

Engineering Education: how can we do it better?



Professor Peter Goodhew FREng

Bonn: November 2014



Some vocabulary

Programme = degree course (3 or 4 years)

Module = unit, class, course (one semester)

Engineer = Ingenieur, Professional Engineer

Engineer \neq Technician, Mechanic, Techniker (?)

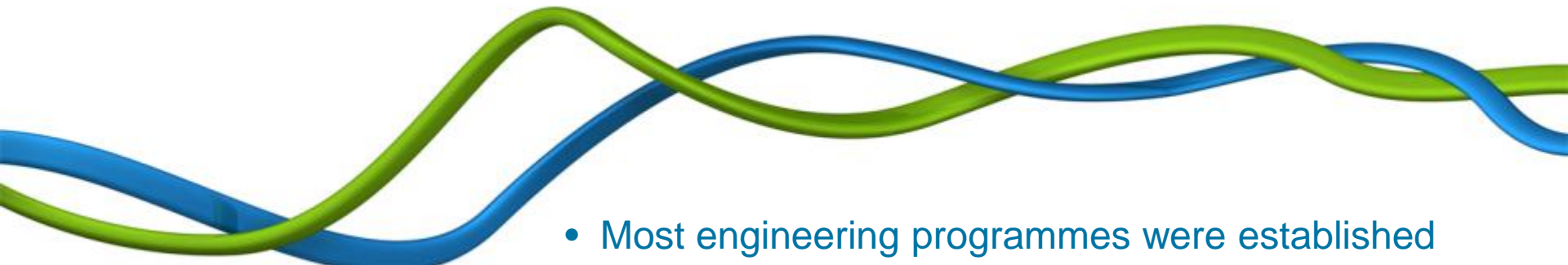


An apology: My perspective is UK-centred, but I hope it is enhanced by some knowledge of engineering education in other countries

Some background

Engineering education is rather important to our societies (and their economies):

- Engineers design and make things and processes;
- Engineering is essential to address many of the world's problems;
- There are already more Engineers than doctors or teachers or accountants or lawyers;
- A graduate will probably work for 50-60 years

- 
- Most engineering programmes were established many years ago
 - Over the past 100 years there has been a great deal of research into learning

Today's agenda

Why innovation is needed

What might be done

How we might do it



Why?

Innovation in engineering education is overdue



Drivers are:

Employers' requirements

Students' expectations

Teachers' perceptions

The changing world

2012

Educating engineers to drive the
innovation economy

2010

Engineering graduates for industry

February 2010



2007

Educating Engineers for the 21st Century

June 2007




“Engineering graduates should be able to do something”

What?

Can teachers of engineering do better?

Yes, for example:



