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Engineering Attractiveness

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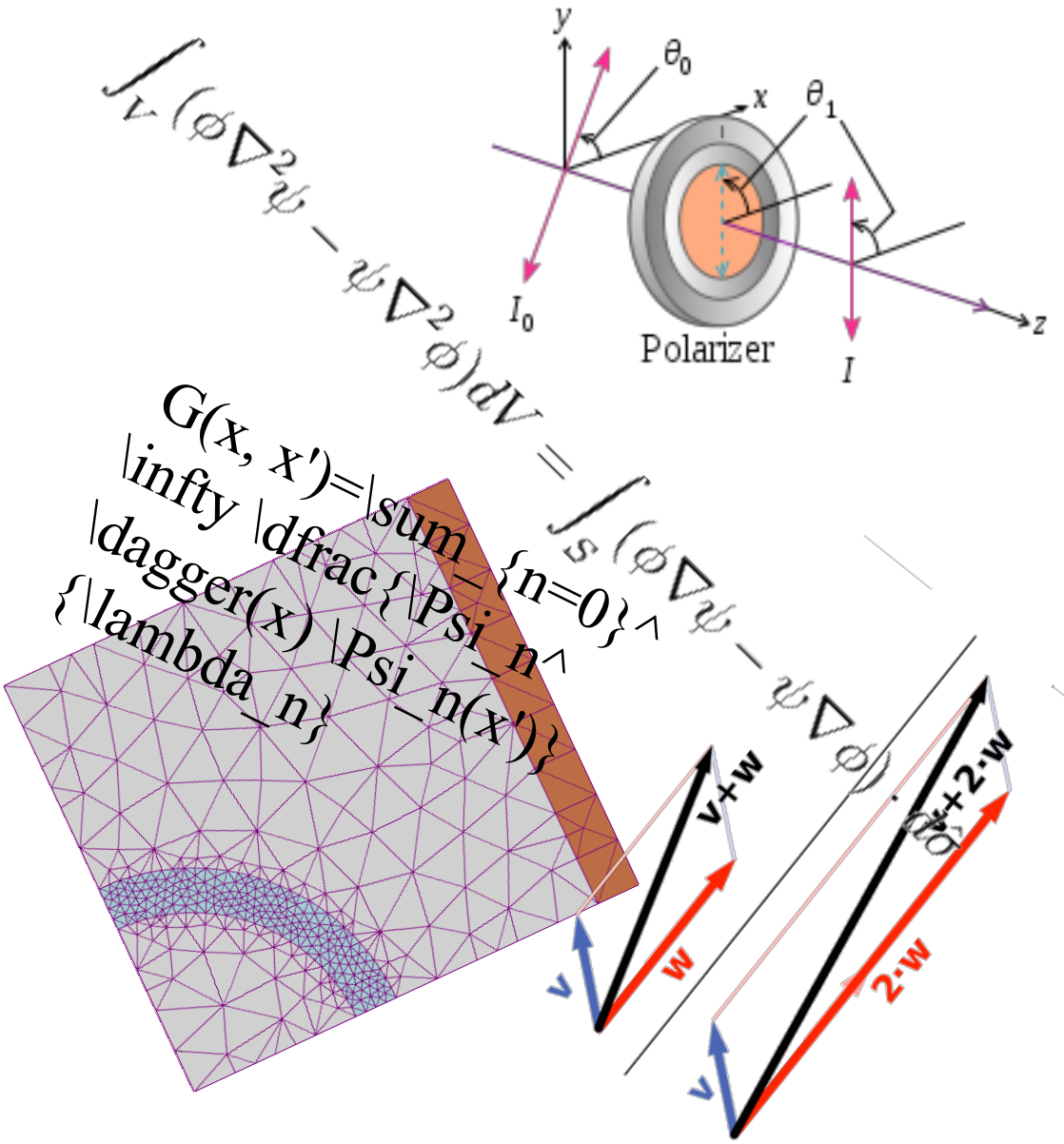


The Challenge

Attraction:

Arousing interest;
Drawing or pulling to oneself;
A force pulling things together.

Oxford English Dictionary

Outline

- Introduction
- Issues in Engineering Attractiveness
- Student perceptions – a survey
- Reflection

Today's world would not be as it is, without the contributions of engineers

Reflect for a moment how the world has changed during the last 150 years through the work of engineers

- Automobiles
- Railways
- Aviation
- Electronics
- Computing
- Wireless
- Telecommunications
- Bridges
- Dams
- Highways
- Chemical plants

And many, many more…….

