Session A47

So What do Engineers do?

Connecting Mathematics to Engineering

Presenter: Debra Leong

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Who am I?

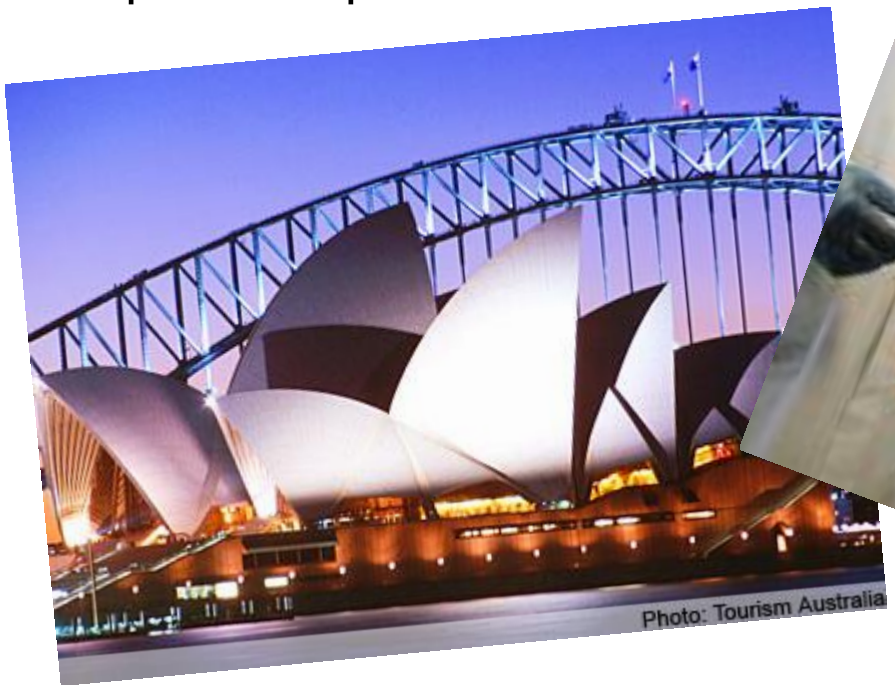
Debra Leong

- Teacher of Mathematics, Hillcrest High School, Hamilton, NZ.
- New Zealand Science, Mathematics and Technology Teacher Fellow 2008
- Investigating the connections of maths to engineering.
  - factors that influence career choice
  - engineers at work
  - applications of mathematics

So what do engineers do?

Engineers use the knowledge of science and technology to solve problems

they may design new products/processes
or design variations of existing
products/processes



This Session: 3 parts

- How **NZ Year 13** school mathematics students make career choices, and their view of engineering
- Engineering as a career
- Examples of mathematics in engineering

PART 1:How (NZ) Y13 maths students make career choices and their view of engineering

The Survey

- The sample:
  Year 13 Mathematics Calculus students from 4 schools in the Waikato, NZ *
- Two Questionnaires: April, October 2008
- ~ 200 respondents
  (175 completed both questionnaires)

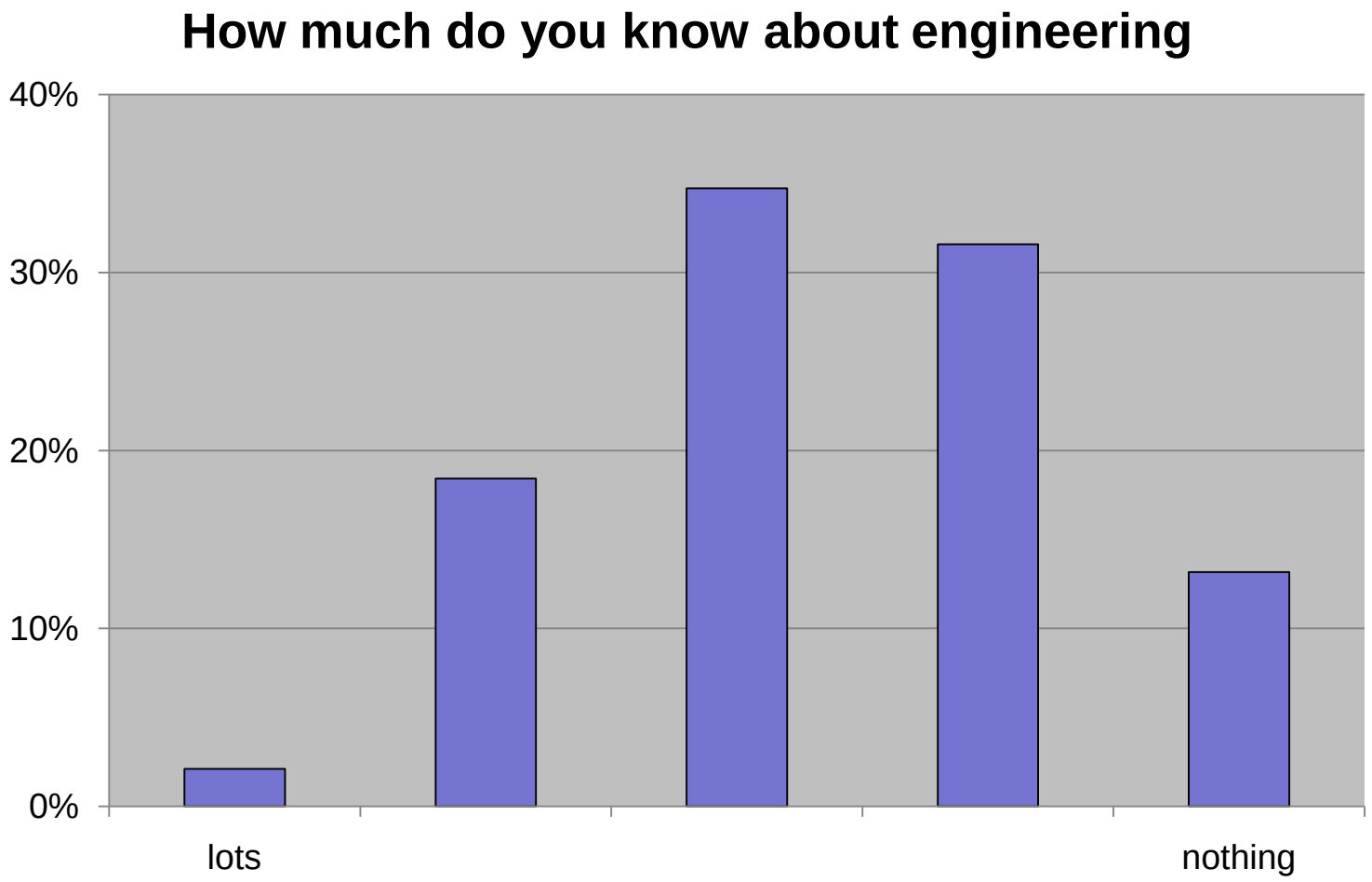
So what do engineers do?

How much do you know about engineering?

