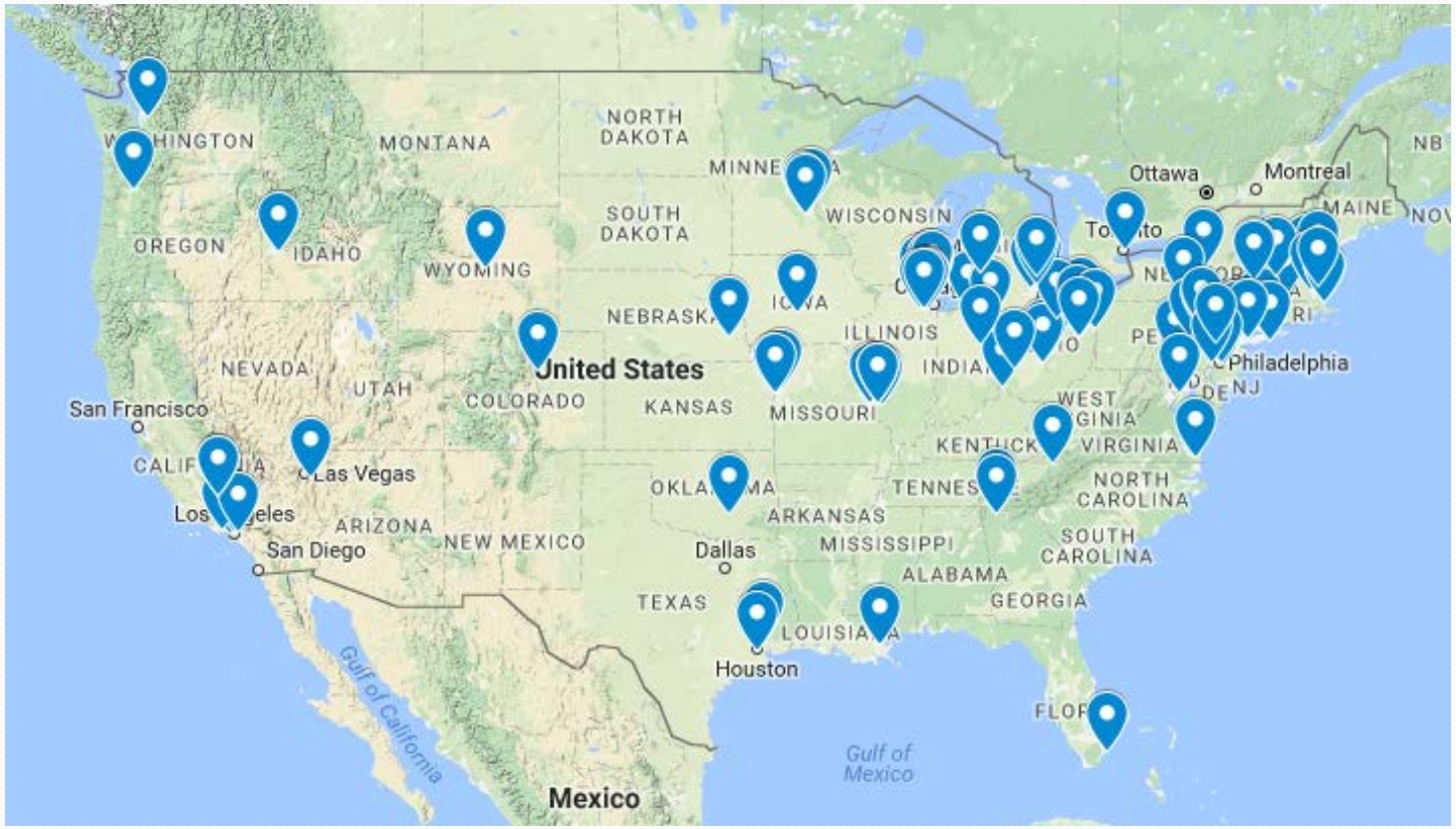
# Chemical and Biomolecular Engineering
# JPW 2017

