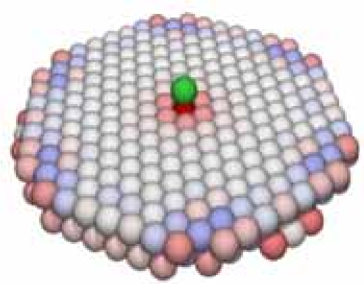
Property	Value	Units	Ref	Notes	Data Type	Uncertainty
Molecular Weight	68.074	kg/kmol	1	1017		
Critical Temperature	490.15	K	38		Experimental	< 1%
Critical Pressure	5.5000E+06	Pa	38		Experimental	< 3%
Critical Volume	0.218	m³/kmol	38		Experimental	< 5%
Critical Compressibility Factor	0.294		0		Defined	None
Melting Point	187.55	K	1379		Experimental	< 0.2%
Triple Point Temperature	187.55	K	1379		Experimental	< 0.2%
Triple Point Pressure	50.026	Pa	0		Predicted	< 3%
Normal Boiling Point	304.5	K	31		Experimental	< 3%
Liquid Molar Volume	0.073109	m³/kmol	0		Experimental	< 1%
Ideal Gas Heat of Formation	-3.4800E+07	J/kmol	471		Experimental	< 3%
IG Gibbs E of Formation	8.2250E+05	J/kmol	0	149	Defined	< 3%
Ideal Gas Absolute Entropy	2.6714E+05	J/kmol K	2577		Experimental	< 3%
Std Heat of Formation	-6.2600E+07	J/kmol	1379		Experimental	< 3%
Std Gibbs E of Formation	-1.8810E+04	J/kmol	0	2920	Defined	< 5%
Std Absolute Entropy	1.7670E+05	J/kmol K	0	2986	Predicted	< 5%
Heat of Fusion at MP	3.8030E+06	J/kmol	31		Experimental	< 1%
Heat of Combustion	-1.9959E+09	J/kmol	400		Experimental	< 3%
Acentric Factor	0.201538		0		Defined	None
Radius of Gyration	2.5590E-10	m	1112		Defined	< 3%

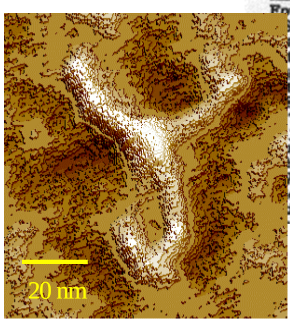
Electrochemical Systems

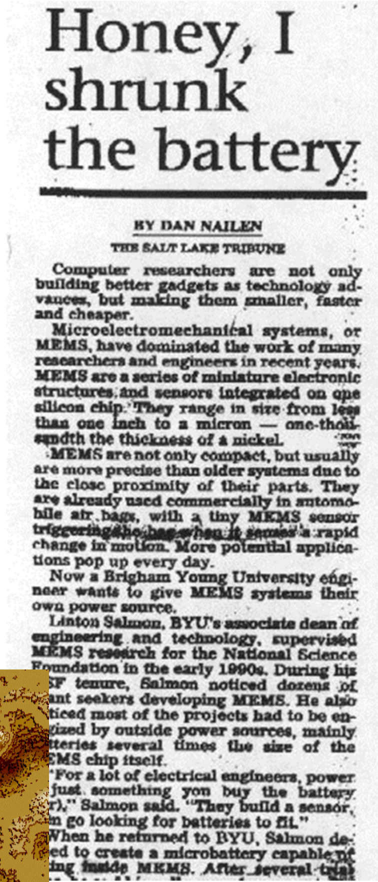
Dean Wheeler

John Harb

- Fabrication and modeling of high-performance batteries
- Development of sugar-powered fuel cell
- Micro- and nano-scale electrochemical devices







Honey, I shrunk the battery

BY DAN NAILEN
THE SALT LAKE TRIBUNE

Computer researchers are not only building better gadgets as technology advances, but making them smaller, faster and cheaper.

Microelectromechanical systems, or MEMS, have dominated the work of many researchers and engineers in recent years. MEMS are a series of miniature electronic structures and sensors integrated on one silicon chip. They range in size from less than one inch to a micron — one-thousandth the thickness of a nickel.