Lots ----------Nothing

1 2 3 4 5

Year 13: April results



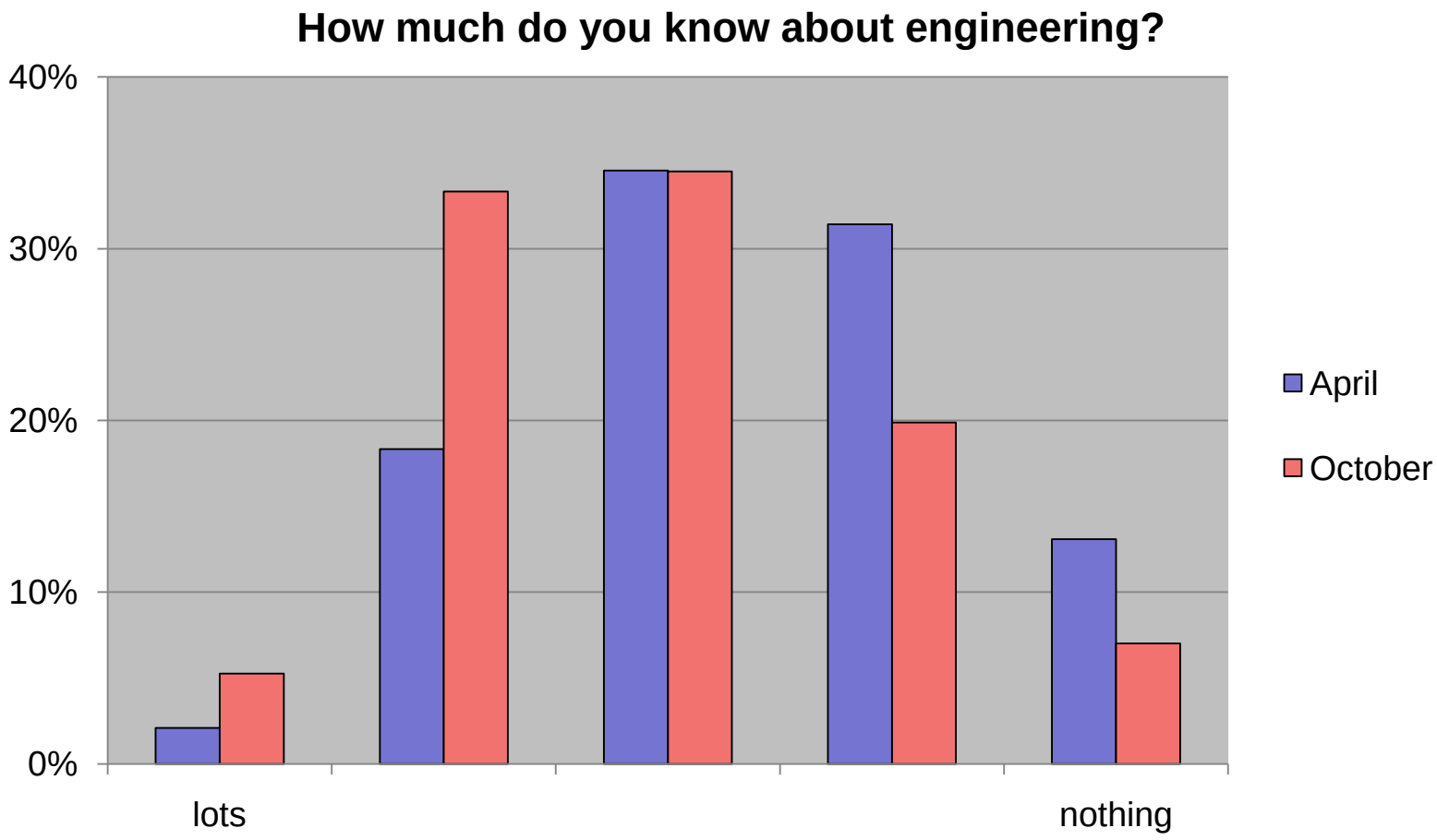
The Intervention

Engineers to speak

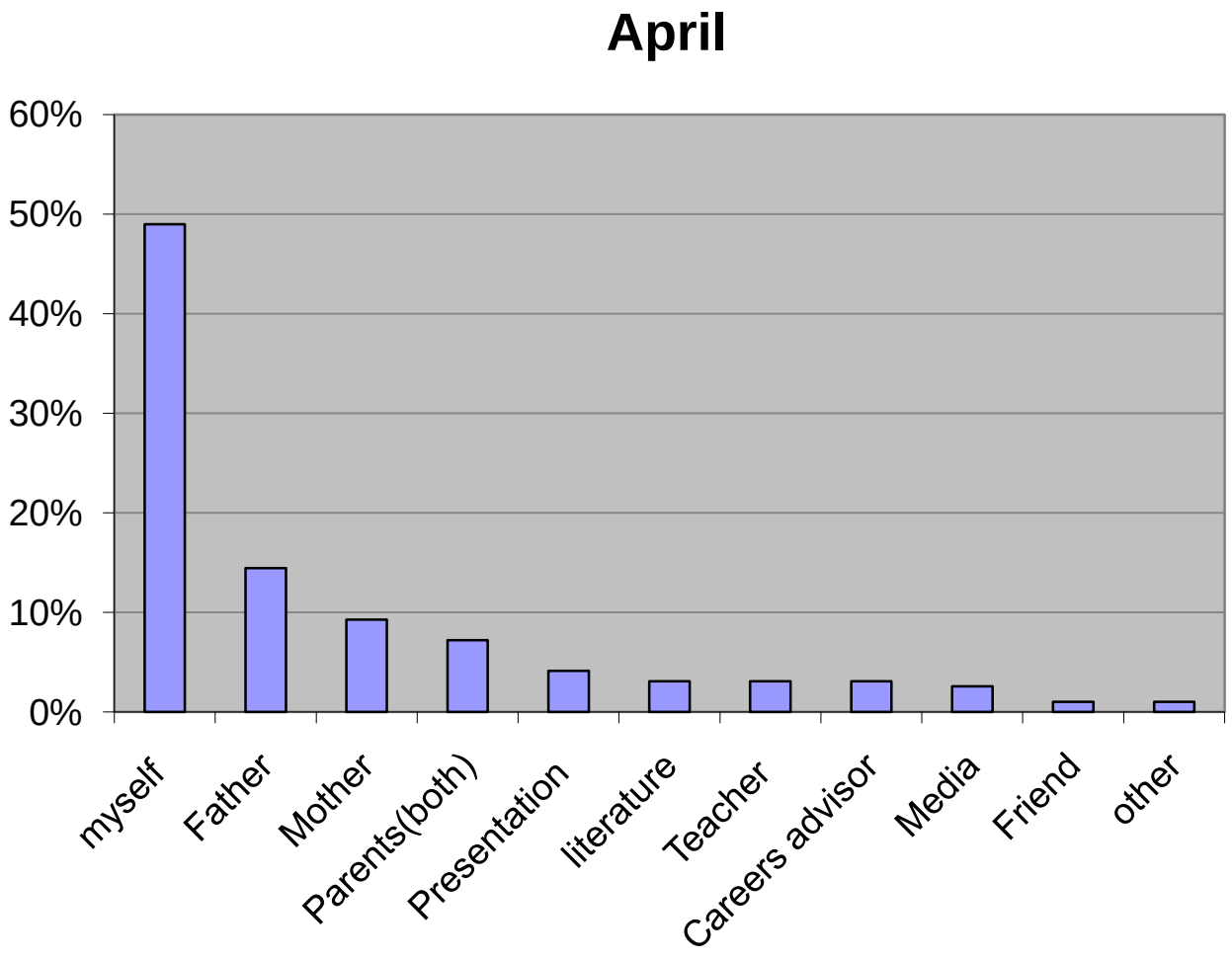
- A variety of engineers
  (biomedical, environmental, chemical, mechanical, electronic, biochemical)
- Different reasons
  - use of mathematics
  - variability in the job
  - information about careers

