Putting a Price on Sustainability

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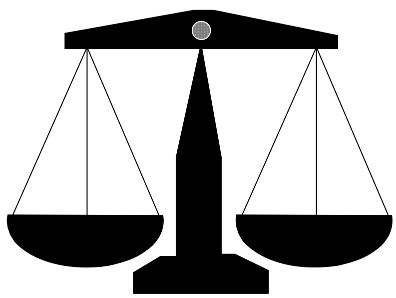
(Tower Painting example provided by National Grid Transco, UK)

Abstract

This paper explains and illustrates the business case and financial impact of inspection and maintenance tasks that have long lead-time effects (such as painting and corrosion protection activities). Traditionally some of the easiest expenditure to cut when times are tight, these activities need to be justified in cost/benefit terms like any others. Using the "prolongation" modelling techniques from the European MACRO project, sustainability can be given a financial value, and the business case becomes clear, even when relying on structured, range-estimated assumptions and impact projections. A case study is used to demonstrate these methods on the evaluation and optimisation of electricity transmission tower painting regimes - where significant benefits have been revealed by targeting appropriate painting strategies to different operational, environmental and design circumstances.

The Long Term Business - Balancing the Costs



Cost of ownership
New asset

Capital cost
Early asset write off
Income - return on investment
Cost of maintenance
Cost of spares
Cost of breakdown - including system

Cost of ownership
Old asset

Capital value
Income - return on investment
Cost of maintenance
Cost of spares
Cost of breakdown - including system

Fig 1

Fig 1 shows the elements that the asset manager will need to balance when weighing up whether an asset is economic to retain, or whether it should be replaced. Despite the wide recognition that best practice should consider whole life costs of ownership from cradle to grave, in practice there are a number of considerations that can lead to the decision making process being skewed. A few are listed below:

- Capital and Revenue budgets have different financial treatments
- Capital budgets are constrained by business/regulatory targets linked to business performance.

- There are immediate business targets to reduce expenditure.
- There are short business planning horizons for cost/benefit analysis.
- Modelling of business benefit is difficult and can include intangibles – for example factoring in the impact of potential adverse publicity, or the change in asset life achieved by using an improved but untried material.
- Maintenance costs are much smaller than capital costs, so are frequently ignored as being of low significance.

It is quite common to require capital investment projects to have a short payback and a high internal rate of return. This can be inappropriate to the long term management of assets in a business such as an electricity utility, where the assets may have very high value and very long lives.

Limitations of Conventional Cost Benefit Analysis using NPV

In the context of long term sustainable business, the conventional approach to evaluating projects using net present value (NPV) has limitations. Consider the following example:

Two alternative compressor designs are available: compressor A costs £100 and compressor B costs £150. They both perform adequately for the job, but compressor A will need replacing after 6 years while compressor B will not wear out for 20 years. Using an NPV approach evaluated over 5 years, compressor A will clearly be evaluated as the better option – but if the evaluation is over 6 years it will almost certainly come out to be compressor B.

