"Employability of engineering graduates: a vision for the future".

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Vice-President, Engineers Ireland

Brussels

13th -14th March 2014

… some initial thoughts …

The ongoing tension!

" … there aren't enough high skilled industry-ready graduates coming out of Irish colleges"

" … we can't redesign our university courses to cover a new trend that has just appeared …"

Two quotations from The Sunday Business Post, 1st Feb. 2014

Employability

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'*a set of achievements – skills, understandings and personal attributes – that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy*'

Professor Mantz Yorke (2004) '*Employability in Higher Education: what it is - what it is not*', Higher Education Academy/ESECT

The USEM model (Knight and Yorke, 2004) outlines employability as four broad and inter-related components:

- Understanding
- Skilful practices (including deployment of skills)
- Efficacy beliefs (including students views of themselves)
- Meta-cognition (including self-awareness and a capacity to reflect on learning)

http://www.employability.ed.ac.uk/What/

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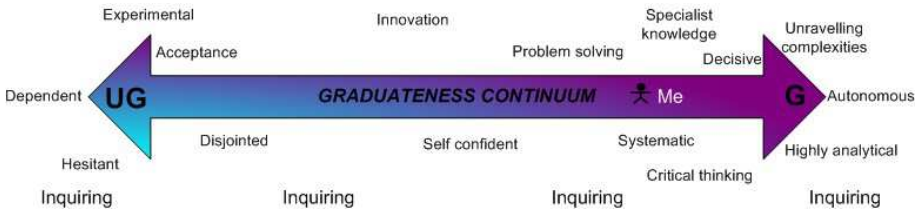
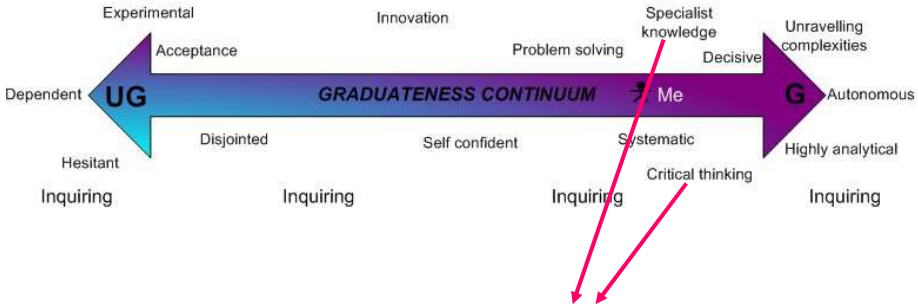
Employability: Graduateness



Taken from: Using Qualification and Level Descriptors (Updated Sept 2008) ARU

Such an appreciation is gained with experience - probably after graduation



Amongst other aspects - an appreciation of the uncertainty, ambiguity and limits of knowledge – this is a fundamental epistemological problem

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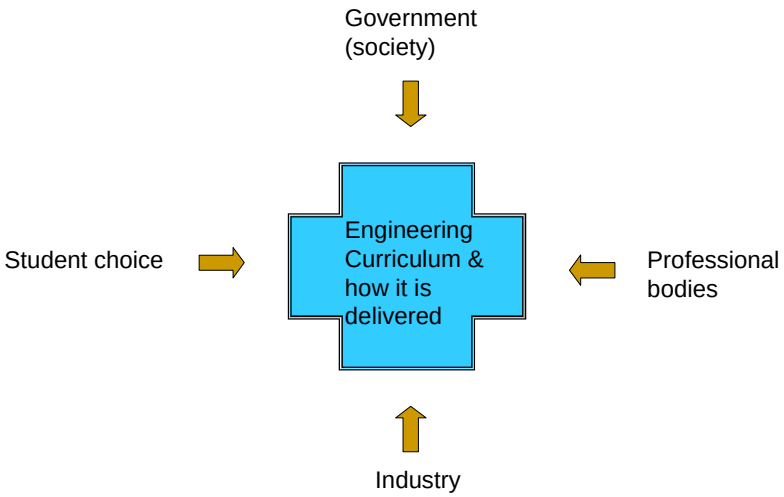
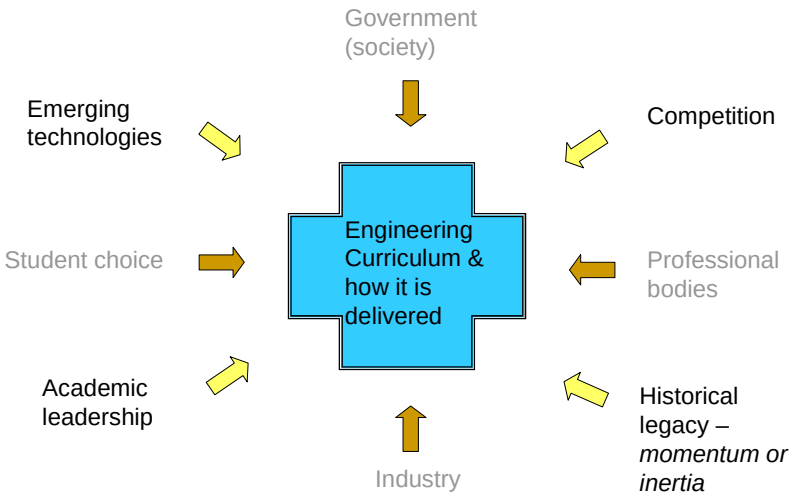
Influences



Influences: a complex set of negotiations



What is the current or orthodox position, in preparing graduates to be employed?

