LIFE CYCLE COSTING

Traditionally the selection of a material for a given application has been on the basis of the cheapest purchase price. It is now recognised that the cheapest purchase price may not be the most economic choice if account is taken of the very real additional costs due to installation, regular maintenance and for periodic replacement should the material's life be less than that required for the product or construction. In the case of equipment installed in factories or processing plants a further cost which must be included for each possible alternative material is that caused by lost time – the time for which production is lost because of unscheduled down-time of the equipment. In many industries this lost time cost far outweighs all other costs, and must certainly be included. The total of these considerations is the "Life Cycle Cost" (LCC), "Total Cost of Ownership" (TCO) or "Whole of Life Cost" (WoL).

In general terms the total LCC can be broken down into components:

LCC =	Acquisition Cost	+	Fabrication and Installation Cost	+	Maintenance Costs (periodic)	+	Replacement Costs (periodic)	+	Cost of Lost Production (periodic)	–	Residual (Scrap) Value

Each of these terms must be known if a realistic result is to be calculated.

EVALUATION OF LIFE CYCLE COST

The calculation of LCC relies upon the concept of the "time value of money" – the notion that a dollar spent next year costs less than a dollar spent today, because the money could in the interim be invested and hence be generating income of its own. Future expenditures can therefore be discounted by a factor which depends upon several inputs, including the cost of funds to the organisation, the prevailing inflation rate and the time period for which the expenditure is delayed. Calculation by manual methods is quite complex, so in the past this valuable tool has been left to the accounting specialists. Using spreadsheets the calculation of LCC has become much easier, but a further step towards ease of use has been made with the implementation of computer programs specifically for this task.

LCC CALCULATION BY COMPUTER PROGRAM

A program has been produced by the International Chromium Development Association (ICDA), Euro Inox and Southern Africa Stainless Steel Development Association (SASSDA) and is available for download from the Euro-Inox website at http://www.euro-inox.org/LCC/flash.html. This website also includes full instructions and a worked example.

The LCC computer program has been written to ensure ease of use; all inputs are keyed into appropriate simple screens, and the resulting changes are reflected immediately in the calculated LCC, giving comparative costs for up to three alternative materials.

This program is intended primarily as a teaching tool – some limitations mean that the most accurate forward projections are best made by the more complex route of a very specific spreadsheet. In particular this simple program cannot account for variations in cost of capital or inflation rates … these are assumed constant for the life of the component. Maintenance events can only be set down at regular intervals, whereas in practice there may be none for the first few years and then increased frequency and increasing amount required.

EVALUATION OF AN EXAMPLE LIFE CYCLE COST ANALYSIS

An example of the use of LCC analysis using the ICDA LCC software is for a simple rectangular mixing tank. The requirement is for a 20 year tank life, to coincide with the requirement for other components of the water treatment plant.

The design brief requested evaluation of three alternative materials:

a) stainless steel – austenitic Grade 304
b) stainless steel – duplex Grade 2205
c) mild steel with applied fibreglass lining

As the 2205 was not readily available in the angle and channel products required for reinforcement of the tank, these were substituted by Grade 304 in the 2205 design; these components were not to be in regular contact with the corrosive environment, so no corrosion problem was anticipated, and welding the grades together is usually not a problem.

Experience suggested that both the 304 and 2205 would survive without replacement for the full twenty years in the stated environment. The 2205 stainless steel was expected to require inspection and cleaning at three yearly intervals, compared to the same minimal regime at yearly intervals for the 304. The mild steel however was expected to require fairly extensive patching of the steel and its lining at yearly intervals, plus full replacement after each eight years.

The "Life cycle summary of a WTP Mixing Tank" table on the next page shows the resulting LCC analysis. The top *Description* section summarises inputs and gives the calculated Total LCC for each option. The following sections break out details for the *Material Costs*, *Operating Costs* and the assumed *Cost Rates and Project Duration*.

This hypothetical example shows the 304 and 2205 as almost identical life cycle costs but with the mild steel substantially more expensive due to its higher maintenance and replacement costs. The Material Cost (acquisition cost) of the mild steel construction is of course by far the cheapest despite the additional need to apply the protective lining.

The negative Replacement Costs for the two stainless steel alternatives reflect the expected significant residual scrap value of the metal at the end of 20 years, discounted from the initial material costs because it is a deferred income. The mild steel option includes a removal cost each time the tank is replaced and for the stainless steels removal at the end of their required service life.

The "Value of Lost Production" in this example is shown as zero - this implies all maintenance and replacement is carried out in scheduled shut-downs for other plant maintenance. Unexpected shut-downs causing lost production could substantially add to the Total Operating Cost of the option requiring this unscheduled maintenance. This would of course radically alter the LCC outcome, in favour of the more durable options.

“What if” questions can be easily answered … What if the 304 fails to survive the full 20 years as expected? What would be the outcome of using a higher cost but longer life coating on the mild steel?

Note: All values are in "Mu" - Monetary units - to enable use of the software with any currency.

Life cycle summary of a WTP Mixing Tank

Description	304	2205	Mild Steel
Material costs	5185	6833	2320
Fabrication costs	2780	2780	2780
Other installation costs	0	0	1500
Initial costs	**7965**	**9613**	**6600**
Maintenance	2572	793	12858
Replacement	-126	-100	7362
Lost production	0	0	0
Material related	0	0	0
Operating costs	**2446**	**693**	**20220**
Total LCC	**10411**	**10306**	**26820**

Initial costs

	304	2205	Mild Steel
Material costs (MU)			
Plate, sheet:	3560	4750	1620
Pipe, fittings:	1062	1520	450
Bar & other (fixings, consumables):	563	563	250
Fabrication & install. costs (MU)			
Cutting, welding, forming, etc. :	1280	1280	1280
Assembly & installation:	1500	1500	1500
Other installation costs (MU)			
Surface protection:	0	0	1500
Special labour skills, etc. :	0	0	0

Operating costs

	304	2205	Mild Steel
Maintenance costs			
Cost per event (MU):	200	200	1000
Elapsed time between events (years):	1	3	1
Replacement costs			
Removal costs per event (MU):	500	500	500
Material & install. costs per event:	0	0	6600
Residual value of material per event:	290	229	90
Elapsed time between events (years):	20	20	8
Annual material-related costs			
Annual cost (MU):	0	0	0

Rates & duration

Cost of capital:	7.9	%
Inflation rate:	3.5	%
Desired life cycle duration:	20	years
Downtime per maintaince/replacement event:	0	days
Value of lost production:	0	MU/day
Real interest rate	**4.25**	**%**

LCC PC PROGRAM - USER ASSISTANCE

The LCC program is simple in operation, but a number of on-line Help screens are available which give assistance.

REFERENCES & FURTHER INFORMATION

1. Moore, P.J. and Matheson, P.J., "Life Cycle Costing & Stainless Steel", Architectural Review, Vol 10, No. 3.
2. "Life Cycle Costing and Stainless Steel", Australian Stainless, No. 1, July 1993, Editorial.
3. von Matérn, S., "Demonstration of a LCC Calculation Program on a PC", Applications of Stainless Steel '92, Stockholm, June 1992.
4. Life Cycle Costing software with on-line instructions, produced by ICDA, SASSDA and Euro-Inox. Refer to the Euro-Inox website at http://www.euro-inox.org/LCC/flash.html.

ATLAS STEELS TECHNICAL DEPARTMENT

Atlas Steels maintains a Technical Department to assist customers and the engineering community generally on correct selection, fabrication and application of specialty metals. Our metallurgists have a wealth of experience and readily available information.

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