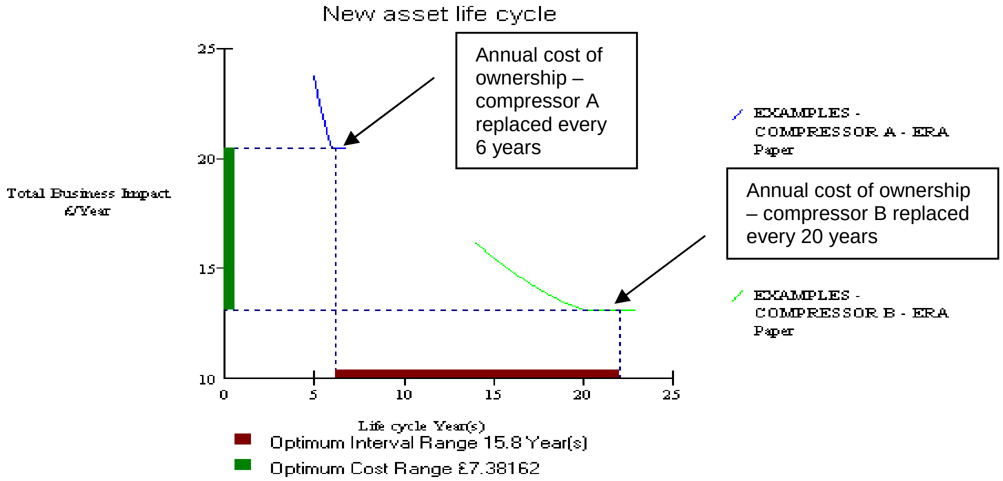
Cost of Capital 6%

Compressor A	Year	
	0	6
Purchase	100	100
NPV 5 Years	100	
NPV 6 Years	£189.00	

Compressor B	Year	
	0	6
Purchase	150	0
NPV 5 Years	150	
NPV 6 Years	£150.00	

This is clearly the most elementary of examples. In a real evaluation there are many additional factors to be considered, but it illustrates the point. For an electrical utility, where assets typically have life expectancy of 40 years or more, and in practice the function of an asset is effectively required for 100+ years – for example a steel lattice tower route – the NPV approach is not adequate. There are a number of alternative options available, most of which are also inappropriate (e.g. IRR) for similar reasons, and this was the driver behind the evolution of a decision support tool (APT-LIFESPAN) developed by the MACRO project which evaluates this type of problem using the 'equivalent annual cost' method {This is not the only tool that uses this approach – ERA also adopt this approach. This is the discounted cost of owning an asset in perpetuity, i.e. in the above example replacing compressor A every 6 years or compressor B every 20 years to infinity. This enables options with different asset lives to be compared. The following shows the same example evaluated by APT-LIFESPAN.

Comparison of all loaded and calculated analyses

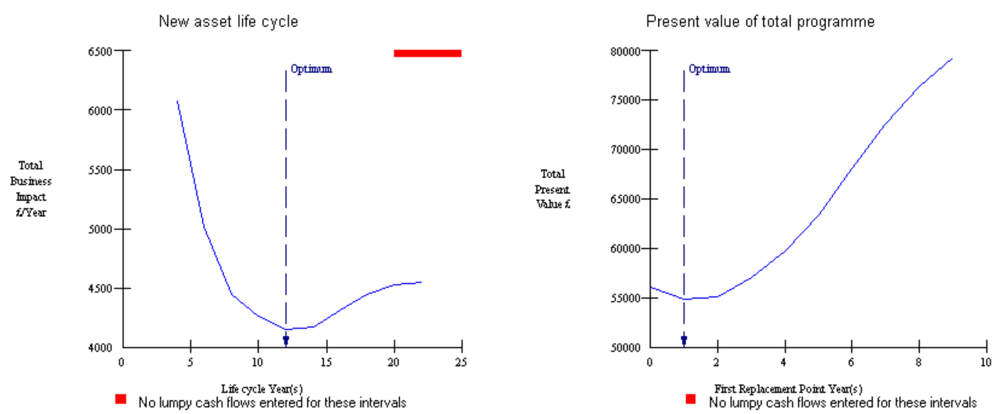


APT-LIFESPAN - APT-Integrated Toolkit v3.1

Fig 2

The graphical display is one of the standard outputs and is often more immediately informative than the table of results. APT-LIFESPAN provides a simple interface for modelling whole life costing problems and is designed to enable alternative scenarios to be evaluated. It is particularly useful for establishing the answer to one of the most frequently asked questions – i.e. WHEN should assets be replaced.

When to replace 5 year old Compressor A with a new Compressor - Replac



APT-LIFESPAN - APT-Integrated Toolkit v3.1

Fig 3

Fig 3 illustrates a more realistic scenario – where inputs are included for degradation, performance, maintenance etc., and an existing 5 year old compressor is in service (not the same compressor used in the simplified example). It will be seen that the optimum replacement strategy is to replace the existing compressor in approximately 1 year's time – deferring the replacement has a cost and this is evaluated. This enables an informed decision to be made on the asset replacement options, using financial values.

