Session 1: Business Problems and Models

Introduction

In this first session, we will look at why many business decisions go wrong and how modelling and decision analysis can be used to improve the ways in which decisions are made. The idea of a model as a simplified representation of a real problem will be emphasised, as will the process of enhancing the model until the representation is good enough to be useful.

Objectives

1) Be aware of some of the types of problems that are amenable to decision analysis and modelling.
2) Be able to discuss why decisions often go wrong.
3) Be able to sketch influence diagrams to represent problems and understand why they are useful.
4) Understand what a model is and why it is often a useful device for solving problems.

Some Typical Business Problems

MBNA Bank, Chester

This bank runs a telephone enquiry service for existing and prospective customers. Enquiries arrive randomly. The bank has a policy that no customer should wait for more than 20 seconds before getting through to a member of staff. How many staff should the bank have on duty at any one time to avoid customers having to wait for more than 20 seconds?

British Gas

The company was planning the building of new headquarters in Swindon. This involved hundreds of different activities ranging from digging the foundations to installing the telephones. How long would it take before the building was ready for occupation?

Tahoe National Forest, USA

Controlled fires are used to clear vegetation that restricts tree growth and causes other problems. Starting a controlled fire requires a large mobilisation of resources to the site. In some weather conditions, there is a danger the fire will burn out of control. Should the forest managers take the risk of mobilising resources if the weather for the day of the burn is uncertain?

We will look at how *decision trees* can help with this sort of decision.

Why do decisions sometimes go wrong?

1. Not thinking through all the implications of the decision

E.g.: Constructing the Aswan Dam in Egypt

This dam, completed on the river Nile in 1970, was designed to bring economic benefits to Egypt by providing electricity and irrigation. But:

1) It caused an unprecedented increase in a debilitating disease spread by water snails.
2) It trapped fertile silt behind the dam so massive amounts of artificial fertilisers had to be applied to the land.
3) The loss of silt, previously carried to the Mediterranean Sea has meant that the sea has encroached on the land.
4) The loss of nutrients flowing into the Mediterranean Sea has destroyed the sardine fisheries; these provided an essential part of the population's diet.
5) An uncontrollable growth in water hyacinth in the lake behind the dam has caused excessive loss of water though evaporation.

2. Sub-optimising

I.e. doing what is best for a small part of an organisation or system, to the detriment of the organisation (or system) as a whole.

E.g.: The sales department insists that sales are maximised by never running out of stock. Thus the company as whole faces financial problems because of the excessive costs of holding high stocks.

Converting a trunk road into a motorway to make the journey between two towns quicker, but the road attracts more traffic, causing congestion in the towns at the end of the new motorway.

3. Relying on intuition

Sometimes the outcomes of a decision seem to contradict common sense. Intuition can be a poor guide to reality and people are often too confident that their intuition is infallible.

E.g.: New roads can lead to more, rather than less congestion because they attract more cars.

To demonstrate a counter intuitive result, consider the following question: Suppose a sheet of paper could be folded 40 times. How thick would the folded paper be? Suppose the thickness of a sheet of paper is 0.1 mm.

Answer:

4. Giving in to group pressures

The experiments of Solomon Asch in the 1950s showed the power that group pressures can have on individuals. One major problem is *groupthink* where nobody is prepared to 'rock the boat' and challenge the prevailing view of the group. The result can be an illusion of invulnerability by the decision-makers who often make rash decisions involving extreme risks. Three well documented examples of this are:

1) President Kennedy's decision to support the invasion of Cuba at the Bay of Pigs in 1961.
2) NASA's decision to launch the Challenger space shuttle on 28 January 1986.
3) The Chernobyl catastrophe.
4) The Millennium Dome.

5. Framing the problem in the wrong way

For years the US car industry worked on the following problem: How many cars of one type (e.g. a four door hatchback) should they produce in a factory before switching to another type (e.g. a two door sports model)? Changing over between models was assumed to take a fixed period of between six and eight hours and was therefore costly. So, too many changeovers were to be avoided. On the other hand, if too many cars of one model were produced at any time huge storage costs would be incurred. Up to the 1970s, sophisticated mathematics were used to determine the 'optimum' number of cars to produce before changing over.