Mark J McCready
Professor and Senior Associate Dean

# Chemical Engineering **Class of 2018**




105 students from 29 states and 3 countries

# “State of the major”

- Chemical Engineering BS degree
- Program quality and resulting graduates
- Opportunities after graduation
  - tactical and strategic
- Just a few more thoughts…

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# Chemical Engineering

- Ultimate *liberal science* degree
  - As with all engineers you have formidable quantitative skills— better at "data" than most — and the ability to distill a observed situation into a series of "problems" that can be solved.
  - Distinct from all other engineers, you are not intimidated by chemistry — which describes how most of the substances we encounter behave: foods and flavors, colors/behavior of paints and fabrics, cleaning products, containers, fuels, …
  - The junior courses: phase equilibrium thermodynamics and transport phenomena are almost exclusively the domain of chemical engineers — in addition to all facets of chemical processing these subject provide direct understanding of environmental and physiological processes that "no one" else has access to!
  - You also have spent quality "classroom" time with "humanists" and tried to make them "happy" with your thoughts and writing… must have some value…

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# CHEMICAL AND BIOMOLECULAR ENGINEERING

For Class of 2017

| First Semester | Cr |
|---|---|
| Composition (A&L 1) | 3 |
| MATH 10550 Calculus I | 4 |
| CHEM 10171/11171 Gen Chem-Fund Prin | 4 |
| EG 10111 Intro to Engr Systems I | 3 |
| Arts and Letters 2 | 3 |
| Moreau First Year Experience | 1 |
| | 18 |

| Second Semester | Cr |
|---|---|
| University Seminar (A&L 3) | 3 |
| MATH 10560 Calculus II | 4 |
| CHEM 10122 Gen Chem-Biological Processes | 3 |
| EG 10112 Intro to Engr Systems II | 3 |
| PHYS 10310 Physics I | 4 |
| Moreau First Year Experience | 1 |
| | 18 |

| Third Semester | Cr |
|---|---|
| MATH 20550 Calculus III | 3.5 |
| CHEM 10172 Organic Chem I w/Lab | 4 |
| CBE 20255 Intro to Chem Engr Analysis | 3 |
| PHYS 10320 Physics II | 4 |
| Arts and Letters 4 | 3 |
| | 17.5 |

| Fourth Semester | Cr |
|---|---|
| MATH 20580 Linear Algebra & Diff Eq | 3.5 |
| CHEM 20273 Organic Chem II | 3 |
| CBE 20258 Computer Methods | 3 |
| CBE 20260 Chem Engr Thermodynamics I | 3 |
| Arts and Letters 5 | 3 |
| | 15.5 |

| Fifth Semester | Cr |
|---|---|
| MATH 30650 Diff Eq | 3 |
| CHEM 30333 Analytical Chem I | 3 |
| CHEM 31333 Analytical Chem I Lab | 1 |
| CBE 30355 Transport Phenomena I | 3 |
| or CBE 30357 Biotransport | |
| CBE 30361 Sci of Engr Materials | 3 |
| CBE 30367 Chem Engr Thermodynamics 2 | 3 |
| | 16 |

| Sixth Semester | Cr |
|---|---|
| CHEM 30324 Physical Chem | 3 |
| CBE 30338 Chem Process Control | 3 |
| CBE 30356 Transport Phenomena II | 3 |
| CBE 31358 Chem Engr Lab I | 3 |
| Arts and Letters 6 | 3 |
| | 15 |

| Seventh Semester | Cr |
|---|---|
| CBE 40443 Separation Processes | 3 |
| CBE 40445 Chem Reaction Engr | 3 |
| CBE 41459 Chem Engr Lab II | 3 |
| or CBE 41910 Biomolecular Engineering Lab | |
| Chemical Engr Elective * | 3 |
| Arts and Letters 7 | 3 |
| | 15 |

| Eighth Semester | Cr |
|---|---|
| CBE 40448 Chem Process Design | 3 |
| Chemical Engr Elective * | 3 |
| Technical Elective * | 3 |
| ** Tech Elective | 3 |
| Arts and Letters 8 | 3 |
| | 15 |