… and one that has delivered, at the very least, good results

… one that recognises that the engineer is all things to all men … (able to satisfy everyone's needs)

The ideal engineer is a composite ... He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems.

N. W. Dougherty

Squaring the circle …

- Mathematics
- PHYSICS
- Chemistry
- *Biological systems*
- Technologies
- *Citizen/society*

- **Regional & State legislation**
- *Global concerns*
- Cost
- *Environment & pollution*
- Energy
- *Quality*
- Ethical considerations

EUR-ACE accreditation criteria for engineering programmes

The Programme Outcomes of accredited engineering degree programmes have the following dimensions:

- Knowledge and Understanding;
- Engineering Analysis;
- Engineering Design;
- Investigations;
- Engineering Practice;
- Transferable Skills.

… accreditation criteria

a) Knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering.

b) The ability to identify, formulate, analyse and solve engineering problems.

c) The ability to design components, systems or processes to meet specific needs.

d) The ability to design and conduct experiments and to apply a range of standard and specialised research tools and techniques.

… accreditation criteria

e) Understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

f) The ability to work effectively as an individual, in teams and in multi-disciplinary settings, together with the capacity to undertake lifelong learning.

g) The ability to communicate effectively with the engineering community and with society at large.

Programme areas to 'deliver' on the 'promise' offered.

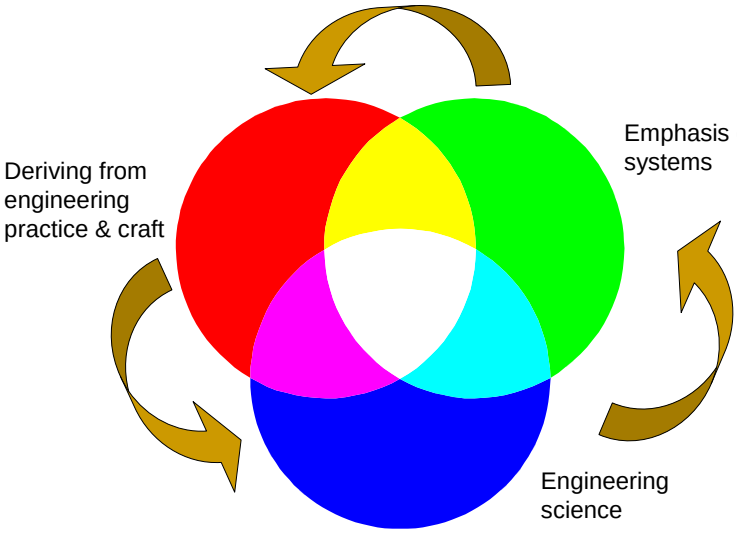
Engineers Ireland, for example, has determined that the study of six Programme Areas is necessary if graduates are to achieve the required Programme Learning Outcomes

Mathematics & Science
Technology
Software & Inf. systems
Innovation
Engineering practice

plus

Social and Business Context

Result: Not overly prescriptive



… and leading to that first interview

- Candidates chosen to be interviewed because of where they received their education?
- Candidates short-listed because they have specific strengths?
- … short-listed because they appeared to have good all-round strengths and are deemed to have potential?

Past, present and the future.

LOOKING TO THE PAST

LIVING IN THE PRESENT

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LOOKING TO THE FUTURE

This all seems reasonable enough

… but there are voices of dissent!

The fundamental challenge … is one of breadth & depth (simultaneously)

Taking the demands from all quarters into account results, in essence, in an overly constrained problem presented to curricula designers.

Striving for breadth and depth inevitably means that choices must be made.

And as each constraint is relaxed potentially the ranks of the disaffected increase!

… further

David Goldberg has written about the 'broken curriculum' and has identified the need for the inclusion of qualitative thinking which he states has its roots in philosophy

Goldberg, D. *Bury the Cold War Curriculum*. Prism (ASEE) vol 17, no 8, April 2008

What is overlooked, perhaps?

The big items are obvious and are probably well addressed !!

But there are other aspects that appear to be left to their own devices. Are they adequately fostered in our engineering schools?

Michael Brooks … we need agile thinkers rather than just more science, technology, engineering and maths graduates. New Scientist, Feb 2014

Braslavsky lists six educational demands associated with the converging trends for change

- educating active, rigorous and flexible individuals, rather than skilled workers for pre-established jobs,
- counterbalancing the increasing inequalities and their consequences in terms of poverty and marginalization,
- treating diversity as a valuable resource different from inequality,
- educating to recreate politics,
- preparing to face an increasingly broad spectrum of personal decisions, and
- preparing for both the introduction and prevention of the paradoxical effects of technical progress.

