CURRICULUM REDESIGN AROUND STUDIOS AND ONLINE LEARNING: Using Design and Innovation to reshape the curriculum

Professor Roger Hadgraft
Faculty of Engineering and IT
University of Technology Sydney
6 DRIVERS OF CHANGE

- **extreme longevity**: Increasing global lifespans change the nature of careers and learning.
- **computational world**: Massive increase in sensors and processing power make the world a programmable system.
- **superstructured organizations**: Social technologies drive new forms of production and value creation.

- **Trans-disciplinarity**
- **Design Mindset**
6 DRIVERS OF CHANGE

- **rise of smart machines and systems**: Workplace robotics nudge human workers out of rote, repetitive tasks.
- **Novel and Adaptive Thinking**: New communication tools require new media literacies beyond text.
- **Social Intelligence**: Increased global interconnectivity puts diversity and adaptability at the center of organizational operations.
- **Computational Thinking**: Globally-connected world
- **Cognitive Load Management**:
GLOBAL CHALLENGES

- Sustainability
- Energy
- Transport
- Communications

- Water
- Food
- Health
- Security
PROBLEM 1: EDUCATE FOR COMPLEXITY
PROBLEM 2: CURRENT TEACHING PROCESSES
PROBLEM 3: THE COMING TECHNOLOGICAL REVOLUTION
"I feel this is something as fundamentally new to education as the invention of printing."

Daniel
Student CS101, New York, USA
WHAT’S OUR PURPOSE?
International Reviews

Robin King’s report (2008)


ASCE ‘Body of Knowledge 2’

The Engineer of 2020, NAE (2004)


RECOMMENDATIONS

Engage students by:

• Balancing **theory** and **practice**
• More **industry** involvement
• More **active** learning
• **Sharing** best-practice
• More student **diversity**
• **Hands-on activity!**
PROBLEM 4:
EDUCATE FOR PROFESSIONAL PRACTICE
ENGINEERING AND ICT

Threshold learning outcomes:

1. Understand the **problem** in context,
2. Use a **problem solving process**,
3. supported by **disciplinary knowledge**
4. Use **teamwork and communication** and
5. Understand, manage and develop **oneself**.

[http://disciplinestandards.pbworks.com](http://disciplinestandards.pbworks.com)
Investigation
Design
Modelling
Assessment
Planning and Management
Audit and Compliance

This is what engineering is about

Figure 2: The Environmental Engineering Capability Cube
The Making of an Expert Engineer

Published: September 22, 2014 by CRC Press
Content: 612 Pages
Author(s): James Trevelyan

» Recommend to Librarian
PROBLEM 5: WHAT IS PROFESSIONAL PRACTICE?!
SO, HOW TO PROCEED?
OPPORTUNITY 1:
EXPERIENTIAL LEARNING
PROJECT-BASED LEARNING
The CDIO™ INITIATIVE is an innovative educational framework for producing the next generation of engineers. The framework provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment.

See what happened at the 2012
HOW IS THIS BEST LEARNED?

Need complex learning situations
E.g., Aalborg University, DK since 1974

Using a sequence of project-based courses: 25-50% of the curriculum

Students learn the BIG PICTURE (professional practice)
## ENVIRONMENTAL ENGINEERING @ UTS (OLD)

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
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<tr>
<td># # # Maths Mod 1 6</td>
<td># # # Maths Mod 2 6</td>
<td># # # Design &amp; Inno Fundamentals 6</td>
<td># # # Eng Eco &amp; Fin 6</td>
<td># # # Eng Proj Man 6</td>
<td># # # Entrepreneur &amp; 6</td>
<td># # # Eng Research 6</td>
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<td># # # Chem 1 6</td>
<td># # # Site Investigation for Enviro 6</td>
<td># # # Prin Enviro Investigation 6</td>
<td># # # Biocomplexity 6</td>
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<td># # # Intro to Civil &amp; Enviro Eng 6</td>
<td># # # Surveying 6</td>
<td># # # Engineering Computations 6</td>
<td># # # Fluid Mech 6</td>
<td># # # Hydraulics &amp; Hydrology 6</td>
<td># # # Elective 6</td>
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### Core Courses:
- Maths Mod 1
- Maths Mod 2
- Design & Inno Fundamentals
- Eng Eco & Fin
- Eng Proj Man
- Entrepreneur &
- Eng Research
- Water & Enviro Design

### Major Courses:
- Phys Mod
- Chem 1
- Site Investigation for Enviro
- Prin Enviro Investigation
- Biocomplexity
- Poll'n Control & Wm't Management
- Water & Enviro Design

### Elective Courses:
- Intro to Civil & Enviro Eng
- Surveying
- Engineering Computations
- Fluid Mech
- Hydraulics & Hydrology
- Elective
- Hydraulics & Hydro
- Water Supply
- 144 CP

### Engineering Practice Program (EPP):
- EPP
- EPP
- EPP
- EPP
- EPP
- EPP

### Work Integrated Learning (WIL):
- 4047 Work Integrated Learning 1
- 4047 Work Integrated Learning 2

### Notes:
- # indicates core courses.
- MAJ indicates major courses.
- EPP indicates Engineering Practice Program courses.
- WIL indicates Work Integrated Learning courses.