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# Chemical Engineers…

- With your knowledge and understanding, you don't have to take someone else's word about scientific observations and technological developments that impact the well being of society and thus need political action…
- As an example:
  - We have a new EPA commissioner who was confirmed in a close vote yesterday…
  - There are (obviously) two opposing views on the need/value/cost/benefit of environmental regulations
  - As a chemical engineer, there is nothing about these issues that you could not explore first hand and develop your own opinion that would be much better informed than having to read the standard print media or watch some talking heads…

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| CHEM 10171/11171 Gen Chem-Fund Prin | 4 |
| EG 10111 Intro to Engr Systems I | 3 |
| Arts and Letters 2 | 3 |
| Moreau First Year Experience | 1 |
| | 18 |

| Second Semester | Cr |
|---|---|
| University Seminar (A&L 3) | 3 |
| MATH 10560 Calculus II | 4 |
| CHEM 10122 Gen Chem-Biological Processes | 3 |
| EG 10112 Intro to Engr Systems II | 3 |
| PHYS 10310 Physics I | 4 |
| Moreau First Year Experience | 1 |
| | 18 |

| Third Semester | Cr |
|---|---|
| MATH 20550 Calculus III | 3.5 |
| CHEM 10172 Organic Chem I w/Lab | 4 |
| CBE 20255 Intro to Chem Engr Analysis | 3 |
| PHYS 10320 Physics II | 4 |
| Arts and Letters 4 | 3 |
| | 17.5 |

| Fourth Semester | Cr |
|---|---|
| MATH 20580 Linear Algebra & Diff Eq | 3.5 |
| CHEM 20273 Organic Chem II | 3 |
| CBE 20258 Computer Methods | 3 |
| CBE 20260 Chem Engr Thermodynamics I | 3 |
| Arts and Letters 5 | 3 |
| | 15.5 |

| Fifth Semester | Cr |
|---|---|
| MATH 30650 Diff Eq | 3 |
| CHEM 30333 Analytical Chem I | 3 |
| CHEM 31333 Analytical Chem I Lab | 1 |
| CBE 30355 Transport Phenomena I | 3 |
| or CBE 30357 Biotransport | |
| CBE 30361 Sci of Engr Materials | 3 |
| CBE 30367 Chem Engr Thermodynamics 2 | 3 |
| | 16 |

| Sixth Semester | Cr |
|---|---|
| CHEM 30324 Physical Chem | 3 |
| CBE 30338 Chem Process Control | 3 |
| CBE 30356 Transport Phenomena II | 3 |
| CBE 31358 Chem Engr Lab I | 3 |
| Arts and Letters 6 | 3 |
| | 15 |

| Seventh Semester | Cr |
|---|---|
| CBE 40443 Separation Processes | 3 |
| CBE 40445 Chem Reaction Engr | 3 |
| CBE 41459 Chem Engr Lab II | 3 |
| or CBE 41910 Biomolecular Engineering Lab | |
| Chemical Engr Elective * | 3 |
| Arts and Letters 7 | 3 |
| | 15 |

| Eighth Semester | Cr |
|---|---|
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| Technical Elective * | 3 |
| ** Tech Elective | 3 |
| Arts and Letters 8 | 3 |
| | 15 |

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# Anticipated electives: 2017-2018

- Bilgicer, Topics in Biomolecular Engineering
- Degnan, Industrial Chemical Processes
- Guo, Polymer Science & Engineering
- Zartman, Cellular/Tissue Engineering
- Kiziltepe, Drug Development & Mechanisms of Action
- Nanoscience and Technology,
- Nanoscience and Technology,
- Immunoengineering
- Structure of Solids
- Mass Transfer in Membranes
- Principles of Molecular Engineering
- Introduction to Bioengineering

- You could also take our regular graduate courses like…
- CBE 60544: Transport Phenomena

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# Program quality

- When I used to talk with prospective students and their parents, I would talk about program quality in the following way…
  - Program excellence depends on
    - talented students,
    - talented faculty,
    - commitment by both to the educational enterprise

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# One measure of student talent!

| | AL | BA | EG | SC |
|---|---|---|---|---|
| Median **SAT** | 1480 | 1460 | 1510 | 1500 |

- These numbers have increased continually over time
  - We can see the difference…
  - Sorry Bob!

