

Educating the Sustainability Engineer: Redesigning Curricula

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21st Century Engineering is complex



Global Engineering Challenges

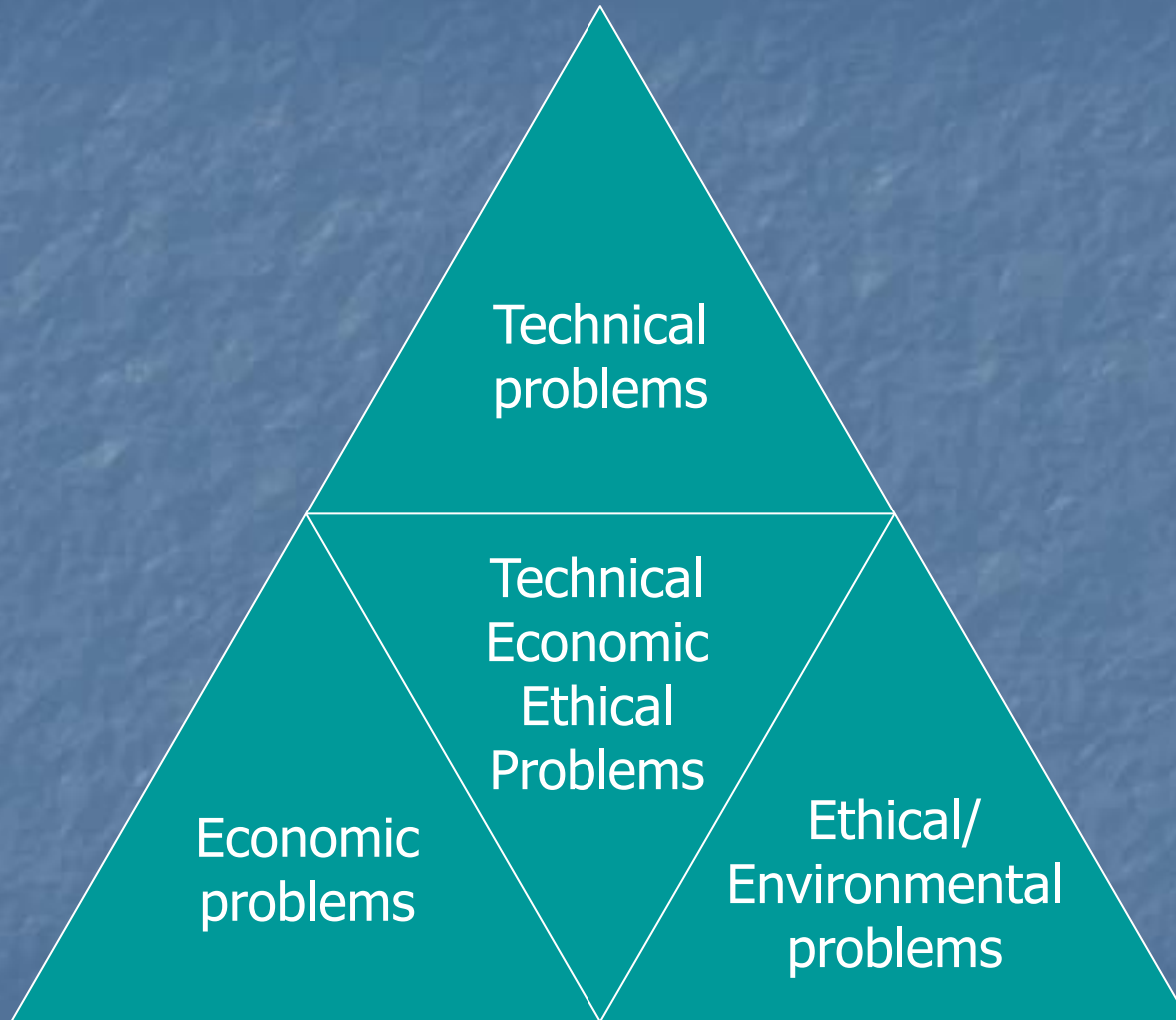
Our future challenges are daunting yet fascinating, to provide sustainable solutions in:

- Water, Sanitation and Public Health
- Food
- Energy
- Transport
- Communications
- Security
- ...



