1. Introduction
   • The value of money – inflation
   • Interest
2. Financing organisations
   • Business plans
   • Sources of capital
   • Financial reporting
3. Financing projects and appraising investments
   • Net present value, internal rate of return
4. Pricing products and contracts
   • Direct and indirect costs
   • Relationship between costs and price
   • Competitive tendering
Most organisations will sell some **products** or **services** in some form or another

A **price** will need to be set for these

In general, the **price** will be governed by the **market** rather than by the cost of providing the product or service

However, in order to decide whether it is worth entering (or continuing in) the market with a specific product or service we will need to know how much it **costs** us to provide it

Even for a relatively simple product this is not straightforward. **COST ≠ PRICE ≠ VALUE**

For a project (which we have not carried out before) it will be even more difficult
Costs of a Starbucks Coffee

- Figures taken from the Daily Telegraph suggest that in a £2 cup of coffee, only 4p of the cost is coffee.
  
  Daily Telegraph, 5/11/07

- “Coffee is now the second most widely traded commodity, after oil, with a total estimated value of $140 billion”

- [These days a Starbucks latte is more like £2.50 … inflation]

From commons.wikimedia.org by cyclonebill, licensed under CC BY-SA 2.0.
The original Mini was a marketing success, over 5m vehicles were made in 41 years.

However, the early production cars were probably priced too low in relation to manufacturing costs.

Estimates suggest that BMC lost £30 on every £497 Mini sold, at a time when Ford made £50 on each £589 Ford Anglia.

(see, for example http://www.aronline.co.uk/blogs/cars/mini-classic/the-cars-mini-development-history-part-1/)
4.1 Direct and indirect costs

- Often a product will go through a complex series of manufacturing operations
- There will also be other contributions to the sale of a product (e.g. marketing)
  - It can be difficult to assess how to include some of these costs in the total cost of a product or service
- It is useful to divide costs into ‘direct costs’ and ‘indirect costs’
  - Direct costs are those which can be directly attributed to the product and which (approximately at least) increase in proportion to the number of products produced.
    • E.g. Material, labour, machine depreciation, etc
  - Indirect costs are more difficult to attribute directly
    • E.g. Marketing, training, buildings, personnel
- It is common practice to charge the direct costs together with an ‘overhead’, which is an additional cost related to the level of indirect costs
Overheads

- In general it is **best** to try and account for as much as possible as **direct costs**
  - For example, most organisations have ‘cost codes’ for different projects
  - Individuals may work on a number of different projects, but may record the time spent using a **time sheet** and the cost of employing them is charged directly to a project

- However, it would clearly be difficult to account for **everything** as a direct cost
  - For example, do you need to record the contract code for each telephone call or photocopy that you make?
  - What about a day at a seminar or undertaking training?

- Organisations must therefore have a **policy** on what counts as a direct cost and what is an indirect cost
Overheads

- Indirect costs must be included somehow in the costs of a product or service (including projects)
- A common way to do this is by the concept of **overheads**
- An overhead rate $R$ can be defined for an organisation, department or project as

$$ R = \frac{\text{Total indirect costs}}{\text{Total direct costs}} $$

- Overhead rates vary, but are typically in the region of 50 to 100%
  - Until relatively recently a figure of 46% was used in the University sector
Observations on Overhead Rates

- One problem with overhead rates is that they can lead to too much emphasis on reducing direct costs and not enough on reducing indirect costs.

- Suppose one has a process with a direct cost of $\Gamma$ per product. The total cost attributed to the product will be $\Gamma(1+R)$.

- If an investment opportunity arises which will reduce the direct costs by 50%, the apparent saving will be $\Gamma/2(1+R)$.

- In fact, only $\Gamma/2$ will have been saved, the remaining $\Gamma R/2$ will need to be met somewhere else in the organisation (perhaps, eventually by a revision of overhead rates).

- So, investment opportunities that impact direct costs can sometimes appear more attractive than they really are and can be made inappropriately.