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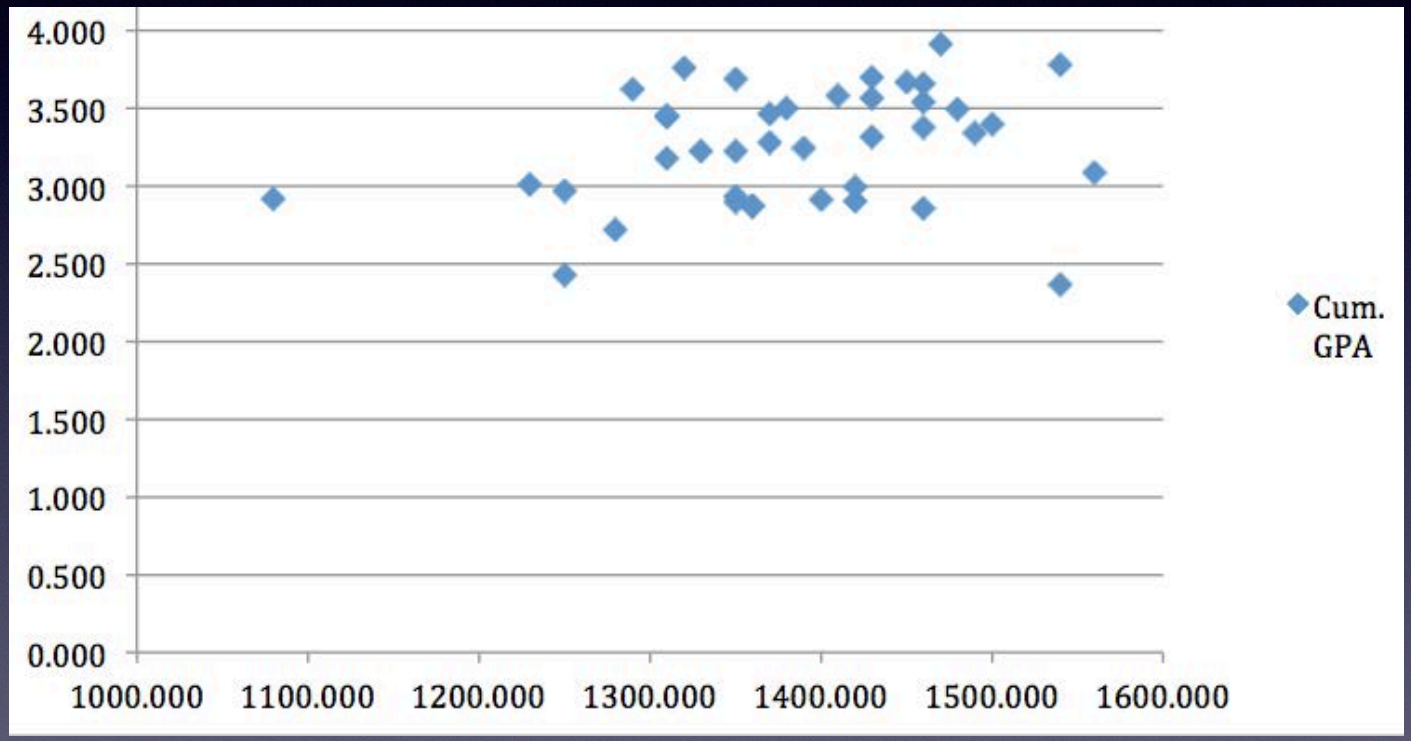
# Interestingly….