- Not all classes had speakers = Control

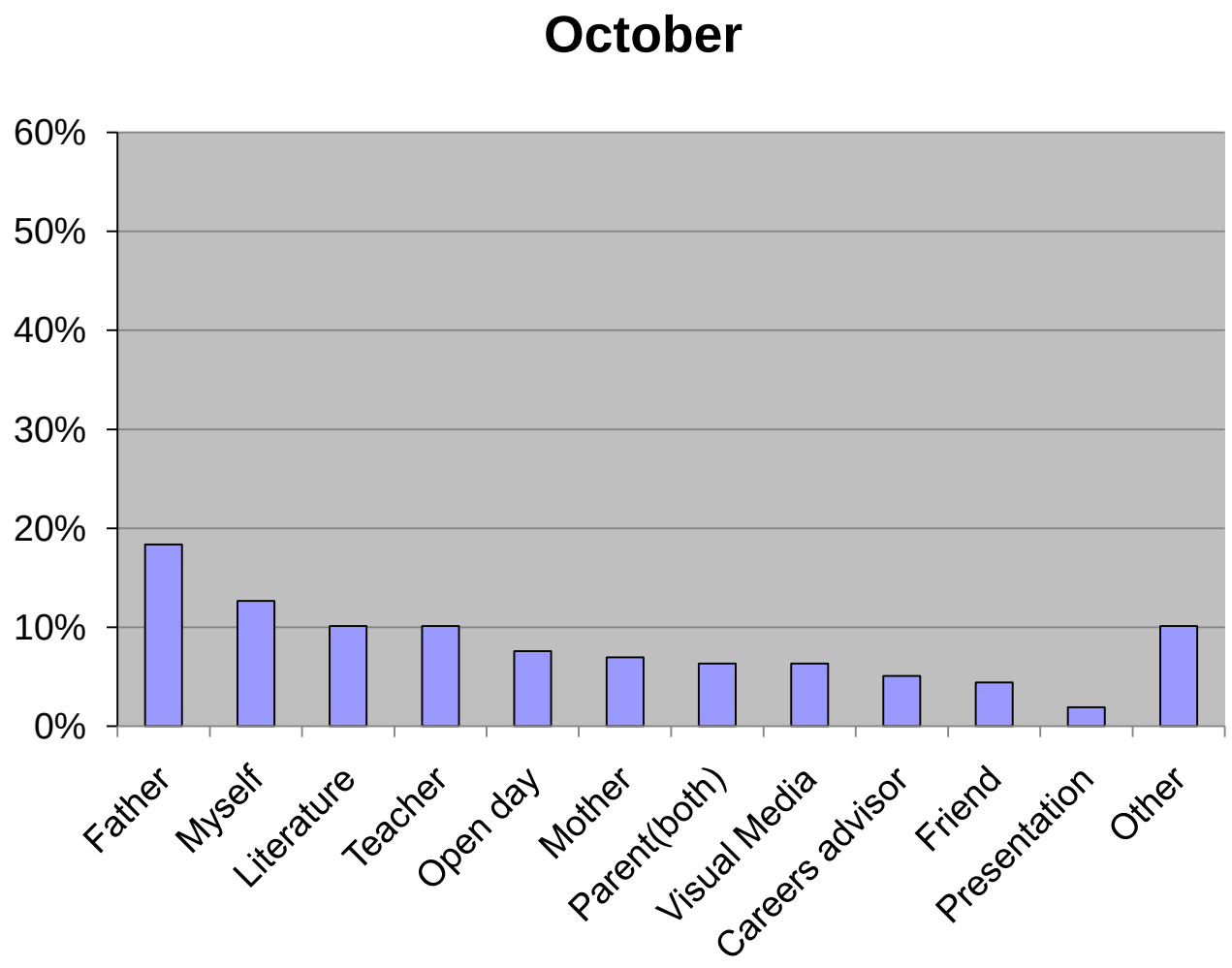
Did they know any more about engineering?



