Learn Chemistry

Commercial Skills for Chemists: Innovation

Student Pack

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Student Pack

Innovation

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Innovation

- Overview
- Task Briefing
- Lecture Resources
- Other Materials

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Innovation – Task Briefing

- You are a group of technologists working for *Mega Chemicals plc*. Your work is to evaluate new technologies and recommend which ones *MegaChem* might wish to take to market
- 5 new projects that *MegaChem* are interested in can be found on the following slides
- Your task, as a team, will be to produce an 'elevator pitch' on each potential project identifying the *features* and *benefits* of the technology, recommending whether to pursue any of them further and how to do so
- You should learn and retain the distinction between *invention* and *innovation* and what creates the latter
- To help with your decision making you have access to lecture material, academic papers, a book, and two short videos

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The New Projects…

Here are the 5 projects MegaChem are interested in…..

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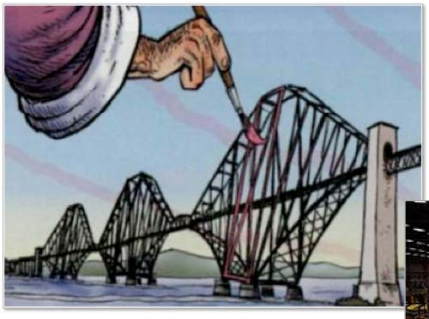
Project 1 Anti-corrosive pigment



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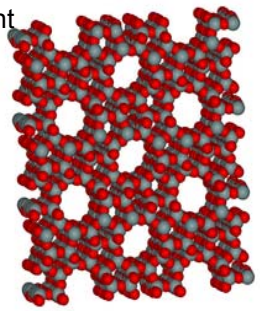
Project 1 – Anti-Corrosion Pigment

- We have discovered a better anti-corrosion pigment using zeolite to encage zinc chromate
- Corrosion costs $1trn in US alone!
- Zinc chromate is a well known effective anti-corrosive that is restricted in use because Cr^{VI} is toxic in the environment
- Because our pigment encages chromate anions, it provides the anti-corrosive benefits without the toxicity issues
- We recommend reviewing the opportunities for developing and commercialising this pigment



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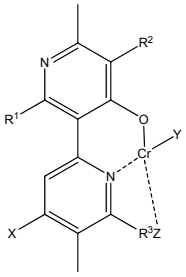
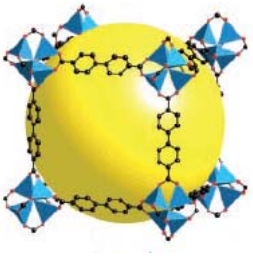
Project 2 Methane Oxidation Catalyst



Catalyst Facts:
Turn over Number:
15Million
Turn over Frequency:
1.5kat
Synthetic Cost:
18000$/kg



8.8x10^7 m^3 methane

1.2x10^5 T methanol

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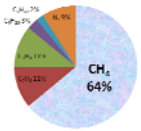
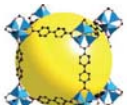
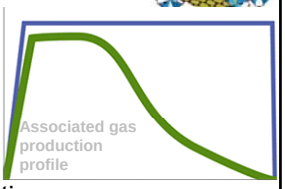
Project 2 – Methane Oxidation Catalyst

- We have a chromium catalyst that can convert methane t methanol at mild conditions
- Methane (natural gas) is difficult and expensive to transport over long distances, while methanol liquid is much cheaper and easier to move
- Commercial Opportunities could include
  - Major methane gas fields around the world
  - Potential to reduce flaring of associated gas
  - Exploit methane hydrates in arctic waters
- We need to assess and prioritise these opportunities







