Chapter 8 – OTHER RELATED LIFE CYCLE COSTING ISSUES

This chapter identifies and discusses other issues that the cost estimator/analyst will have to consider in conducting a life cycle cost estimate.

8.1 TAXATION

Income tax and other tax effects on capital investments are significant and should be considered carefully from the early phases of a system's life cycle (e.g. during feasibility studies). Taxes are assessed as a percentage of taxable income, usually on a graduated basis: the higher the taxable income, the higher the tax rate. Taxes reduce the income from investments.

A typical example for taxation, first introduced in France in 1954 and later extended to several Western European countries is the Value-Added Tax (VAT). The following is an example of the application: as a material moves from the raw material stage to the finished product, whenever it changes ownership, the product is taxed at a fixed rate on the value of the product after all the costs of manufacture (materials and other expenses) have been deducted.

The advice from legal advisors at the NC3A (NATO Command, Control and Consultation Agency) suggest that the following statement is included in the Contract Conditions.

- Bidders are informed that the Purchaser, by virtue of his status stipulated in the provisions of the NC3O (NATO Consultation, Command and Control Organisation) Charter, Article 67(c)(3), is exempt from all direct taxes (including VAT), and all customs duties on merchandise imported or exported. This provision reads as follows:

  "Each participating nation undertakes to grant to NC3A under the terms of Articles 9 and 10 of the Ottawa Agreement, exemption from all direct taxes (except rates, taxes and dues which are no more than charges for public utility services) from the taxes on the sale of movable and immovable properties, and from customs and excise duties in respect of equipment imported or exported by NC3A or its appointed agents."

- The bidder shall therefore exclude from its price quotation all taxes, duties and customs charges from which the purchaser is exempted by international agreement. This practice could however differ among the member nations.

The text above provides guidance on how NATO is treating the issue of taxation within NATO programmes. **However, in individual nations, the regulations may be different and it is recommended that advice should be sought with the appropriate national authorities**.

8.2 DISCOUNTING AND PRESENT VALUE

8.2.1 Discounting

Discounting is a technique used to compare costs and benefits that occur in different time periods. It is a separate concept from inflation, and is based on the principle that, generally, people prefer to receive goods and services now rather than later. This is known as time preference.

Most cost comparison techniques take into consideration the time value of money: e.g. a Euro today is worth some amount less in the future. For comparison purposes, future expenditure, occurring at different points in time, must be adjusted to a common point in time. This adjustment to a common point in time is

called discounting or present value analysis. Discount factors can be calculated once an interest rate and period of analysis is determined. These discount factors indicate the present value (today's value) of a Euro, Dollar. GB Pound, etc., expended at the end of each respective year (assuming end of year discounting is used). Therefore, discounting converts various cash flows occurring over time to equivalent amounts for differing interest costs and the time value of money resulting from expenditures over varying time periods.

Recommended discount rates are usually determined by a nation's Treasury Department and must be used consistently on all programmes. Calculating the present value of the differences between the streams of costs and benefits provides the Net Present Value (NPV) of an option. The NPV is the primary criterion for deciding whether government action can be justified.

8.2.2 Net Present Value

The present value (PV) of a stream of expenditures is the sum of discounted Euros (or other currencies as applicable) over the life of a programme. The following data is needed before beginning the PV process:

- **Base Year.** The base year is the year to which all costs are discounted. This is usually the same year that costs begin to accrue for any alternative.
- **Period of Analysis.** The period of analysis is normally the time from the start of a programme to the end of the mission requirement. In most cases this will coincide with the economic life of a project as described below:
  - The economic life of a project is the period of time over which the benefits to be gained from a project may reasonably be expected to accrue.
  - Benefits from a project are limited ultimately by its physical life. This is the period a facility or piece of equipment can be used before it is exhausted in a physical sense, that is, unable to perform its stated mission. The economic life of a project is further limited by its technological life; that is, the period before improved technology makes the building, machine, etc., obsolete. Military or political considerations that may suggest benefit accrual for a much shorter period may further limit the economic life of a project. Ways in which economic life can be determined include policy, management judgement, Government or industry standards and experience.
- In general, the economic life will be measured against a stipulated level of threat, or represent the period during which a given mission or function is required or can be supported. Once the base year and period of analysis has been determined, the PV is calculated using the following procedure:
  - Determine in what years the expenditures for the alternative will be made.
  - Select a discount rate appropriate to the period of analysis and list the discount factor for each year, using either year-end or mid-year discount factors. Specify and document which one is being used.
  - Multiply each yearly cost by its discount factor to get discounted currency for that year. Use the constant currency rate if your cost basis is in constant currency (as will normally be the case); otherwise use the current rate.
  - Sum the annual discounted currency to get a total PV of costs. Perform similar calculations for quantifiable benefits. The difference between the totals of PV benefits and costs will be the net present value of the project.
  - If there is a concern that the preferred alternative may change if a different discount rate is used, recalculate the results, varying the discount rate to see at what point (if ever) the preferred alternative changes. This will provide additional insight for the decision makers as they weigh the alternatives.