<http://designpublic.in/blog/wp-content/uploads/2013/05/india-water-and-sanitation.jpg>

Scientific/Technical



Jamison,
Kolmos,
Holgaard:
*Aalborg
University,
Denmark*

Entrepreneurial

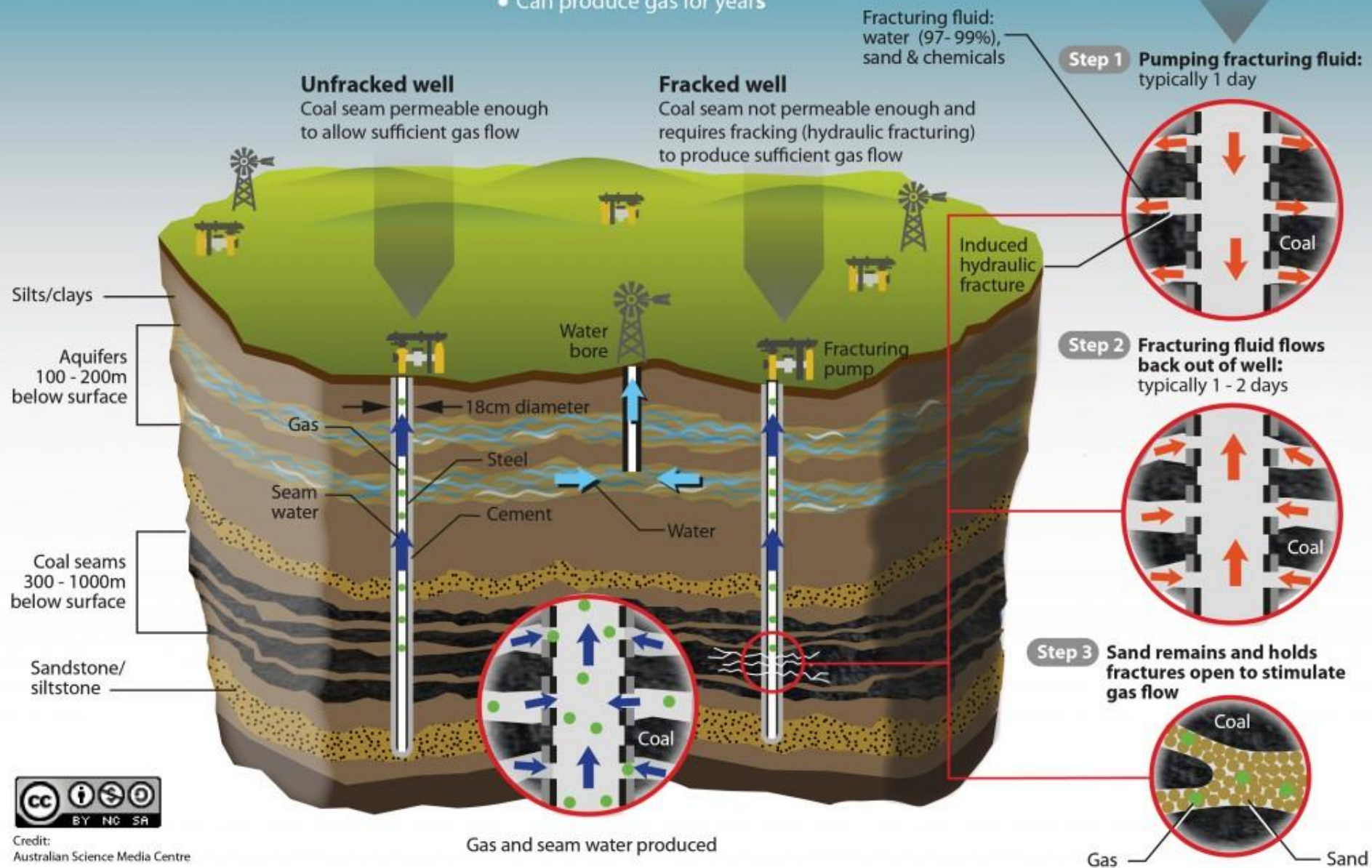
Social/Ethical

diagram not to scale
illustrative purposes only

Coal seam gas

- Wells typically take 2 weeks to drill
- Can produce gas for years

Steps involved in fracking (hydraulic fracturing)



How do we educate engineers for
this challenging environment?

