Industrially based case studies

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Case studies introduced in

‘Materials Selection in Design’

in 2003

Materials Selection in Design

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- Course Background
  - The course is taken in year 3/4 by 150 students from Materials, Bio-materials, Medical Engineering and Mechanical Engineering streams.
  - Mixed backgrounds and knowledge base. Project groups are engineered to get good interaction between the groups.
- Materials students have extensive experience of problem based learning in years 1 and 2.
- Engineering students have less exposure to problem solving case studies.
- More than 50% overseas students.

Industrially Based Case Studies

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- Course Structure
  - 25 lectures on design, materials and manufacturing (basis of multiple choice exam) - 30 marks
  - ~10 case studies (formatively marked and some assessed in an examination) - 30marks
  - 7 industrial case studies delivered by different industrial (examined both in session and during exam) - 40 marks
- Motivation to running industrial based case studies. Students have a limited:
  - Awareness of materials selection in design.
  - Awareness of the role of a materials engineer in industry.
  - Exposure to role models in industry.
  - Practical experience of making decisions in a group.

Structure of Industrial Case Studies

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- Visiting professors deliver a 1 hour lecture on a specific materials selection problem taken from industry. (7 visitors in 2003)
- Students work in teams for about 5 weeks on their specific case study. (4 teams of five/six students per case study)
- Each group presents a 15 minute review of their conclusions.
- Each group submits a 5 page group report.
- These are assessed by the visiting professor, who then gives a 1 hour report on their proposed designs and the actual solution used in practice.

MAT 602 -The Team

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- Course Organiser:
  - Dr. James Busfield
- Guest Lecturers:
  - Prof. Alan Richie, Du Puy
  - Prof. Gordon White, BG
  - Prof. Mike Collins, British Aerospace
  - Prof. Geoff Kirk, Rolls Royce
  - Prof. Mike Winstone, DERA
  - Dr. Barrie Hayes, CIBA
  - Dr. Mark French, Qinetiq

Role of Visiting Professor

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- Each case study has a Visiting Professor who:
  - Conceives the case study
  - Writes it up for the students
  - Presents the case studies to the students
  - Assesses how the student groups deal with the case study
  - Provides feedback at the end of the case study
- Students can usually contact the Visiting Professor via E-mail during the case study.

Case 1 - Turbine blades.

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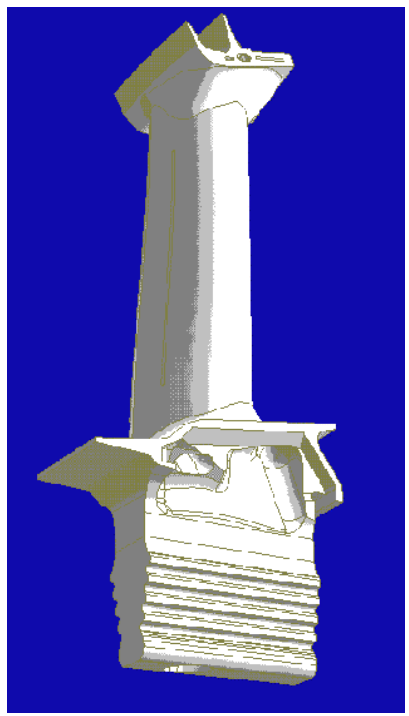
Case Study 1 - GK			
Group 1	**Group 2**	**Group 3**	**Group 4**
HUNDEYIN	EKWUE	ARIYO	ALIM
LIN, TIE	HOSSEINI	CHOUDHURY	DHILLON
NILAR	LIANG	LI, ZHONGSHI	DIAMANTOPOULOS
PAN JIN	MA, JIA	LIU, RUI	LIN, YONG JIANG
WU, WEI	WU, KANGFEI	WANG, YIWEN	WANG, XU