- The median SAT may track the talent of students in an overall sense, but certainly is not accurate individually nor does it predict academic outcomes!




These data are **not** from current junior chemical engineers, but the plot looks the same.

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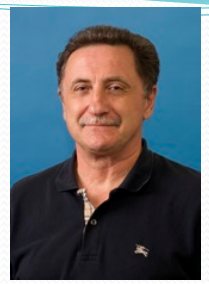
# Talented Faculty

Dr. Edward Maginn- CBE 20260, Chemical Engineering Thermo I

Dr. Jonathan Whitmer- CBE 20260, Chemical Engineerin g

Dr. David Leighton- CBE 30355, Transport Phenomena I, CBE 20958 Numerical & Statistical Analysis

Dr. Ruilan Guo-CBE 30361, Science of Engineering Materials



Dr. Alexander Mukasyan- CBE 30361, Science of Engineering Materials

Dr. William Phillip- CBE 30356, Transport Phenomen a I

Dr. Jeffrey Kantor- CBE 30338 Chem Process Control, CBE 20255 Intro to C I

Dr. Mark McCready- CBE 30357, Biotransport

Dr. Davide Hill- CBE 30367, Chemical Engineering Thermo II, CBE 20260, Chemical Engineering Thermo I

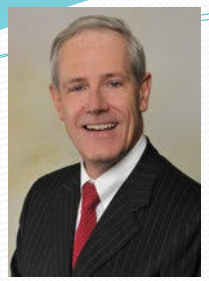
Dr. Jeremiah Zartman- CBE 30386, Intro to Bioengineeri ng

Dr. Salma Saddawi- CBE 31358, Chemical Engineering Lab I

Dr. Chia Chang- CBE 30356, Transport Phenomena II

Dr. William Schneider- CHEM 30324, Physical Chemistry for Engineers

Dr. Jennifer Schaefer- CBE 40425, Energy, Economics & Environmen t



**Dr. Thomas Degnan- CBE 40430, Industrial Chemical processes, CBE 40448, Process**

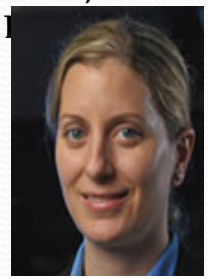
**Dr. Mark Stadtherr-CBE 40448, Process Design**

**Dr. Paul Bohn-CBE 40435, Electrochem /Echemical Engineering**

**Dr. Paul McGinn-CBE 40461, Structure of Solids**

**Dr. Matthew Webber- CBE 40725, Principles of Molecular Engineering**

**Dr. Jason Hicks- CBE 40445, Reactions Engineering**



**Dr. Tanyel Kiziltepe- CBE 41910, Biomolecular Eng Lab, CBE 40325, Immunoeng**

**Dr. Merlin Bruening-CBE 40525, Ambient Methods Surface Characterization**

**Dr. Joan Brennecke-CBE 40498, Energy & Climate**

**Dr. Alexander Mukasyan-CBE 40477, Nanoscience**

**Dr. Salma Saddawi- CBE 41459, Chemical Engineering Lab II**

**Dr. Basar Bilciger-CBE 40483, Topics Bioengineering**

Five College “teachers of the year” and numerous Joyce and Kaneb awards

# Apparently, the students are willing to work!

CIFs!

Spring 2016

| Engagement | |
|---|---|
| Intellectual Challenge | Time Studying Outside of Class |
| | |
| 4.90 ± 0.10 ⇧ | 9.80 ± 1.00 ⇧ |
| 4.20 ± 0.20 | 7.20 ± 1.00 ⇧ |
| 4.30 ± 0.20 ⇧ | 6.50 ± 0.90 |

Fall 2016

| Engagement | |
|---|---|
| Intellectual Challenge | Time Studying Outside of Class |
| 4.70 ± 0.20 ⇧ | 7.80 ± 1.20 ⇧ |
| 4.70 ± 0.10 ⇧ | 7.90 ± 1.10 ⇧ |
| 4.60 ± 0.20 ⇧ | 8.00 ± 1.40 ⇧ |
| 4.50 ± 0.30 ⇧ | 8.20 ± 1.40 ⇧ |

CBE: 20258, 20260, 30355, 30357,30367

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# Chemical Engineering as Career

- Students: As much as you love the courses, your classmates and “Notre Dame”…
- Parents:  As much as you have enjoyed guiding and interacting with your children for the past 20 years…
- May 2018 is only 15 months away….