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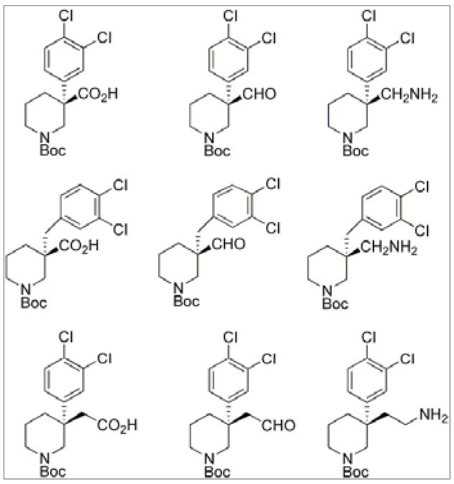
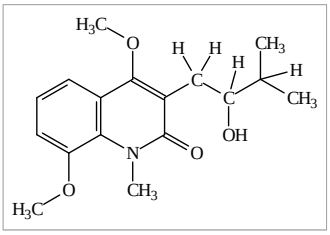
Project 3 New antibacterial synthesis





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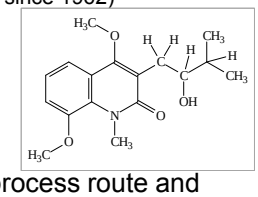
Project 3 New antibacterial synthesis

- We have a new route to synthesizing specific enantiomers of intermediates and drug candidate molecules
- Using specific enantiomers avoids some major potential side effects caused in drug trials by the presence of the opposite enantiomer
  - See 'thalidomide'
- In particular, we have a route to an enantiomer of lunacridine, which has potential anti-bacterial activity
  - Lunacridine could be the precursor of a whole new family of antibiotics, the first major discovery since 2000 (which was the first since 1962)
  - Constant demand for new antibiotics
  - World market around $15bn pa



- We would like to determine the value of the process route and the new antibiotic candidate

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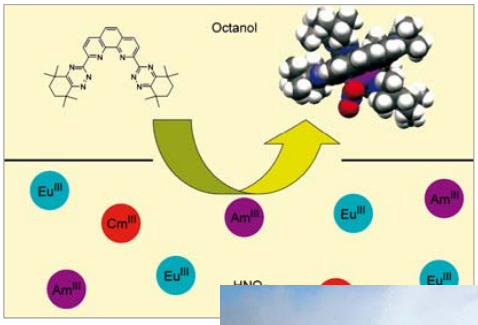
Project 4 New Separation Technique



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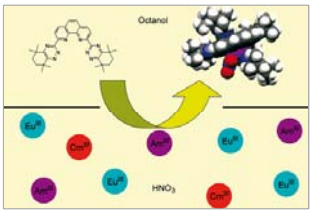
Project 4 New Separation Technique

- Lanthanides ('rare earths') and actinides are chemically similar and hard to separate
  - Lanthanide fission products are a problem in nuclear waste
  - Thorium is a contaminant in lanthanide mining
  - Lanthanides have interesting magnetic properties and important industrial uses
- We have discovered a new phenanthroline-derived ligand that can separate actinides (Th, Am, etc) from chemically similar lanthanides
- We plan to explore opportunities in both nuclear waste decontamination and clean-up of rare earth mines



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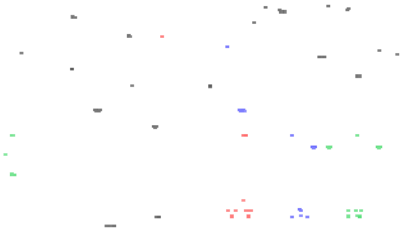
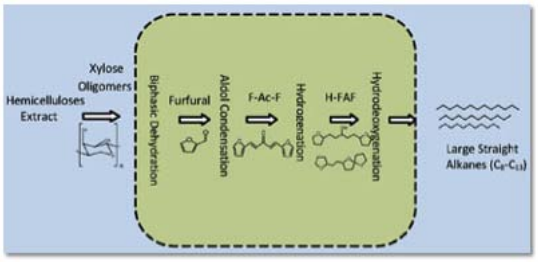
Project 5 Bio-diesel from Lignin





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Project 5 Bio-diesel from Lignin

- There are few current processes for making Jet Fuel from Biomass sources
  - Demand for Jet fuel around 5million barrels/day
- We have a multiple step process that converts lignin hemicellulose to C_8-C_{12} paraffins suitable for Jet Fuel
  - Lignins are major constituents in certain tropical and temperate plants
  - Other biomass process tend to make lighter paraffins not C_8-C_{12}
- We recommend further study of the economic and logistics of this process

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Innovation – Lecture Resources