What is it that engineers
actually do?

Define Your Discipline

1. “Write TASKS that a graduate would be expected to perform in your organisation”
2. CLUSTER the tasks in meaningful ways



Australian Government



Office for
Learning & Teaching



MELBOURNE
SCHOOL OF
ENGINEERING



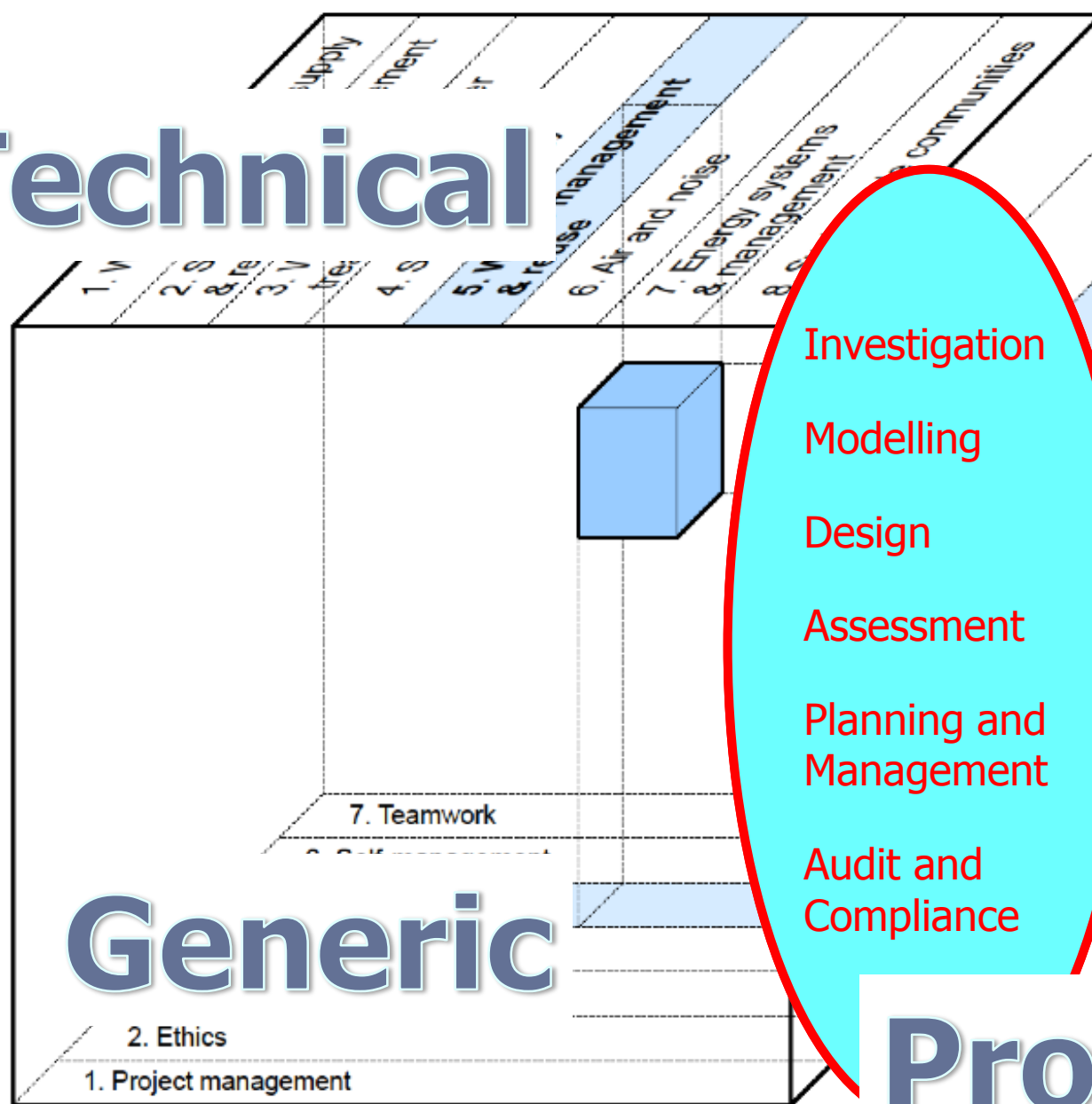
ENGINEERS
AUSTRALIA



UNIVERSITY
OF SOUTHERN
QUEENSLAND



Technical



Generic

Process

Figure 2: The Environmental Engineering Capability Cube

ABET Process skills

- a) **apply knowledge** of mathematics, science, and engineering
- b) **design and conduct experiments**, as well as to analyze and interpret data
- c) **design a system**, component, or process to meet desired needs within realistic constraints ...
