Opportunities and Challenges for Chemical Engineers

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Outline

• Some of our alums and their careers
• (Needed) contributions of chemical engineers to society
  – What the future might hold?
• Career planning for your daughter or son
Some alums

• I have chosen a few alums from different time periods to give a sampling of what chemical engineers from Notre Dame do when they leave.
Shawn O’Grady ChEg ‘86

- Currently: VP Consumer Food Sales, General Mills
  - Air Products for 2 years
  - Harvard MBA, 1990
    - Chose General Mills over ICI, DuPont, Air Products and Monsanto
    - Several awards from General Mills, manages 250 people with $2Bil in revenue
Melanie Sanchez-Jones ChEg ‘89

- Currently: Manager, Global Employee Benefits, Air Products and Chemicals
  - 18 years at Air Products with jobs: Product manager, University relations, New product commercialization, Product marketing
  - MBA Lehigh, 1998
Joseph McCarthy, ChEg ‘93

• Associate Professor and William Kepler Whiteford Faculty Fellow, Department of Chemical and Petroleum Engineering
  – Research interests: transport phenomena in particulate and/or discrete systems.
Brian Fitzpatrick  
ChEg ‘97

• Currently Professor at Vanderbilt Law School
  – Harvard Law School (graduated #1)
  – Clerk for Anthony Scalia
  – Private Law firm in Washington
  – Special Counsel for Supreme Court nominations for a US senator
  – Areas of Expertise
    – Civil procedure, appellate litigation, federal courts, the Supreme Court, constitutional law
Jennifer Ehren ChEg ‘99

- Currently a graduate student at Stanford in Chemical Engineering
  - ND Valedictorian
    - Not always a ChEg!
  - ACE program 2 years
  - Merck for 2 years
  - Last stages of PhD program
    - Oral therapeutic for Celiac Sprue disease
Andrew Downard ChEg,’03 MBA ‘04

• Currently graduate student at Caltech
  – Not based on long term plan
• Business partner with three of us -- helped with a small startup company for a couple of years
  – Other faculty realized the value of an “Andy”
Sarah Keefer ChEg ‘04

- Currently in medical school at St. Louis University
  - One year at Accenture
  - Varsity athlete (rowing)
  - Missed the first semester for chemical engineers to study in Spain
Eric Sauer ChEg ‘05

- Currently a graduate student at Wisconsin
  - One of few students to pass all of the qualifying exams at UW on the first attempt.
  - Graduate school was not original plan -- spurred by doing research
Pamela Jefson ChEg ‘06

- Global Operations Leadership Development (G.O.L.D) Program, Johnson & Johnson
  - Manufacturing engineering with Ortho Clinical Diagnostics (OCD), Rochester, NY
  - Had been a quality engineer in a manufacturing facility in Juarez, Mexico -- Ethicon Endo-Surgery
Challenge/Opportunity

• As a chemical engineer, what can you do to make the world better?
Big impact areas

• Energy
• Healthcare
• Jobs/Economy
Humanity’s Top Ten Problems for next 50 years

1. ENERGY
2. WATER
3. FOOD
4. ENVIRONMENT
5. POVERTY
6. TERRORISM & WAR
7. DISEASE
8. EDUCATION
9. DEMOCRACY
10. POPULATION

2003  6.5 Billion People
2050  8-10 Billion People

Slide from: R. E. Smalley
Rice University
Energy!!

• Where it comes from now!!

- Fossil Fuels
- Nuclear
- Renewable
Energy

• Even though there is no end in sight for carbon-based fuels
  – And there are chemical engineers trying to make this process as efficient and clean as possible
• this is inherently *unSustainable*
  – At some point, particularly with increased world-wide usage, we will run out*.  
  – CO₂ levels in the atmosphere will continue to increase and there is certainly a possibility of deleterious climate change.
Renewable Energy
Roles for chemical Engineers

• Solar cells
  – New materials, designed on a molecular scale, to capture energy more efficiently,
  – New processes to make these at lower cost.