COBSE Conference 2002 … Cecilia Braslavsky,

ASEE : Ongoing project (Special Interest Group - International Engineering Development) - Attributes of a Global Engineer

- **Engineering Science Fundamentals**
- **Engineering**
- **Context in which Engineering is practiced**
- **Communication**
- **Teamwork**
- **Leadership**
- **Flexibility**
- **Curiosity and Desire to Learn - For Life**

(Show initiative, Inquire & Learn)

- **Ethical Standards and Professionalism**

ASEE : Ongoing project (SIG Int. Eng. Dev.) Attributes of a Global Engineer

Engineering Science Fundamentals

- o Mathematics (including statistics)
- o Physical and Life Sciences
- o Political and Socio-economic Sciences
- o Information Technology - Digital Competency

Engineering

- o Understanding of Design and Product Processes
- o Understanding of Product Life Cycle Development
- o Effective Teamwork/Common Goals
- o Possess a Multi-Disciplinary, Systems Perspective
- o Maintain Focus with Multiple Project Assignments

The Attributes of a Global Engineer Project: Updates, Inputs, Faculty Development Considerations. Stephen Hundley & Lynn Brown. ASEE Int. Forum. June 2013

ASEE : Attributes of a Global Engineer

Context in which Engineering is practiced

- o Economics/Finances of Projects
- o Basic Supplier Management Principles
- o Customer and Societal Emotions and Needs
- o Cultures, Languages, and Business Norms
- o Societal, Economic, and Environmental Impacts of Engineering Decisions
- o An International/Global Perspective

Communication

- o Written (Memos, reports, email, letters, etc.)
- o Verbal (Technical & non-technical presentations)
- o Foreign Language (Technically fluent in at least two languages)
- o Graphic (Design drawings, charts & graphs, presentation, and basic brochure design)
- o Digital Competency
- o Listening
- o Competent at Internet Collaboration and Communication Tools (Web-based meeting tools, team rooms, teleconferencing; file sharing, E-mail)

ASEE : Attributes of a Global Engineer

Teamwork

- o Active and Effective Participation in Team Efforts
- o A Willingness to Respect the Opinions of Others and Support Team Decisions

Leadership

- o An Acceptable Personal Image and a Positive Personal Attitude
- o Treating People with Fairness, Trust, and Respect
- o Respect for Diversity
- o Courtesy and Respect
- o An Eagerness to Help Others

Flexibility

- o Self-Confidence to Adapt to Rapid/Continuous/Major Change
- o Thinking Both Critically and Creatively - Independently and Cooperatively

ASEE : Attributes of a Global Engineer

Curiosity and Desire to Learn - For Life (Show initiative, Inquire & Learn)

- o Seeking Advice and Forming Daily Questions to Discover New Insights.
- o Commitment to Quality, Timeliness, and Continuous Improvement
- o Understanding Basic Project and Risk Management and Continuous Improvement Concepts (like LEAN+)

Ethical Standards and Professionalism

- o Operate in Accordance With Acceptable Business, Societal, and Professional Norms
- o Maintain the Highest Level of Integrity, Ethical Behaviour, and Professional Competence
- o Understand and Applies Good Personal Judgment

Big question: can all the 'boxes' be ticked?

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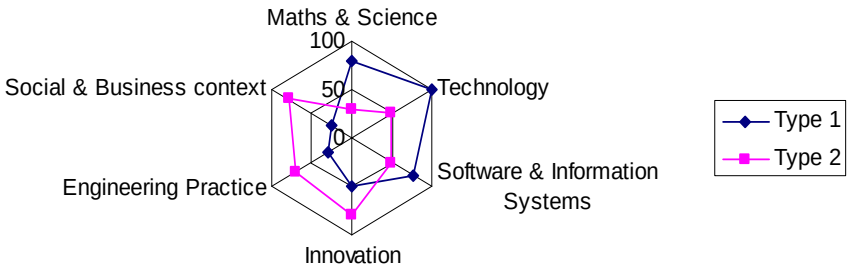
I don't think so

Conclusions

1. No one individual graduate can be expected to have all the attributes listed in fair measure
2. No one programme can be expected to provide the learning environment in which its graduates would normally excel in all or most attributes previously listed
3. The underlying problem is not addressable solely by having either short cycle or long cycle programmes
4. What is required is greater diversity. Diversity should be valued both in respect of individuals and educational programmes
5. Accrediting bodies should consider relaxing their criteria to allow for greater diversity

Radar plots of different types of graduate



A range of 'footprints' should be permitted

Conclusions contd

6. Having enhanced agility as an attribute should not preclude specialisation (meeting a specific industry need) where a degree of lock-in might arise
7. The formation of an engineer (as a professional and person) should not be thought of as being restricted to only undergraduate/postgraduate education. Models from the medical profession should be considered as well as the chartered or licensed approach
8. Re-education or re-training of engineers should be better facilitated and not considered as arising from a career glitch (negative)
9. Engineering schools need to capitalise more on the experience of practicing engineers and accordingly rely less on purely academic engineers.

Finally