8.2.2.1 Example

If the government discount rate is used to determine the level of government investment spending that will maximise inter-generational social welfare, the use of risk premiums (individuals, companies and market risk) are indisputable. However, it is a formidable task to implement such an approach because of problems associated with identifying the value of the social rate of time preference. Some alternative approaches are discussed below:

- Step (a) – The use of the consumer rate of interest as the social rate of time preference can be justified only in very special circumstances; the ethical issues involved in choice of a social rate of time preference are not easily resolved.
- Step (b) – There seems to be a consensus that there can be a multiplicity of social discount rates depending on the nature of the finances, risks, and the degree of spill over effects of a given programme.
- The opportunity cost school approach can be derived as a special case of trying to introduce market risk principals.
- The shadow price approach is formally equivalent to the opportunity cost approach. Although it uses a uniform discount rate (social rate of time preference), the approach adjusts the special features of individual cases by the choice of multipliers to compute consumption-equivalent costs and benefits.

On the other hand, if the discount rate is used to filter government programmes rather than to determine the level of government investment expenditure needed to reach some societal optimum, then the existing theories do not adequately address the problem. In this case, the government opportunity cost rate (risk free rate/State bonds [say 10 years]) is the better choice.

The role of government in (a) is highly idealised. In reality, the level of government investment spending is the result of a complicated political process in which economic efficiency is only one of many factors at work. ***The recommended approach is step (b).***

8.3 EQUIVALENT ANNUALISED COSTS

Annual value is a measure of costs in terms of equivalent equal payments made on an annual basis. The equivalent annual cost of a programme is calculated by dividing the net present value of the programme by the cumulative discount factor for the number of years of programme life. An alternative approach would be to multiply the net present value by the appropriate annuity factor, where the annuity factor is the reciprocal of the cumulative discount factor.

Annual value analysis often involves fewer calculations than present value analysis if differing lives are under consideration for investment alternatives, because annual value implicitly assumes equal replacement values and the least common multiple of the different lives without extra calculations. Consequently, the major advantage of the annual value method of comparing alternatives on the basis of periodic payments is that the complication of unequal lives of competing alternatives is automatically taken into account and the same selection decision as the present value technique will be yielded.

For example, consider the appraisal of a programme which has examined two options to achieve the required objective:

- The NPV cost of Option A over a 5 year life is £10 m.
- The NPV cost of Option B over a 7 year life is £12 m.

The EAC (Equivalent Annual Cost) of Option A is calculated by dividing the NPV of £10 m by the cumulative discount factor for 5 years of 4.5151 (assuming a discount rate of 3.5%) to give £ 2.215 m. Alternatively, the NPV of Option A could have been multiplied by the 5 year annuity factor of 0.2215 (assuming a discount rate of 3.5%) to give the same EAC of £ 2.215 m.

The equivalent annual cost of Option B using the cumulative discount factor of 6.1145 or the 7 year annuity factor of 0.1635 is £ 1.962 m.

Option A has the lower NPV cost. However, selecting the preferred option by the NPV criteria would result in a poor choice. As the two options have different lives, it is important to base the decision on Equivalent Annual Costs in order to compare like with like. Option B should be selected as it has the lower EAC.

8.4 VARIATION OF PRICE

Under conditions specified in contracts, there may be provision for revision of contract prices. A typical occurrence is a contract of a duration longer than a specified limit (e.g. 2 years), concerning the procurement of advanced technology defence systems through an international cooperation programme.

In such cases, prices agreed at certain economic conditions are escalated to the period of actual performance.

The formulae to be used for this purpose contain a material and wage/salary related portion of the price as well as indices in accordance with which the basic values have to be escalated. Price indices are percentages of annual increases in costs for a given economic sector. In the different countries, such price indices by sectors are published by governments or by specialised trade and industry associations, with an official acknowledgment.

As soon as the minimum specified duration is exceeded, contract prices can be revised taking into account a price index applicable to labour rates (e.g. in connection to productivity improvements and in accordance with the annual increase in wages and salaries) and a price index applicable to specified classes of materials (e.g. steel, plastic, etc.). The source and the specificity of the indexes used must be clearly established at the time of the contract.

The following equation provides a generic price revision formula:

$$P_1 = (P_0 /100) * [a + b * (M_1 / M_0) + c * (L_1 / L_0)]$$

where:

P_0	=	*Initial price as stipulated in the contract*
P_1	=	*Price payable under revision clause*
a	=	*Percentage of price excluded from adjustment (e.g. 5 to 15 per cent)*
b	=	*Average percentage of labour cost (e.g. 45 to 65 per cent)*
M_0	=	*Price index of specified materials (initial date)*
M_1	=	*Price index of specified materials (revised)*
c	=	*Average percentage of materials cost (= 100 – a – b)*
L_0	=	*Average labour rate (initial date)*
L_1	=	*Average labour rate (date of revision)*

Mathematical formulae used in price revision can be perceived as a reasonable compromise between parties in a long-term agreement, as well as an interesting tool to control future costs. Fixed elements within the price revision formulae have to be negotiated on a case by case basis, e.g. taking into account inflation constraints.