- Similarly, there is little direct incentive to reduce indirect costs.
Council for Industry and Higher Education, response to the Roberts report on the sustainability of University Research, September 2003:

“ways will have to be found to ensure that there are efficiency pressures on institutions (including on central overheads that are not project related). Otherwise HEIs will become cost-plus organisations with no incentive to contain their costs rather than just pass them on; our member companies have experience of controlling costs in their own research laboratories and of framework agreements covering cost recovery on third party work; this could help inform HEI approaches on this issue.”

http://tinyurl.com/o537xzb
4.2 Cost Centres

- **Cost centres** are a useful tool in splitting down an organisation's activities and helping to allocate direct costs which might otherwise become indirect costs.

- Cost centres can also help in **dividing up indirect costs** more in line with actual use:
  - By allocating **local responsibility** for a ‘bottom line’ which includes indirect costs the concept can help to reduce indirect costs by keeping some of them (at least) under local control.

- A related concept is a ‘profit centre’, which includes an allocation of income (even if only from ‘selling’ to other internal customers!):
  - Some would say that this is simply a trendy name for the same thing as a cost centre.
Cost Centres

- A cost centre must:
  - Be part of the organisation, whose work and costs can be relatively easily separated out → *like a separate ‘virtual’ organisation*
  - Have a measurable output

- Often, output must simply be measured in ‘man hours’
  - (please read ‘man hours’ = ‘human hours’ here)

- Typical productive man hours from a full time employee might be 37 hours per week for 46 weeks per year (1702 hours)

- In practice a lower figure is often used, to account for other factors (e.g. sickness, maternity/paternity leave, and time not spent directly on productive output)
  - At the University of Oxford, a figure of 1650 hours is used
  - A more typical figure might be 1500
A man hour rate can then be calculated

\[ M = \frac{\text{Direct costs attributed to cost centre} + \text{share of indirect costs}}{\text{No. of full time employees} \times 1500} \]

To estimate the cost of carrying out a piece of work in the cost centre it is simply necessary to estimate the number of man hours involved and to multiply this by the man hour rate.

A typical man hour rate for a professional engineer might be £50 - £75 per hour (2007)
Observations on cost centres

- Once an estimate has been made, actual costs can be obtained by requiring staff to fill in time sheets
  - This is not always popular and may not be accurate
  - However it is a reasonable way of monitoring project costs against budget and taking appropriate corrective action

- Cost centre man hour rates can be compared to the price of ‘outsourcing’ the work to another company
  - This helps to benchmark the efficiency of internal processes
4.3 Costing a project

- As we have seen in the project management lectures, engineers are often involved in putting together a financial proposal for a specific piece of work or ‘project’
- This can be for an *internal* or an *external* customer
- The procedure is fairly straightforward, but one needs to approach the task *with care*
  - The consequences of getting it wrong can be quite serious
- It is good professional practice to *keep a clear record* of how you arrived at the costing
Categories to include will be:

- **Direct costs**
  - *Consumables* – things which will be used up on the project (e.g. raw materials or components)
  - *Staff time* – estimate the man hours required to complete the project and multiply by the man hour rate
  - *Use of equipment* – use by the project of equipment will need to be explicitly costed unless it is included in indirect costs
  - *Travel and subsistence* – will you, or anyone else need to work away from home? If so, how much will it cost
  - *Subcontracting* – any part of the work which will be sent out to a third party (you will need to get a price from them)
• Indirect costs
  • *Overheads* – these may be specifically included in the man-hour rate, or may need to be applied separately to some or all of the project items
    • They may need to be applied to consumables and equipment as well as to staff costs

• Contingency
  • It is usual to add a specific ‘contingency allowance’ to cover *unforeseen events*. This can either be applied individually to some or all of the project items or to the final costing.
  • An allowance of 10% might be typical, but higher figures are often used, particularly where there is a significant level of project *risk* (e.g. if you have not done this type of work before)
Profit

- An allowance may also need to be made for profit
- This will depend **what sort of organisation you are** and **who the customer is** (internal/external)
- Universities are educational charities and are not allowed to make a profit, although they can seek to make a surplus in some areas (e.g. conference provision) to offset a loss in others (e.g. undergraduate education!)
- Strictly speaking, profit is probably something that needs to be considered when one comes on to discuss ‘**price**’ rather than cost, but we shall come on to this later. It does no harm to bear it in mind at this stage.
It is good to have a template to make sure that you haven’t missed anything out.