Changing the Asset Life – refurbishment and painting

From the previous discussion, clearly the asset life is a crucial factor in determining the capital plan – extending asset life has a value. One frequently ignored aspect of planned preventative maintenance is the influence that this can have on asset lives. Practical asset management in well-managed utilities involves integrating a strategy of preventative maintenance with asset replacement – this includes such activities as the refurbishment of assets and the painting of equipment in order to manage asset performance and risk while optimising overall expenditure.

Tower Painting Example – Overview

During 1995, National Grid Transco (NGT) carried out a review of tower painting facilitated by The Woodhouse Partnership, as an evaluation exercise in the use of the software now incorporated into APT-MAINTENANCE. The early studies confirmed the suitability of the method, and were instrumental in convincing National Grid Transco to become sponsors of the MACRO project. A number of alternative scenarios were evaluated, out of which a preferred approach was demonstrated as optimum. The findings of the studies have been progressively incorporated into NGT policy. These included:

- Use of vinyl 2 stage paint system
- Nationally co-ordinated programme of painting (rather than local planning)
- Preferred method of tower painting to be tower bodies painted non-outage, cross-arms carried out with a single circuit out of service.
- Painting intervals extended.

By 2003, the APT tools were available and the impact on asset life could be modelled. There was improved information of tower performance, and some of the original assumptions on costs were no longer valid. It was therefore decided to carry out a new review, facilitated by The Woodhouse Partnership.

The example used in this paper is based on the 2003 case study. For commercial reasons, the figures used have been changed – the example should thus be recognised as indicative only. It should also be recognised that the pattern of degradation of steel lattice towers is dependent on many specific issues including operating environment, commissioning date, pre-existing condition and paint system used – therefore the conclusions should not be taken as general. Figure 4 illustrates the overall degradation pattern of a steel lattice tower:

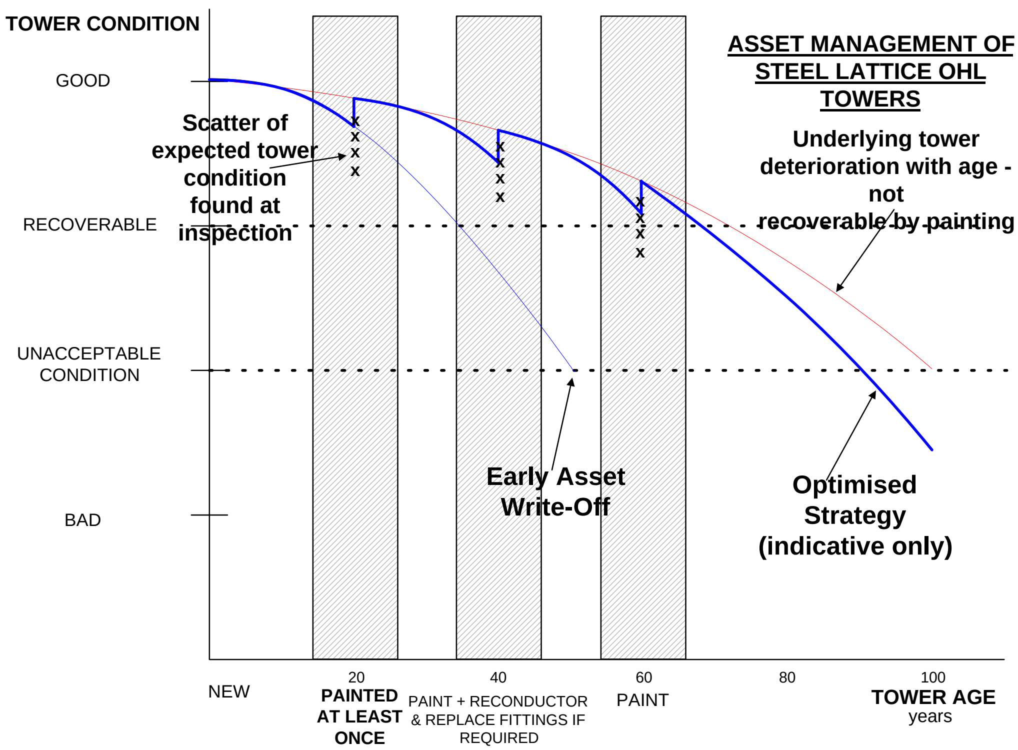


Fig 4

It will be seen that if towers are not painted, they can be anticipated to degrade along the path culminating in 'early asset write off'. There will be a scatter of condition data for towers at inspection, and treatment (painting) will result in the improvement of their condition but NOT restore them to an 'as new' state. There is an underlying deterioration pattern which represents degradation which is not addressed by painting. Somewhere between the 'early asset write off' position and the underlying degradation curve lies the ideal management approach. An added complication with the modelling is that once lattice towers are allowed to degrade to a certain level, there is a very substantial increase in costs to restore the tower – either because enhanced surface preparation is required before painting and/or because some steel members could need replacing in order to retain tower integrity. The original conductor systems are being replaced at around 40 years from new in order to address