MEMS are not only compact, but usually are more precise than older systems due to the close proximity of their parts. They are already used commercially in automobile air bags, with a tiny MEMS sensor triggering the bag when it senses a rapid change in motion. More potential applications pop up every day.

Now a Brigham Young University engineer wants to give MEMS systems their own power source.

Linton Salmon, BYU's associate dean of engineering and technology, supervised MEMS research for the National Science Foundation in the early 1990s. During his SF tenure, Salmon noticed dozens of ant seekers developing MEMS. He also ticed most of the projects had to be engized by outside power sources, mainly tteries several times the size of the EMS chip itself.

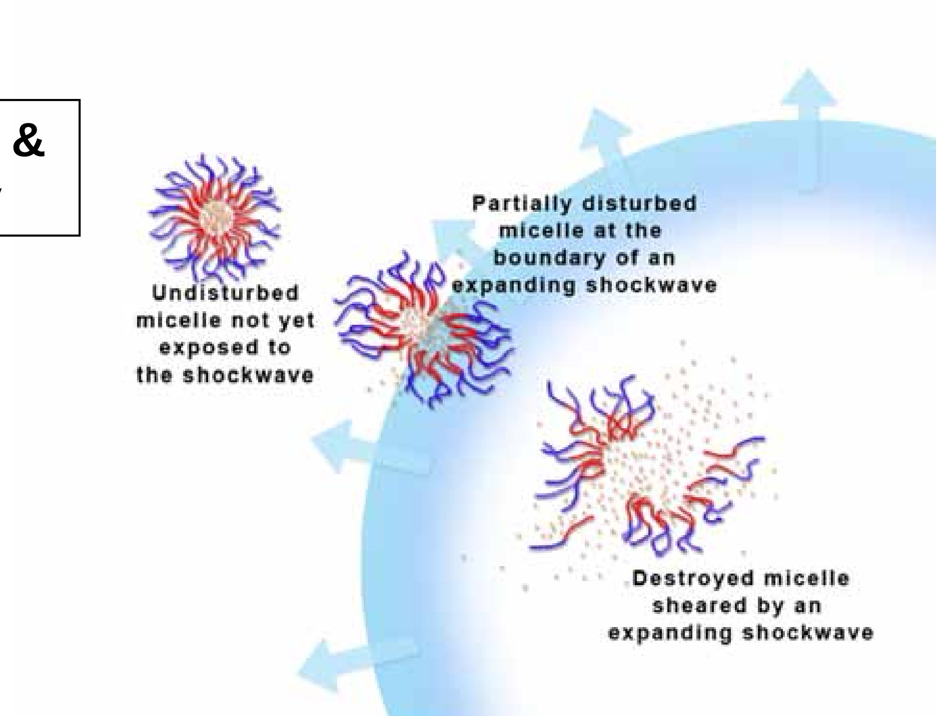
"For a lot of electrical engineers, power just something you buy the battery r)," Salmon said. "They build a sensor, n go looking for batteries to fit."

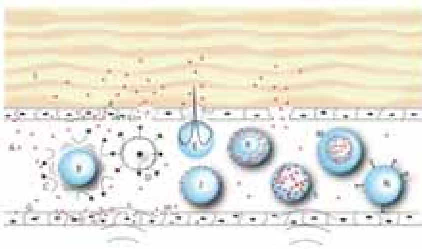
When he returned to BYU, Salmon deed to create a microbattery capable of ing inside MEMS. After several trial