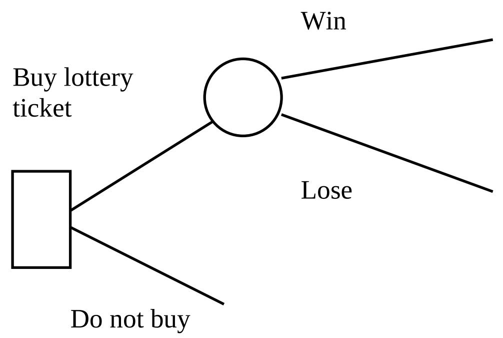
The new Japanese car manufacturers looked at the problem from a totally different point of view. They asked: Can the changeover time be reduced? By attacking this problem, they managed to reduce the changeover time at Toyota to 44 seconds. This gave them a competitive edge because they could carry smaller stocks, have a bigger variety of models and respond quicker to customers' orders and nearly led to the demise of the US industry.

Using models

Models are representations of real objects or situations.

E.g.: A model car is a *representation* of a real car.

The following diagram *represents* the options and outcomes faced by a decision-maker:



The following formula *represents* the relationship between the number of cars sold per week and the number of advertisements we have per week on local television:

No. of cars sold = 20 + 5 x No. of advertisements

Note that models are usually *approximations* or *simplifications* of the real situation:

The decision diagram ignores other options available to the decision-maker (e.g. buy two tickets, gamble on a horse race etc.), and the different sizes of wins available to lottery winners (e.g. £10, jackpot etc.).

Other things will affect the number of cars sold besides the number of TV advertisements. Also, if we place too many adverts, they may lose their effectiveness.

It is usually a good idea to start with a simple model and then gradually enrich it until it is a good enough representation of reality to help us with our decision:
E.g.: No. of cars sold = 20 + 5 x No. of adverts + 2 x No. of sales staff employed

Why use models?

1) Their simplicity helps us to gain an understanding of the real problem, without being confused by details.
2) We can use a model to identify the 'best' decision. Experimenting with the real system may not be practical. Sometimes the real system may not yet exist.
3) Models break the problem down into smaller parts so we do not have to carry the whole problem in our heads at one time.
4) By making problems explicit, it is less easy for groups of decision-makers to bury issues away because it is inconvenient to confront them.

Pre-tutorial Work: Read AMS pp1-40.

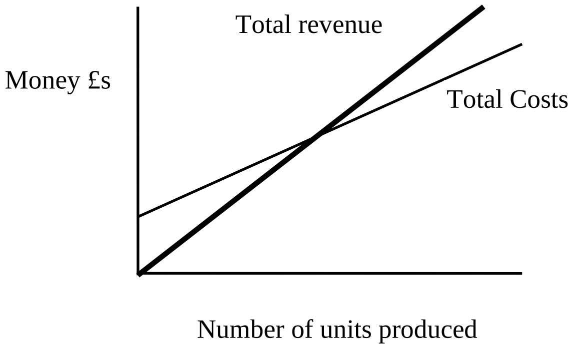
Tutorial Questions

1) The following equation is a mathematical model, which is used to predict the sales of a product. It represents the relationship between the annual sales and the annual amount spent on advertising the product.

Number of units sold = 5000 + 40 x Advertising expenditure (£s)

a) Explain why this model is likely to be a simplification of the real way in which sales are determined.
b) Why, despite this, might the model still be useful?

2) The following diagram shows the costs and revenue associated with the production and sales of a product. Why might this model be a simplification of the real situation?



3) Pictured below is a Ford Mustang car. An estimate of the total surface area of the car's body is required (excluding the underside of the vehicle and the windows) in order to determine the amount of paint which will be needed to re-spray the vehicle.

a) Assume that, with wheels removed, the width of the car is about 1.6 metres, the height of the bonnet about 0.4 metres, the height of the roof about 1 metre and the total length of the car is about 4.5 metres. Also, assume that the bonnet protrudes by 1.1 metres and the boot by 0.6 metres. Formulate a simple model that could be used to give a rough estimate of the surface area.
b) How would you enhance your model to obtain a better estimate of the surface area?

4) The Nine-Dot Problem: Look at the nine dots below. Connect them all using only four straight lines, never retracing a line or removing your pen from the paper as you draw.