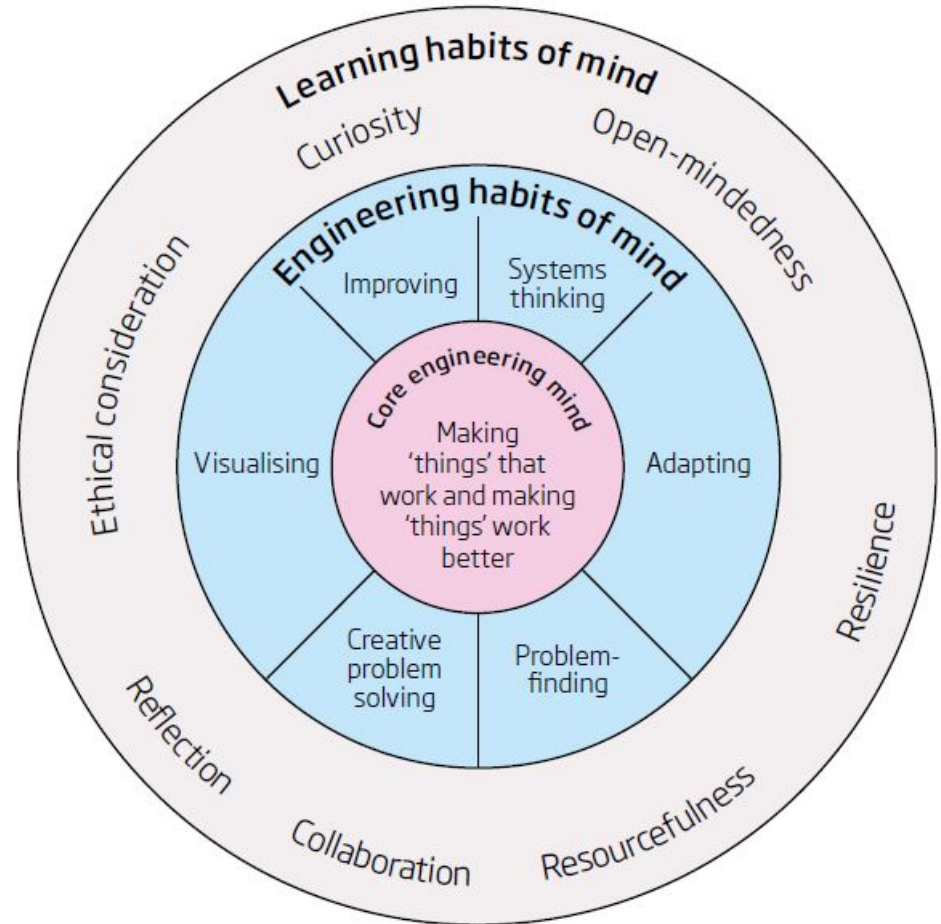
- Active learning
- Flipped classroom
- Team working
- Design, build, test
- Concept questions

Engineering Habits of Mind (EHOM)