So.....?

Is there a problem about engineering?

Why?

Can we solve it?

A problem even in Germany?

‘Vorsprung durch technic’

Audi strapline
Advertisements: 1980s onwards

A company that can promote itself in the UK for more than 25 years, with a strap-line such as this, must surely value technology?

Attractiveness issues in Engineering

- Pre-university time
- Transition to university level studies
- Maintaining enthusiasm
- Graduation & start of a working life
- Following a lifetime career in Engineering

Each in its own way needs attention,
....but we can't address them all here!

Here we confine our attentions

- Pre-university time
- Transition to university level studies
- Maintaining enthusiasm
- ~~Graduation & start of a working life~~
- ~~Following a lifetime career in Engineering~~

How might we address these

Lifetime challenges of attractiveness

- Pre-university time
- Transition to university level studies
- Maintaining enthusiasm
- Graduation & start of a working life
- A lifetime career

Pre University experience

Sub-dividing this into 4 areas:

1. Appreciation
2. Awareness
3. The School experience
4. Barriers to Higher Education

(1) Appreciation

- Engineering achievements taken for granted
- Shortage of role models – competition from media and sport
- ……

From the Financial Times

Monday July 26 2007

Caption reads:

‘Engineers work on the Waterloo and City line, part of Metronet’s BCV Contract’

The image of the Engineer (UK)

Seen on the cover of a Careers Guide for Final year Graduates

A ‘special issue’ focussing on Engineering and Technology

Is this how others see us?

Is this the image we want to be portrayed?

The image of the Engineer (UK)

THE SUNDAY TIMES
thesundaytimes.co.uk/environment
22.01.12
9

An engineer at work on the Pelamis wave energy device

(1) Appreciation

- Engineering achievements taken for granted
- Shortage of role models – competition from media and sport
- Lack of contact with general public
- Lack of opportunities for school students to be exposed to engineering
- Decreased opportunities to have hobbies involving constructional creativity
  - e.g. with ‘Meccano’, basic electronics, chemistry sets, car maintenance, etc.

(2) Awareness

- Uncertain ideas about the activities of engineers. (What does an engineer do, what are the skills?)
- School teachers themselves may only have the vaguest of ideas about engineers.

(3) The School experience

- Less challenging subjects than mathematics and sciences available.
- Good laboratory facilities not always available and Health & Safety can limit activities.
- Shortage of knowledgeable or inspiring subject teachers, very few having had any exposure to engineering.
- Image: Is it a ‘cool’ subject – or for nerds?

(4) Barriers to Higher Education

- Europe needs an educated workforce in general and specifically in engineering – yet still unemployment in many areas
- The high cost of studies in some countries, e.g. in the UK universities can charge annual fees of £6,000 or with agreement £9,000.

