Civil Engineering

What is Civil Engineering?
What can you do as a Civil Engineer?
Curriculum at CU

“Engineers solve ill-defined problems that have no single “right” answer but many better or worse solutions....”

– Engineering and the Mind’s Eye, Ferguson

ABET Definition:
• Engineering is the profession in which knowledge of math and sciences, gained by study, experience, and practice, is applied with judgement to develop ways to economically utilize the materials and forces of nature to benefit mankind

Profession = knowledge, organization, public good

• “ultimately, what most satisfies engineers is complex, technical problem-solving and the opportunity to work with stimulating colleagues and to make a meaningful contribution to society”

–The Civilized Engineer, S.C. Florman

Engineering is:
• Applied science
• Problem solving
• Science and “art”

What is Civil Engineering?
• The oldest engineering profession
• Projects that benefit society as a whole
• Sub-disciplines
  – Transportation
  – Structures
  – Environmental & Water Resources
  – Geotechnical
  – Construction
Transportation
• Design roadways
  – Where to locate
  – Number of lanes, width of lanes, slope of lanes, HOV lanes
  – Traffic control: stop light timing, pvmnt markings (lines, raised reflectors), signs
  – Bridges
  – Pavement type - asphalt vs concrete
  – Drainage
  – Safety: shoulders, guard-rail, etc.

Intersection Design
• Stop lights vs stop signs
• Set timing vs trigger
• Time of day variances
  – (night to flashing yellow, flashing red)
• Turn lanes vs. no turn lanes
• T-intersection versus Y
• Pedestrian and bicycle access

Transportation
• Design airports
  – Runways: orientation per wind direction, length per plane types
  – Taxi-ways
  – Terminals and parking
  – Noise, de-icing, environmental concerns
• Design light rail, railroads
  – Route selection
  – Grading
  – Tunnels
  – Terminals

Structural
• Design Bridges
• Design Dams
  – Three Gorges Dam in China
• Design Skyscrapers
  – Taller,
  – Resistant to earthquake damage

Structural
• Select materials
  – Steel, reinforced concrete, wood
• “Dead load” forces
  – Weight of structural members and walls, floors, furnace, etc.
• Dynamic forces
  – Wind, water, earthquakes, moving vehicles

Environmental & Water Resources
• Treat water so it is clean to drink
• Treat wastewater so it is safe to return to rivers, lakes, and into the ground
• Clean-up hazardous wastes
• Supply enough water for public use
• Design solid waste handling
Environmental & Water Resources

• How clean is clean?
• What is safe?
  – Pathogens and disease-causing bacteria...
  – Chemicals that cause cancer, birth defects...
  – Human safety vs fish, frogs, birds, etc.
• Fundamentals: chemistry, biology, microbiology

Geotechnical

• Design foundations
  – Expansive soils in Colorado
  – Buildings and roads
• Tunnels
• Stable slopes on road cuts, etc.
• Landfills

Construction

• Getting a design from plans on paper to implementation in the real world
  – Over-sight for construction activities
  – Certifying built to specifications
• Scheduling construction stages
  – When to get supplies on site
  – Critical path: tasks that can only be done once other tasks have been completed
• Estimating costs

• Most major engineering projects today are multi-disciplinary so you will work with other engineers and non-engineers
  – Wastewater plant = environmental, structural, electrical, mechanical, ...
  – New road = transportation, geotech, structural (if a bridge), environmental (impact stmt), ...
  – Government regulations, public input

What new engineers need to know? (industry surveys)

<table>
<thead>
<tr>
<th>Skills</th>
<th>Ranks</th>
<th>% important</th>
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<tbody>
<tr>
<td>Communication</td>
<td>1 / 1</td>
<td>89</td>
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<tr>
<td>Teamwork</td>
<td>3 / 4</td>
<td>94</td>
</tr>
<tr>
<td>Ethics</td>
<td>2</td>
<td>85</td>
</tr>
<tr>
<td>Creative thinking</td>
<td>3</td>
<td>85</td>
</tr>
<tr>
<td>Design</td>
<td>7 / 2</td>
<td>88</td>
</tr>
<tr>
<td>Fundamentals</td>
<td>5</td>
<td>73</td>
</tr>
</tbody>
</table>

Also: business skills (3), computing (5)

What can you DO as a civil engineer?

• **Design** a road, bridge, water treatment plant, etc.
• **Talk** with the public, clients, etc. to determine their needs
• **Field work** - oversee construction, test materials on site, collect samples, ...
• Work with a **TEAM** to complete complex tasks
…what else can you DO?

- **Write** technical reports, expert opinions, etc.
- Work with computer-aided design programs
- **Travel** to job sites
- Have meetings with clients, etc.
- Give oral presentations to public, answer questions, ....
- Do research in a laboratory

A wide variety of opportunities in Civil Engineering is the KEY.

Find what fits your personality the best!

Many Civil Engineers will do all of the previously listed tasks over a career....

Civil Engineering Work

- Federal, state, local government 32%
  - Environmental Protection Agency
  - Department of Transportation
  - City Engineer
- Consulting firms and industry 49%
  - From international to single office
- Private business / self employed 14%
  - Highest % of all engineering types!
- Peace Corps/social service abroad

There is always a need for Civil Engineers

- We always need to modify roads
- We always need clean water to drink
- We always have wastes to treat and dispose
- We always build new structures on soil
- …we always want cheaper and better ways to improve all of the above....
  ....job security!