degradation of conductors and fittings; reconductoring can also be done to improve circuit utilisation by increasing circuit capacity. It is undesirable to revisit circuits after reconductoring in order to refurbish towers; this clearly leads to extended circuit unavailability, unnecessary disturbance to landowners and increased costs.

This is an example of a complex set of decisions involving maintenance, asset replacement alternative scenarios and very long asset lives – and the correct approach lies at the heart of ensuring a sustainable business.

Modelling Maintenance

As with all scenarios of this nature, the problem is built up from a series of related studies starting with the simpler decisions. The first part of the problem was to optimise the maintenance strategy – in this case, painting.

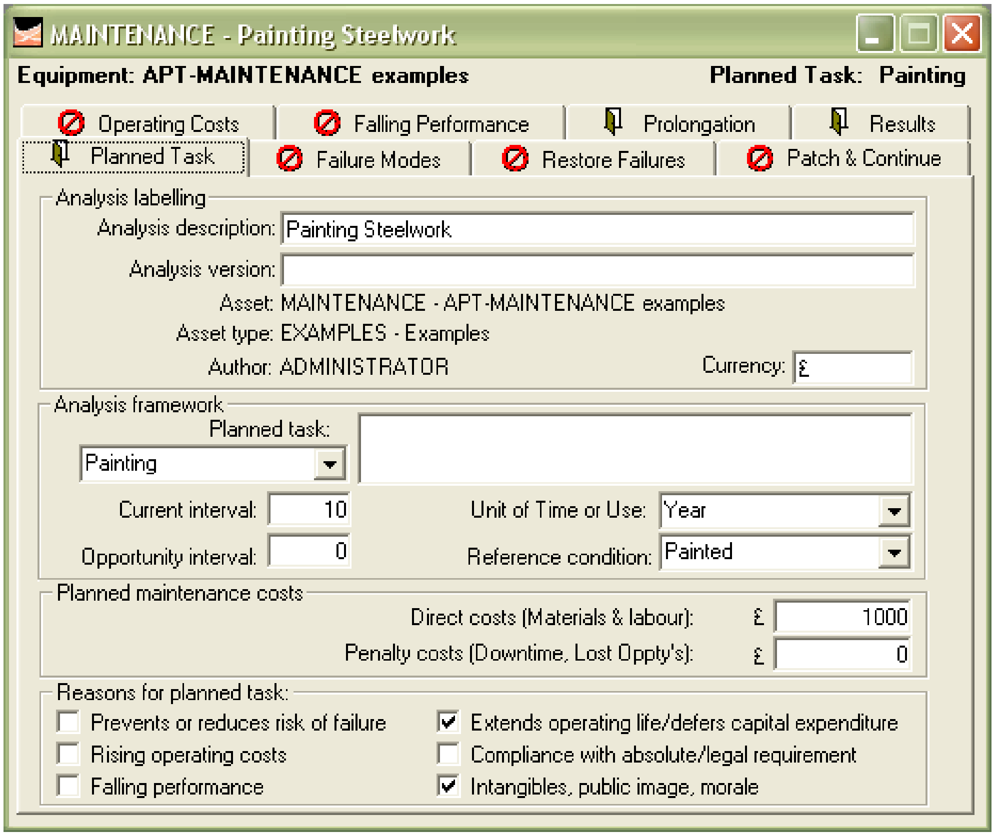


Fig 5

APT-MAINTENANCE was chosen from the MACRO toolset to analyse this decision. There are a number of screens and options available which match with the MACRO set of decision drivers, i.e.

