A COMPLETE REDESIGN OF FRESHMEN ENGINEERING COURSE

Professor Ryan Munden, Electrical Engineering
Professor Shanon Reckinger, Mechanical Engineering

Fairfield University's Center for Academic Excellence
Collaborations for Empowerment and Learning
Innovative Pedagogy & Course Redesign
12th Annual Summer Conference
May 29th-31, 2013 | Fairfield University, CT

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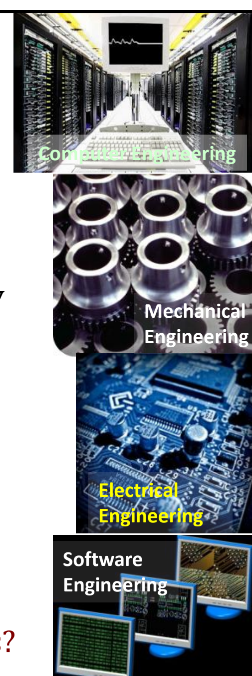
Motivation



EG31 – Fundamentals of Engineering

- First engineering course for all undergraduate engineering majors (Mechanical, Electrical, Software, Computer)
- Freshmen and mostly traditional students (very few part-time, adult students)
- Cornerstone course
- Many students are declared "undecided engineering"
- Some students are undecided, in general

How can we develop this course for maximum learning and make it most useful for the students?

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Outline

- Background of EG31
- CAE's Summer Institute on Integrative Learning 2012
- EG31's Backward Design Process
  - Course Goals
  - Course Outcomes
  - Assessment
  - Curriculum
- Linking Course Goals
- Reflections on the Redesign

Background

- EG31 – before the redesign
  - 2 semester sequence, 6 credits total
  - Course content was technically heavy (topics included DC circuit analysis, digital logic, stress and strain in solids, programming, etc.) with little to no retention by students
  - Software training (including Excel, MATLAB, Multisim, Working Model, etc.)
  - One Instructor: part time, adjunct, Electrical Engineering, taught course for 5 years.
  - Traditional course format: lecture based, in class exams, turbos.

Background

Old EG31	New EG31
2 semester sequence, 6 credits	1 semester, 3 credits, no turbos!
Content Technically Heavy	No "Technical Content", links to math & physics
Software Training	No Software*
1 Instructor, adjunct	2 Instructors, full time, multidisciplinary
Mostly lecture based, traditional exams	Active learning, based off of education research, hands on, project oriented

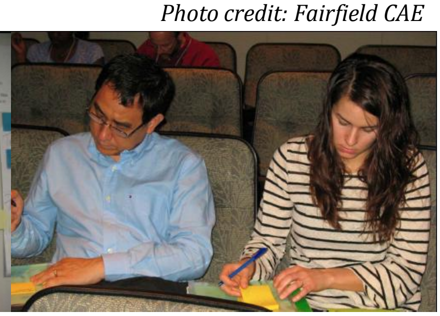
*this training now takes place in EG145, a new course taught by Professor Reckinger

Where it all began…

2012 CAE's Summer Institute on Integrative Learning!

- Munden (EE), Reckinger (ME), and Yoo (SE) participated
- Many ideas were implemented in redesign of EG31
- Learned about techniques for course design

Photo credit: Fairfield CAE



Backward Course Design

Photo credit: Fairfield CAE

Thank you
Dr. Christine Siegel &
Dr. Larry Miners!

Backward Course Design

- Course Goals
  - What will the students take away from the course 5+ years from now?
- Course Outcomes
  - What do we expect the students to learn?
- Assessment
  - How will we know the students have learned?
- Curriculum
  - Through what experiences will the students learn best?

Backward Course Design

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Course Goals

What will the students take from the class 5 years from now?

- Create a passion for engineering.
- Develop an engineering mindset, problem solving skills, and critical thinking.
- Develop engineering professionalism.

2013 Engineering Graduates

Backward Course Design

- Course Goals
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- Curriculum
  - Through what experiences will the students learn best?

Course Outcomes

What do we expect the students to learn?

- Understand the roles of engineers in different fields and different industries.
- Be familiar with the different engineering majors at Fairfield.
- Develop an awareness of modern technology and its use in the engineering field.
- Develop skills in:
  - Oral communication
  - Technical writing
  - Team work
  - Project and time management
  - Problem Solving
  - Engineering ethics & best practices

Course Outcomes

What do we expect the students to learn?