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# ChEg 2016 Initial jobs

| |
|---|
| Accenture, Chicago |
| ACE Program |
| Anhauser Busch |
| Bank of Montreal |
| Bechtel Bettis Labs in Pittsburgh |
| CB&I, Houston |
| Chemstaff, Joliette |
| Credit Suisse |
| Deloitte, San Francisco |
| Dow Chemical |
| Eli Lilly & Co |
| Epic - Madison , WI |
| Exxon Mobil |
| Ford Motor Co., Dearborn |
| Fulbright Taiwan |
| General Electric |
| Geneva Energy Markets, Chicago |
| Goldman Sachs-NY |

| |
|---|
| Graduate School |
| Huron Consulting |
| Jefferies, LLC |
| Johnson & Johnson |
| Keurig- Green Mountain |
| Kymanox |
| McMaster-Carr, Chicago |
| Medical School |
| Military |
| PBI |
| Premier, Int'l, Chicago |
| Qgenda |
| Regeneron Pharm. |
| Sacramento Kings |
| Saint Gobain |
| Spartan Energy Partners, Houston |
| Stryker Orthopeadics |
| Target |
| Dow Chemical Company |

If seeking a PhD, this is at no cost to the parents!

As of now, everyone is employed!

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# 2015 first jobs

| | | | |
|---|---|---|---|
| ExxonMobil | Upstream Engineering Computing | Houston | TX |
| GE Aviation | Operations Management Leadership Program | Cincinnati | OH |
| GE Oil and Gas | Operational Management Leadership Program | Alexandria | LA |
| General Electric | Edison Engineering DP | Wilmington | NC |
| GlaxoSmithKline | Manufacturing Associate | Rockville | MD |
| Goldman Sachs | Operations Analyst | New York | NY |
| Hiland Partners LP | Chemical Engineer | Williston | ND |
| McGladrey | Technology Consultant - Associate | Columbus | OH |
| Natural Exotic Beverages, LLC | Member / Engineer | Gaithersburg | MD |
| Newport News Shipbuilding | Nuclear Engineer I | Newport News | VA |
| NovelMed Therapeutics | Intern | Cleveland | OH |
| PPG Industries | Chemical Engineer | Pittsburgh | PA |
| Procter & Gamble | Manufacturing Engineer | Bear River City | UT |
| Procter & Gamble | Process Engineer | Bear River City | UT |
| PwC | Assurance Associate | McLean | VA |
| Samsung Austin Semiconductor | PIE II Engineer I | Austin | TX |
| Schlumberger | Field Engineer Trainee | New Orleans | LA |
| SPX Flow Technology | EDP Engineer | Rochester | NY |
| Stryker Endoscopy | Business Planner | San Jose | CA |
| Trinity Consultants | Environmental Consultant | Cincinnati | OH |
| UOP | Chemical Engineer | Des Plaines | TX |
| US Marines | 2nd Lieutenant | Quantico | VA |
| US Navy | Student Auditor Candidate | Pensacola | FL |
| Valence Health | Associate Application Developer | Chicago | IL |
| Veyance Technologies | | St. Mary's | OH |