- e) **identify, formulate, and solve** engineering problems
- h) **understand the impact** of engineering solutions in a global, economic, ...
- k) **use the techniques, skills**, and modern engineering tools necessary for engineering practice.

ABET Generic skills

- d) function on **multidisciplinary teams**
- f) an understanding of professional and **ethical responsibility**
- g) **communicate** effectively
- i) engage in **life-long learning**
- j) a knowledge of **contemporary issues**

International Reviews of Engineering Education

Sheppard, S. D. et al. (2008).
Educating Engineers: Designing for
the Future of the Field.

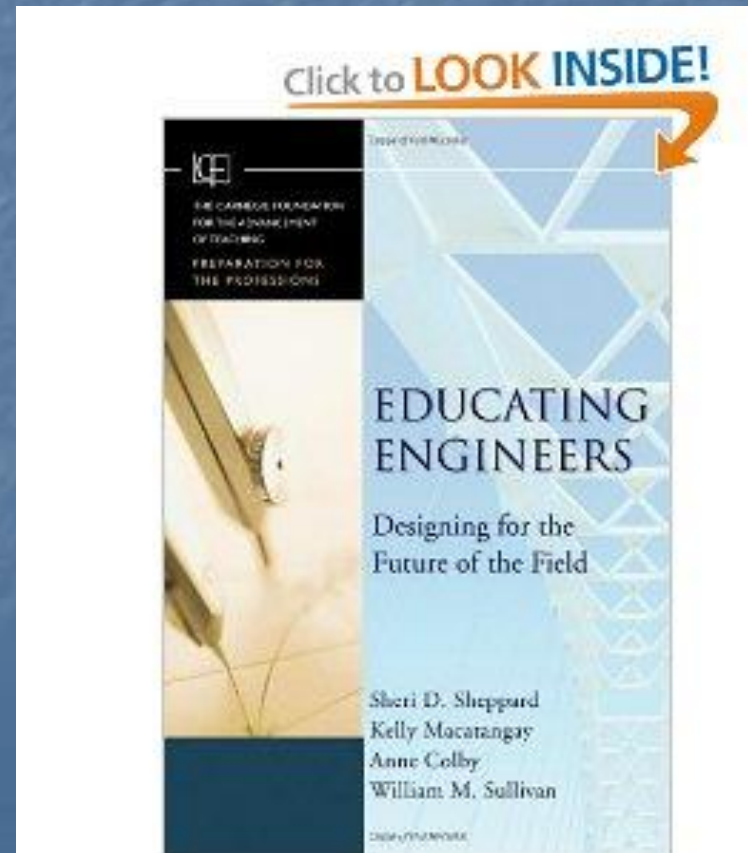
ASCE 'Body of Knowledge 2'