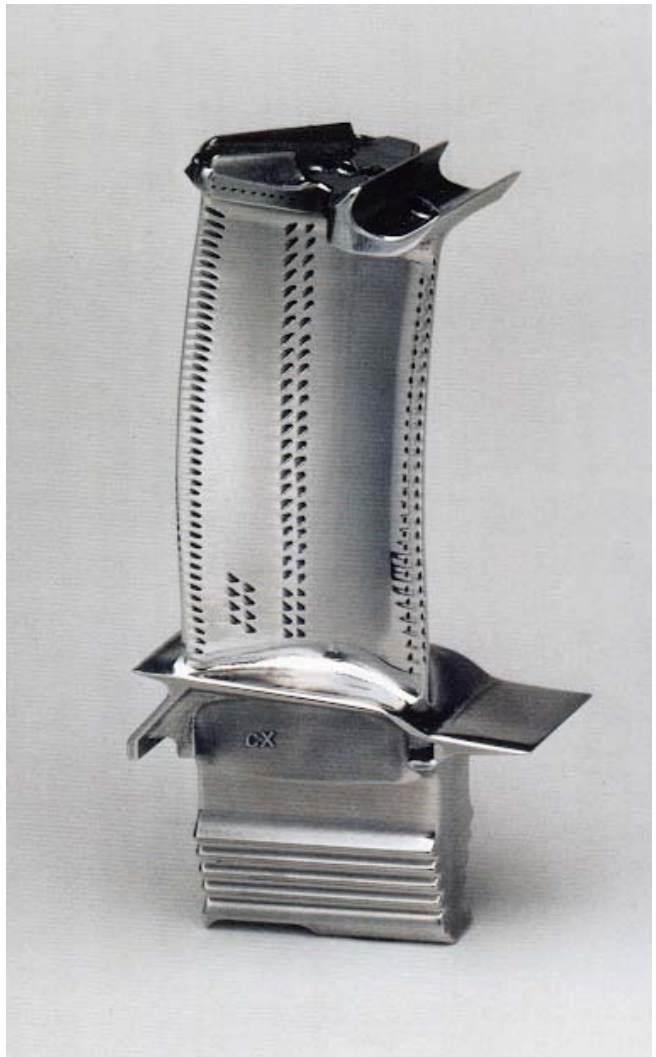
Possible Materials options

- SiC/SiC
- Forged Nickel Cobalt (Nimonic 105)
- Cast Nickel Cobalt
- Directionally Solidified Cast Nickel Cobalt
- Single Crystal Cast Nickel Cobalt



Case study 1 - Issues

- What would you advise for maximum turbine entry temperature and stress levels for the various materials?
- How are the requirements met by each of the material options and how successful are they?
- What material or process improvements would be beneficial to the component?
- What other material properties that have not been discussed could be important in this application?



Case 2 - Refrigerated truck body panel.

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What materials and basic manufacturing method would you propose to make a refrigerated food delivery truck body given the following requirements?

- Excellent Thermal Insulation
- Good Impact Resistance
- Easy to Clean and Sterilise
- Corrosion Resistant Exterior
- Smooth Surfaces for Cleaning and Advertising
- Low Weight
- Simple Production and Assembly
- High Strength and Stiffness
- Competitive Cost
- Size: 13m x 3m x 2m

Case 3 - Tail fin for fighter planes.

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- What is the role of the tail fin?
- The structural arrangements within the fin, defining structural elements, material selection and the supporting rationale behind the choices?
- The requirements for any systems, such as electronics, air and fuel.
- Today's design principles for manufacturing and assembling each of the elements?

Case 4 - Fighter plane tail keel design.

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- High stiffness to withstand loads
- High strength/ fatigue resistance, 6000h
- High corrosion resistance for 25 year life
- Low mass for agility
- Reasonable cost
- Low production rate
- Repairable
- Low risk
- Fire resistant
- 350°C temperature

Case 5 - Offshore corrosion of gas pipes.