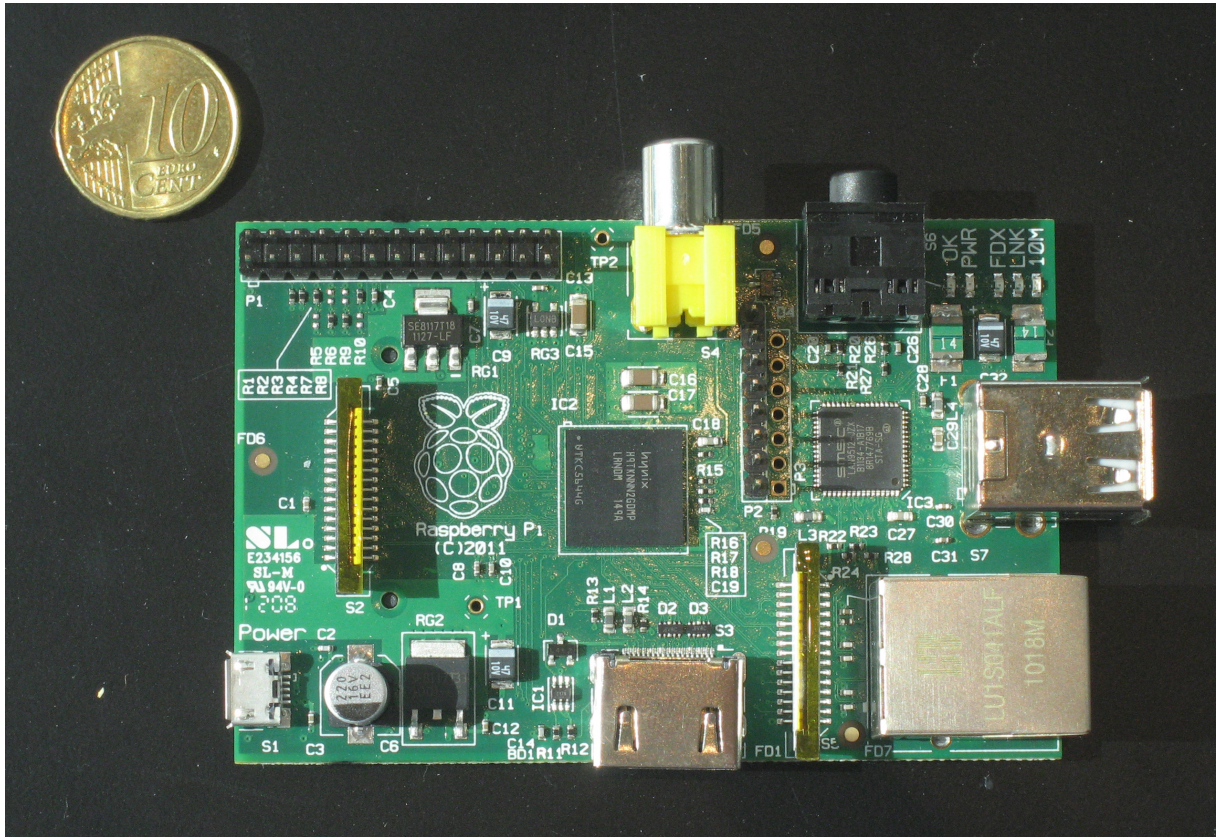
How can we meet these Challenges?

- University staff or students visiting schools to give talks.
- Take an active role and cooperate in school science programmes.
- Develop programmes in the university for both staff & students in schools.
- National, European, global initiatives like STEM, Young Scientist, Science fairs, Maths or Science Olympics etc.

We all know Raspberry pie – many of us like it

But what is Raspberry Pi?

This is Raspberry Pi



ARM 1176 700MHz processor: Video Core GPU: SD Card

USB 2.0; Ethernet, Audio, RCA Video, HDMI

Lifetime challenges of attractiveness

- Pre-university time
- Transition to university level studies
- Maintaining enthusiasm
- Graduation & start of a working life
- A lifetime career

Transitioning to University

- Teaching style
- Establishing secure fundamentals
- Enthusiasm

(1) Teaching Style

- Distinct change in style
- Probably less personal
- From structured to guided
- Responsibility transferred to student

(2) Establishing Secure Fundamentals

- Students can arrive from diverse backgrounds with different teaching styles.
- Grasp of important fundamentals is essential.
- The same key concepts and core ideas need to be approached in different ways.

(3) Enthusiasm

- Frequently students arrive with idealism for what engineering can do.
- Very important not to loose this, while at the same time developing technical understanding and overall competencies.
- Need to ensure students are exposed to the ‘bigger picture’.
- Ideas and concepts need to be related to where they lead.

Transition to university

Amongst the challenges that have to be faced by faculty in developing a student cohort are:

- Capturing the idealism of youth – ‘engineers make the world for humanity’;
- Recognising the change of teaching style and the expectations;
- Establishing secure fundamentals;
- Developing an understanding of the ‘bigger picture’ – the diversity of engineering;
- Developing an enthusiasm to be an engineer.

Transition to university - responses

- Endeavour to establish a secure and stimulating start;
- Communicate the change of teaching style and the expectations;
- Include incidental detail into tuition – engineers are also people!
- Use of variety of approaches to established fundamentals – small groups;
- In addition to core lectures create opportunities to be exposed to the ‘bigger picture’, guest lectures etc., etc.;
- Develop an enthusiasm to be an engineer – conviction – help students with inappropriate expectations;.

Lifetime challenges of attractiveness

- Pre-university time
- Transition to university level studies
- Maintaining enthusiasm
- Graduation & start of a working life
- A lifetime career

Maintaining enthusiasm (a)

- Engineers are humans - give the subject humanity – responsibility – ethics.
- Relate to worldly problems, develop an understanding of the ‘bigger picture’;
- The challenge of enthusiasm vs knowledge to meet requirements of exam, of grade etc.;
- Are the learning platforms sufficiently diverse?
- Engineering involves teamwork try to provide opportunities for team working, cohort building etc.