The Engineer of 2020

**Educating the Engineer of
2020**

UK Henley Report

King, R. – Australia



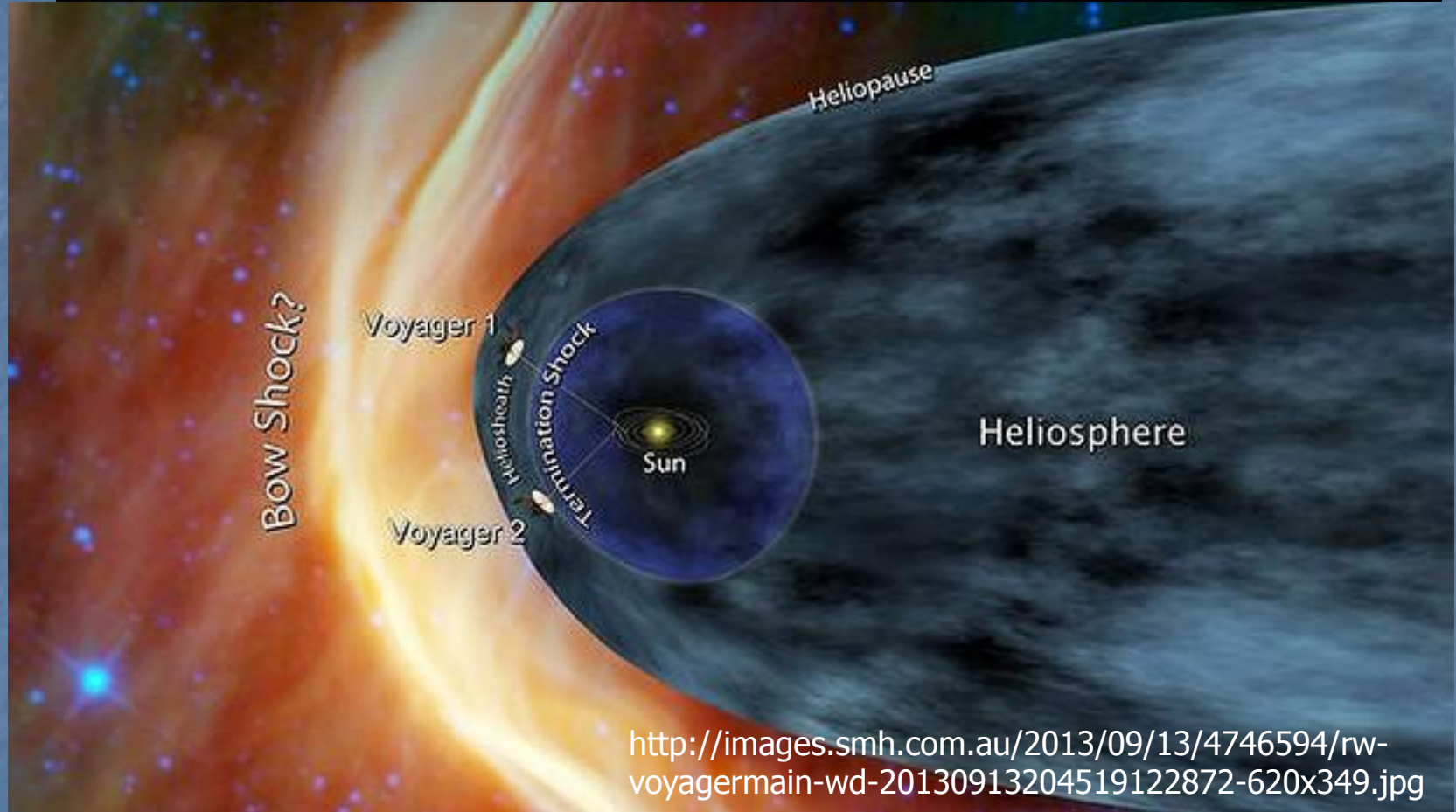
Recommendations

Engage students by:

- Balancing **theory** and **practice**
- More **industry** involvement
- More **active** learning
- **Share** best-practice
- More **diversity**