- The following slides are from a workshop on innovation given to chemistry students at a UK University in 2012
- You may read or use as much of this material as you like, working through the exercises if need be, to help you produce your assignments
- Part of this lecture is available on video at http://www.youtube.com/watch?v=KUT0O41XogQ&feature=youtu.be

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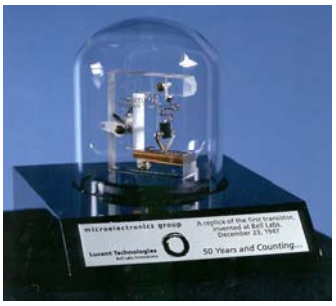
Innovation Skills for Chemists



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Here is part of the UK in 1900

- What are the main technologies that have changed people's lives since then? How many of these have been chemical?
- Spend 10 minutes coming up with a list!

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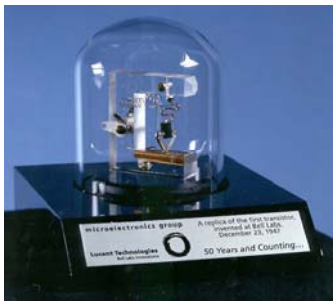
Chemistry in the 20th Century



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Chemistry in the 21st Century

What will be some of the main challenges facing chemistry in the 21st century?
How many ideas can you come up with?

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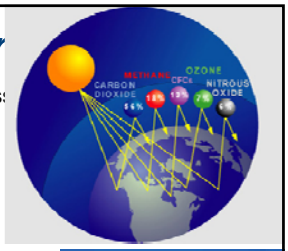
Chemistry Oppor



- Transport – fuel cells batteries (enough Li?), H_2 storage, biomas
- CH_4 emissions (& clean-up in atmosphere)
- Substitutes for rare earth magnets
- PV - efficiency, a-Si/µc-Si, CdTe
- CCS – CO_2 absorption, reservoir chemistry
- Power Transmission – cable technology, super-conductors
- Building insulation – 40% UK CO_2 from buildings, glass - Temperature control or energy gain?
- Nitrogen fixation
- Methane Methanol conversion
- Reduced Water and Pesticides in Cotton
- Cheaper ways to clean/distill water
- Nuclear waste

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Good Commercial Ideas

What turns a technical advance into a commercial idea?

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Approaches to Advertising - Exxon

- Late 1990's, Exxon (Esso) invent way of integrating credit cards (pre chip n' PIN) with petrol pump electronics
- New software, magnetic strip recognition, various algorithms, safety and security interlocks
  - What do they say in their advertisements…?

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The Advertising Industry distinguishes

What and how a product is made - its features
from what it does for the customers - its benefits

'My PC has a 2Ghz chip'
'I can run Death Star 3 on that'

'My car has 7 seats'
'I can take the kids and all their friends and all the

'My consultant has degrees from Harvard and Cambridge'
'Perhaps he can treat my cancer'

'My skin care product has active protein bio-molecules'
'People will still think I'm attractive'

You advertise the benefits, not the features!

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There are 4 generic benefits (?)

Lets look at the next 4 case studies:

- The invention of the transistor
  - 'a small piece of silicon'
- A new cutting fluid
  - 'with caprylic acid'
- A positron tomography scanner
  - 'it can image metabolising cancer cells'
- The 1960's – mini cars and mini skirts
  - 'transverse engine and new polymer fibres'
- Let's look for the benefits!

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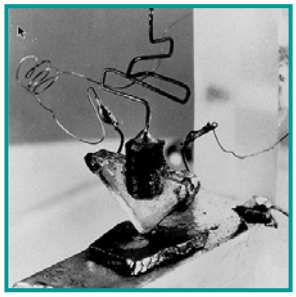
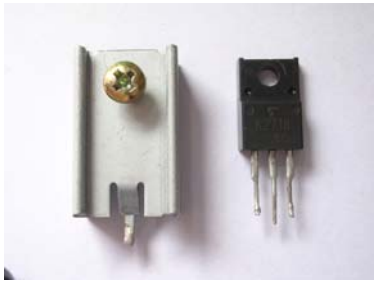
In 1950 Bell Labs invented the Transistor





- Invented by Bell Laboratories for use in Telecoms
- This prototype evolved into a device like this
- Used in amplification circuits, radio circuits, and eventually in calculators and PCs

