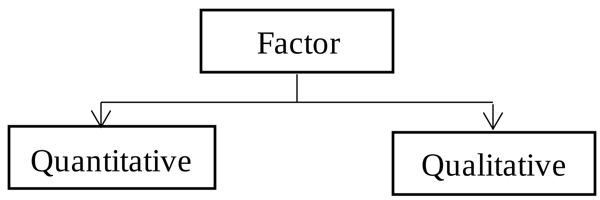
Chapter 02

MODELING SKILLS

Basic and important step in the modelling process requires us to list all the factors that we can identify as being relevant to the problem. This may well be a long list we try to keep the model as simple as possible and this is usually means reducing the list of factors to manageable size.

Listing Factor

Number of different entities.



Quantitative Factors

Quantitative factors are outcomes from contains actions that are measurable in numbers or numeric terms.

E.g. cost, revenues

Qualitative Factors

Qualitative factors which can be named but not measured numerically.

E.g. moral

Constant: A fixed value (E.g. the speed of the light)

Parameter: Fixed value for particular problem but can change from problem to problem (E.g ; fluid density)

Variable:

- Discrete: capable of taking only certain isolated values such as integer
- Continuous: capable of taking all values of in real intervals.

Making Assumptions

A variety of assumptions may be necessary E.g. the following

1. Assumptions about whether or not to include certain factors
2. Assumptions about the relative sizes terms of the relative magnitudes of the effects of various factors
3. Assumptions about the forms of relationship between variables.

Types of Behavior

Linear	$y = y_0 + at$	$; t = 0 , y = y_0$
Growing without limit	$y = y_0 e^{at}$	
Increasing to a limit	$y = y_0(1 - e^{-at})$	
Decaying to a limit	$y = y_0 e^{-at} + b$	
Simple maximum	$y = at - bt^2$	
Maximum followed by tailing off	$y = bte^{-at}$	
Oscillatory	$y = a\sin(\omega t)$	
Decaying oscillations	$y = ae^{-bt}\sin(\omega t)$	

Example No: 01

A culture of bacteria is growing rapidly. If its size now is 100 organisms and the population in size now is 100 organisms and the population doubles in size every 5 min, what expression could we use for the population size at time t?

Example No: 02

Suppose that we wish to model the daily average number of hours of sunshine at a particular location. If we start measuring from the winter minimum when the average no of hours of sunshine is y_{min}, And let t be the time in days from this point, then a suitable model might be $y = y_{min} + b\sin^2(\omega t)$

What values should we take for b and ω?

Translating into Mathematics

Care must be taken when selecting one an appropriate mathematical corresponding to a verbal statement concerning variables.

For example, if one variable y is stated to be directly propotional to another variable x,

$$y \propto x$$

$$y = kx$$

If y is proportional to x_1 and proportional to x_2,

$$y \propto x_1 \& y \propto x_2$$

$$y = kx_1x_2$$

But, $y \neq k_1x_1 + k_2x_2$

If $y = k_1x_1 + k_2x_2$ mean y is increase by an amount of k_1 for every unit increase in x_1 and by an amount k_2 for every unit increase in x_2.

Example No: 03

Suppose that an ice cream seller at a summer fair guesses that the amount A of ice cream that he will sell is going to be

(a) Proportional to the number n of people who come to the fair,
(b) Proportional to the temperature excess over 15^0C and
(c) Inversely proportional to the selling price p.

What would be an appropriate model for A?

Choosing Mathematical Functions

Example No: 04

Suppose that after twenty minutes of heavy rain, $^1/_2$ in of rain has fallen. Form a model to calculate the rate of rain fall for following cases;

a) Steady continuous rain at a constant rate.
b) It could start to rain slowly before picking up to a maximum and then subsiding again over the 20 minute period, with the total amount collected remaining at half in.

c) The rate increasing steadily for 2 minutes and then remain constant for the next 60 minutes, before decreasing again until it stop after 20 minutes.

Relative Sizes of Terms

If a particular variable makes an insignificance contribution to the answer when compared with the contribution of other variables, then it makes senses to abundant that variable. That variable specially simplifies the model. The same principle is applied to expression and equation which appears in the model.

Units

There are several different systems of units which have been used in the past. And unfortunately, are still in use today. We therefore need to be clear about which particular system we are using and keep to it consistently. It will often be necessary to convert from one system to another.

E.g.: meter, second, candela

Dimension

In mechanics, all quantities can be expressed in terms of the fundamental quantities; mass, length and time. Any other physical quantity will be combination of these three. And the particular combination is referred to as dimension of the physical quantity.