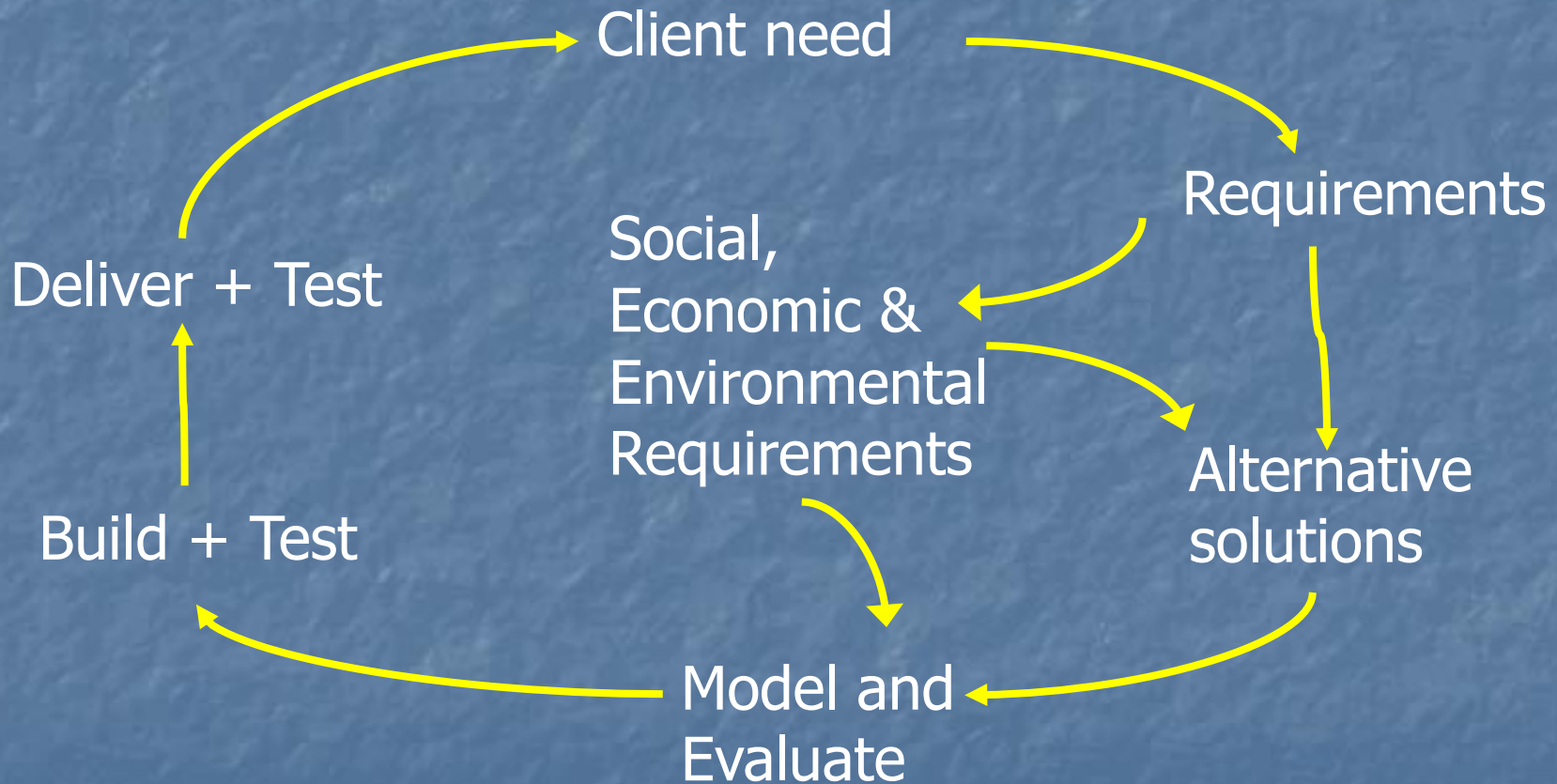


So, how do we do engineering?