Solt and Hill give an example (shown on the right) of what they call a ‘price make up sheet’

It is also good practice to go through the costing with others either formally or informally (what Solt and Hill call the ‘Price Settlement Meeting’).
The example given is a research project costing using the ‘Full Economic Cost’ approach used by the University.

Numbers have been changed so as not to give away any secrets to competitors, but they can be regarded as broadly representative.

You may like to reflect on the procedure used for allocating indirect costs.
Example – costing a research project

<table>
<thead>
<tr>
<th>Directly Incurred costs</th>
<th>£ '000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher</td>
<td>100</td>
</tr>
<tr>
<td>Research student maintenance</td>
<td>37</td>
</tr>
<tr>
<td>Research student fees</td>
<td>18</td>
</tr>
<tr>
<td>Consumables</td>
<td>20</td>
</tr>
<tr>
<td>Travel</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total directly incurred</strong></td>
<td>180</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Directly allocated costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic staff</td>
<td>22</td>
</tr>
<tr>
<td>Technician</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total directly allocated</strong></td>
<td>49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indirect costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Estates charges - academics</td>
<td>8</td>
</tr>
<tr>
<td>Estates charges - researcher</td>
<td>50</td>
</tr>
<tr>
<td>Indirect costs - academics</td>
<td>20</td>
</tr>
<tr>
<td>Indirect costs - researcher</td>
<td>125</td>
</tr>
<tr>
<td><strong>Total indirect</strong></td>
<td>203</td>
</tr>
<tr>
<td><strong>Total project cost</strong></td>
<td>432</td>
</tr>
</tbody>
</table>

| Effective overhead rate on all costs (%)| 89     |
| Effective overhead rate on research staff (%) | 166   |

- Example shows a ‘Full Economic Cost’ costing for a **four year** research contract with approx. **7 man-years** of effort.
- Note that the University **only receives 80% of the FEC** from the research council:
  - Where does the rest come from?
- Estates and indirect costs are standard ‘overhead’ rates applied to research and academic staff only
  - i.e. not to research students or technicians.
Cost and Price

- Strictly speaking, what we have been discussing so far is how to estimate the **project cost** (i.e. what it will cost to carry out the work)

- We now need to decide on the ‘**price**’ (i.e. what we will charge to carry out the work). This is best thought of as *quite distinct from the cost*.
  - Hence the 80% research council ‘price’ in the previous example
  - A 20% discount is applied to account for other government funding routes e.g. HEFCE

- If the customer is internal, the price may simply be equal to the cost.
Cost and price

- For **external customers**, other factors come into consideration, including
  - The need to make a **profit** (at least on average)
  - The need to keep **cash flowing** in to the business
    - If we have no work, it may be better to take on a project at a loss than no project at all
  - Whether there is the prospect of **subsequent sales** and/or follow on business
    - e.g. do we wish to develop a particular customer or win them away from a competitor?
    - Will there be consequent sales opportunities? (e.g. can we sell a product ‘at cost’ and then make a profit on spare parts?)
We need also to consider what our competitors are likely to be doing:
- For *commodity products* it can be relatively easy to find out what their prices are
- For ‘one-off’ *contracts* this may not be so simple
- Direct *collusion* on pricing is anti-competitive and illegal

Ultimately the price is set by the market:
- The customer will pay up to what he or she thinks that the product is worth
- However, competition will tend to bring the price down towards the lowest cost for producing the product
- Companies can try and ‘segment’ the market (e.g. airlines giving lower fares to non-business customers who stay over a weekend, or shops giving a student discount).
4.4 Competitive tendering

- Often a customer will choose the successful supplier for an engineering contract by means of a ‘competitive tendering process’
- Each potential supplier will need to prepare a proposal of how they intend to address the requirement, including a price for the work
- The customer will not necessarily award the contract purely on the basis of price, but it will clearly be a significant element in the decision
  – *Technical evaluation* of the proposed solution will play a role, but customers aren’t necessarily good at assessing this.
Competitive tendering