Biomedical Engineering

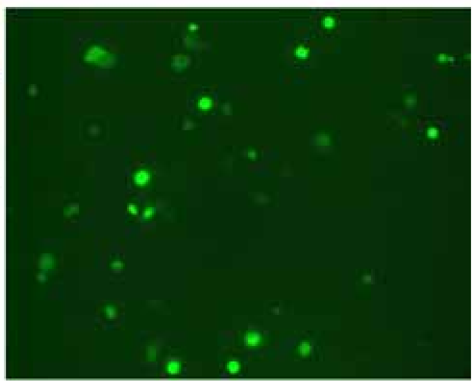
Bill Pitt

Ultrasonic Drug & Gene Delivery





Ultrasonic Gene Delivery

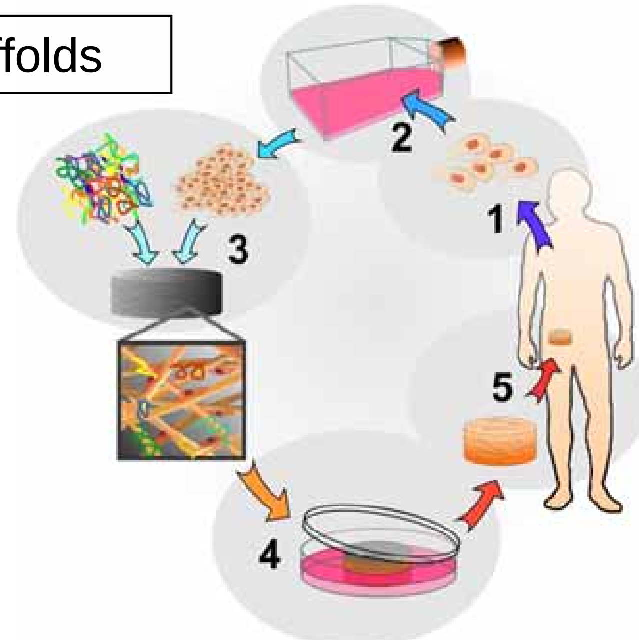


Chemotherapy

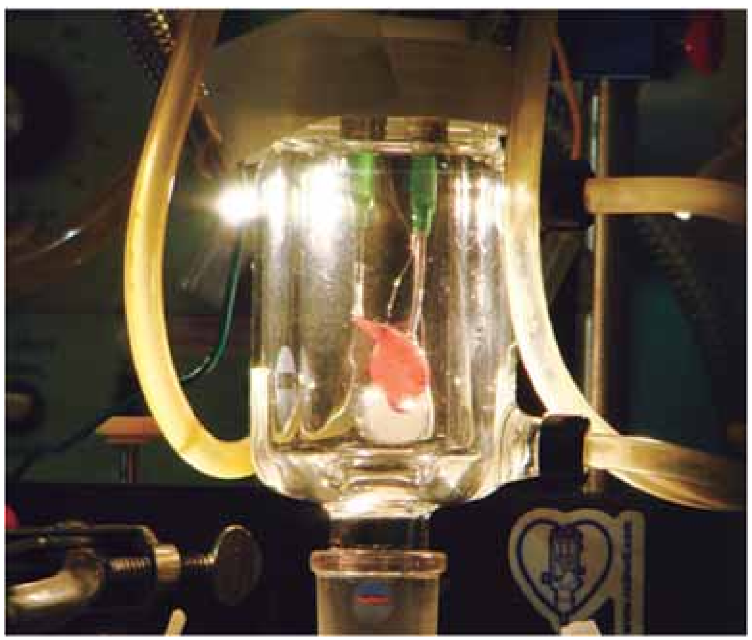
Biomedical/Tissue Engineering

Lon Cook

Tissue Engineering on Scaffolds



Growing Hearts in a Bioreactor

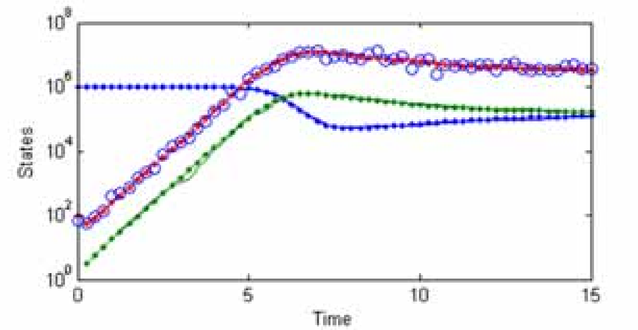


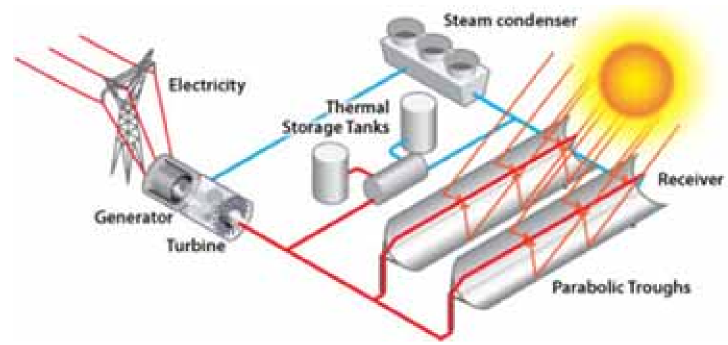
Human Ear on Back of Mouse

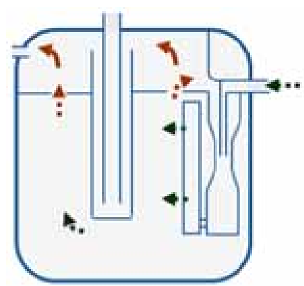
Process Control and Optimization

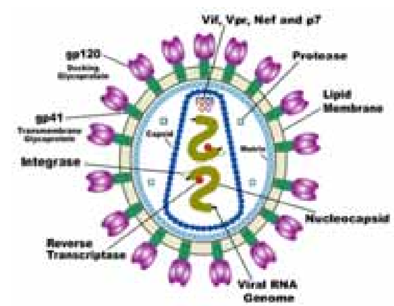
John Hedengren

- Energy Systems
- Computational Biology
- Optimization Technology
  - Nonlinear Programming
  - Mixed Integer Systems



