Teaching Sustainable Development at Oxford

RAEng Visiting Professor Roger Booth & Professor Richard Darton

- Started in 1999
- Theme of Sustainable Energy
- Consistent with University's teaching practices
- Find suitable spaces in heavily loaded curriculum
  - Year 2 Engineering & Society
  - Year 2 Course Work Modules
  - Year 3 Design Project
  - Year 4 Chemical Processes
- Given by Visiting Professor
- Not classical (Harvard type) case studies
- Now fully embedded in undergraduate teaching

Engineering Science at Oxford

- One of the UK's largest unified departments
- 600+ undergraduates (> 20% women), 200 researchers
- Close links with industry – 9 spin-off companies
- Four courses (accredited by Institutions):
  - Engineering Science
  - Engineering & Computing Science
  - Engineering, Economics & Management
  - Engineering & Materials
- All are members of a college, with tutor.
- Academic Committee & Sub Faculty approve curriculum

Summary of Teaching Materials

Year 2 Engineering & Society

- Both optional & core elements
- Initially Sustainable Energy optional (~60 students)
- Academic Committee approval as core from 2001
- Increased from four to eight lectures
- Supported by College tutorials
- Examination question

Year 2 Engineering & Society Lectures

Engineering & Sustainability ***(Prof Darton)***

- Engineering & the Environment
- Regulation & Compliance
- Introduction to Sustainable Development
- Can We Assess Sustainability?

Sustainable Energy ***(Dr Julia Stegemann)***

- Energy & the Environment (Introduces LCA)
- Scope for Renewable Energy
- Clean Cars & Renewable Fuels
- A Sustainable Energy Future?

Tutorial - 8 numerical questions:

Global warming, GHG emissions, global energy use, BIPV, nuclear waste, car emissions, multi-criteria decision making.

Year 2 Course Work Module

- **Five days – 25 students**
- **Builds on Engineering & Society Lectures**
  - **Sustainable development**
  - **Energy supply & use**
  - **Climate change**
  - **Scenario development**
- **Opportunity for team work, role-play & presenting**
- **Flexible half or one day modules (mix & match)**
- **Outside speakers – Jeff Hulse's 1-day Byker very popular**
- **Site visits**

Year 3 Design Project

2000

Professor Rankin developed a project for:

Hydrogen plant for a fleet of fuel cell buses

IChemE approval

2002

All project teams to assess sustainability:

- **Brief (2 page max) section of the report**
- **Supported by quantification (e.g. ratios)**

Lecture:

'Assessing the sustainability of projects – A Guide for Design Teams'

Consultancy service

Year 3 Design Project

- Positive & negative sustainability impacts:
  - Social development
  - Economic development
  - Resource efficiency
  - Environmental protection
- +ve, -ve or neutral impact on future generations?
- Modifications made
- Improvements for next iteration
- Comment on methods used
- Who are the stakeholders? Consultation required?
- Proceed without further modification? (Go/no go)

Year 4 Chemical Processes lectures

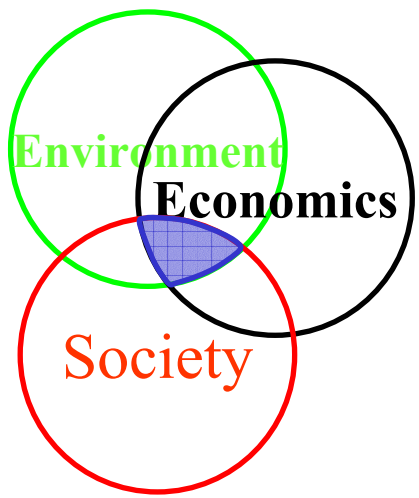
Part of the Chemical Engineering option

- **LCA – A Tool for Sustainable Development**
  - **Two lectures:**
  - **Refresher on sustainable development**
  - **Methodology & examples of LCA**
  - **Taken over by Dr Julia Stegemann**

- **Fuel cells – a process engineering challenge?**
  - **Two lectures:**
  - **History, theory & status of fuel cells**
  - **Taken over by Dr Richard Stone**

Core Knowledge

- Engineers make things!
- Turn raw materials to products
- Use energy & create waste
- Need to understand their responsibilities to:
  - The Environment
  - Society
  - The Economy.



Core Knowledge

Includes an understanding of:

- Background to Sustainable Development
- Resource depletion
- Carrying capacity of the environment
- Climate change (IPCC & UNFCCC)
- Inter- & intra-generational equity
- Legislation & compliance (EMAS & ISO 14,000)
- Role of the engineer
- Stakeholder analysis
- Triple bottom line
- Material & energy efficiency
- Sustainability indicators

Skill sets

SD a holistic property - potential conflicts.

Familiar engineering dilemma! ***(High flexibility / low cost)***

Go / no go decision point – similarity to safety

- **Modelling & design skills**
- **Arts of analysis & synthesis**
- **Deal with defined & open ended problems**
- **Application of judgement**
- **Basic LCA**
- **Multi-criteria decision making**
- **Effective team working (multi-disciplinary)**
- **Communications skills (written & oral)**

Teaching approach

Some see as 'soft', non-quantitative with poor fit to engineering

Oxford approach follows the approach to engineering:

- **Provide theory or information**
- **Give a practical**

  (calculations, essays, laboratory work, project work, role-play, presentations)
- **Test**

Tutorials and year 2 Course work - opportunity to assess

Integrates transferable skills

(multi-criteria decision making, team working, role-play, communications….)

Conclusions

- Teaching SD now fully embedded at Oxford
- Taken over by academic staff - will continue!
- New material must be consistent with teaching practices
- Initial delivery by VP essential
  - Understand students
  - Significant changes years 1 to 5
- Close co-operation and support of mentor et al essential
- Students responded positively
- New entrants have greater awareness than 5 yrs ago
- Outside world moved on in 5 years
  - Rate of change far higher than typical u/g material
  - Still a demand – must be well planned and up to date