- **Understand the roles of engineers in different fields and different industries. (I)**
- Be familiar with the different engineering majors at Fairfield.
- Develop an awareness of modern technology and its use in the engineering field.
- Develop skills:
  - Oral communication
  - Technical writing
  - Team work
  - Project and time management
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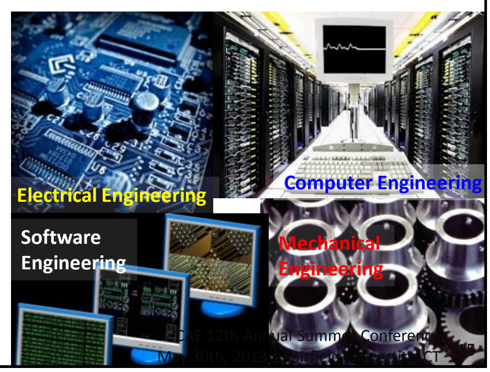

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Course Outcomes

What do we expect the students to learn?

- Understand the roles of engineers in different fields and different industries.
- Be familiar with the different engineering majors at Fairfield.
- **Develop an awareness of modern technology and its use in the engineering field. (I)**
- Develop skills in:
  - Oral communication
  - Technical writing
  - Team work
  - Project and time management
  - Problem Solving
  - Engineering ethics & best practices

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Course Outcomes

What do we expect the students to learn?

- Understand the roles of engineers in different fields and different industries.
- Be familiar with the different engineering majors at Fairfield.
- Develop an awareness of modern technology and its use in the engineering field.
- **Develop skills in:**
  - **Oral communication (III)**
  - **Technical writing (III)**
  - **Team work (II,III)**
  - **Project and time management (III)**
  - **Problem Solving (II)**
  - **Engineering ethics & best practices (III)**

Backward Course Design

- Course Goals
  - What will the students take away from the course 5+ years from now?
- Course Outcomes
  - What do we expect the students to learn?
- Assessment
  - How will we know the students have learned?
- Curriculum
  - Through what experiences will the students learn best?

Assessment

How will we know the students have learned? (code for: how did we grade them)

- Regular Assignments
  - Weekly problem set (PS) (CO8)
  - Weekly writing assignment (WA) (CO1-5,9)
- Projects
  - Individual Technical Writing Piece (ITW) (CO5)
  - Individual Technical Oral Presentation (ITP) (CO4)
  - Team Final Design Project (TDP) (CO6-7)

Assessment – PS

Problem Set - Example

EG31 Fundamentals of Engineering
Munden/Reckinger
Due Date: *C02*-10/22/2012, *C01/03*-10/23/2012

Problem Set #4
Terminal Velocity

1. Felix Baumgartner just became the first person to break the sound barrier in free fall while skydiving (on Oct 15th, 2012). He reached a maximum speed of Mach 1.24 or 833.0 mph. He jumped from a balloon lifted capsule at the height of 128,100 feet (over 24 miles) above the surface of earth and free fell for 4 mins 20 sec. Assume Felix weighs 170 lbs. What was his drag coefficient during free fall?

   http://abclocal.go.com/wpvi/story?section=news/national_world&id=8847680

Anne Kennedy | Problem Set #4 | 7/10

$V = 833\ mph = 372.4\ m/s$

$a = 0\ m/s^2 \rightarrow$ maximum velocity = no acceleration

$d = 128{,}100\ ft = 39{,}044.88\ m$

$t = 4\ min\ 20\ s = 260\ s$

$w = 170\ lb = 77.11\ kg$

b. What are you trying to find? (-1)

assume: Skydiver is left = 1.823 m tall (h)

$C_d = \frac{2mg}{V^2} SA$ (assume equation is correct)

wrong eq'n use physics book not google (-1)

$SA = \frac{.007184\, w^{.425} h^{.725}}{2}$ (assume equation is correct)

no wind *why?*

$C_d = \frac{2mg}{V^2} A \qquad SA = \frac{.007184\, w^{.425} h^{.725}}{2} \qquad w = mg$

$C_d = \frac{2w}{V^2} \cdot \frac{.007184\, w^{.425} h^{.725}}{2}$

$C_d = \frac{2(77.11\ kg)}{(372.4\ m/s)^2} \cdot \frac{.007184\,(77.11\ kg)^{.425}(1.823\ m)^{.725}}{2}$

units don't match (-1)

$C_d = 5.06 \times 10^{-5}$

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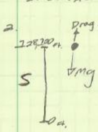
Ariel Miranda | Oct. 23, 2012 | EG-31 | 7/10

Problem Set 4

1. Felix Baumgartner just became the first person to break the sound barrier in free fall while skydiving. He reached a maximum speed of 833.0 mph. He jumped at the height of 128,100 ft. above the surface of earth and free fell for 4 mins and 20 sec. Assume he weighs 170 lbs. What was his drag coefficient during free fall? ✓

2. 

good

3. Assumptions:

$128{,}200\ ft. = 39044.88\ m = S$ ~~170 lbs = 77.25 kg~~

$833\ miles/hr = 1{,}340{,}580.25\ m/hr = V_f = V_{Terminal}$ *m/s (-1)*

time = 4 min and 20 sec.