- Preparation of bids (i.e. ‘tenders’ for the work) is carried out independently by the companies who are tendering
  - They do so in response to an ‘invitation to tender’ produced by the customer which contains the specification
  - For major public sector purchases/contracts, these invitations must be published openly
  - Tenders must be submitted by a specified date
  - It is illegal under competition law for companies to share information during preparation of the tenders
Competitive tendering

Model

INVITATION TO TENDER

INVITATION TO TENDER

for the

PROVISION OF

[type of equipment]

To:

Date:

Dear Sirs

CONTRACT FOR THE Provision of [type of equipment]

CONTRACT No. : [your contract reference number, if any]

You are invited to tender for the above contract. The Invitation to Tender consists of the following documents:

- Letter of Acknowledgement
- Part 1 - Tendering Instructions
- Part 2 - Conditions of Tender
- Part 3 - Form of Tender
- Part 4 - Contract Documents

Please check the contents of the Invitation to Tender package when you receive it and then return the Letter of Acknowledgement to us.

You are required to hold all information pertaining to this contract confidential and to limit the dissemination of information within your organisation on a need-to-know basis.

Your tender must be received by noon on [date], which date will be the Tender Date in the attached Invitation to Tender. It is our intention to complete our tender evaluation in such time that the contract for this work will be awarded by [date].

Yours sincerely,

[(tender’s name)]

From http://rhul.ac.uk/finance/purchasing/invitation%20to%20tender%20model%20doc.pdf
Observations on tendering

- Time for preparation of tenders is often rather short
- A limited amount of resource can be devoted to preparation of the cost estimate:
  - You will not win more than a proportion of tenders (one in four?)
- The cost estimate is likely to contain errors which mean that the actual cost will be larger or smaller than your estimate
- You are less likely to win contracts where your tender price is too high
- **Putting this all together:**
  - Many of the contracts that you do win through competitive tendering will turn out to cost more than you thought
  - “Any contract let to the lowest bidder is let to the contractor who made the biggest error in a proposal”
  - “Every major project is being built by a contractor who doesn’t have enough money to do it properly”
An astronaut was (reputedly) asked what he thought about whilst sitting waiting for a launch.

The reply was: “what I think about is that every component on this vehicle was sourced by competitive tendering and that the contract for each was awarded to the company who quoted the lowest price for the job.”
Practicalities of competitive tendering

- In practice, *things aren’t quite so cut and dried* as the basic process suggests.
- After a tendering process a customer may select one or two contractors and work through things in *more detail* – firming up on the specification and trying to identify potential problems before agreeing on a final contract price.
- **Problems** will almost certainly come to light *during contract execution* – often the cause may not be completely clear and *may have something to do with the customer’s specification*.
  - Customer and contractor will need to **work together** to resolve these and to agree a **contract variation** (including a price variation).
  - If the customer has varied the specification after contracts are awarded, he/she may not have much bargaining power over the increase in price.
  - This can be where the contractor seeks to increase the price to cover mistakes made in preparing the cost estimate.
The course has covered **four general areas**, which should provide the basic understanding of financial issues to allow an engineer to function in an organisation, and particularly in a project team.

**These include**

1. **Money as a measure of value**
   - *Borrowing money has a cost* associated with it
   - *Interest rates vary* with macroeconomic factors, but also with lender’s *risk*

2. **Financing organisations**
   - Organisations need to have adequate *cash flow* to be able to pay the bills
   - *This is often more important* on a short-term basis than making a profit
– Financing organisations (contd)
  • Organisations need adequate *working capital*
  • This needs to be obtained via bank loans or by issuing shares
  • There is a requirement for *financial reporting* in a standard format (financial accounts)
  • These must deal with *depreciation of assets* as well as *income* and *expenditure*

3. Financing projects and appraising investments
  • Simple measures such as ‘payback time’ are largely inadequate
  • It is important to consider the *time value of money*
  • Discounted cash flow calculations (*Net Present Value* and *Internal Rate of Return*) take this into account
  • The choice of the *discount rate* is important, but not straightforward
4. Cost and price of products and projects
   - Calculation of the *price* of a project, product or service is inexact and involves a degree of judgement
   - The answer will depend on the accounting policies of the organisation (e.g. for dealing with indirect costs)
   - *There is a difference between cost and price*