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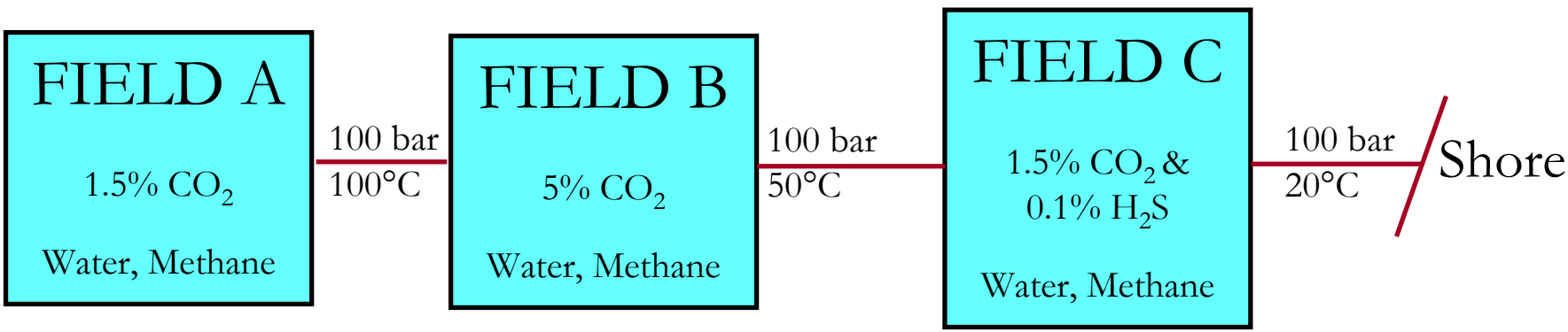
- Considering the gas chemistry, cost and potential repairs identify suitable materials and corrosion control for the 3 stages of the pipeline system.

- Include a discussion of corrosion allowance and the use of inhibitors with your selection.



Case 6 - Ankle Joint Design.

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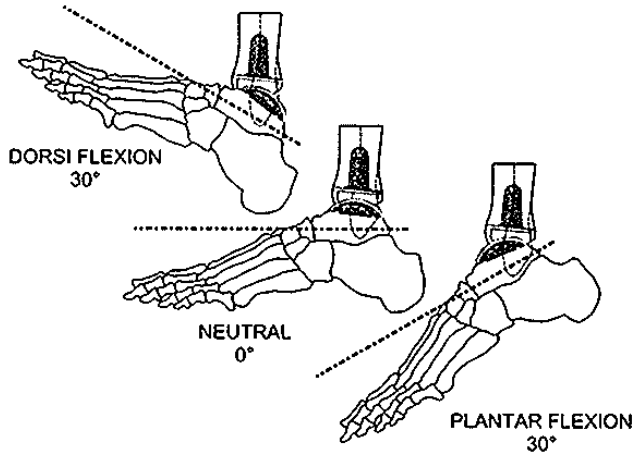
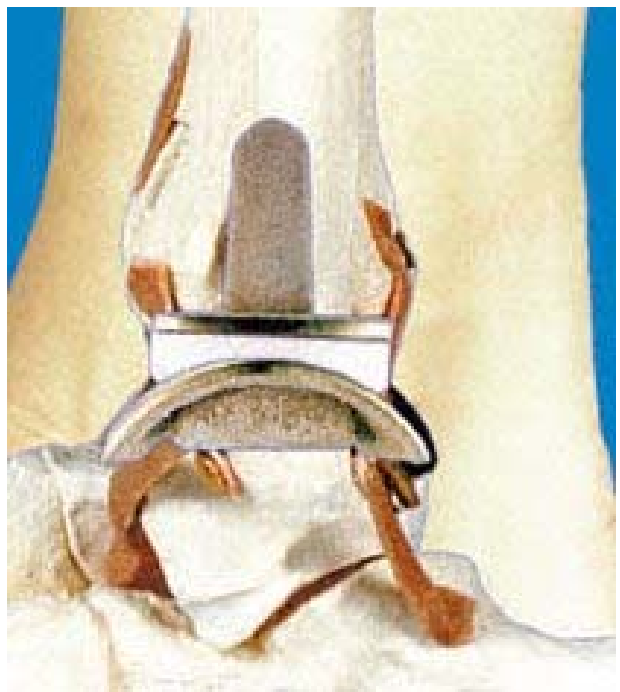
- Describe the possible material combinations for use in a mobile bearing ankle device in a 40 year old female.
- Describe your choice with reference to the following aspects.
  - Wear.
  - Fixation.
  - The effect of implant/bone modulus matching on the stems of the components.
  - Minimisation of bone resection.
  - Cost





Case 7 - Anti-ballistic design in tanks.