Maintaining enthusiasm (b)

- Curricula with diverse pathways – but a coherent body of knowledge
- Experiences beyond the lecture theatre, laboratory etc.
- Students must be challenged, stretched, but also today - supported
- Maintaining enthusiasm to be an engineer, by providing opportunities for students to take initiatives.
- Establishing the capacity to motivate, assess and develop one's own skills independently
- Establish the basis for lifelong learning

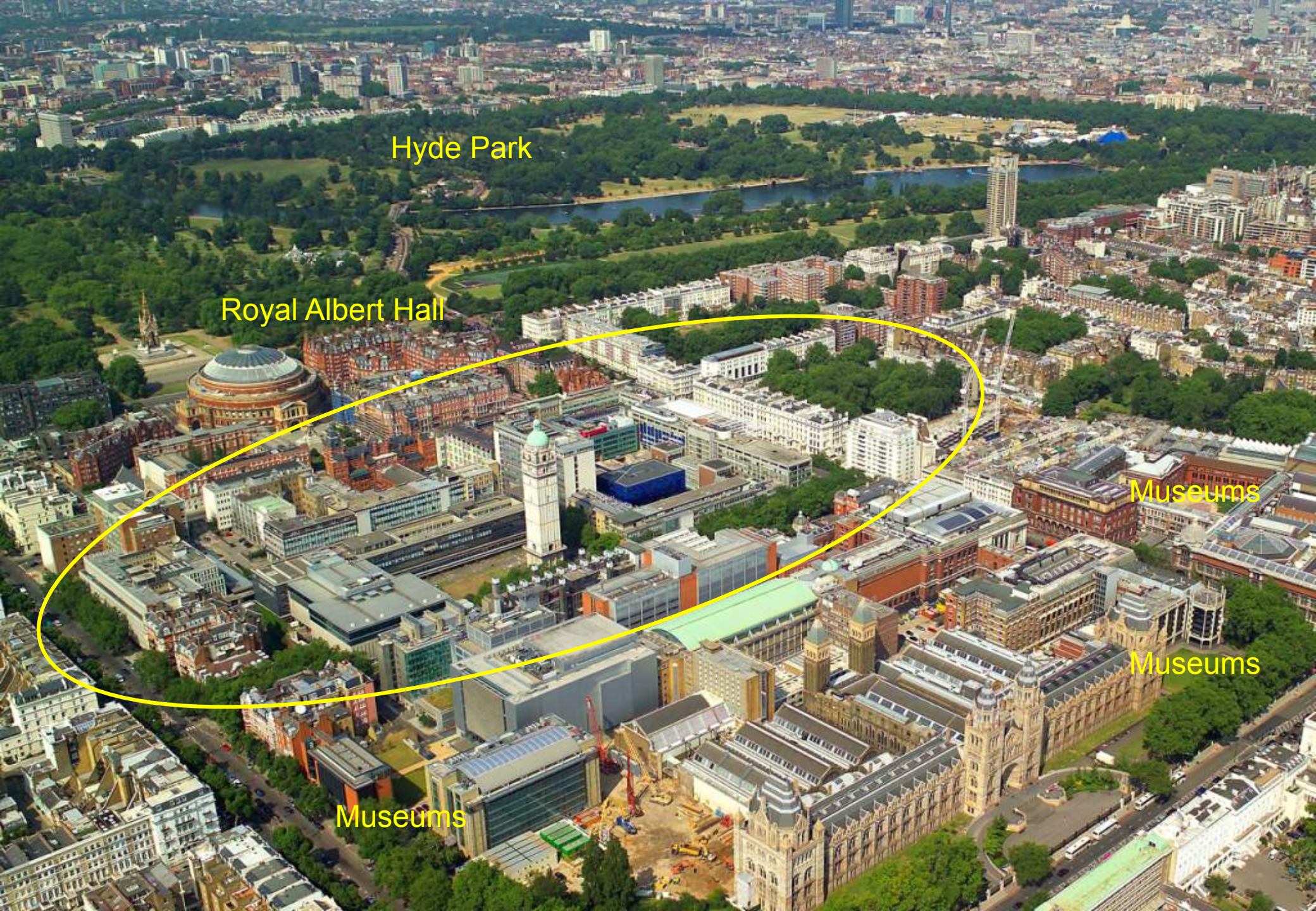
E.Quinox - Engineering Summer Projects in Rwanda