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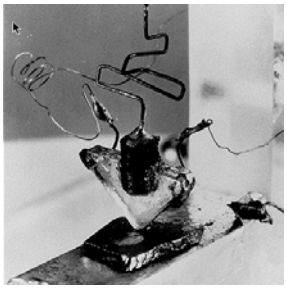

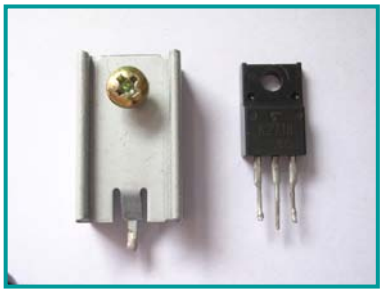

- Invented by Bell Laboratories for use in Telecoms
- This prototype evolved into a device like this
- Used in amplification circuits, radio circuits, and eventually in calculators and PCs

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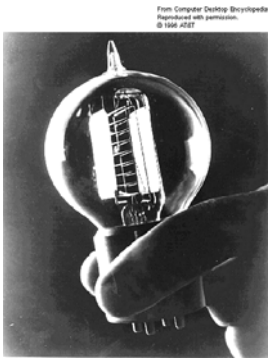
This is what it replaced…..



- Thermionic valve, and the home (valve) radio
- The transistor is smaller, lighter, more robust, and consumes less current than a valve
- One company used the transistor like this…

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The Transistor Radio

- While one company in Japan used the transistor to build a radio like this
- Who will be more successful.....?

Benefit 1 – doing something new (e.g. portable music)

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A New Cutting Fluid

'Cutting fluids are chemical formulations used to cool and protect metal surfaces during machining processes in manufacturing'

- Consider the following statements:
  - 'Our machine tool cutting fluid uses caprylic acid as an anti-wear additive'
  - 'Our cutting fluid helps machine steel to a surface roughness controlled to within 10 microns tolerance'
  - 'Our cutting fluid lets a major prestige car manufacturer finish the cylinder bores on its engines without the need for an expensive extra honing stage'

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Describing a Benefit

- 'Our cutting fluid saves one extra stage of rework at the cylinder boring centre at the Jaguar engine plant
- 'This could save Jaguar $2.5m per year'
- 'It achieves this because its use of caprylic acid as an anti-wear additive gives very good surface finishes on machined steel surfaces'
- Benefit 2 – saving money (especially ongoing costs)

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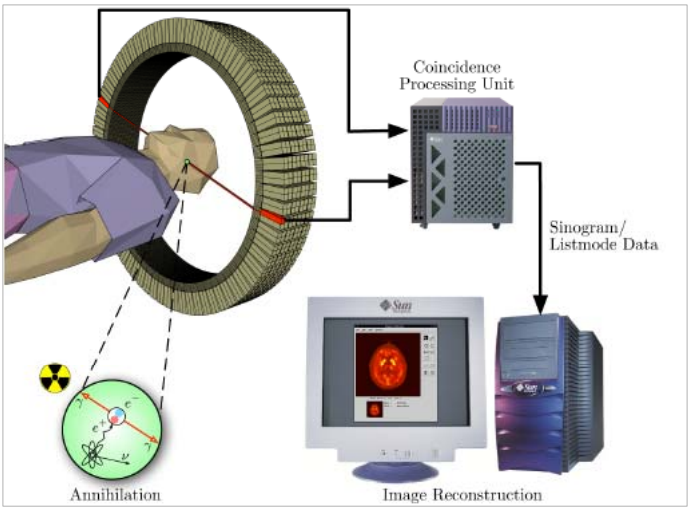
Radiochemicals for Medical Imaging



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Radiochemicals for Medical Imaging

- Positron Emission Tomography (PET) allows imaging of metabolising organs
- Has potential to replace diagnostic surgery for some cancer patients - secondaries from breast cancer
  - 30-50% of diagnostic surgery proves to have been unnecessary
    - can still lead to patient infection
  - Current cost of diagnostic surgery around £5k per operation
  - 45,000 patients a year get breast cancer in UK alone
- PET is very dependent on rapid production of very short half life radiochemicals
  - Current one-off batch process
  - New generic, efficient, and highly selective approach to the formation of [18F]fluoroarene agents will widely increase ease and availability of PET
- Benefit type 3 – making life much easier (for patients, doctors, medical chemists!)