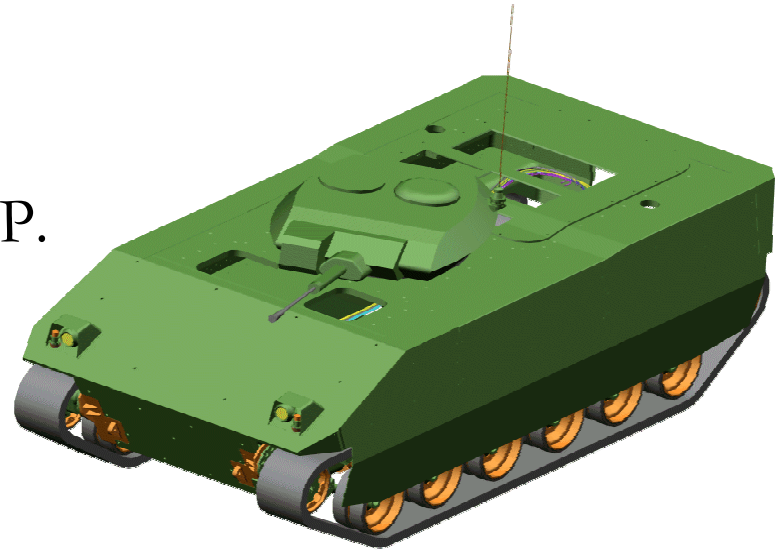
Material selection for tanks:

• Consider the application of a range of materials for tanks:

- steel, aluminium, titanium, GRP, CFRP.

• Evaluate the advantages & disadvantages covering:

- mechanical properties e.g; strength, stiffness, fatigue,
- material properties; wear, temperature, corrosion, impact
- manufacturing processes, cost, health & safety
- performance driver; weight



Reasons for Working in a Group

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- Integrate knowledge and skills from a range of multidisciplinary modules.
- Acquire knowledge through self-study.
- Teach students how to work in groups and manage group projects.
- Improve and develop the communication skills of the students.
- Develop the problem solving skills of the students.

Group Meetings

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- Throughout the project it is expected that you will meet at least once a week for a group discussion.
- To make these meeting work you must assign group roles.
  - The chairman has the task of directing the conversation.
  - The scribe does so by taking down important matters on a white board or flip chart.
  - One students acts as secretary.

Stepped Project Plan

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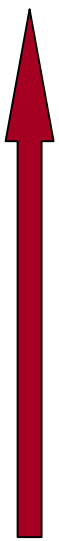

- Step 1 Explain unknown wording, statements and concepts
- Step 2 (Re/)Define the problem
- Step 3 Brain-storming
- Step 4 Make a systematic inventory
- Step 5 Formulate self-study assessments
- Step 6 Perform self-study assessments
- Step 7 Report on self-study

Students role

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- Individuals in the group should demonstrate:
  - Ability to analyse
  - Inventiveness
  - Critical ability
  - Theoretical knowledge
  - Practical skills
- As well as a group contributions which may be:
  - Role as a chairman
  - Role as a minutes secretary
  - Role as writer
  - Role as group member

Student Response to the Case Studies

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- Positive:
  - All the lecturers were excellent.
  - A fascinating course.
  - I don't like materials, but the teaching method made the course more interesting.
  - The guest lecturers spoke about new and exciting topics, and have made this my favourite course in my final year.
  - Course gives an insight into my potential future role in UK industry.
- Negative:
  - For BEng students the case study clash with the final year project.
  - Too much coursework was set.
  - Not enough time to prepare our case study.
  - Case studies have replaced true understanding.