Most influencing factor in career choice

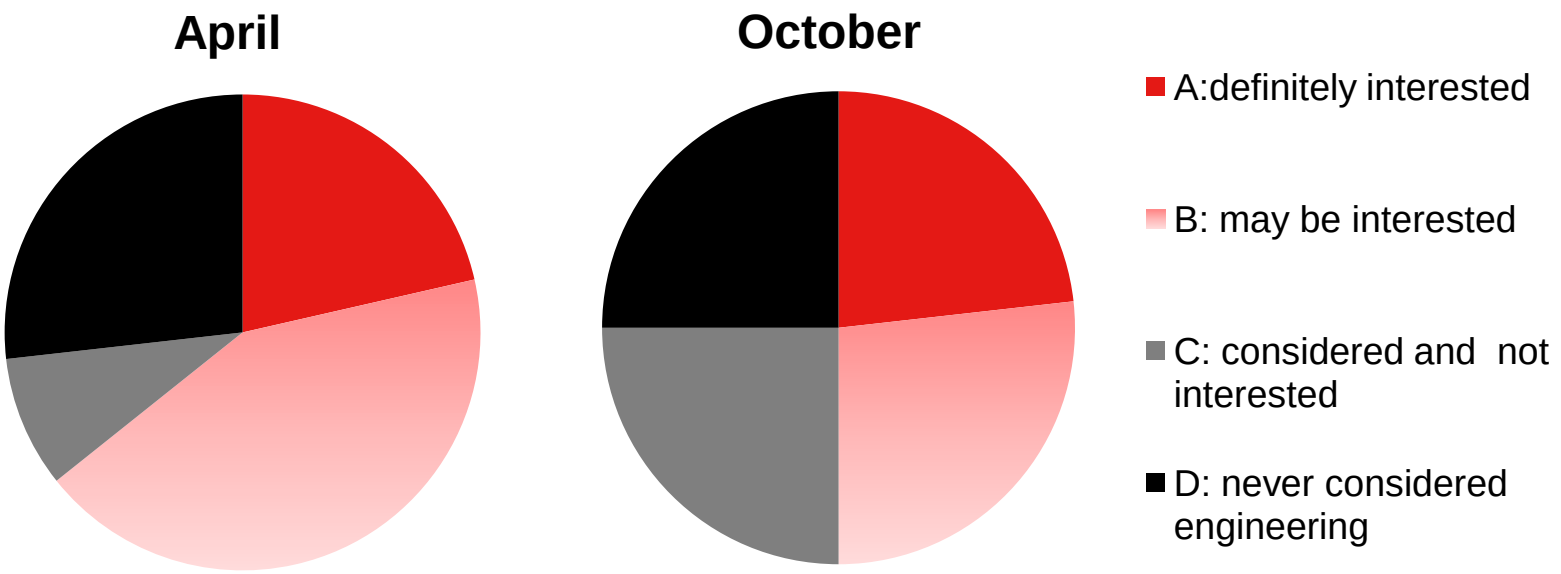


Most influencing factor in career choice



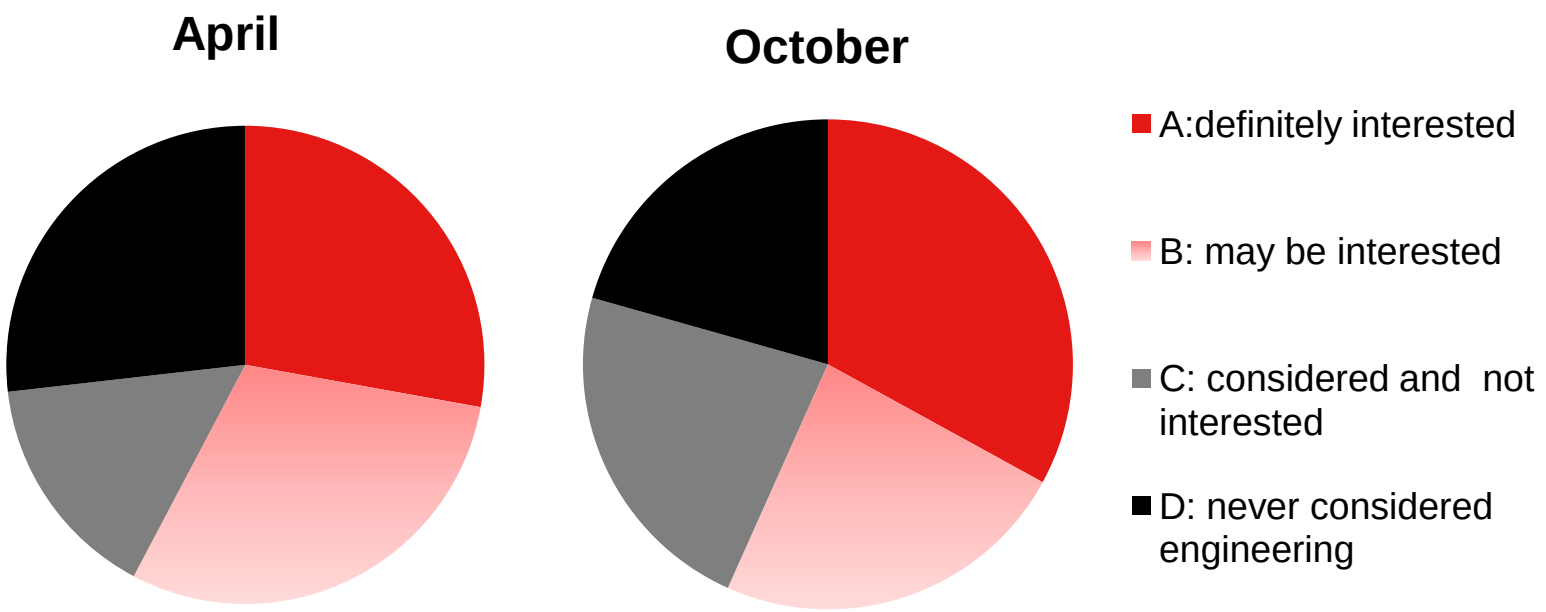
Did the intervention(speakers) make a difference?

Control group – no speakers



Did the intervention(speakers) make a difference?

Group with intervention – speakers



Summary

Evidence shows that

- Parents as a group seem to have the most influence on the students' career choice
- Teachers (including careers advisors) have little influence

My results suggests that

- Teachers can have a larger role in providing opportunities for students to learn about careers, which will open more pathways.

Part 2: Engineering careers for mathematically inclined students

Attributes of an engineer

- Logical thinker, good at problem solving, Intellectual
- Curious, a Lifelong learner
- Reliable and dependable
- Honest, ethical
- Good communication skills

Structural engineers

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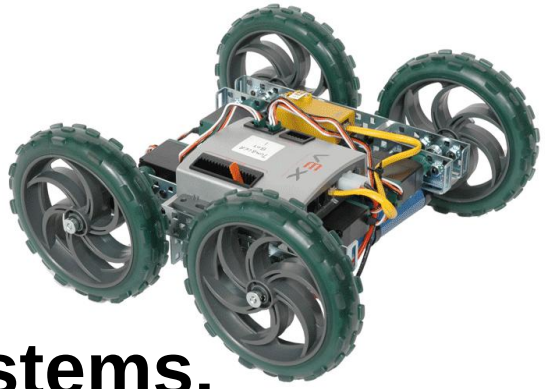
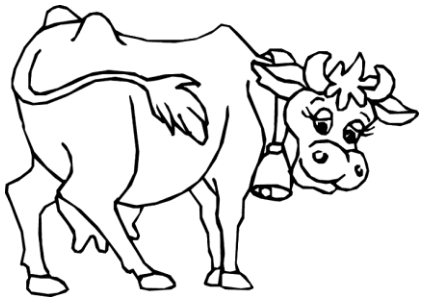
Mechatronic engineers



where mechanical, electronic systems, and computer software overlap.