Thinking like an engineer
Implications for the
education system

Summary report, May 2014



2014

Some issues worthy of debate and development

Systems

Feedback

Assessment, teams, pass mark

Design, build, test, cost, compete



End of life, sustainability

Critical thinking

Risk

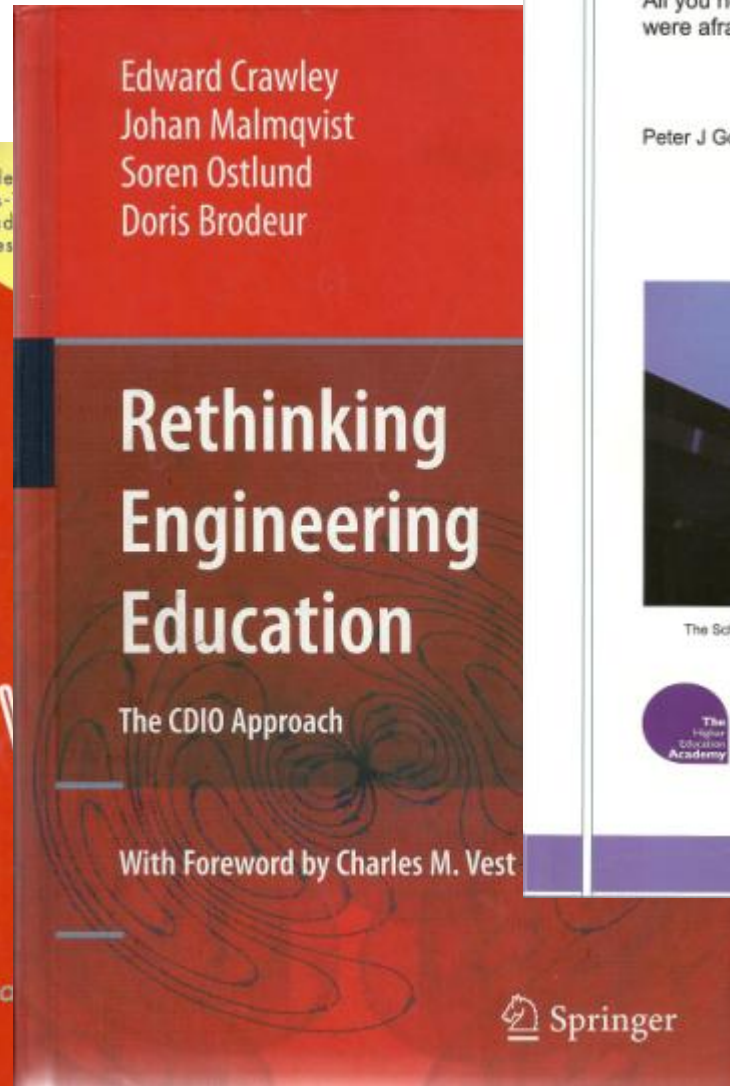
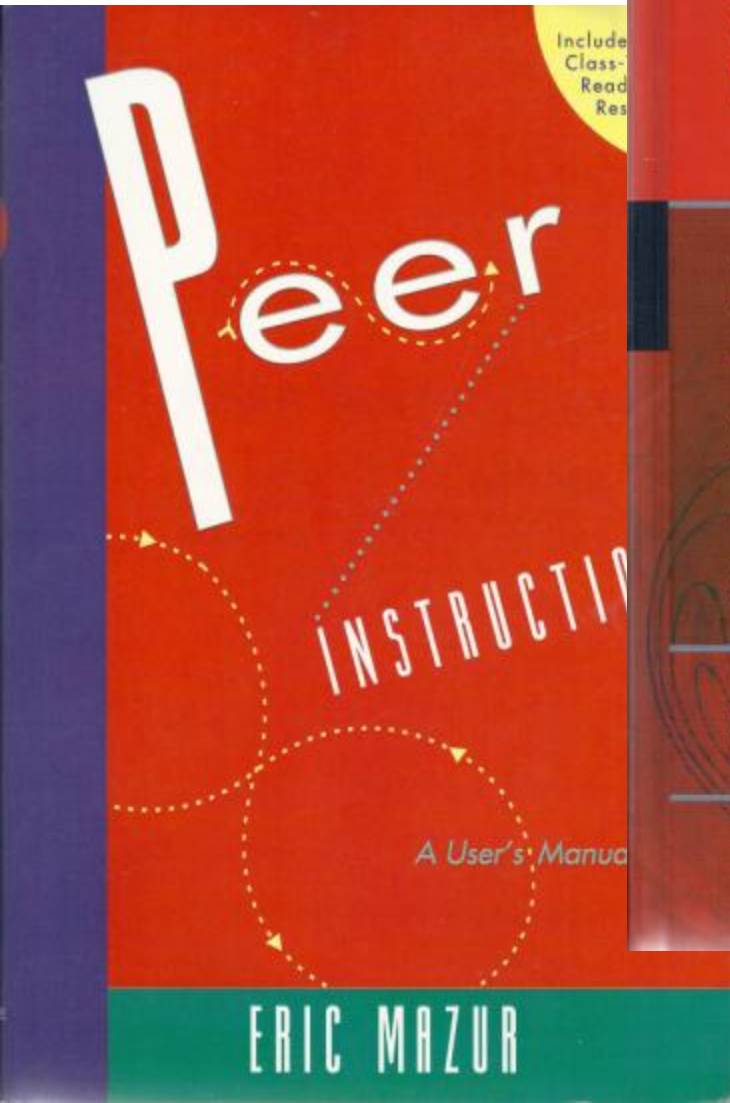
A concept question

You are sitting in a boat in a small pond [Teich]. You have a six-pack of beer. You throw it into the water and it sinks to the bottom.