There is constant acceleration at 9.8 m/s² throughout the fall. *not true*

V_i is zero mph

Surface Area & Friction from his clothes have no affect on the drag coefficient *not true*

Felix's weight is equal to his mass times the constant acceleration of free fall *not true*

4. Physical Law Needed:

$W = mg \rightarrow 170\ lbs = m \cdot g$ *yes*

$V_{Terminal\,(At\,max)} = \sqrt{\frac{m \cdot g}{D}}$ ✓

$\text{Drag Coefficient } (D) = m \cdot g / V_{terminal}^2$

5.

$D = m \cdot g / V_{Terminal}^2$

$mg = 170\ lbs$

$V_{Terminal} = 1{,}340{,}580\ m/hr$

$D = (170\ lbs) / (1{,}340{,}580\ m/hr)^2$

$= 9.45E^{-11}\ kg/m$

units! (-2) convert: lb → kg, mph → m/s

mercy

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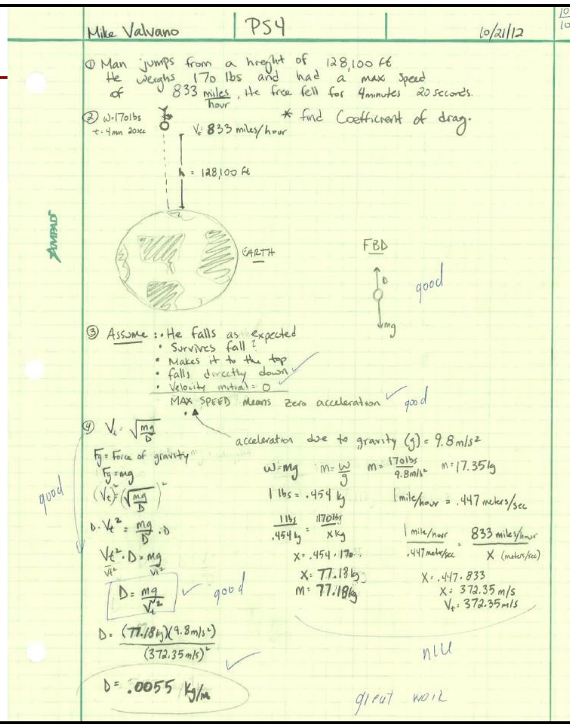
mmer Conference
ield University, CT



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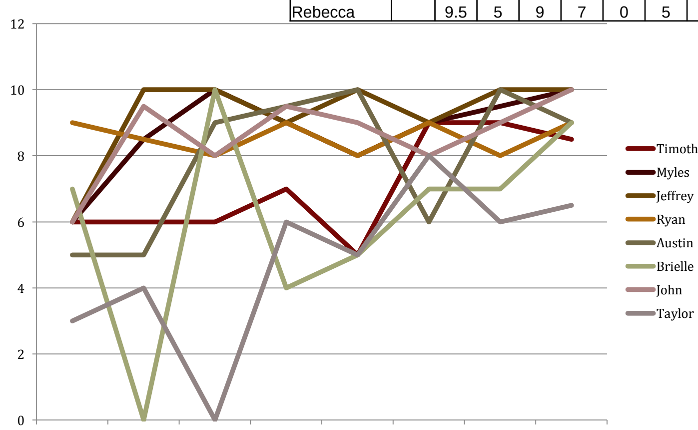
Assessment - PS

	Total	100	10	10	10	10	10	10	10	10	10	
	First Name	Part	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	PS avg
	Jeffrey		9	6	10	10	9	10	9	10	10	9.2
	Timothy		9	6	6	6	7	5	9	9	8.5	7.3
	Myles		9.5	6	8.5	10	9	8	9	9.5	10	8.8
	Ryan		7	9	8.5	8	9	8	9	8	9	8.4
	Austin		9.5	5	5	9	9.5	10	6	10	9	8.1
	Brielle		9	7	0	10	4	5	7	7	9	6.4
	John		8	6	9.5	8	9.5	9	8	9	10	8.6
	Taylor		9	3	4	0	6	5	8	6	6.5	5.3
	Rebecca		9.5	5	9	7	0	5	9	7	9	6.7