Chemical/Process and material engineers



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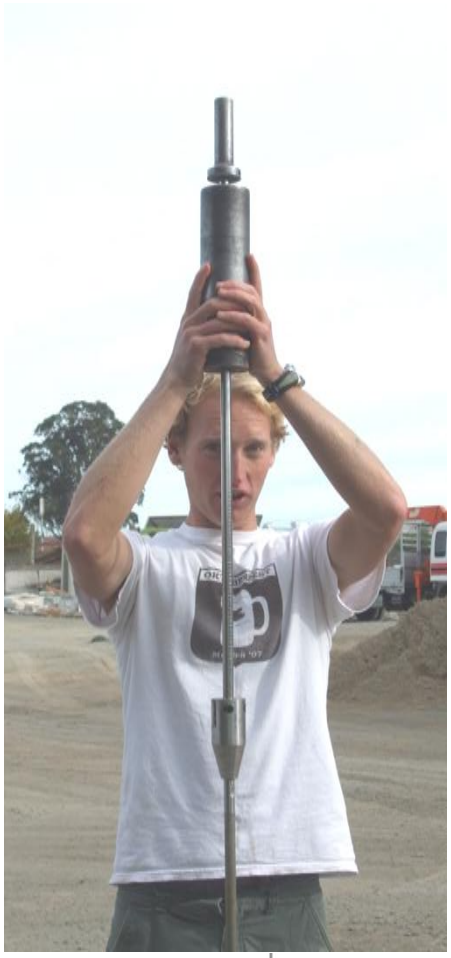
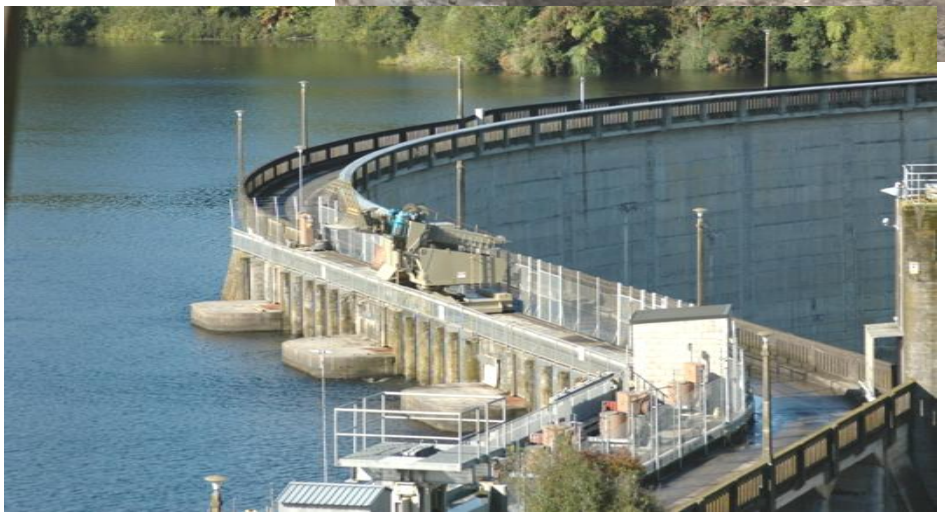
Environmental engineers





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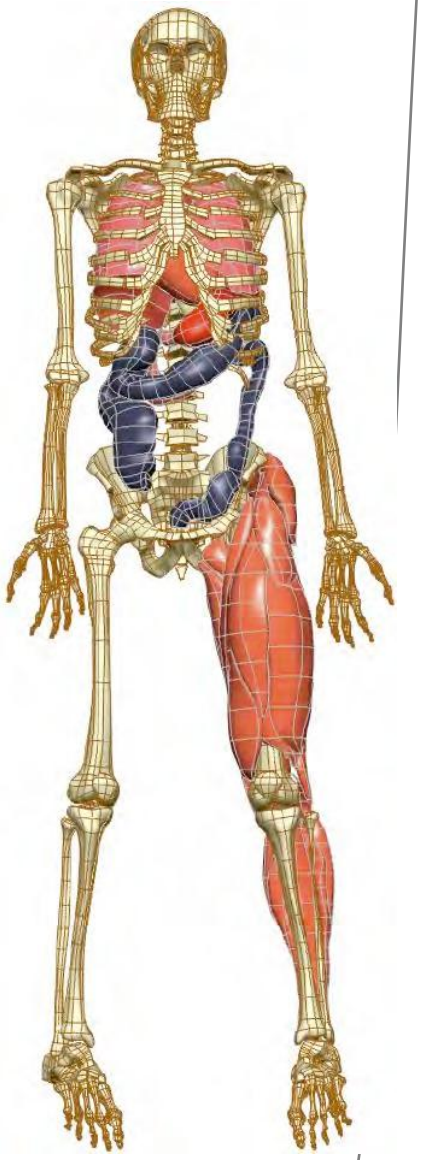
Biomedical Engineering

- bridges the gap between engineering, medicine and biology.
- uses/creates mathematical models



What Engineering has to offer….

- Engineering uses mathematics as a tool.
- Variable – no job is ever the same
- Engineers make a difference
- Many opportunities for promotion, travel, variety of areas to work in
- Well paid
- Life – work balance

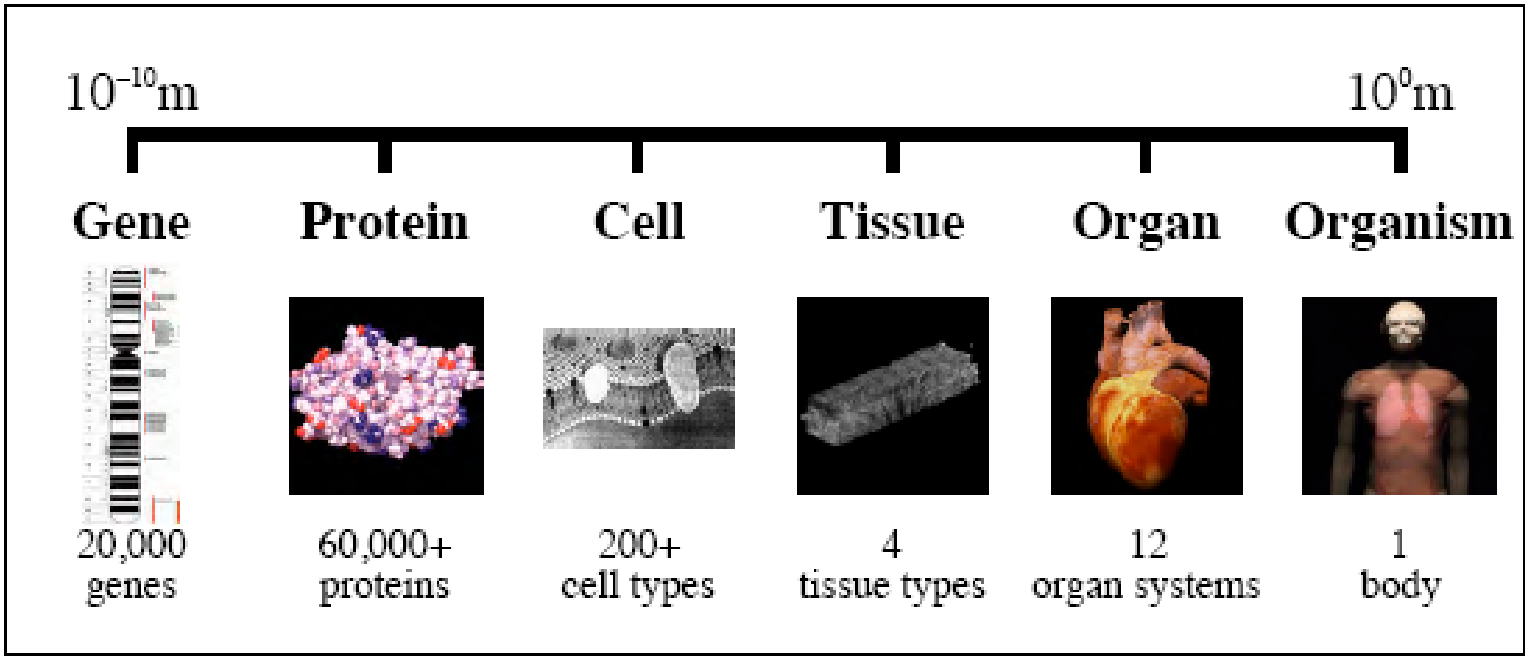
What do students need to enter engineering at a tertiary level?