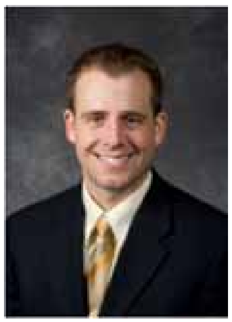






Biochemical Engineering / Simulations

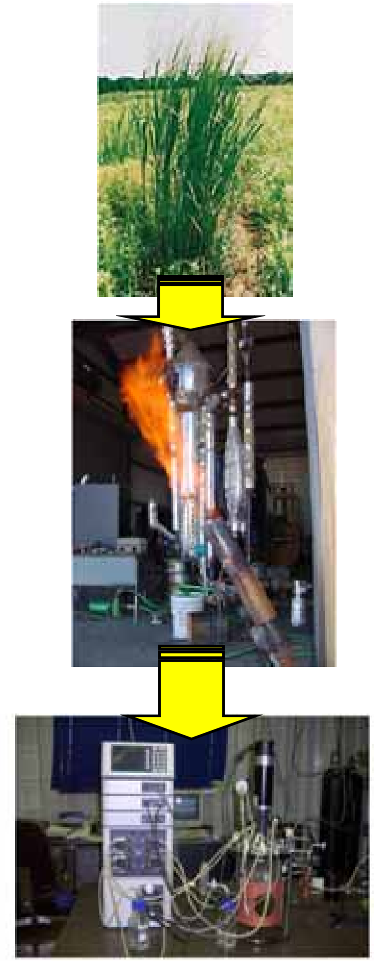
Brad Bundy

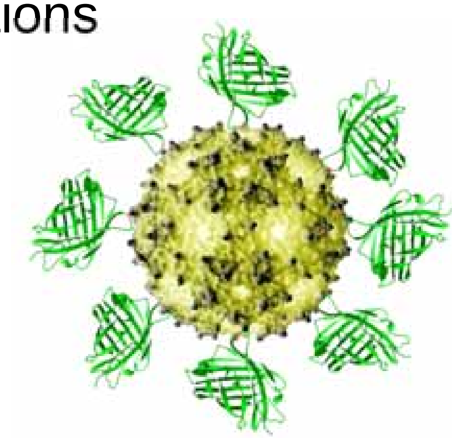


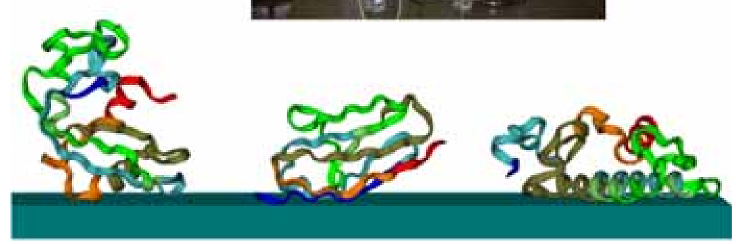
Thomas Knotts

Randy Lewis

- Kinetic modeling of bioprocesses including fermentation
- Production of fuel and other products from biomass
- Virus-like particles production and modification for vaccines, drug-delivery, and nanotemplating
- Simulations of biomolecular systems, including biosensors, DNA micro-arrays, and protein-surface interactions







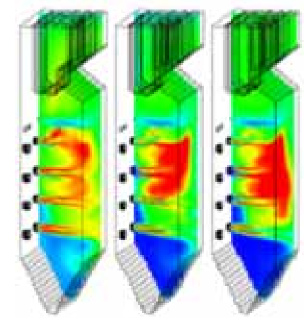
Turbulent Reacting Flow Simulation

85% of world 's energy comes from fossil fuels!

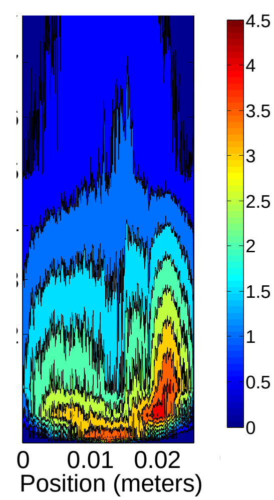
- Needs
  - Efficient reactors with low pollution
  - Modeling capability for analysis, prediction, and design
- Problems
  - Multi-scale physics
    - All modes of heat transfer
    - Complex kinetics