- Involves EE with some Civil & Mech E students working in teams, all student led
- Development of battery hire and solar power installation energy kiosk
- Support from UNDP and Rwandan government
- Awarded the "Supreme Humanitarian" award of the IEEE President's 'Change the World '
- http://www.e.quinox.org/

E.Quinox - Student-led Engineering Summer Projects in Rwanda

- The GE Ecomagination Challenge's Innovation Award worth US$100,000.
- The JP Morgan "Give-it-Away" competition worth US$50,000.
- Spin-off projects now can be assessed
- http://www.e.quinox.org/

A student survey at Imperial College London


Hyde Park
Royal Albert Hall
Museums
Museums
Museums

Imperial Statistics 2010-2011

Student Numbers

	Total	Faculty of Engineering
Undergraduate	8,800	3,600
Taught Postgraduate	2,400	1,100
Research Postgraduate	2,600	1,000

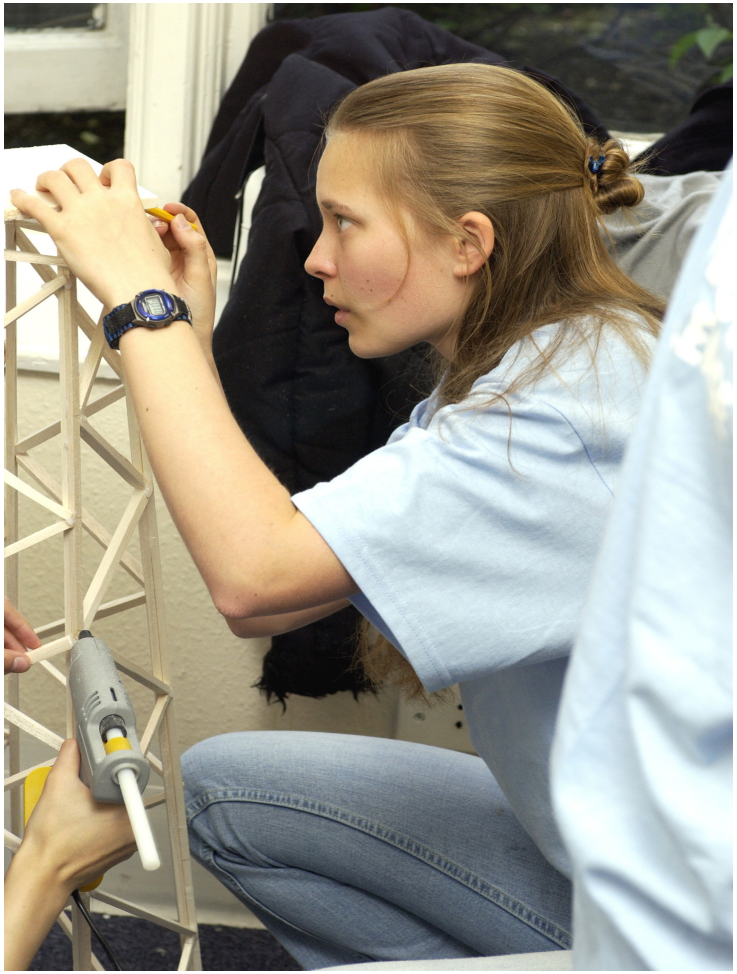
Total Engineering Staff 1,200 Student/Staff ratio 16.5:1

Applications : Admissions Undergraduate 5.5:1, Postgraduate 7:1

Budget of Institution £700M 55% private sources, 45% public sources
Faculty Budget £96.8M

Imperial's target graduate profile

- Outstanding technical expertise in engineering sciences.
- Ability to identify, analyse, synthesise and design solutions.
- Ability to innovate and create new ideas, products and services.
- Have effective team working skills.
- Potential for leadership roles.
- Communicate effectively.
- Understand engineering roles and responsibilities.
- Be inspired by engineering and its benefits.



But……. what do the students think?

- Factors which influence motivation and career decisions?
- a desire for change in course content and learning experience?

We tried to find out…..!

The study

- Questionnaire: embracing closed and open ended questions
  - pre-university career influences
  - criteria for university selection
  - attitudes and motivation towards engineering studies
  - student career and life aspirations
  - preferred course content
  - transferable skills needs
- Cross-faculty (7 departments); embracing 4 years and involving 2330 students and achieving a (77% return rate) and involving 108 alumni.