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1960s innovation - Minis 'cars & skirts'

- Mini skirt
  - 'we wore them because it made us feel fashionable/good about ourselves'
- Mini Car
  - 'we drove them because it made us feel fashionable'
- Both underpinned by technical innovation (polymer fabrics, transverse engine), but that didn't make us buy them!
- We buy things that make us feel better about ourselves

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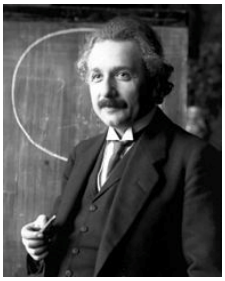
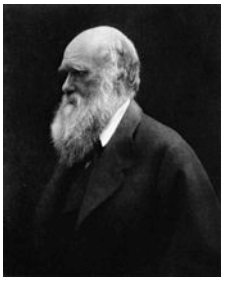
What did these people do?





'More than any other scientist, Charles Darwin changed the way we view the world' (Dr Hopi Hoekstra)

'The contributions made by Rosalind Franklin allowed us to uncover the structure and behavior of DNA…we've come to understand more about ourselves, where we've been, and what tomorrow will bring' (Chicago Medical School)

'The most enduring change brought by Einstein's work was to shake our sense of certainty' (Prof J.D Norton)

Their theories changed the ways we think about ourselves

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'Intangible' Benefit Type 4

We are interested in things which make us feel better about ourselves, or change the way we think about ourselves

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Benefits – Look for the technical target(s)

- Benefits may result from features but features are not benefits
  - It is not a benefit to have a 16valve engine or 1TB of memory
- A feature may benefit one user but not another
  - Not everyone needs a 7 seater car
  - Not everyone needs a way of making liquid fuel from coal
  - But some will!
- How good do we have to be to deliver a benefit to a customer?
  - NB. There is no direct relationship between advancing technical features and increased customer benefit
  - The features/benefit graph is non-linear and has abrupt discontinuities!

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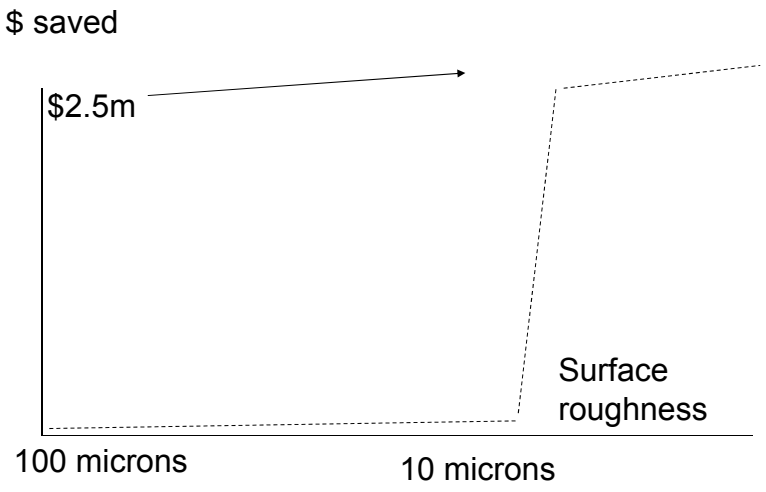
Benefits vs Features



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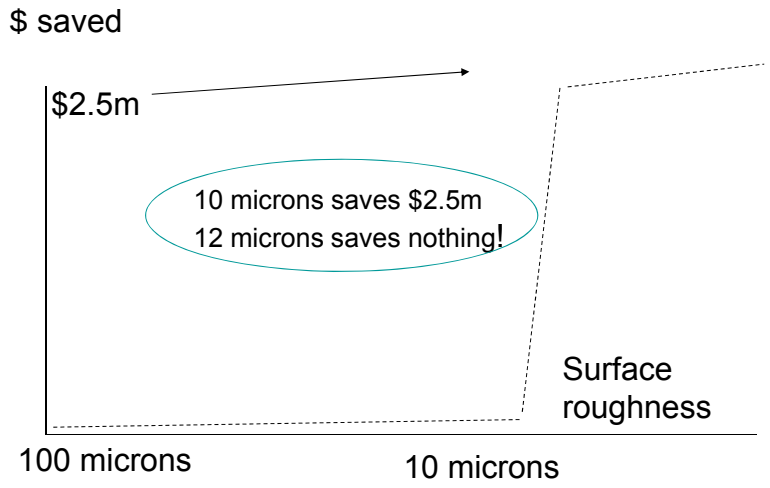