- Reliability (reduces risk of failure)
- Efficiency (rising operating costs/falling performance)
- Life (extends operating life/defers capital expenditure)
- Compliance
- Intangibles (or 'shine')

Inputs are designed to enable complex scenarios to be evaluated – in the actual study, penalty costs for unavailability were considered. Clearly the principal driver here is life extension and getting the correct balance between revenue and capital expenditure, with additional minor intangible considerations – e.g. the public image of the company could be detrimentally affected by rusting towers. The study was worked up with a cross-functional client team, facilitated by a consultant. As the work progressed, additional expertise was seconded into the team. This enabled access to the best available evidence of equipment condition through experienced field staff and technical specialists.

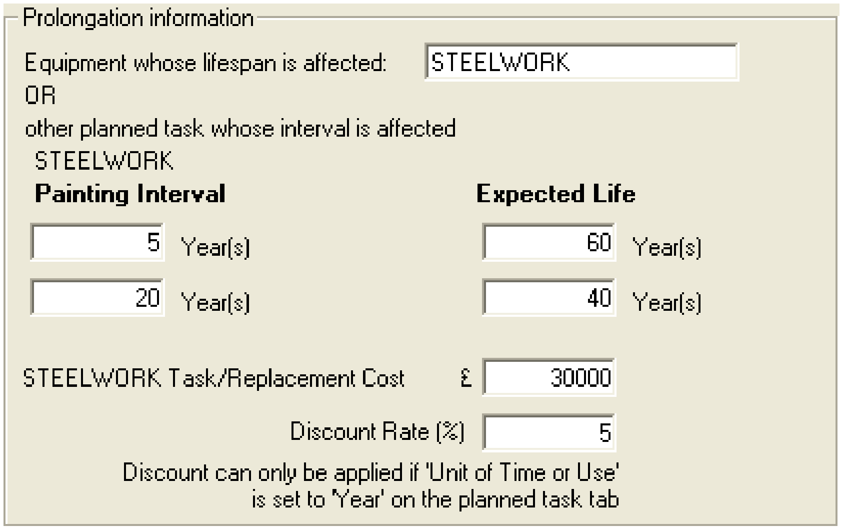


Fig 6

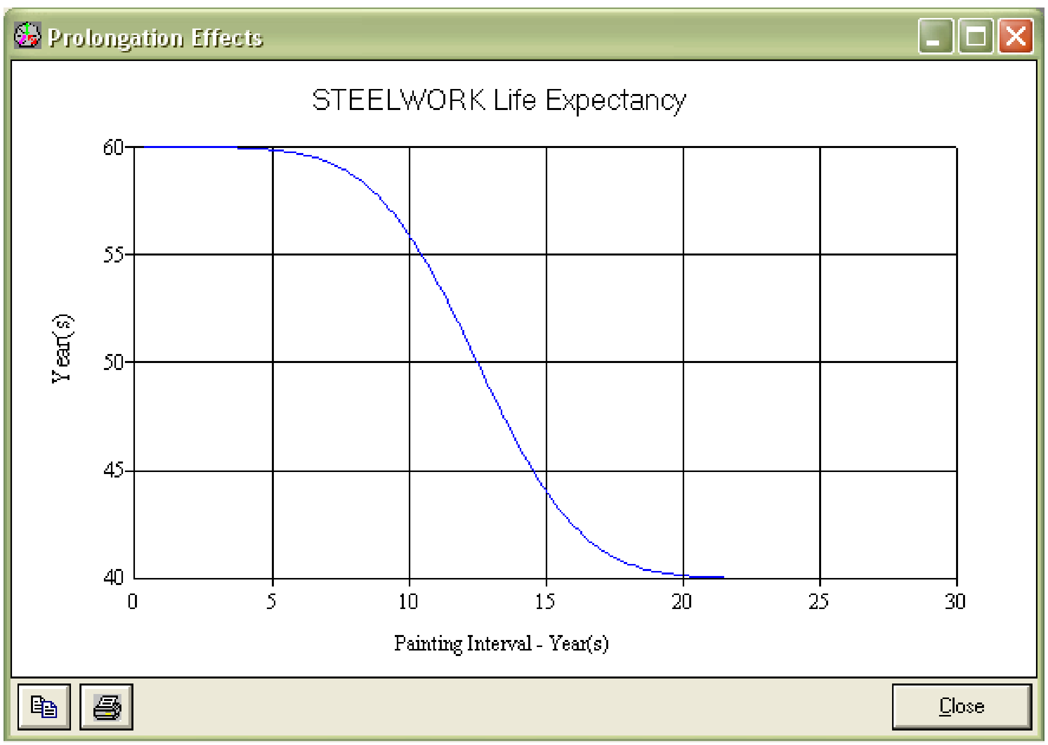


Fig 7

Opening up the 'prolongation' tab provides access to the screen shown in Fig 6. By reference to civil engineering research and tower inspections, figures were available to complete the inputs and then range estimates were used to determine 'best' and 'worst' case scenarios. The graphical output (fig 7) was most useful in ensuring that the implication of the input data was understood and credible. In the example, this illustrates that steelwork will degrade to an irrecoverable condition after 40 years if painting intervals are 20 years or longer; painting at 10 years will give a 50% life extension to 60 years.