The questionnaire

background

- {General: year of study; course; gender; age; category of registration (UK, EU, Overseas); type of school (single or mixed sex); gap year taken.}
- At what age did you decide to study engineering?

pre-University influences and life aspirations

- Who most influenced your aspirations to study engineering?

  Options: friends; parents; siblings; school / teacher; media; clubs or societies
- Please indicate whether either you mother or father is an engineer / scientist / mathematician.
- What would you most like to have achieved in life?

  Options: invented something new; made a difference to the world; financial security; travelled / seen the world; respect from friends / family / peers
- Did you feel at the time that a degree would help attain these achievements? (yes / no)
- Why did you decide to study engineering?

  Options: desire to make a difference to the world; enjoyment of maths / physics; enjoyment of hands-on work; financial reward; pioneer or explore new technologies; range of career options on graduation; specific interest in engineering projects

criteria for University selection

- What measure of quality would you most care about when choosing a University to study engineering?

  Options: research excellence; position in league tables; teaching excellence; highly paid future employment; future employment in chosen field; quality of facilities; satisfaction of current students
- Why did you choose Imperial College London to study engineering?

  Options: research excellence; position in league tables; quality of the course content; reputation of Imperial College; reputation of department / faculty; good job prospects on graduation

current attitudes to Imperial College and the degree course

- Do you feel that you really know what an engineer is? (yes/no)
- In retrospect, do you think you really knew what an engineer was when you were selecting which courses to study at University? (yes/no)
- What do you see as a major drawback for studying engineering at Imperial College London?

  Options: cost of living in London; safety of living in London; lack of gender diversity in the College; lack of students studying non-scientific courses; quality of facilities such as labs, workshops and lecture theatres; lack of a common engineering course in the first-year; lack of specialism in the courses offered; course level too difficult; course level too easy
- What have been your impressions of Imperial College and your course?
- Which of the following areas would you prioritise for future course development?

  Options: engineering theory; lab projects; maths teaching; practical work; transferable skills (5-point grading of each)
- What transferable skills would you like to see developed as part of your course?

  Options: communication skills; engineering law / intellectual property; environment awareness; ethics; language training; management skills; teamwork and negotiation skills; presentation skills (5-point grading of each)
- Do you feel that your education is a major priority to the faculty, department and lecturing staff? (yes/no)
- How motivated do you feel towards your engineering studies? (10-point grading scale)
- If you became an engineer after graduation, how confident would you be with your engineering abilities? (low, medium, high)