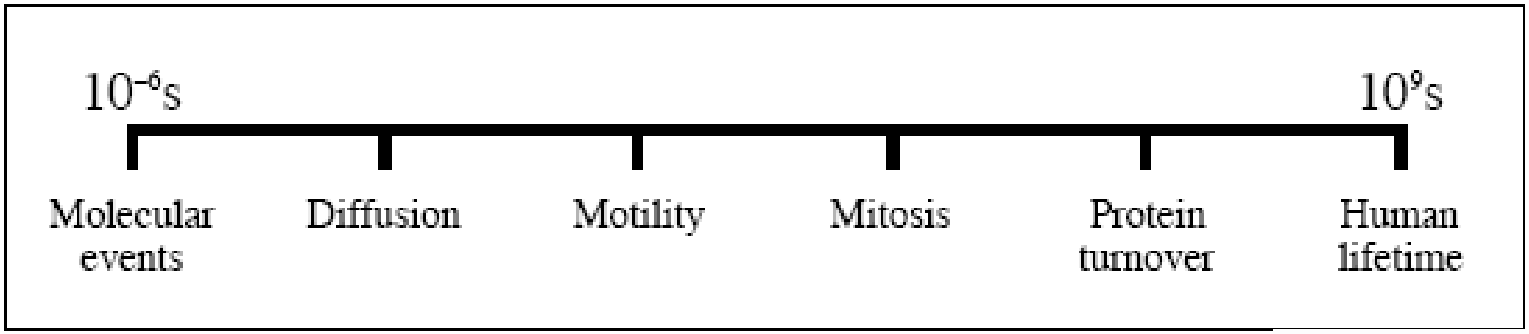
- An interest in the branch they want to enter..?
- Preferably have taken mathematics, physics and chemistry
- Mathematics with Calculus is strongly recommended.
- Ability to persevere
- First year courses are general, so specialising takes place in 2nd year or 3rd year.

Part 3: Examples of mathematics

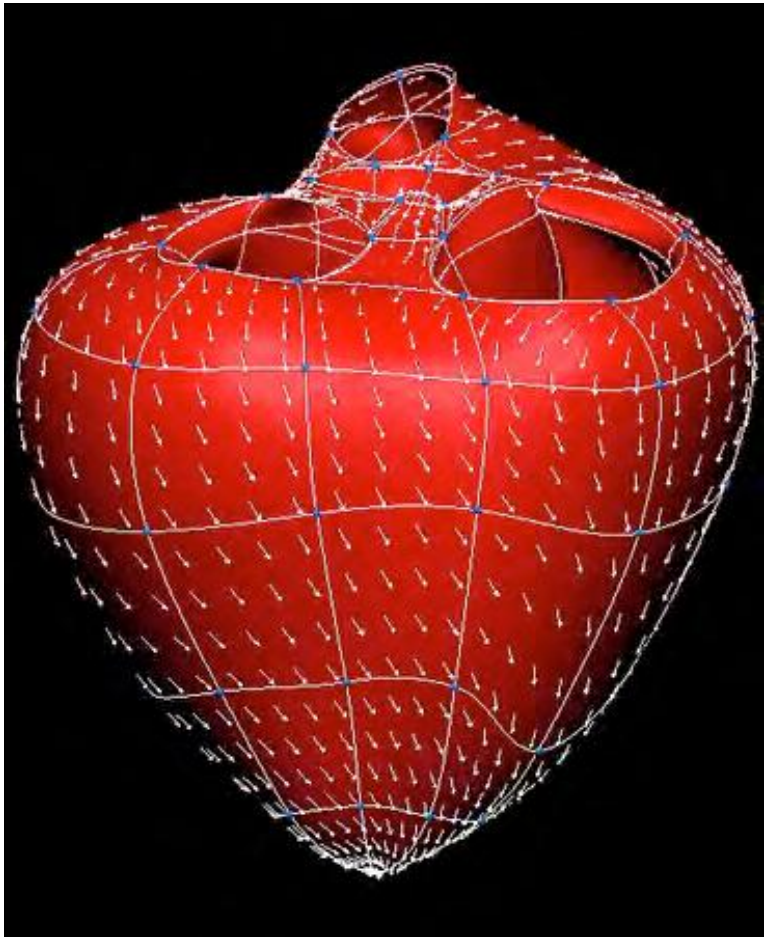
- Curve-fitting
- Integer
- measurement
- Simultaneous Equations
- Calculus

Spatial and temporal scales





Modelling a surface
eg: the surface of a heart



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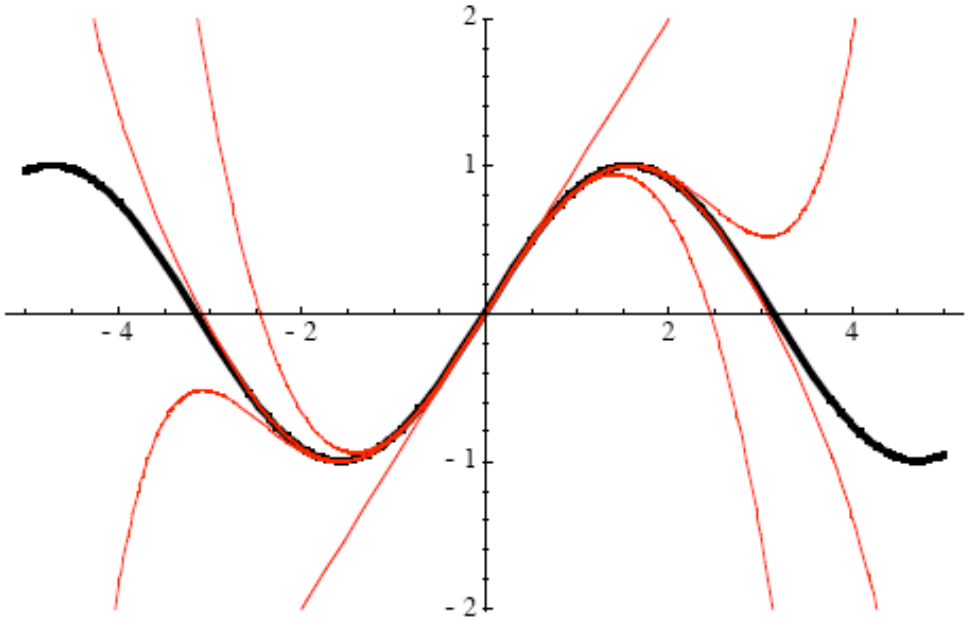
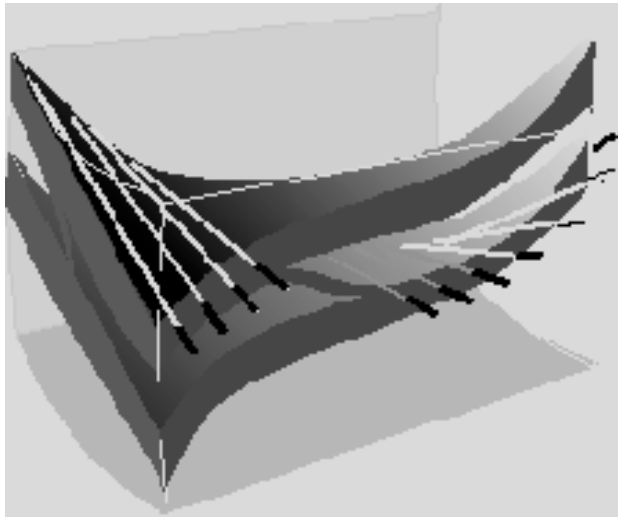
Approximating functions