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# 2016 Class: 6 months out

**First Destination 2016 - College of Engineering - Primary Post-Graduation Activity by Major - Expanded for dual degrees and double majors - OSPIR and Career Center sources - EXcluding Status unknown**

| | | Primary activity | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Education | Employment | Service | Military | Seeking employment | Other | Valid N |
| Major | Aerospace Engineering | 16% | 68% | 0% | 8% | 8% | 0% | 25 |
| | Civil Engineering | 10% | 86% | 2% | 0% | 0% | 2% | 42 |
| | Chemical Engineering | 20% | 72% | 4% | 1% | 0% | 3% | 76 |
| | Computer Engineering | 0% | 87% | 0% | 7% | 7% | 0% | 15 |
| | Computer Science | 17% | 75% | 6% | 2% | 0% | 0% | 65 |
| | Electrical Engineering | 29% | 65% | 3% | 3% | 0% | 0% | 31 |
| | Environmental Engineering | 8% | 67% | 8% | 0% | 8% | 8% | 12 |
| | Mechanical Engineering | 9% | 81% | 2% | 5% | 3% | 1% | 108 |

**First Destination 2016: Starting Salary by Major - Full-time jobs - Expanded for dual degrees**

| | | Self-reported starting salary | |
|---|---|---|---|
| | | Valid N | Median |
| Major | Aerospace Engineering | 15 | 65000 |
| | Civil Engineering | 33 | 60000 |
| | Chemical Engineering | 52 | 68000 |
| | Computer Engineering | 11 | 72000 |
| | Computer Science | 43 | 75000 |
| | Electrical Engineering | 19 | 70000 |
| | Environmental Engineering | 7 | 55000 |
| | Mechanical Engineering | 76 | 70000 |

All the chemical engineers are employed

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# Employment

- Current seniors appear to be on about this same track
- Still, one should not be complacent
  - The ND class of chemical engineers is larger
  - The number of chemical engineers in the country is also higher
- So try to get an internship
- If this does not work out, take actions to increase employability for fall
  - Become an “Excel” guru and get an on-line certification
  - Research desirable companies, find ND alums at these companies and start to make connections
  - Do something in the community that benefits others and that will help to build your internal character

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# One example:  Current senior

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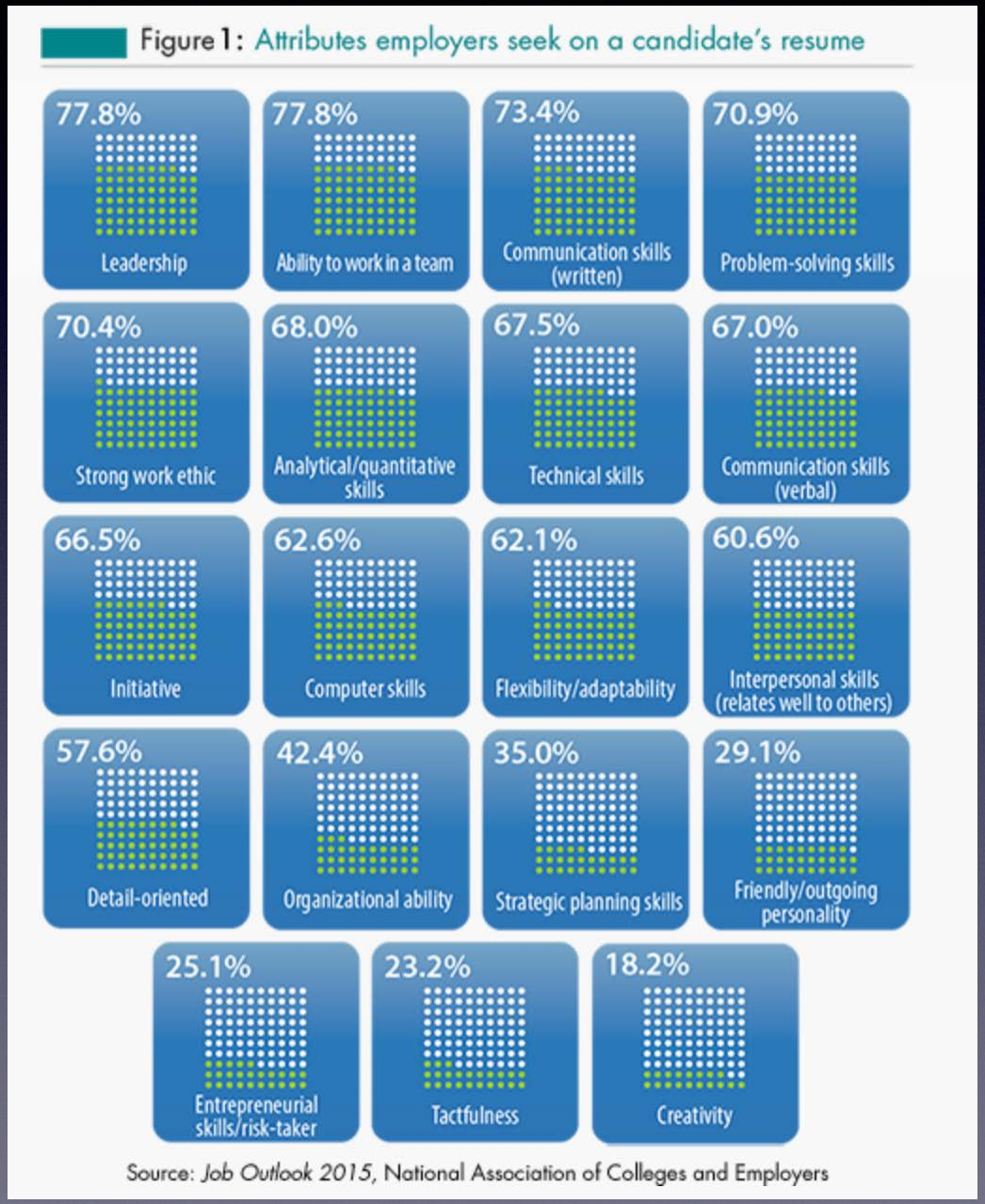
# What Employers “think” they want!