http://www.thehindu.com/multimedia/dynamic/01583/Voyager_1583343f.jpg

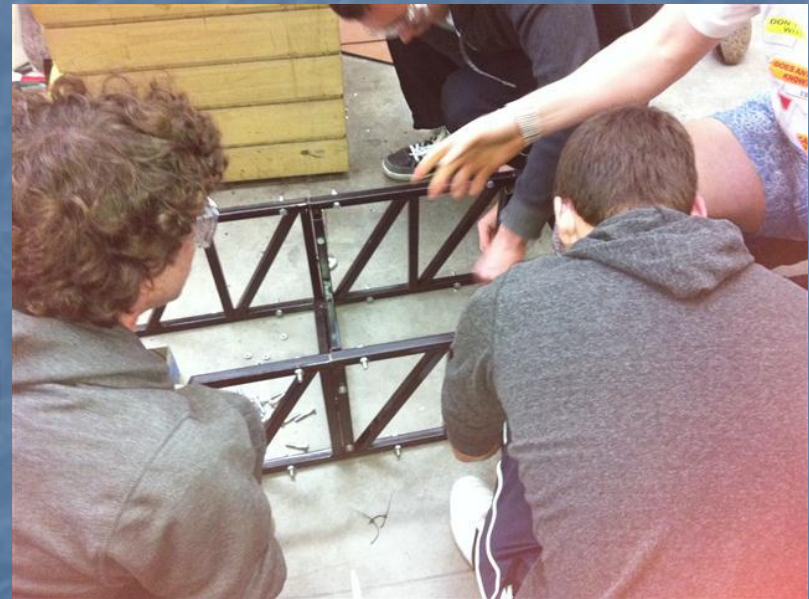
The Design Process is central: Systems Engineering



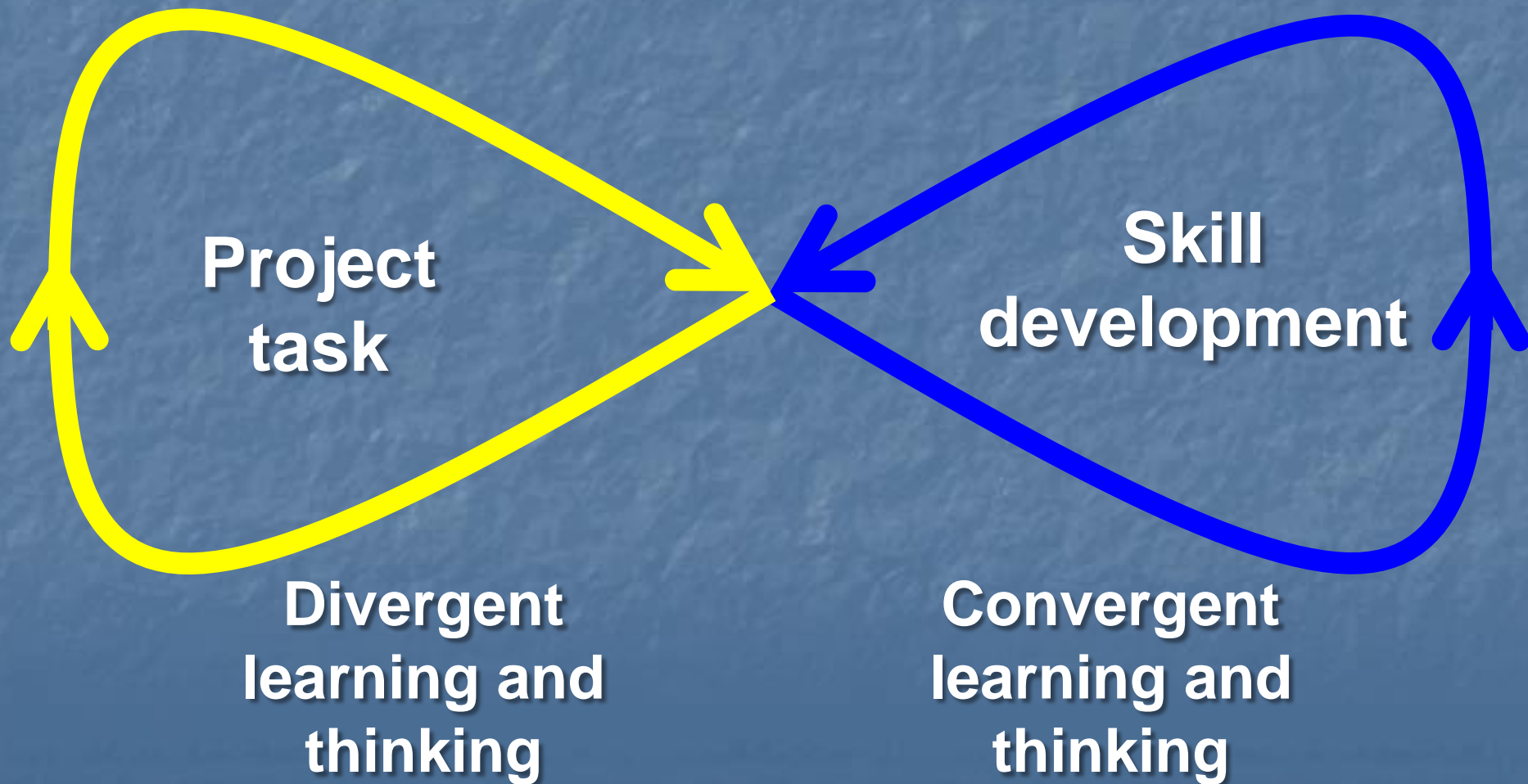
Sustainability is key to decision making