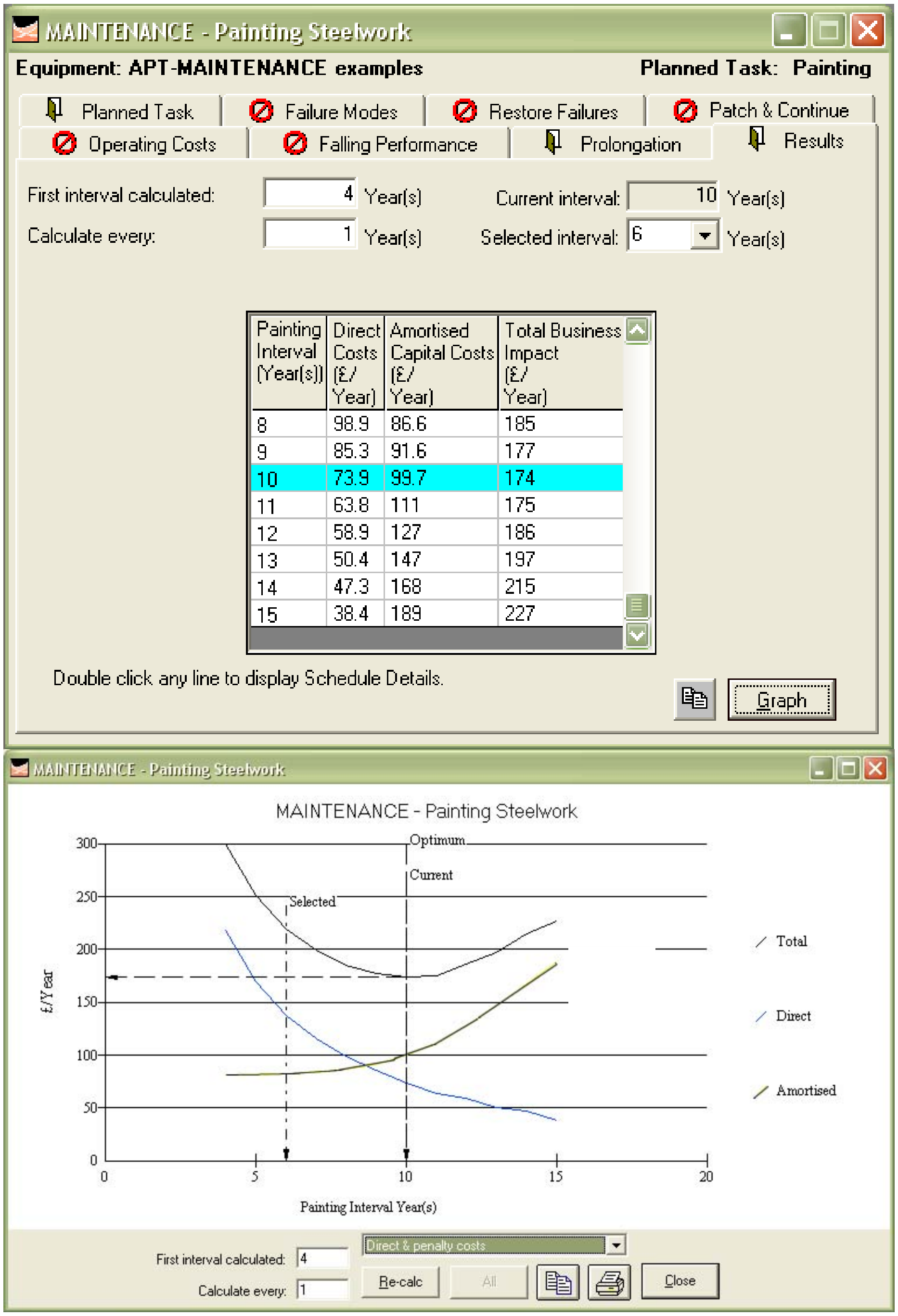


Fig 8

Fig 8 shows how APT-MAINTENANCE is used to calculate the optimum maintenance interval, and the difference in cost from existing strategy. For the actual studies, the costs were modelled as increasing in steps as the steelwork needed enhanced preparation, and eventually part replacement in order to recover the equipment condition. This analysis provided strong evidence to support a painting regime at approximately 18 years (in a range of 15-20 years), and enabled a number of scenarios to be modelled, including the painting of towers when new (avoiding initial degradation in galvanising) and strategies for prioritising and planning the work. The findings of the 1995 review were confirmed and reinforced with this improved modelling. NGT condition monitor routes, enabling prioritisation of work within this strategy based on actual condition.

Whole Life Modelling

In order to evaluate the total impact on the capital plan resulting from the revenue spend on tower painting, APT-LIFESPAN was used.

The following screen shots show how the software is used to evolve an overall strategy, and evaluate the total impact of a regime based on both capital (asset replacement) and revenue (maintenance) costs.