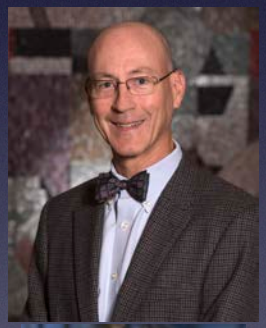


# To Future grads

- For greatest success: Make yourself the best you can be
  - Take responsibility
  - Work on your weaknesses!
- Make a difference personally…
  - If Newton had never lived, nothing in the world would be different, may also be true about Einstein but…





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# The name of this event?

- Is it:
- Junior Parents Weekend
- Junior Parents' Weekend
- Juniors Parent Weekend
- Junior's Parent Weekend
- Which of course… reminds me something:









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# London:  One last chance

- If you missed last year, you can still go for the “pilot plant” course at Imperial
- July 24-August 11.  Three CBE elective credits
  - ~$4K

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# It is OK to challenge accepted thinking!

- Some things we thought we knew:
  - Margarine was considered a health food
  - Left-handed people die sooner because of the hazards of the right-handed word
  - Stomach Ulcers are caused by stress
  - Plants absorb CO2 and emit O2
  - The adult brain has no capacity to regenerate itself
  - Komodo Dragons bit their prey and waited for them to succumb to bacterial infections
  - It is bad to eat eggs!

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# "Tassel" List

- Go with your lab or HW group for breakfast or lunch with one of the faculty
- voluntarily take a deep academic experience e.g., figure out what the 2nd law really means, or what a normal viscous stress is or figure out why infinite domain transport problems have similarity variables naturally arising.
  - we can help!
- Ask a really perceptive question in class, or any question if you have never done it!
- Compliment a faculty member on a particularly good lecture

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http://ndcbechair.blogspot.com/

# Tassel list (continued)

- Explain (e.g.,) the utility of knowing the consequences of the first law of thermodynamics when, say, making green energy policy at ND, to a non-engineer !
- Read a publication written by one of the faculty members and discuss it with him or her over coffee.
- Attend a department research seminar or a similar seminar in another department
- Develop a fully-informed and well thought position on an important world problem
- Make a constructive suggestion for course improvement on the CIF

http://chemeprof.com/



http://ndcbechair.blogspot.com/