How is this best learned?

- Need complex learning situations
- Using a sequence of project-based courses
- Supported by online skill development and assessment



Two basic processes are required



How do we change curricula?

Civil Engineering (CQU)

	Current PBL sequence	Specialisation	
	12 cp	6 cp	6 cp
1	Engineering Skills 1	Engineering Foundation Mathematics	Engineering Physics A
2	Engineering Skills 2	Engineering Mathematics	Engineering Physics B
3	Engineering Design & Management Planning	Engineering Mathematical Applications	Analysis of Structures
4	Engineering Design & Management Implementation	Materials Science and Engineering	Solid Mechanics
5	Transportation Engineering Design	Hydraulics	Steel Structures
6	Water and Environmental Design	Geotechnical Engineering	Surveying and Mapping
7	Capstone Structural and Geotechnical Design	Engineering Project Planning	Concrete Structures
8	Engineering Project Implementation	Traffic Engineering	Elective



The Worldwide CDIO Initiative is rich with student projects and features active group learning experiences inside and outside the classroom.

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[Benefits of CDIO](#)

[Implementing CDIO at Your Institution](#)

[CDIO Collaborators](#)

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[Meetings & Events](#)

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[CDIO History](#)

[Implementation Kit \(iKit\)](#)

IN THE SPOTLIGHT:

Welcome to our newest CDIO collaborators: Linnaeus University; University of Skövde; Novia University of Applied Science; Dalian Neusoft Institute of Information; Suzhou Industrial Park Institute of Vocational Technology; Beijing Institute of Petrochemical Technology; Duy Tan University; and Skolkovo Institute for Science and Technology (Skolkovo Tech)

[See what happened](#) at the 2012

SEARCH:

GO

[JOIN CDIO](#)

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.

**We're moving from a focus on
scientific knowledge**



**To a focus on Process Skills
(Design, Investigation, Modelling, ...)**

Through Online supported, Project Based Learning



2012

Mar

May

Jul

Sep

Nov

2013

Mar

May

Jul

Sep

Nov

2014



TODAY



AND THE WINNER IS ...



In Summary

1. Students learn **sustainable practice**
2. through **complex projects**
3. supported by **online skill development.**
4. Use **professional practice** to build **process skills.**
5. Access **knowledge** as required.



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Combining projects and skills ...

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1	Engineering Skills 1	Engineering Foundation Mathematics	Engineering Physics A
2	Engineering Skills 2	Engineering Mathematics	Engineering Physics B
3	Engineering Design & Management Planning	Engineering Mathematical Applications	Analysis of Structures
4	Engineering Design & Management Implementation	Steel structures (including requisite solid mechanics and materials)	
5	Transportation Engineering Design	Hydraulics (analysis and design)	
6	Geotechnical Engineering Design (incorporating surveying, mapping and site investigation)	Concrete Structures (analysis and design) - elective	
7	Engineering Project Planning	Water and Environmental Design - elective	
8	Engineering Project Implementation	Traffic Engineering (analysis and design) - elective	