- $\sin(x) = x - \frac{x^3}{6} + \frac{x^5}{120} - \frac{x^7}{5040} +$





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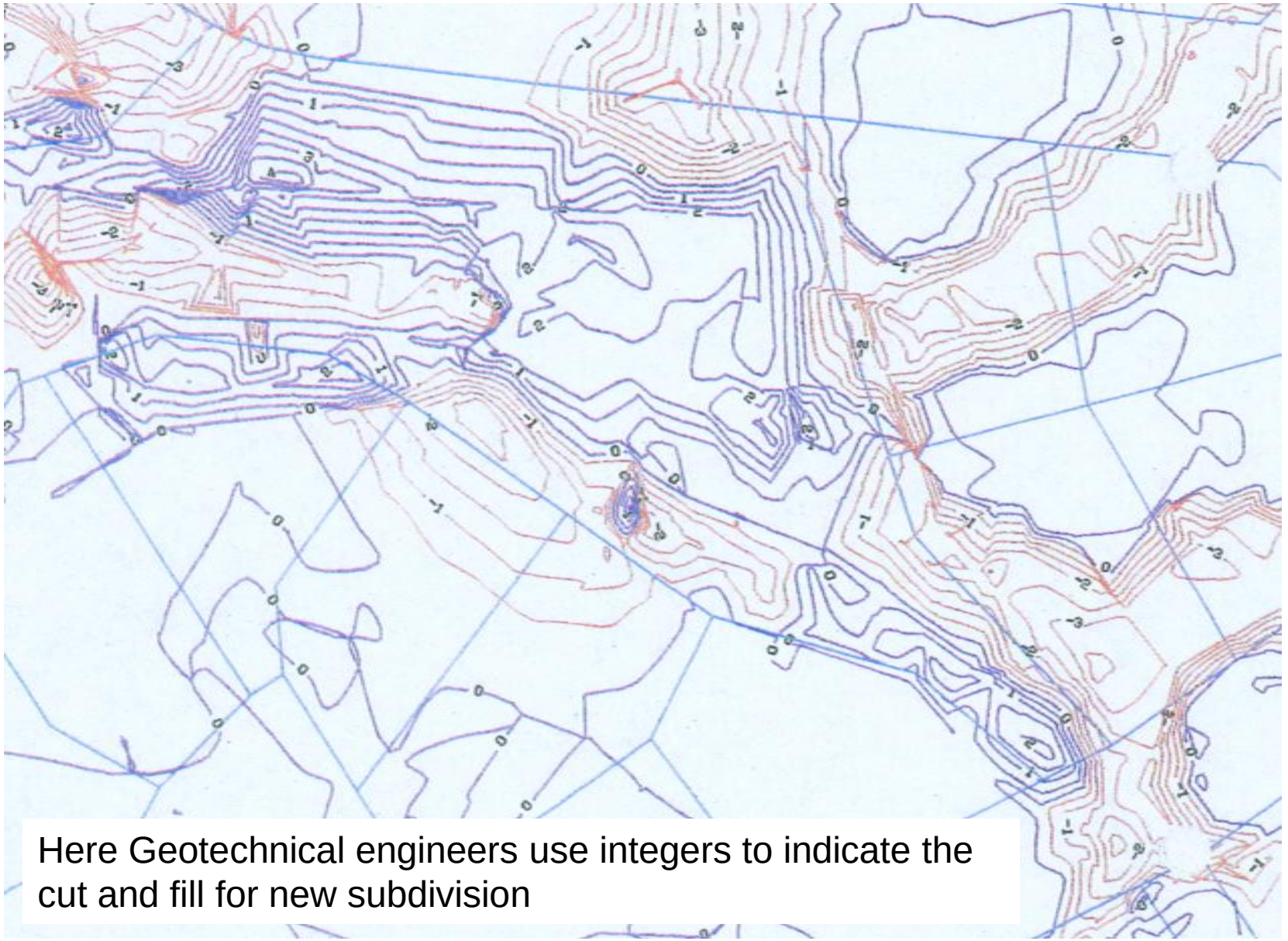
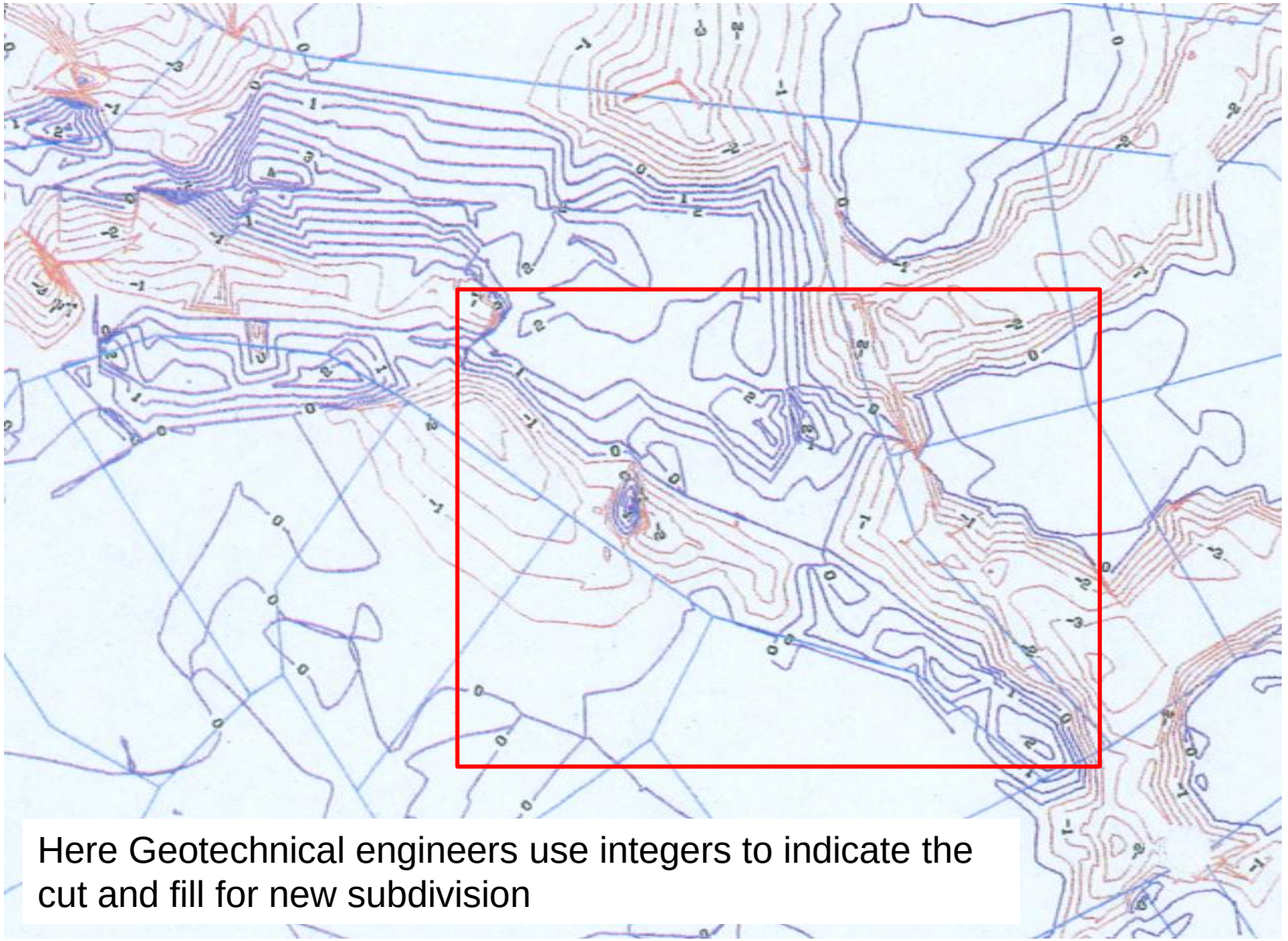