Does the level of the water in the pond:

1. Rise?
2. Fall?
3. Stay the same?



Teaching Engineering

All you need to know about engineering education but were afraid to ask

Peter J Goodhew



The School of Engineering's Active Learning Lab at The University of Liverpool



"I learn more from being asked questions, and having to respond"

The textbook updated

teachingengineering.liv.ac.uk

2014



Commentable

Print on demand

Updated every 6-12 months

Teaching Engineering

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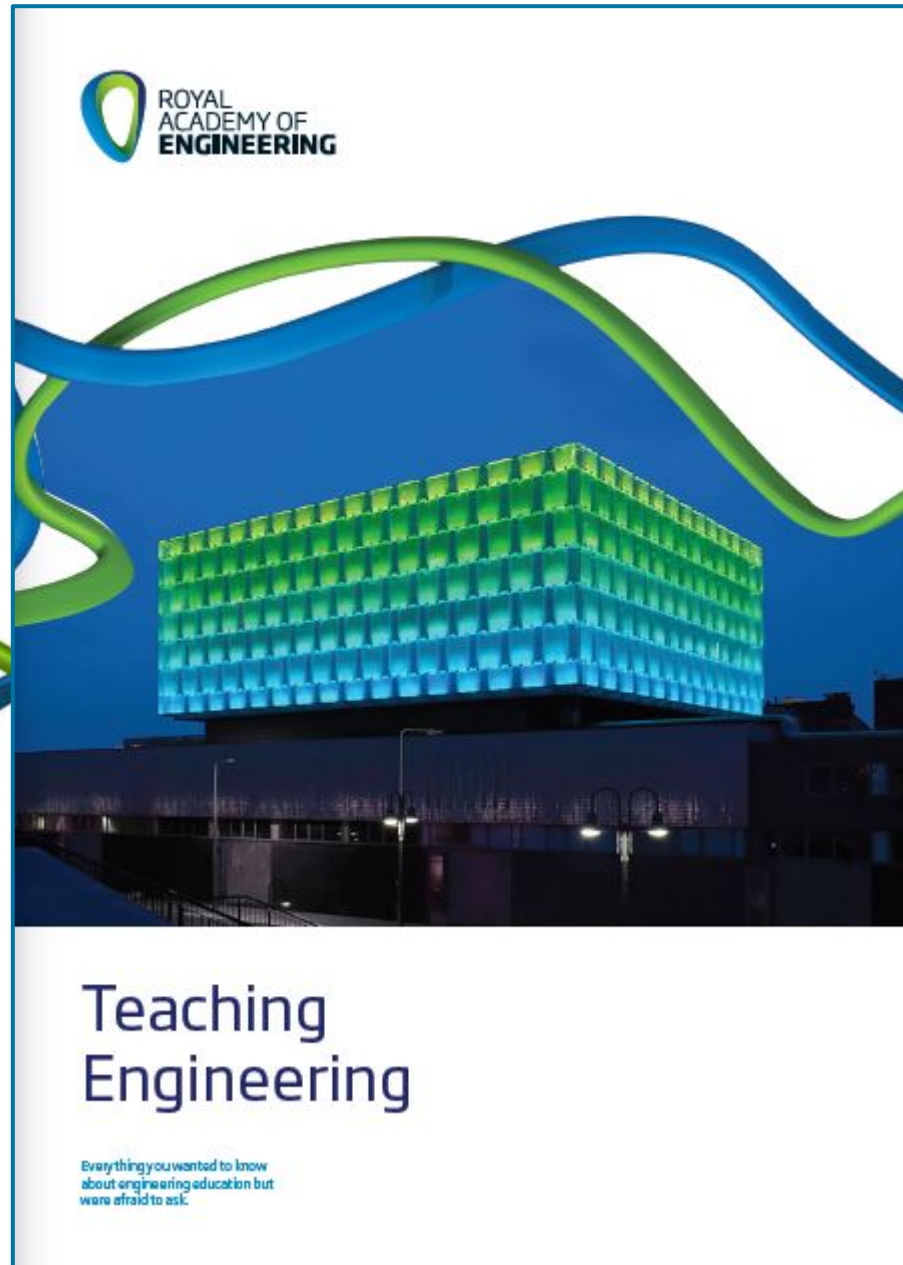


