Queen's University
Mechanical Engineering

McLaughlin Hall
Kingston, Ontario, Canada

Capstone Design – Experience with Industry Based Projects

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First CDIO Annual Conference
June 7 to 8, 2005
Queen's University, Kingston

Mechanical Engineering at Queen's

- 1st year physics, chemistry, math, drafting
- 2nd and 3rd year courses in thermodynamics, fluid mechanics, solid mechanics, dynamics

common

- 2nd year courses in materials and manufacturing which include 12 weeks of machine shop
- 3rd year courses in machine design, electronics, statistics, and automatic controls
- business, humanities and social science courses
- 4th year tech electives plus ***capstone design project***

First, perspective on where engineering education starts

E=MC²

High school engineering outreach courses must be hands-on

5 days of lectures, tutorials, labs and working together on mobile robots

E=MC²

Hands-on is important, counter the negative view that university is about sitting in a classroom for 4 years

Engineering education is about hands-on labs

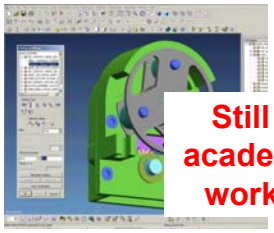
But this only addresses the engineering science component, what about design ?

2nd year introduction to manufacturing

12 week course in machine shop practice, what are the tools and what can they do ?

3rd year introduction to design, build, test, admire (CDIO)

DBT a pump in 12 weeks (elective)



Still viewed (by some) as an academic exercise, when do we work on "real" engineering ?

Competition Teams – now this is real

But this are student driven (led) and only involve about 20 % of the students … and very expensive

MECH 460 – Conceive and Design (2004)

- required 1 term (12 week) course for 130 students
- 32 projects with 4 students per project
- 28 were industry based (4 were vehicle team based)
- doesn't have the implement component, a paper design only for most projects (with some exceptions)

Comments

- provides the "senior year team design experience" that is required in CEAB guidelines
- ***students are allowed to select their own groups***

MECH 462 – Implement and Operate (2005)

- continuation of MECH 460
- elective 1 term (12 week) course for 56 students (about 40% of the MECH 460 class)
- 14 projects with 4 students per project
- 10 were industry based (4 vehicle team based)

Comment

- elective nature provides flexibility, can drop those projects (and students) who don't work out
- means you don't expend resources on students who have no intention of becoming engineers

MECH 460 Listing of Industrial Projects (2004)

Company	Project
ASK Science	Autonomous Fish
Bosal Canada	Manufacture of Muffler Boxes
Continental Conveyor	Seal Cartridge Assembly
Decoma Autosystems	Xenon Automotive Headlamp
Energy Depot	Integrated Solar Energy
Enerworks	Photovoltaic Powered Pump
Fuel Cell Research Centre	Fuel Cell Powered Golf Cart
Goodyear	Rubber Material Handling
Hydrogenics	Polymer Electrolyte Fuel Cells
Kilmarnock	Machine Noise Suppression
Knorr Brake	MCL Actuator Brake Seals
KTH Shelburne	Inspection of Stamping Operations
MCW Custom Energy	Variable Air Volume Systems
Millenium Biologix	Tube Roller
Muskoka Renewables	Automated Solar Tracker
Niagara Prosthetics #1	The Niagara Foot
Niagara Prosthetics #2	The Prosthetic Pylon
Northern Cables	Ventilation Assessment
Pennsafe	Safety Snap Hook Design
Procter & Gamble #1	Olay Material Handling
Procter & Gamble #2	Reject Verification Optimization
Pump House Museum	Steam Turbine Demo Unit
Samui Corp	Bicycle Trailer Design
Shorewood Packaging	Auxiliary Driven Oscillator
Superior Wind	Self-Erecting Wind Tower
Transformix Engineering	Underwater Camera
Van Rob Stampings	Wire-feed Speed in Arc Welding
Waterstick Paddles	Performance Canoe Paddles

Size of company varies from 1 employee (consultant) to job shop with 10 employees to manufacturing facility with 1500 employees

- no fee charged, company covers expenses when over
- $200/project MECH 460
- $1,000/project MECH 462

MMO Budget Guidelines

Item	Budget
Adjunct faculty for course coordination	$15,000
Administrative staff	$5,000
One person project	$500/project
Two person project	$1200/project
Three person project	$3500/project
Average project expense	$1500/project

- cost is $50,000 (CAD), MMO grant makes it possible
- Materials and Manufacturing Ontario (MMO), awards grants to underwrite industry project expenses
- valid expenses include travel, supplies, materials and administrative salaries