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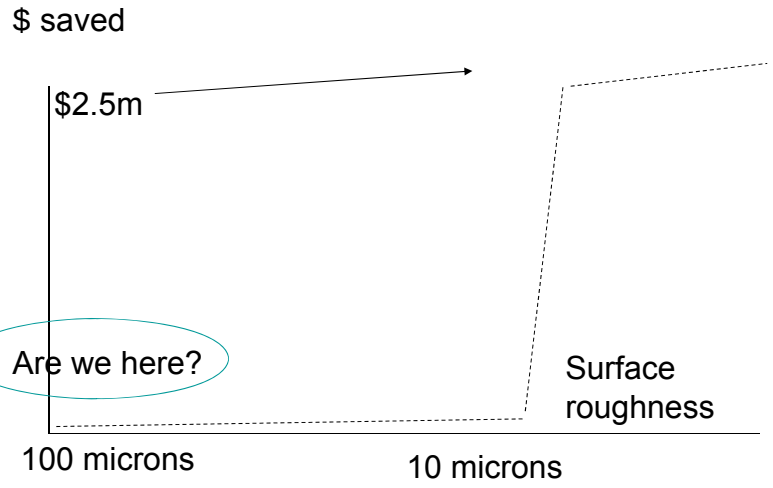

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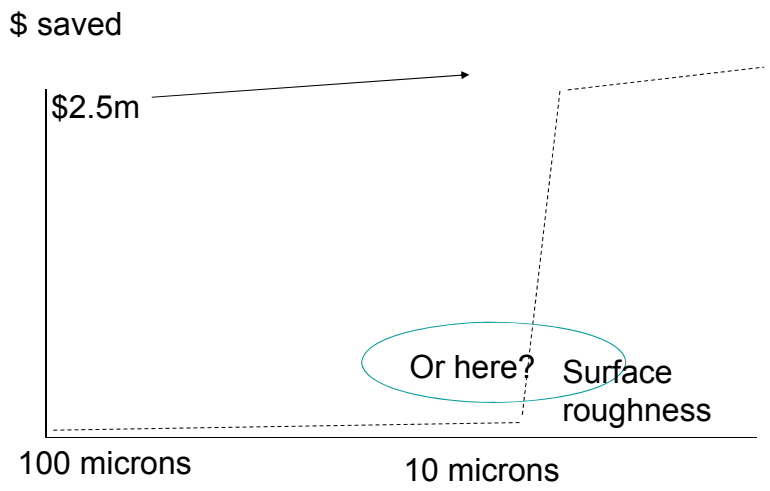
Benefits vs Features



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Benefits

- Features and benefits are not the same!
- A feature may benefit one user but not another
  - We need to identify how good our feature (technology) needs to be
- There are 4 types of benefit
  - do new things (the transistor radio)
  - save money (cutting fluid)
  - make life easier (radiochemicals for PET)
  - changing our ideas about ourselves (fashion, consumer goods, scientific theories)
- Can you think of any potential benefits of the work you do?

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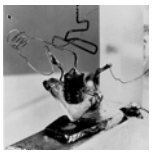
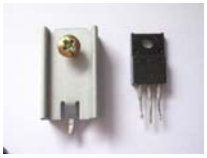
How to innovate…


- Technology/know-how is not commercially interesting in itself
  - Its what you can do for people!
- You need to use your unique technology to do something interesting for:
  - the people who are going to use it and/or pay for it
- What kind of things are interesting to customers/politicians/the public?
  - New things
  - Cost Saving
  - Hassle reduction
  - Change their view of themselves
- *'Someone with money and a problem is an opportunity for you'*

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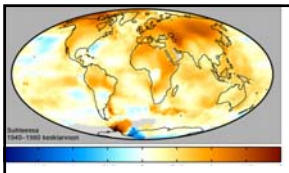

Potential Benefits – Green Issues?