The School of Engineering's Active Learning Lab at The University of Liverpool



2010

Textbook 2015



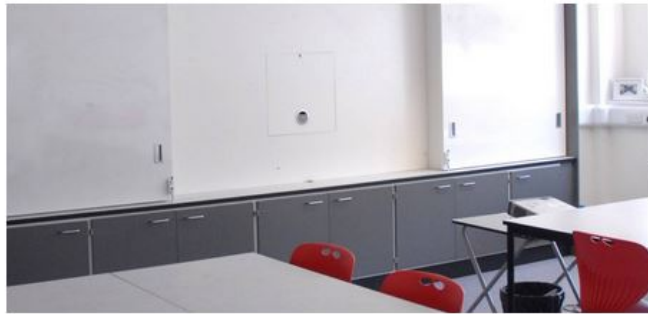
What is
Engineering?

Training
Engineers

Introduction

It might be helpful to clarify what engineering education (in the context of this book) is not.

It is not about the acquisition of specific practical skills, however useful or interesting they might be to any individual. It is not about training people to run CFD codes or send CAD designs to a CNC machine or to grow crystals or to sign off structural steelwork. It is about the conceptual, planning and design skills which should precede all these activities.



Video on this site is responsive, and will automatically resize for different screen sizes. To add a video, just paste the video's YouTube or Vimeo URL into the content.



1



DavidCW

September 19, 2014

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How?

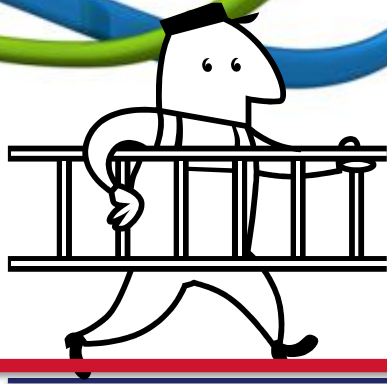
Can we persuade engineering teachers to change?



Externally-driven need
A coherent approach and plan
Internal leadership
(A modified learning environment)

Another concept question

A ladder [Leiter] is upright against a vertical wall. Both the wall and the floor are perfectly slippery (no friction between ladder and floor or wall). You pull the bottom of the ladder away from the wall slightly and it starts to slip down. At some angle it loses contact with the wall. What does this angle depend on?



1. The mass of the ladder
2. The length of the ladder
3. g (gravity)
4. None of these
5. All of these

Some barriers to improvement

Research

Arrogance

Externally-imposed quality procedures



Students and staff from different educational cultures

Few metrics and slow evidence for excellent teaching



The Royal Academy
of Engineering



Massachusetts
Institute of
Technology

Achieving excellence in engineering
education: the ingredients of
successful change

March 2012



“It is rare for Engineering faculty to come together to talk about education”

The Active Learning Lab at The
University of Liverpool



Active engineering students



Externally-driven need
A coherent approach and plan
Internal leadership
A modified learning environment

Questions for university programme directors

How do you assess the learning outcomes given in this module specification?;

Where do you assess deep learning?;

Where and how do you assess creativity?;

Why is the pass mark $x\%$?;

Why do you allow a choice of questions in written exams?;

Do you scale marks and if so why?;

How do you assess individual contributions to team work?;

How do you eliminate the influence of the supervisor when assessing student project work?;

Have you detected any plagiarism? What do you do about it?;

What is the process and timescale by which my comments will taken account of?;

And of course: Have you read Peter Goodhew's book?

What might the future hold?



Modest advances in engineering
MOOCs?

Unknown technology and social behaviour
Global challenges

What will you remember from this presentation?

1. The titles of the RAEng reports?
2. The bridge shown in slide 4?
3. The name of the new teaching space at Liverpool?
4. The question about the boat and the beer?
5. My smiling face?



Over to you



... for questions, comments and debate!