### Credits:
- CP: Credit Points
- 60: Total Credits
# ENVIRONMENTAL ENGINEERING WITH STUDIOS

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<td># Eng Proj Man 6</td>
<td># Entrepreneur &amp; Commercialisation 6</td>
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<td># Eng Mechanics 6</td>
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<td># Physical Mod [CJ]</td>
<td># Chemistry 1 6</td>
<td># Intro to Civ &amp; Env Eng 6</td>
<td># Urban Water &amp; Waste Management 6</td>
<td># Energy 6</td>
<td># Managing Land &amp; Water Resources 6</td>
<td>Elative 6</td>
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## UTS:

[uts.edu.au](http://uts.edu.au)
STUDIOS IN ENVIRONMENTAL ENGINEERING

1. Environmental Engineering Practices
2. Sustainable Urban Transport Systems
3. Urban Water and Waste
4. Energy Engineering
5. Land and Water Management

a) Investigation
b) Modelling
c) Design
d) Impact Assessment
e) Audit & compliance
f) Environmental management
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<tr>
<th>First Year</th>
<th>Stage 1</th>
<th>33130 Mathematical Modelling 1</th>
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<tr>
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<td>Stage 3</td>
<td>68037 Physical Modelling</td>
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<td>Stage 9</td>
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<td>Stage 10</td>
<td>Elective 3, or Honours Project Ext</td>
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<td>Fifth Year (Honours)</td>
<td>Stage 9</td>
<td>41029 Research Preparation</td>
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<td>Stage 10</td>
<td>41030 Honours Project</td>
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</tbody>
</table>
PROJECT/STUDIO STRUCTURE

1. Develops professional **capabilities** (outcomes)
2. Supporting **online modules** (+ assessment)
3. **Project/studio** (group/team) work
4. **Multi-age** structure
5. **Exhibition**, presentation, interview
6. **Portfolio** as evidence of attainment
EASY TRANSITION TO A PBL CURRICULUM

1. Make **projects** in more courses
2. Rethink **sequences** of courses, e.g. fluids, structures
3. Identify a project course in each **semester**
4. **Share** projects across semesters
5. **Combine** subjects into bigger units with bolder objectives
6. Introduce multi/ **transdisciplinary** projects
PROBLEM 6:
CURRICULUM REDESIGN AROUND ENGINEERING DESIGN
WHAT IS DESIGN?

Client need

Explore the Problem

Social, Economic & Environmental requirements

Explore the solutions

Evaluate & choose

Build + Test

Deliver + Test

Design needs to be central
3DEXPERIENCE Portfolio

Enabling Maximum Flexibility and Optimal Total Cost of Ownership

Learn More

Brand Applications & Services

Best in class product development software applications, delivered on the 3DEXPERIENCE platform, enabling 3D Design, Engineering, 3D CAD, Modeling, Simulation, Data Management and Process Management.
Graduate outcomes, requiring human input in the learning process

Professional practice

Enabling skills

Easily 50% of most engineering curricula is easily replaced by technology
+ ONLINE ASSESSMENT

Students demonstrate competence online

Treat it like a computer game

- Many levels to explore and accumulate points
- Collect “talents, prizes, medals, badges, …”

Example: Peerwise (Univ. of Auckland)

Supported by tutorial classes as required
OPPORTUNITY 2: ADAPTIVE COMPUTER TUTORIALS WITH E-ASSESSMENT
IN a car crash, the vehicles' mass, size and velocity are the key factors to estimate the damages to the vehicles and the driver. This Adaptive Tutorial covers the principle of impulse and momentum using a hypothetical simulation of a crash of a vehicle.
Over 300 Statics Videos!

I know you have all heard that statics is said to be a weeder class for engineers. It doesn't have to be, get off with the right foot by learning engineering statics from Professor Jeff Jones. Jeff has taught statics for over 25 years and practiced as a structural engineer for an additional 10 years before becoming a teacher!

Professor Jones has recorded over 350 engineering statics videos that cover just about every aspect of statics. He doesn't just solve the problems but teaches you the skills required to tackle any statics problem. Check out some of the free sample problems below or browse through our book for all 350+ statics videos.

Over 20,000 students have mastered STATICS with our videos!
IF WE DON’T CHANGE …

Others will take away (parts of) our business
SOLUTION:
PROJECT-ORIENTED CURRICULA
WITH ONLINE SUPPORT
WE’RE MOVING FROM TEACHING USING TRADITIONAL METHODS

To Personalised Learning in the Age of Google

e-portfolio supported, project oriented learning
E-PORTFOLIOS

From day 1, students accumulate:

1. Career intentions – industry, employer, etc.
2. Capabilities to be developed
3. Evidence of capabilities developed
4. Reflections on learning and future learning needs
5. Exposition for various audiences of competitive advantage
THE TEACHER'S FUNDAMENTAL TASK IS TO GET STUDENTS TO ENGAGE IN LEARNING ACTIVITIES... (SHUELL 1986)
Design a better, faster and cooler F1™ car of the future

The Worlds Largest Science, Technology, Engineering & Mathematics (STEM) Competition

The F1 in Schools™ Technology Challenge is the
IN SUMMARY

Problems:
1. Complexity of problems
2. Technological revolution
3. Professional practice
4. What is professional practice?
5. Old fashioned curricula
SUMMARY 2

Solutions:
1. Projects
2. Online tutorials plus assessment
3. E-Portfolios
4. Redesign the curricula
5. Re-educate (re-hire) the staff
QUESTIONS?