- The world's current installed power generation capacity is around 4000GW, 22% renewables such as hydropower. What is the forecast demand for 2030?
- The UK's largest contribution to carbon emissions comes from one sector which produces 40% of the total emissions. What sector is that?
- What is the difference in energy efficiency between the best and worst office buildings?
- How much of all the food purchased in the UK is wasted?
- How much land is needed to grow enough biofuel to power a jumbo jet?
- Are algae plants, animals, or bacteria, and can we patent them?

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Potential Benefits – Chemistry and Medicine?

- What can beans and peas do, for free, at room temperature and pressure, that costs us a billion dollars a time?
- What is a typical relaxation time and mechanism of vibrationally excited carbon dioxide molecules?
- What is bluetongue and where was it seen recently?
- Can you do anything with natural gas (methane) except burn it?
- What portion of the patent life of a drug is used up before the drug gets to market?

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Potential Benefits – Electronics?

- What can they do on Star Trek that would save the EU €1bn a year?
- Who is trying to corner the market in rare earth elements, and why?
- What is the world market for speech recognition software?
- How can people with only one eye watch 3D television?

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Potential Benefits – Social, Economic, and Political?

- What is the most popular clothing fabric in the world, and is that a good thing?
- What do 45% of people in the USA believe about geology?
- What do 15% of the population of Egypt, Tunisia, and Libya want to do (its only 5% in the UK)?
- Why did Korean Airlines have a much worse safety record than Air New Zealand?
- How can we put a net present value on assets that last for 200 years?

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Potential Benefits – only for scientists?

- Artists?
  - Change the way we view ourselves
- Architecture
  - better buildings increase productivity and reduce carbon footprint
- Linguistics
  - ethnic diversity correlates with bio-diversity
- Musicians/bands/recording studios
  - Are all small businesses!
- History
  - ...is about economics, causes of war, importance of technology

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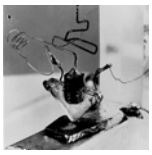
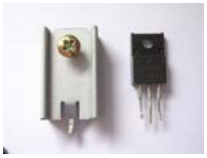
Your Elevator Pitch…


- Point 1 – someone, somewhere in the world has an important problem!
  - (How many people, how big a problem?)
- Point 2 – we have a unique and interesting piece of technology
- Points 3/4 – its not obvious, but we can explain how our technology could solve the problem
  - Link features and benefits
  - Identify the type of benefit
  - Who gets the benefit – patients, customers, teenage music fans etc?
  - Identify how good technology has to be to deliver benefits, and how good it is now
- Points 5 – What would you recommend to do next?

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Innovation – Other Resources

- Video: *What Makes a Good Commercial Invention?*
  - http://www.youtube.com/watch?v=ArJvmjGfNVg
- Video: *The Difference Between Features and Benefits*
  - http://www.youtube.com/watch?v=stv3ePGNBcE

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Innovation – Other Resources

- Video: *A great 2 minute 'elevator pitch'*
  - http://www.youtube.com/watch?v=zq_XY9oU_Kc

- Video: *Biotechnology YES scheme Business Presentations*
  - http://www.youtube.com/watch?v=nClc9iTOi8s

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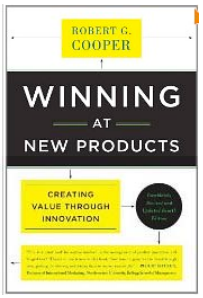
Innovation – Other Resources

- Paper: Great Mistakes in Technology Commercialisation
  - *Journal of Strategic Change, Volume 10, Number 7, pages 383-390, John Wiley & Sons, (November 2001)*
  - Download here:
    - http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/419/Great%20Mistakes.pdf

- Book: Winning at New Products, Robert G Cooper
  - Basic Books; 4th edition (28 July 2011)
  - ISBN-13: 978-0465025787



- Journal: Chemistry World, published by Royal Society of Chemistry, all/any editions from 2010 and 2011

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