Civil Engineers are needed to solve Problems in Colorado

- “Crisis looms as aquifers drawn down”
  - June 24, 2001; Denver Post, front page
  - Groundwater use exceeding resupply, so water levels in local wells dropping
  - Water resources engineers needed

Civil Engineers are needed to solve Problems in Colorado

- “State’s aging bridges draw scrutiny”
  - Feb. 20, 2001; Denver Post, front page
  - Aging bridges need repairs before disaster
  - Nationally ~29% of 587,755 bridges “deficient”
  - Structural engineers needed
Civil Engineers are needed to solve Problems in Colorado

- “Yale, Hampden sections to see first T-REX work”
  - Wednesday, June 13, 2001; Denver Post
  - I-25 expansion to keep pace with traffic growth
  - Transportation and construction engineers needed
    - Good design important for traffic flow when done
    - Good planning for construction needed to minimize public inconvenience during construction
  - Large amount of public concern

Civil Engineers are needed to solve Problems in Colorado

- “EPA: Gold mine fouling water”
  - April 13, 2001; Denver Post, pg. B1
  - Cyanide, copper exceed limits in nearby surface waters, violating Clean Water Act
  - Fish kills, etc. likely
  - Environmental engineers needed

Civil Engineering at CU

- 37 professors & 4 senior instructors
- Most classes 20-60 students
- “General” CE degree
  - structures, geotech, construction, env/water
- Environmental & Water Resources track
  - More depth in env/water, less in others
- Combined BS/MS possible

Std Year 1 Classes

<table>
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<tr>
<th>Course</th>
<th>Credits</th>
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<tr>
<td>Calculus 1 for Engr</td>
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<tr>
<td>Calculus II for Eng</td>
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<tr>
<td>Chemistry for Engr</td>
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<tr>
<td>Physics I</td>
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<tr>
<td>Chem Lab for Engr</td>
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<tr>
<td>Plane Surveying</td>
<td>3</td>
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<tr>
<td>Intro to Computing</td>
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<td>SS&amp;H Elective</td>
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<tr>
<td>SS&amp;H elective</td>
<td>3</td>
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</tbody>
</table>

TOTAL: 16 cr. 17 cr.

Notes on Recommended Schedule:

- Course schedule to graduate in 4 yrs
  - 4.5 yrs average
  - Some classes offered in summer
- Time management will be important
  - # credits vs contact hrs + homeworks
  - Sem 1: 16 vs 19 + (?48?)
- If deviate from the recommended schedule, watch pre-requisites and check with advisor
- Important to get off to a good start!

Advisors

- Goal: to help you select classes
  - Also help if on probation, transfer classes, etc.
- Assigned by department
  - Somewhat random
  - Can change to fit interest area (structures, environ, etc), personality, etc.
- MUST see each semester prior to registration
  - 1 designated week per semester for advising
  - Computer has block until we remove it
  - Will keep you on track, advise of course changes, etc.
Further required classes

• Increase complexity as you build on basic math and sciences
  - Design bridges, buildings, water distribution systems, wastewater plants etc. senior year
  - Pre-reqs become increasingly important
• Technical Electives
  - More depth in specific sub-topics
• Some classes only offered spring or fall...

Civil Engineering classes...

• Lots of hands-on
  - ITLL modules to demonstrate concepts in fluids, hydraulics, thermodynamics...
  - Labs in materials, geotechnical, environmental...
• Tours and real world ties
  - Local job sites, facilities
  - Design projects, faculty research

Almost all CE classes are taught by professors or full-time instructors

• May be outside professional for grad class
• <1 class/semester by PhD student
• Most large classes have a teaching assistant (TA)
  - Graduate students
  - Run lab sections, “recitations”
  - Grade homeworks
  - Have office hours to help with your questions

Where is my professor?

• Come ask questions during office hours
• When not in office:
  - Teaching other classes
  - Working on research (>half our time)
    • In laboratory with graduate students
    • Writing papers, books (may be at home)
  - Service activities (faculty meetings, professional society meetings, expert panels)

To Select SS&H Electives

• Need some level of “depth” in at least 1 topic (require ≥3000-level course)
• Can complement engineering courses
  - Economics, business, “engrg and society”
• Can explore range of interests
  - Languages, psychology, sociology, history, ....

Take advantage of opportunities

• Professional societies
  - ASCE = general civil engineering; concrete canoe, steel bridge, prof. contacts
  - AGC = construction; speakers, contacts
  - SEE = environmental; tours, community projects
• Undergraduate research
• Summer internships
To Graduate

• 128 credits minimum
• Fulfill required courses
  - Graduate on “catalog” that you enter with, or any new curriculum up to graduation if ALL requirements are met
• Cumulative GPA >2.00
• Departmental GPA >2.00 (CEAE classes)
• Take the Fundamentals of Engineering (FE) exam

After you graduate:

• Improvements in technology, regulations, etc. change the “state-of-the-art” in civil engineering
  - Life long learning!
• Becoming a registered Professional Engineer (PE) is important