Here Geotechnical engineers use integers to indicate the cut and fill for new subdivision



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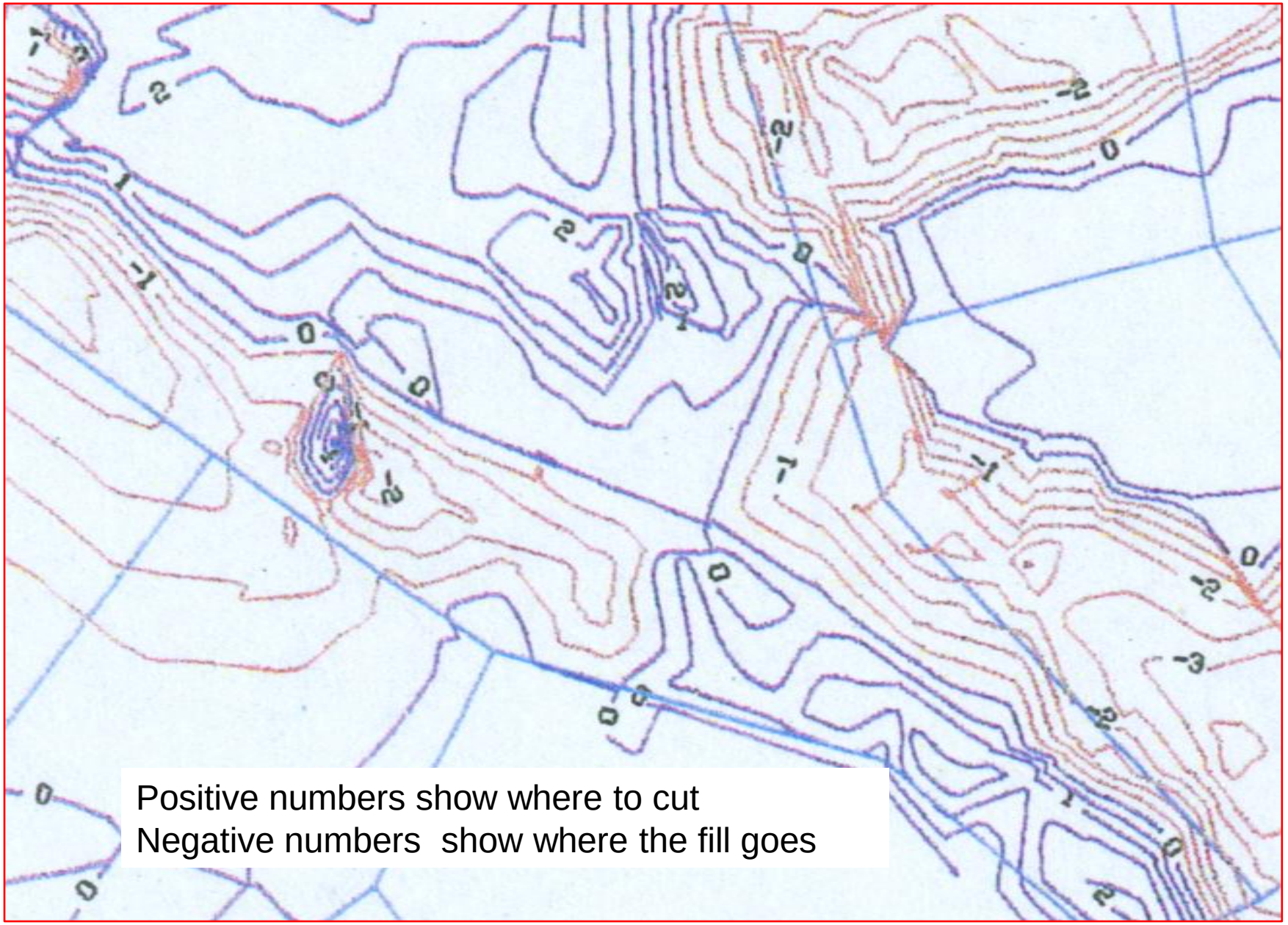

Positive numbers show where to cut
Negative numbers show where the fill goes

Re-sealing and widening a 10m wide road

Find the cost of materials for widening and resealing an existing 10m wide road by 60 cm

Specifications

- 3% batter (slope) so water runs off it
- New top seal must be min 150mm thick
- Widen road by 60cm (ie: 30cm each side).
- New Base layer on each side must be 300mm deep

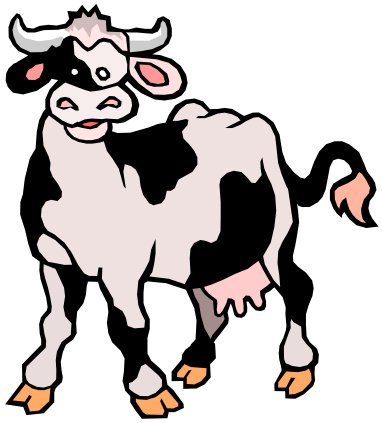
Assumptions

- Old road is flat
- No need for new base under old road

Cost of materials

- $90 /$m^3$ Topseal
- $80 /$m^3$ Base layer

Simultaneous equations



How much cream?

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Calculus examples

1. A Leaky tank
   - forming a differential equation
   - Integration,
   - graphing,
   - maximum point and
   - x-intercept

2. Simple Harmonic Motion
   - rich in skills but higher level mathematics

My message

- Talk about careers, you will open doors
- Connect mathematics to the real world
- Use real examples of real mathematics
- Share with others!

Thank you for coming

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