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Assessment – WA

- WA1: Interview an engineer and explain where they fit in to the field, role and industry discussed in class. (CO1)
- WA2: Explain how something works. (CO3)
- WA3: Tell about a time you learned the most or were most fascinated by a speaker. Explain why. (CO4)
- WA4: Reflective writing on what you learned about technical writing from your own writing or your peers. (CO5)
- WA5: Reflective writing on three things you could do to improve your presentation skills. (CO4)
- WA6: Review Popular Science article. (CO3)
- WA7: Find a photo that represents each Computer and Electrical Engineering and write 1-2 sentences about it. (CO2)
- WA8: Find a photo that represents each Mechanical, Automation and Software Engineering and write 1-2 sentences about it. (CO2)
- WA9: Reflect on the industry visits and the class field trip. (CO1)

EG31 Class Blog

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FRIDAY, SEPTEMBER 21, 2012

WA2 How a wind turbine works by Kevin Willson

How a wind turbine works

Finding alternate forms of renewable energy, or "green energy", is very hot topic in many parts of the world today. With each passing year the fossil fuel reserves are quickly diminishing. The use of wind turbines to produce wind energy as a power source is a good alternative to non-renewable resources, mainly fossil fuels. There are two types of wind turbines, horizontal axis turbines and vertical axis turbines. Most horizontal axis turbines have three blades. Most utility turbines need a wind speed of 10 mph or more to start turning the blades. The blades on a turbine are connected to a drive shaft, which is connected to an electric generator. Once wind turns the blades, the blades turn the drive shaft, which creates mechanical energy. This energy is gathered in the electrical generator and transferred to electricity. This electricity is then carried through wires and collected, given to the local power grid to be used for energy. To make these turbines more efficient, the turbines have a computer system that monitors wind speed and direction, and adjust the blades accordingly. Small wind turbines will usually create around 100 kilowatts of energy, while big turbine farms can crank out several megawatts of energy which in-turn help energize many people in various towns and cities.

Posted at 9:57 AM Permalink ∞ 1 Comment
Tags: WA2 submission

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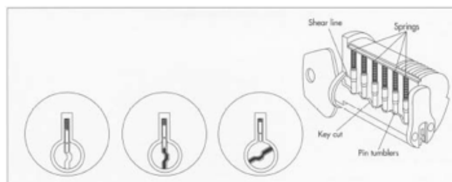
THURSDAY, SEPTEMBER 20, 2012

Locks and Keys

Locks and keys are still used in todays' society as a way to keep items secure. Inside the inner workings of a lock are many different pieces that fit together. Each key can only fit one lock, unless they are mass-produced and are exactly identical. Most companies make low-security locks, which means they can be cheaply and easily made. These kinds of locks are more commonly used for mass production, and only when one asks for a more high-security lock will the company have to use more intense material and a more complex lock.

In order to open a lock, the key must be slid into the opening and turned to the right. To unlock a door the key must be turned to the left. This system works the same as tightening and loosening caps or screws. Once the key is inside, it fits along a set of pin tumblers that are raised to the height of the key cuts. The springs that hold the pin tumblers in place are turned by the rotation of the key. The pin tumblers must align perfectly with the key cuts or the lock will not open. This helps to ensure that locks are not easily picked. In order to pick a lock, the pin tumblers must meet an object at the same height otherwise the springs will not release and the lock will remain closed. When the key is turned, the pin tumblers will release and lock will open.



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FRIDAY, OCTOBER 26, 2012

WA6 by Blanca Aca: What I Learned from "How the Greenest Skyscraper Complex Ever Is Rising Out of the Rubble of the World Trade Center"

The tragic collapse of the World Trade Center on September 11, 2001 was a source of deep grief for the American population. Now, upon the construction of the new World Trade Center (WTC), the site can be a symbol of renewal. Not only is the new WTC being constructed with "the most environmentally advanced technologies," according to "How the Greenest Skyscraper Complex Ever Is Rising Out of the Rubble of the World Trade Center," it is also in line for a gold certificate from Leadership in Energy and Environment Design (LEED). Since LEED serves as "an internationally recognized third-party verification system [...] to confirm that a building [is] designed and constructed with the aim of improving energy savings, water efficiency, CO2 emissions, indoor environmental quality, and intelligent resource management," this is a significant achievement. Indeed, the construction of the WTC is impressive on all these accounts. During construction contractors could only use "ultra-low sulfur diesel fuel" to "reduce nitrogen oxide and particulate emissions." The vehicles used by contractors used "extra particulate filters" to reduce CO2 emissions, and, to ensure that emissions stay at a low rate, WTC is planning on "reducing the amount of vehicular traffic in the area by providing ample public transportation access and extensive facilities for bicycle commuters." Already 75 percent of the building is composed of "post-industrial recycled content," and the construction project itself recycles "80 percent of the waste generated at the site." Consumption of energy and water are also at a low rate. WTC reduces the need for energy by implementing "daylighting," sensors that automatically dim interior lights if there is enough sunlight coming in through the building's ultra-clear glass. Hydrogen fuel cells take wasted steam from steam