Assessment for MECH 460 Design Project

Item	Mark
Letter of Intent	0
Design Notebook	5
Weekly Progress Memo	10
Oral Presentations (two, progress and poster)	10
Design Proposal Report	10
The Poster	10
Final Design Report	50
Industry client assessment	5
Thank you letter to industry client	0
	100

- projects posted on website, students submit a letter to identify their 3 top choices and to “sell” their qualifications
- coordinator matches groups to projects
- each project has faculty supervisor and industry advisor

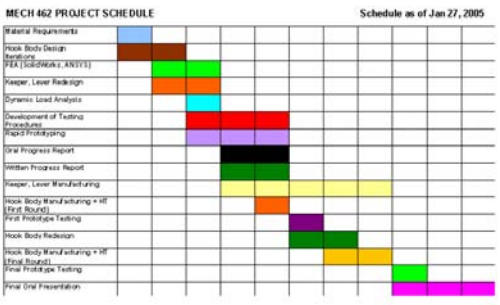
Project Poster Session at End of Term

- organized like a job fair
- 3x4' poster to summarize project
- posters (and supporting oral presentation) marked by faculty ***and*** industry

Prototype on rapid prototyping machine in the ILC

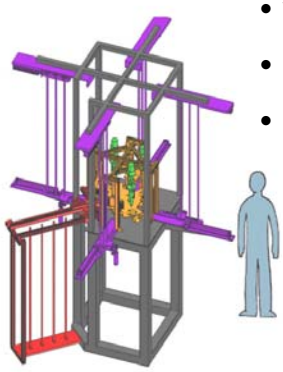
Pensafe safety hook

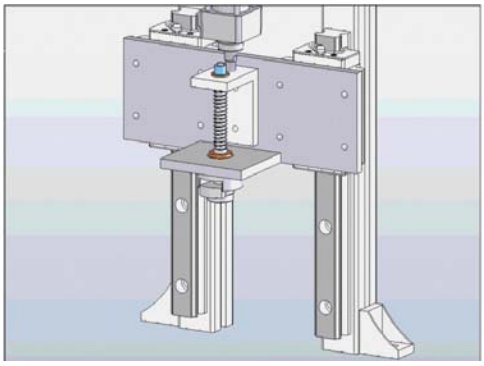
- **prototyping example**
- **widget design**
- **sample GANTT chart**



Continental Conveyor cartridge assembly

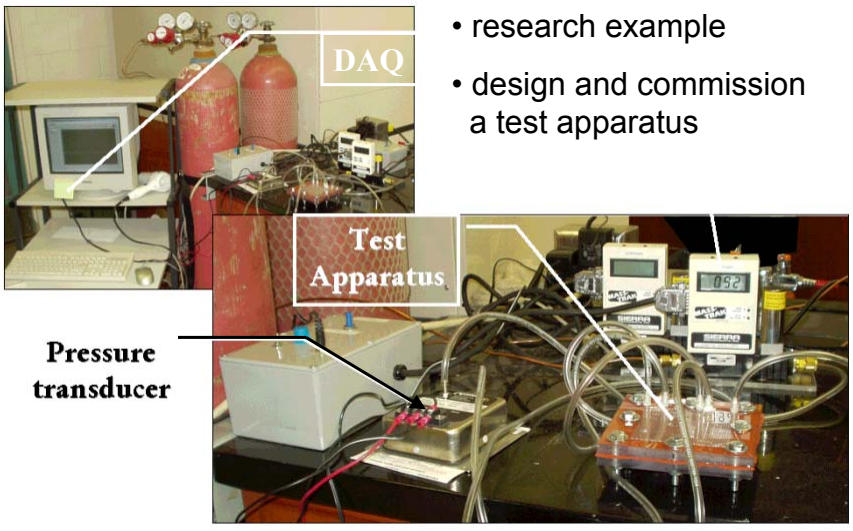
- virtual prototyping example
- machine design
- automate a manual process





Hydrogenics fuel cell test apparatus

- research example
- design and commission a test apparatus



At end of term, students in MECH 462 compete with students from Electrical and Civil for a cash prize from Procter and Gamble

- oral presentation
- industrial application (30%)
- innovation (30%)
- resourcefulness (20%)
- mastery in discipline (20%)
- four judges from P&G

Some Problems

- matching groups to projects
- budget control (student expenses)
- quality control (supervisor commitment)
- finding good projects (scope)

What makes a "good" project ?

- company has no expectations
- challenging to students, but realistic in terms of finishing in 12 weeks

Some Answers

- post more projects than required
- weekly memos (3rd party monitoring)
- **constant communication between faculty, industry and students**
- recycling of good projects
- industry advisor provides a mark
- students fill out same Queen's expense forms as used by the faculty