    - Multi-phase mass transfer
    - Turbulent fluid mechanics
  - Cannot resolve all scales→ models
- Goals
  - Provide insight into reacting flow
  - Provide data for model development
  - Simulation tools for analysis/design

DNS of soot formation

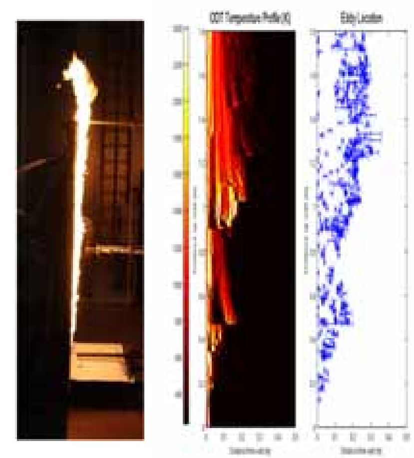
RANS of biomass in boiler



ODT of CaCO3 precip. in mixer



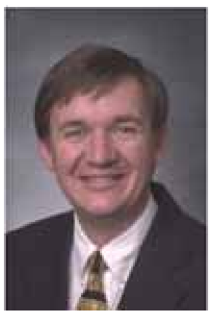
ODT of wall fire



Combustion and Sustainable Energy

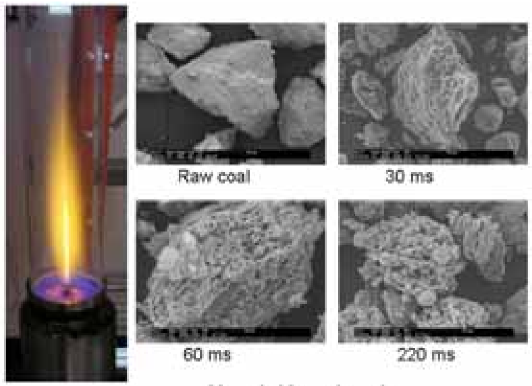
85% of world 's energy comes from fossil fuels!

Tom Fletcher



Larry Baxter

- Clean coal, oil shale, and biomass energy conversion
- Modeling fundamental processes
- Advanced diagnostics for combustion and gasification
- Ignition conditions of wildland fires
- Analysis of carbon capture and storage systems



Coal Gasification

Oil shale

Wildland fires

Particle suspended on laser

NSF Graduate Research Fellowship Panel

Graduate Student Panel