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FRIDAY, OCTOBER 26, 2012

3-D Printable Guns

I read the article "A Blueprint to Let Anyone 3-D Print an Open-Source Gun At Home" by Colin Lecher on popsci.com. This article was really interesting because there is this group called "Defense Distributed" that said that if he were to make a code on how to print a 3-D gun via your printer at home then he claims that "wherever there's a printer, there's a weapon." The called the coding for the 3-D gun the "Wiki Weapon". They want to set up a project, where they think that for under $20,000, they can have the information on hoe to do so available to the public for little or no cost. There is also two types of prototypes they thinking about creating: one that does not have moving parts and one that do have moving parts. The question arose that if they were to create the one that has moving parts, if but works once, and made it available to the public to access this information on the internet, would that be illegal? They wanted to show that politicians and government can talk about gun laws and protecting human dignity, in a world that accelerating humanity, but if that process were to be successful then guns laws and regulations can be thrown out the window. They said they might not get their now but maybe the world will figure out how to make a 3-D functional gun and have that available to the public. The end by saying that "Information should be free, an it wants to be" as a way to justify the reason why making the coding available online is a good idea.

Posted at 2:47 PM Permalink ∞ 3 Comments
Tags: WA6 submission

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Assessment - ITW

- Three rounds of review (idea from 2012 CAE Summer Institute):
  - Self review
  - Peer review (read aloud in trios, as in EN 11/12)
  - Instructor review
- Final grade was received after instructor read second draft
- Library class
- 5 references, 2 library references

Grade: 75

Jay Cook
Draft 2

title?

For years, Competitive swimming has been for years about who can out power the person in the next lane using merely their muscles and strength to move through the water. Yet there is a new shift in competitive swimming that has occurred in the early 2000's. Companies like speedo have begun to look into the physics and dynamics of how the body moves through the water. Speedo, with help from NASA and mechanical engineer Herve Morvan of the University of Nottingham, came out with what has been called the Rocket Swimsuit: Speedo's LZR Racer. [1, 2] This swimsuit is the most engineered swimsuit in the world. Its ability to cut down drag and help swimmers reach there full potential is locked inside the technology behind the swimsuit. Speedo's design the LZR Racer is based off the research done by NASA and Herve Morvan, in which NASA and Morvan looked for different ways to minimize drag on the body and to maximize support to the different muscle groups to provide maximize strength.

In order to understand how the LZR Racer works a closer look at water drag must be taken. The less drag on the swimmer the fast the body can move through the water. Drag is resistance on the body due to a fluid or solid. In this case it's the resistance on the body due to water. There are two different kinds of drag, which include form drag and skin drag. Form drag is "the drag created by the shape of the body". [2] If the body is not in a straight line or streamlined position then more form drag will be pushing against the body, which will slow it down. The other type of drag is skin drag. Skin drag is "the resistance of the water against the surface of the body." [2] The larger the surface area of the body the more drag will be created. These two types of drag would be NASA and Morvan's main force in order to create the LZR Racer.

check all you tense

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Assessment - ITP

- Student presented on same technical topic as they wrote about
- Presentations were video taped, so students could watch themselves presenting and reflect on their own presentation skills
- Grade was determined by on-the-fly peer and instructor review via Mentor

Materials | Communications | Student Work | Grade Book Tools | Assessment Tools | Setup

Assignments
Reflective Portfolios
Tests & Surveys
Blog Posts
Projects

Ryan Brown Summary Peer Review

Switch Off Further Peer Review Submissions: No

Reviewee Sees: Summary Data, Individual Reviewer Data

Show Comments

Student Reviewers	Rubric	Score	Include	Display
Blanca Aca-Tecuanhuehue		0.00	☑	☑
Jason Alderisio	View Rubric	89.33	☑	☑
Evan Apanovitch	View Rubric	86.67	☑	☑
Christopher Calitri		0.00	☑	☑
William Carley	View Rubric	84.00	☑	☑
Jorge Chiluisa		0.00	☑	☑
Jeffrey Cook		0.00	☑	☑
Timothy Dessureau		0.00	☑	☑
Oliver Dumoulin		0.00	☑	☑
Brandon Dwyer	View Rubric	90.67	☑	☑
Michael Genovese	View Rubric	88.00	☑	☑
Tayler Goldstein	View Rubric	89.33	☑	☑
Myles Golymbieski-Rey		0.00	☑	☑
Ryan Hirschthal		0.00	☑	☑
Austin Hliboki		0.00	☑	☑
Nathan Hoey	View Rubric	90.67	☑	☑

Assessment - ITP

Individual Technical Presentation - Example

Assessment - TDP

Design Goal:

Teams must design a system that propels a single person (the "operator") across the entire length of the RecPlex swimming pool with a walking or running motion above water.