• Biomass
  – Enabling technologies are needed
    • Wood, “grasses” to liquid fuels
      – Breaking down Cellulose to fermentable sugars is a combined chemistry and mass transfer challenge

• Geothermal
  – Design affordable systems to efficiently transfer energy

• Wind Power
  – Better materials: lighter and stiffer
Short(er) term alternatives

- **Clean Coal technologies**
  - High temperature gas separations
  - CO$_2$ sequestration
- **Oil shale**
  - How to produce useful fuel efficiently
    - Still have the CO2 problem
- **Nuclear energy**
  - Materials, process operation, waste issues remain important
- **Increased efficiency**
  - Energy growth is about 4% world wide
    - Great challenge for engineers: Gain >4% in efficiency worldwide!
    - Find and demonstrate where greatest payback will be!
Big impact areas

- Energy
- Healthcare
- Jobs
Health Care

• I am going to predict that health care costs will asymptote at something less than 20% of GDP (current value, 17%)
  – As this occurs, there will be great pressure to
    • Do the processes more efficiently
      – Medical tests:
        » Microfluidics
    • Make the products more cheaply and reliable
      – Drug manufacturing --
        » Get each batch exactly correct
  – Still will need to be new products but there will be more pricing pressure
New health care products

• **Implantable insulin pump**
  - *Process control* is a key issue

• **Replacement human tissue**
  - Liver, heart, currently being grown in laboratories
    - Growing tissue requires even more *Reaction Engineering* than most chemicals currently manufactured

• **New drug delivery strategies**
  - Molecular targeting to specific sites in the body
    - *Mass transport* issues determine if this will work

• **Feedback drug delivery for many treatments**
  - Several “on line measurements” used to prevent side effects and adjust dosing for best benefit,
Salvage more drugs in the “pipeline”

• You may heard of the expression
  – “Drug pipeline” as it refers to pharmaceutical compounds that are in various stages of clinical trials.
  • Most of the drugs that show some utility in laboratory settings and on test animals, don’t make it through the pipeline
    – Often side effects or lack of efficacy are the reason
    – However it might work for some people, or it might for most people if dosage could be carefully controlled.
• Chemical engineers, with their ability to quantitatively “decipher” data
  – Genomic, proteomic, metabolomic….
Big impact areas

- Energy
- Healthcare
- Jobs
Jobs

• Not the issue of a first job for our graduates,
  – Which for the first time has dropped in value
• But here I am looking at the Country
• Reality, is that any new job will have to produce value, now judged in the world economy, that exceeds the cost of the person by some reasonable percent.
A summer pastime
where will some of these kids work?
What will these boys do? (II)
US Trade deficit

• US trade deficit is about $710 Billion/year
  – It is ~5% of the GDP
  – What should the “divisor” be?

$5.4 Billion Real Estate Deal
Since 1960 GDP is up 5 times
Population is up only up 1.5 times
Productivity
Productivity: Engineers are the key!

• Technology drives productivity
  – Workers can contribute value-added that exceeds what you like to pay them.

• Engineers create new ideas for products and services
  – This needs to be encouraged.

• Of course, any cost-saving improvements in processes and products are a positive contribution to productivity
Careers/ your child’s future

• Anything ever done by chemical engineers is still open
  – If a position with an industrial concern is desired, then at least one internship would be really helpful.
    • Should be looking really hard right now
  – If she/he has an interest in graduate school, doing undergraduate research is very important,
    • Apply by November 2008
  – Law school
    • Take LSAT soon, apply next year
  – Med School
    • Should have pre-planned this but it still could be done.
    • MCAT this spring, apply in summer 2008
  – Service activities (e.g., ACE)
    • Various application deadlines -- next academic year
Random sampling of recent grads

- Accenture (IT / business consulting)
- Bayer, Merck, Lilly (pharmaceuticals)
- Procter and Gamble (brand mgmt)
- UOP (process engineering)
- TRW (satellite systems)
- Merrill Lynch (investment banking)
- GE (aircraft engines division)
- Loyola (law school)
- Air Products (Career Development Program)
- I.U (medical school)
- Military (medical service corp, flight school)
- MIT, Stanford, UCSB, Minnesota (graduate school in chemical engineering)
- Eli Lilly (pharmaceuticals)
- BP, Marathon (Oil industry)
Summary

• Our graduates follow many different career paths
  – I gave some examples
    • these paths often change
• Impact of engineers on society
  – Energy,
    • Problems waiting to be defined and solved across the board
  – Healthcare
    • Only a little impact from chemical engineers has already been felt
      – More is coming!
  – Jobs
    • Task and responsibility of engineers to create jobs and make people more efficient
    • It probably really is time for your son or daughter to get serious about the future
• Ultimate challenge
  – Change view of society on key issues
  – Political careers