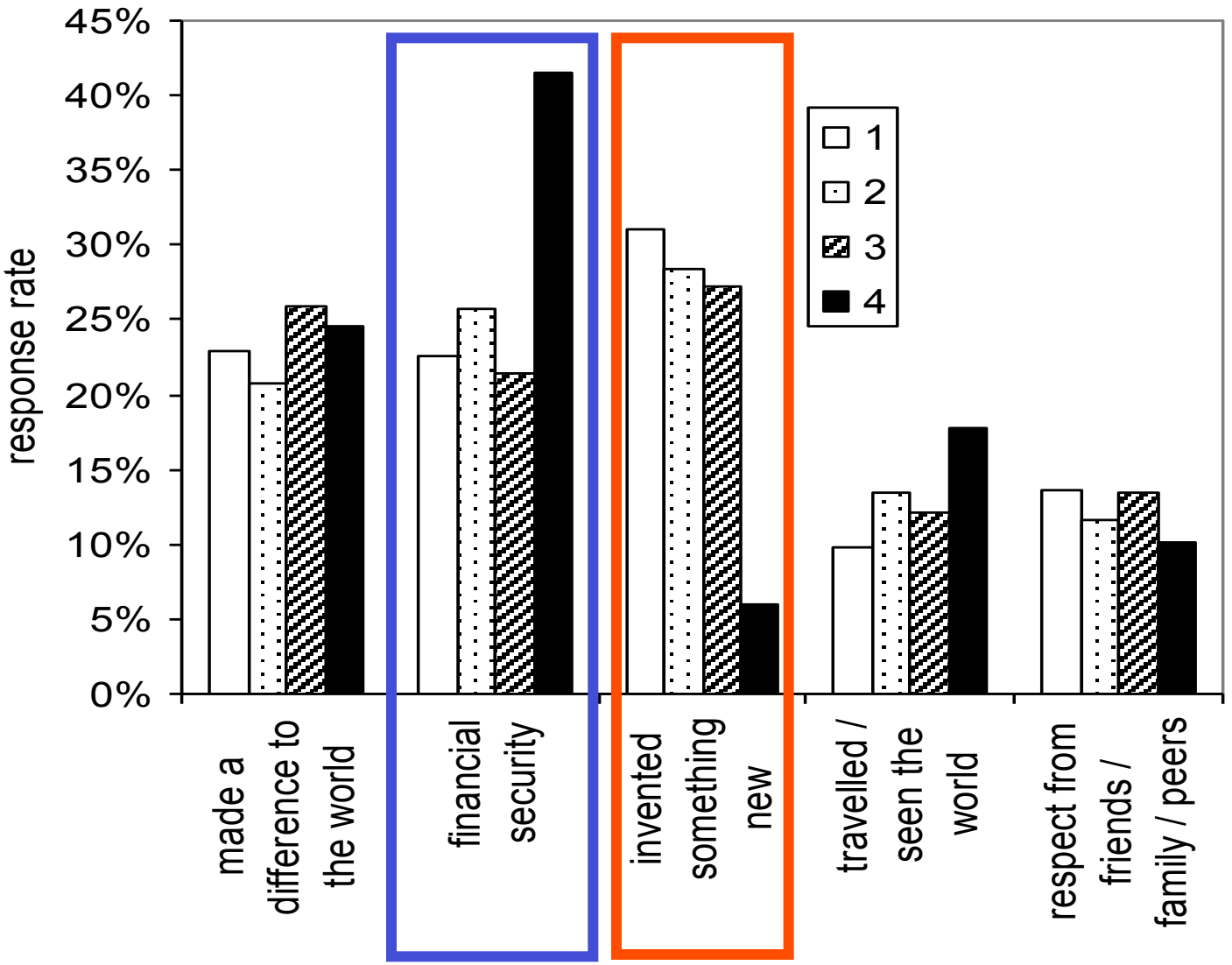
career plans

- Do you plan to become an engineer on graduation? (yes/no)
- What are your career plans after graduation?
- Are you aware of any barriers or reasons not to further your career in engineering after graduation?
- If you have any other comments about the course, or your experiences, please specify.