Project/Competition Rules:

1. All systems must fit in single regulation sized swimming lane.
2. Total project cost must not exceed $100. However, no materials will be provided so it is encouraged that you find spare, unused, and recycled materials to work with.
3. If the operator falls into the water they must either: (a) get back up in that location unassisted or (b) return to the start and have their team help them remount.
4. Absolutely no cardboard or paper can be used in the design of the WOW system. Be considerate and do not use any materials that could potentially cause damage to pool drains.
5. The operator must be able to swim and we highly recommend that you wear a helmet.

YOUR TURN: What would YOU design?

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Assessment - TDP

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CAE 12th Annual Summer Conference
May 30th, 2013 | Fairfield University, CT 35

Assessment – Outcomes Connection

We moved from graded assignments:

		Homework - Writing Assignments				Homework - Problem Sets							
		1	3	9		8	8	8	5	4	6, 7, 8		
ID	Attendance - Attendance	Homework - WA1	Homework - WA2	Homework - WA9	Grade	Homework - PS1	Homework - PS9	Grade	Paper - Individual Technical Writing (ITW)	Presentation - Individual Oral Presentation (IOP)	Project - Final Team Design Project (TDP)	Calc Percent	Final Percent
	0.20	0	0	0	0.2	0	0	0.2	0.1	0.1	0.2	1	N/A
103445	100	100	100	80	97.78	75	95	89.44	100	96.95	80	93.14	93.14
102439	100	90	90	70	85.56	95	90	86.67	75	87.96	90	88.74	88.74
20677	92	100	0	100	66.67	100	90	91.11	85	92.32	75	82.69	82.69
99446	96	0	100	80	83.33	95	80	79.44	90	88.36	80	85.59	85.59
98522	96	90	100	95	96.11	70	100	84.44	95	88.38	70	87.65	87.65
100168	85	80	0	60	76.67	90	90	78.89	75	92.79	50	74.89	74.89
40467	23	0	0	0	0	0	0	0	0	0	0	4.6	4.6
106775	96	90	80	80	84.44	90	100	92.22	80	94.54	95	90.99	90.99
101637	96	100	100	90	97.78	90	85	72.78	90	90.27	100	91.34	91.34
40542	92	100	80	0	47.78	70	0	34.44	85	84.36	70	65.78	65.78
95822	100	0	0	20	41.11	60	0	23.33	80	85	80	65.39	65.39
101935	100	90	90	80	84.44	85	80	66.11	85	93.03	65	80.91	80.91
98427	92	100	90	90	92.22	95	90	87.22	95	96.42	95	92.43	92.43
102865	100	100	100	100	98.89	95	100	88.33	90	94.99	80	91.94	91.94
95452	100	70	100	100	95.56	70	90	83.89	90	90.15	95	92.9	92.91
97810	88	90	90	70	87.78	95	90	81.11	75	89.83	70	81.86	81.86
82396	96	70	0	80	72.22	80	100	85	100	92.53	50	79.9	79.9
109757	96	100	100	90	98.89	90	90	64.44	90	88.07	70	83.67	83.67
99589	100	90	100	70	81.11	80	90	84.44	95	96.85	100	92.3	92.3
99664	92	100	80	80	56.67	90	65	52.78	90	89.85	85	75.28	75.28
104564	92	100	90	60	65.56	85	85	83.33	100	88.83	90	85.06	85.06

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Assessment – Outcomes Connection

To provide "graded" course outcomes

Course Outcome Calculations (ABET a-k underneath)									
2	7	6	8	9	4	5	4,5	1	3
n/a	c	d	e	f	g	g	g	h	i,j
100	80	80	89.44	80	96.95	100	98.475	100.00	100
90	90	90	86.67	70	87.96	75	81.48	85.00	90
100	75	75	91.11	100	92.32	85	88.66	50.00	50
100	80	80	79.44	80	88.36	90	89.18	45.00	95
100	70	70	84.44	95	88.38	95	91.69	90.00	100
90	50	50	78.89	60	92.79	75	83.895	85.00	45
0	0	0	0	0	0	0	0	0.00	0
90	95	95	92.22	80	94.54	80	87.27	90.00	80
100	100	100	72.78	90	90.27	90	90.135	100.00	100
0	70	70	34.44	0	84.36	85	84.68	50.00	40
0	80	80	23.33	20	85	80	82.5	40.00	45
90	65	65	66.11	80	93.03	85	89.015	85.00	85
100	95	95	87.22	90	96.42	95	95.71	95.00	95
100	80	80	88.33	100	94.99	90	92.495	100.00	100
100	95	95	83.89	100	90.15	90	90.075	85.00	95
90	70	70	81.11	70	89.83	75	82.415	90.00	90
90	50	50	85	80	92.53	100	96.265	75.00	45
100	70	70	64.44	90	88.07	90	89.035	100.00	100
0	100	100	84.44	70	96.85	95	95.925	95.00	100
0	85	85	52.78	80	89.85	90	89.925	90.00	40
90	90	90	83.33	60	88.83	100	94.415	50.00	45

Assessment – Outcomes Connection

Which were ultimately converted into ABET outcome rubric scores

Outcome Rubric Score								
c	d	e	f	g	h	i	j	Average red = student at risk
3	3	4	3	5	4	4	4	3.75
4	4	4	3	3	4	4	4	3.75
3	3	5	5	4	2	2	2	3.25
3	3	3	3	4	2	4	4	3.25
3	3	4	5	4	4	4	4	3.875
1	1	3	2	3	4	2	2	2.25
1	1	1	1	1	1	1	1	1
5	5	5	3	4	4	3	3	4
5	5	3	4	4	4	4	4	4.125
3	3	1	1	3	2	2	2	2.125
3	3	1	1	3	2	2	2	2.125
2	2	2	3	4	4	4	4	3.125
5	5	4	4	5	4	4	4	4.375
3	3	4	5	4	4	4	4	3.875
5	5	4	5	4	4	4	4	4.375
3	3	4	3	3	4	4	4	3.5
1	1	4	3	5	3	2	2	2.625
3	3	2	4	4	4	4	4	3.5
5	5	4	3	5	4	4	4	4.25
4	4	1	3	4	4	2	2	3
4	4	4	2	4	2	2	2	3

Outcome Rubric Key

Score c,d,e,f,g	Rubric	Score h,i,j	Rubric
95	5	85	4
85	4	70	3
70	3	0	2
60	2		
0	1		

Outcomes c,d,e,f,g were graded objectively, so the score translates more accurately into the rubric value. For outcomes h,I,j they were only measured by completion of the writing assignment, so I only chose rubric values between 2-4. Any of these can be varied based on instructor perception of student performance on an in class, unevaluated activity.

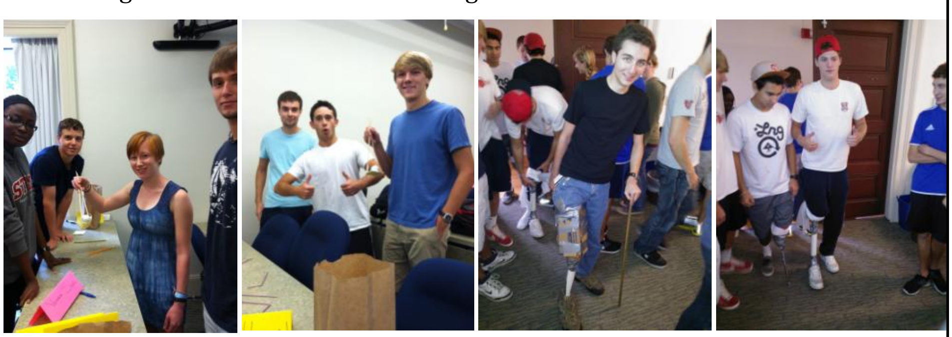
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Backward Course Design

- Course Goals
  - What will the students take away from the course 5+ years from now?
- Course Outcomes
  - What do we expect the students to learn?
- Assessment
  - How will we know the students have learned?
- Curriculum
  - Through what experiences will the students learn best?

Curriculum – In Class Design Projects

- Hands on, Interactive, In-class design projects
  - Design a method for transferring radioactive golf balls from one location to another
  - Design a prosthetic leg
  - Program an arduino to turn on a light



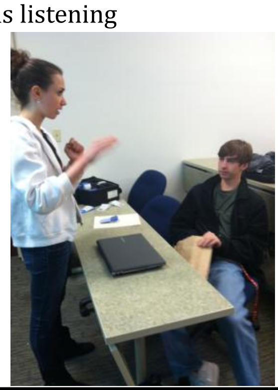
Curriculum – Team Building

- Fun, teamwork, creativity activities
  - Estimate the height of the Engineering building using only a mirror, a pencil, and a piece of paper
  - “Cross the river” with only a few supplies
  - Brainstorming activities