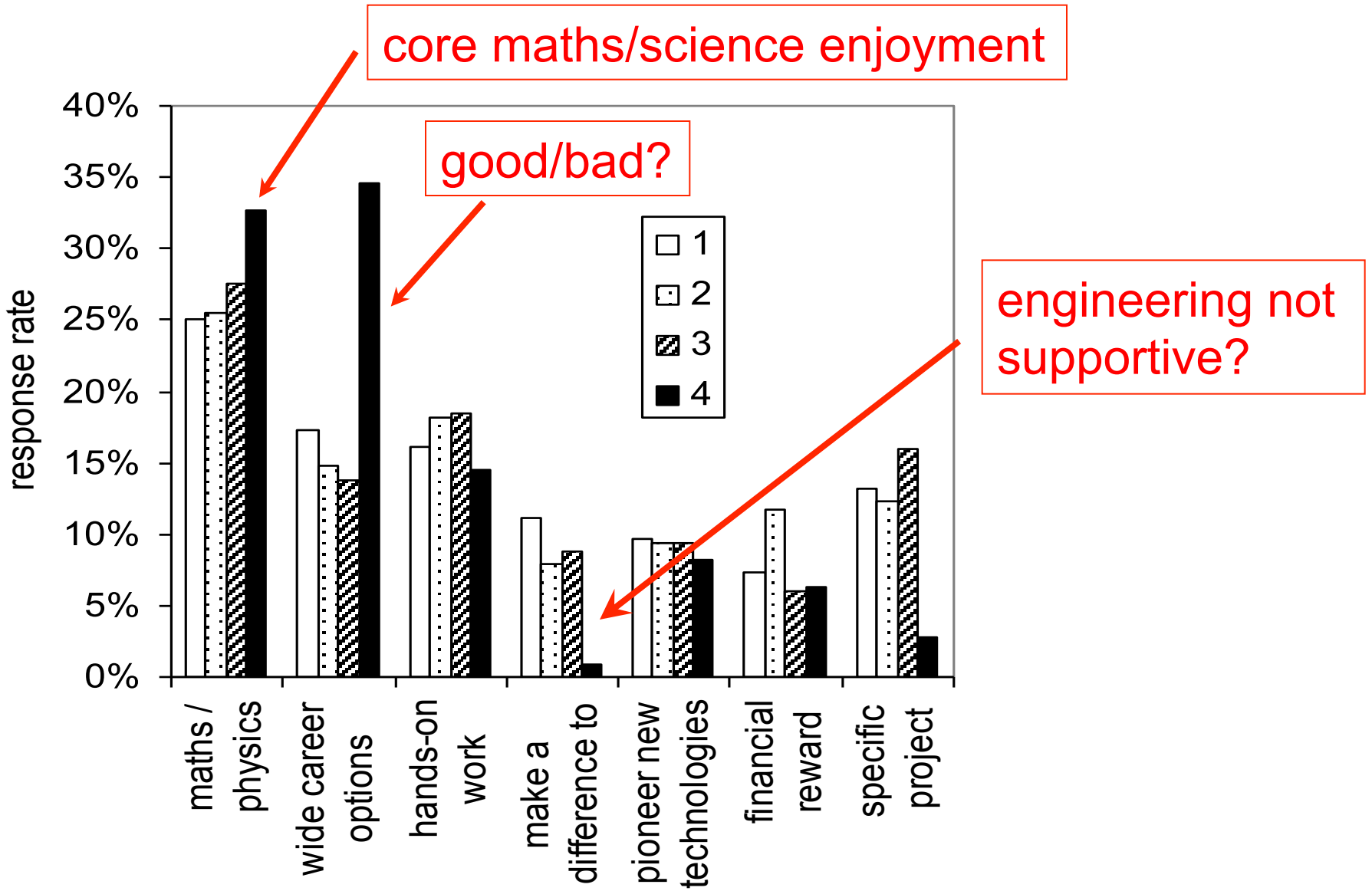
Pre-university life aspirations

	aspiration (%)	relevance of degree (%)
invent something new	24.0	76.0
made a difference to the world	21.3	77.0
obtain financial security	20.5	51.0
travel / see the world	10.6	58.0
respect from friends / family / peers	10.6	57.0
other	13.0	--

Life aspirations (shown by year of study)



Why engineering chosen?



Intention to work as engineers

	1	2	3	4
self-rated motivation scores overall (male and female)	80.2	65.9	61.6	63.7
intention to work as an engineer (%)	81	74	49	44

Top 4 barriers to an engineering career

(Based on 245 responses; qualitative data)

1. Pay / financial incentives (38%)
2. Subject boredom / low interest (17%)
3. Job prospects (9%)
4. Ability / job demand (8%)
5. Other issues (all <7%) included
   ‘prefer career in finance, undesirable job location, recruitment process, career progression, lack of job diversity’

Some of the lessons learnt…

✓ Greater experiential project work: e.g. industrial projects, real-world	making a difference, practical work
✓ Professional skills embedded in technical subjects	but explicit – basis, reflection
✓ Faculty-wide development of flag-ship programmes	practical, creative, meaningful
✓ Greater flexibility in the curriculum	e.g. communication (across disciplines)

Reflection on survey results

- Student survey can be helpful to understand issues as seen by them
- Challenging results generated - require further investigation
- Although some may be parochial to Imperial College London, others are of much wider concern

Alpay E, Ahearn A L, Graham R H, Bull A M J, (2008), '*Student enthusiasm for engineering: charting changes in student aspirations and motivation*', European Journal of Engineering Education, 33, 573 – 585.

NAE's Grand Challenges (2008)


Make solar energy economical


Provide energy from fusion


Develop carbon sequestration methods


Manage the nitrogen cycle


Provide access to clean water


Restore and improve urban infrastructure


Advance health informatics


Engineer better medicines


Reverse-engineer the brain


Prevent nuclear terror


Secure cyberspace


Enhance virtual reality


Advance personalized learning


Engineer the tools of scientific discovery

But surely…..… there is something vital missing?

NAE's Missing Challenges

- To communicate the vital role that engineers have played in making the world as it is.
- To communicate the vital role that engineers will play in solving the problems that confront us all.
- To inspire in the young a sense of wonder of what has been achieved and what can be achieved
- To **attract** the brightest, most creative, most enthusiastic to want to become engineers and retain that enthusiasm

Complacency is not an option

Reflection

- The roles of universities and the expectations of society have changed significantly
- Basically students have not changed, but their school education and society have changed
- Attractiveness is a significant challenge for the engineering profession, requiring a range of inputs
- There are specific aspects that academic staff are well equipped to addresss. They should!

Thank you for your attention

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