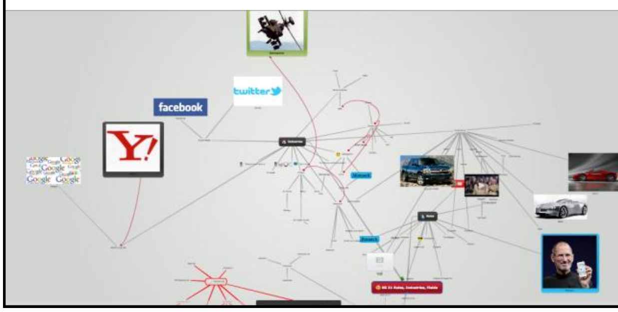

Curriculum – Communication Skills

- In-class activities to improve listening, writing, reading, and speaking skills
  - One-minute technical speeches
  - Writing instructions for using “technically challenging” devices (iPods, toaster ovens, microwave, hair dryer, etc.)
  - Instructor reads technical article out loud, followed by clicker quiz to see if anyone was listening
  - Blind Building


Curriculum – Professional Engineering

- Various professional engineering activities
  - Mindmap of engineering industries, fields, and roles (idea from CAE Summer Institute 2012)
  - Professional Engineers gave presentations to students from Covidien, ASML, and Yale ROTC
  - Optional field trip to Sikorsky Aircraft for tour
  - Class visit from career center, resume writing, engineering ethics discussion, case studies from real engineers solving problems, intro to project management.



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YOUR TURN: Radioactive Golf Balls

- **Objective**: Using the supplies provided, design a device to see who can transfer 5 golf balls from one bag to the other in the shortest amount of time.
- **Rules**:
  - The teams may alter the supplies in any way necessary;
  - The golf balls must be moved one at a time;
  - No part of a person's body or clothing may touch the golf balls. The balls must stay at least 3 inches away from any body part–notably the hand.
  - If anyone touches a ball or if a ball gets dropped, there is a contamination leak! A member of the team must return the contaminated ball to bag #1;
  - This is a speed competition! The team whose device successfully completes the task in the shortest amount of time wins.

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Linking Course Outcomes to…

- Course Goals
- Accreditation Board for Engineering and Technology (ABET) Student Outcomes
- Fairfield University's Core Pathways

Fairfield's 6 Core Pathways

- Engaging Traditions
- Creative and Aesthetic Engagement
- Global Citizenship
- Rhetoric and Reflection
- Quantitative Reasoning
- Scientific Reasoning

Linkage – Goals/Outcomes & ABET

Course Goals

I. Motivate learning of, and create a passion for, engineering.
II. Develop an engineering mindset, problem solving skills, and critical thinking.
III. Develop engineering professionalism.

Course Outcomes

1. Understand the roles of engineers in different fields and different industries in a global, economic, environmental, and societal context. (h) [I]
2. Be familiar with the different engineering majors at Fairfield. [I]
3. Develop an awareness of modern technology and its use in the engineering field. (i, j) [I]
4. Demonstrate effective oral communication about technical content. (g) [III]
5. Demonstrate effective technical writing. (g) [III]
6. Be able to work in interdisciplinary teams. (d) [II,III]
7. Be familiar with project and time management. (d) [III]
8. Be able to identify, formulate and solve engineering problems. (e) [II]
9. Develop an awareness of best practices and ethics in engineering and their use by professionals. (f) [III]

ABET Outcomes

(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues

Linkage – Core Pathways

- Quantitative Reasoning and Scientific Reasoning – obvious linkage
- Global Citizenship – solving problems that benefit humanity.
- Rhetoric and Reflection - communicate clearly with peers, clients, and customers
- Reflect on the various Pathways and draw those connections between seemingly disparate courses. Find ways in which one course or activity benefits understanding of another—Connection to English and Physics

Reflections on Redesign

A few comments from student evaluations:

- "This class has inspired me to become an engineer."
- "Great class, I learned a lot of technical concepts when she was teaching. Fun while challenging at the same time."
- "Very interesting class. Great group work skills. Fun yet challenging class."

Anecdotal Comments from students:

- "I really liked working on an engineering project with a team. It was rewarding to actually get it to work."

Reflections on Redesign

From IDEA Evaluations:

- 96%/88% of students ranked 4 or 5 out of 5 "Acquiring skills in working with others as a member of a team" ***(Essential)***
- 92%/77% of students ranked 4 or 5 out of 5 "Developing skills in expressing myself orally or in writing" ***(Essential)***
- 80%/81% of students ranked 4 or 5 out of 5 "Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to this course" ***(Important)***

Lessons Learned

- Make two "tracks" through EG 31, PS 15, MA 145, with a cohort of students in each track to maximize the benefit of being a cornerstone
- Use Mentor for blog instead of Tumblr!
- Get help with grading (teaching assistant)
- Consider giving more time for TDP. Have students check in or turn in project progress.
- In-Class participation, 10% of grade, more rigorous assessment of this? (2/7 absences)

Participant Reflection

- What methods have you learned that you can apply in your courses, and how?
- Were there any activities that we did that you can apply to your course?
- Could you use backward course design to improve one of your courses?

Thank you!