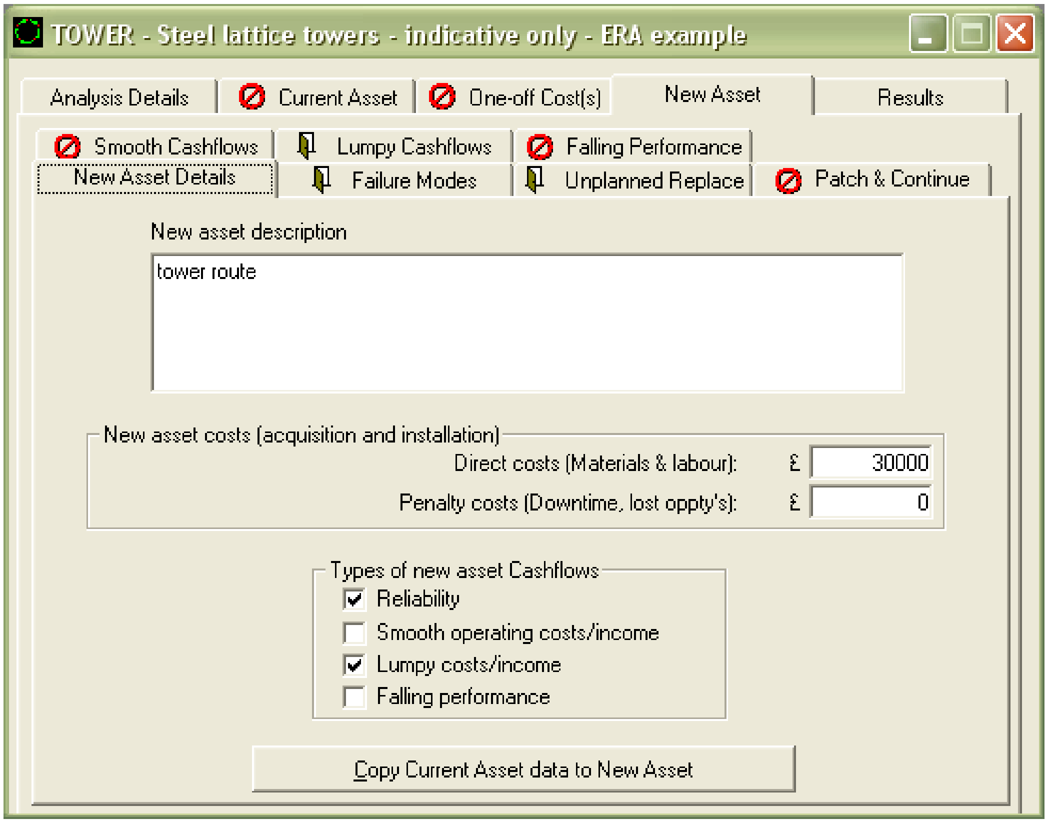


Fig 9 – This input screen defines the costs of a new asset and cashflows. Note no existing route was input to this study as it was used to compare alternative options for new routes.

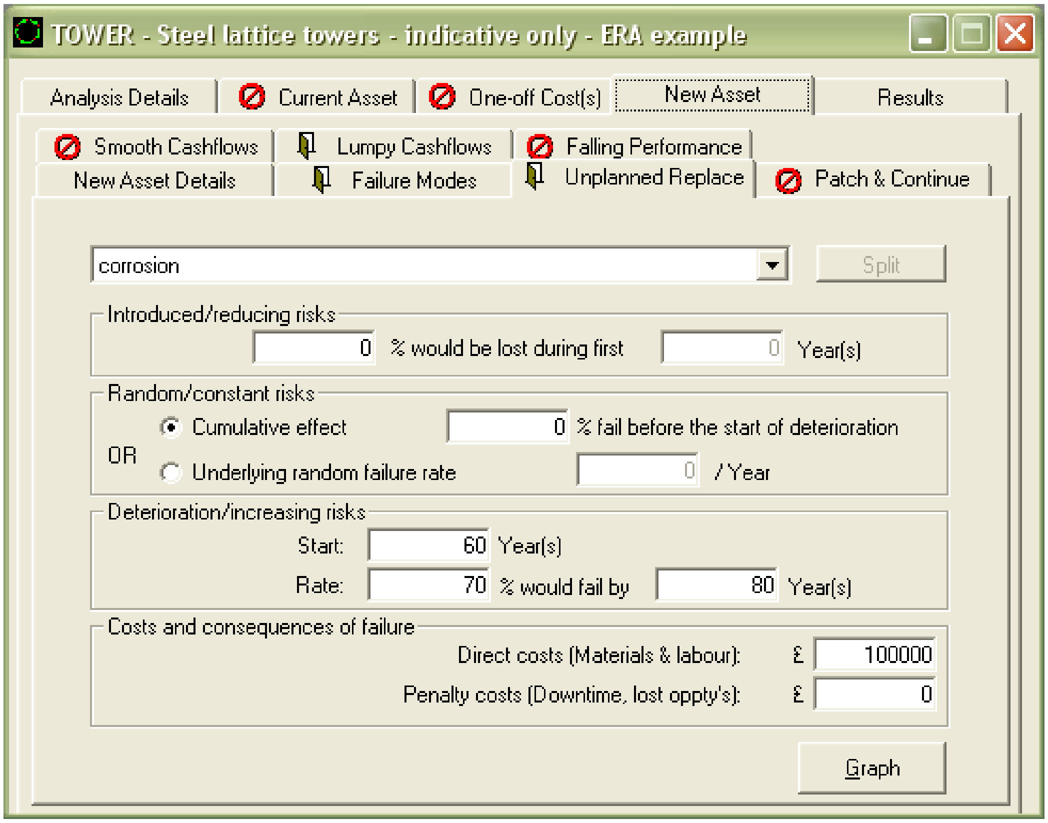


Fig 10 Modelling the end of asset life – with the painting regime

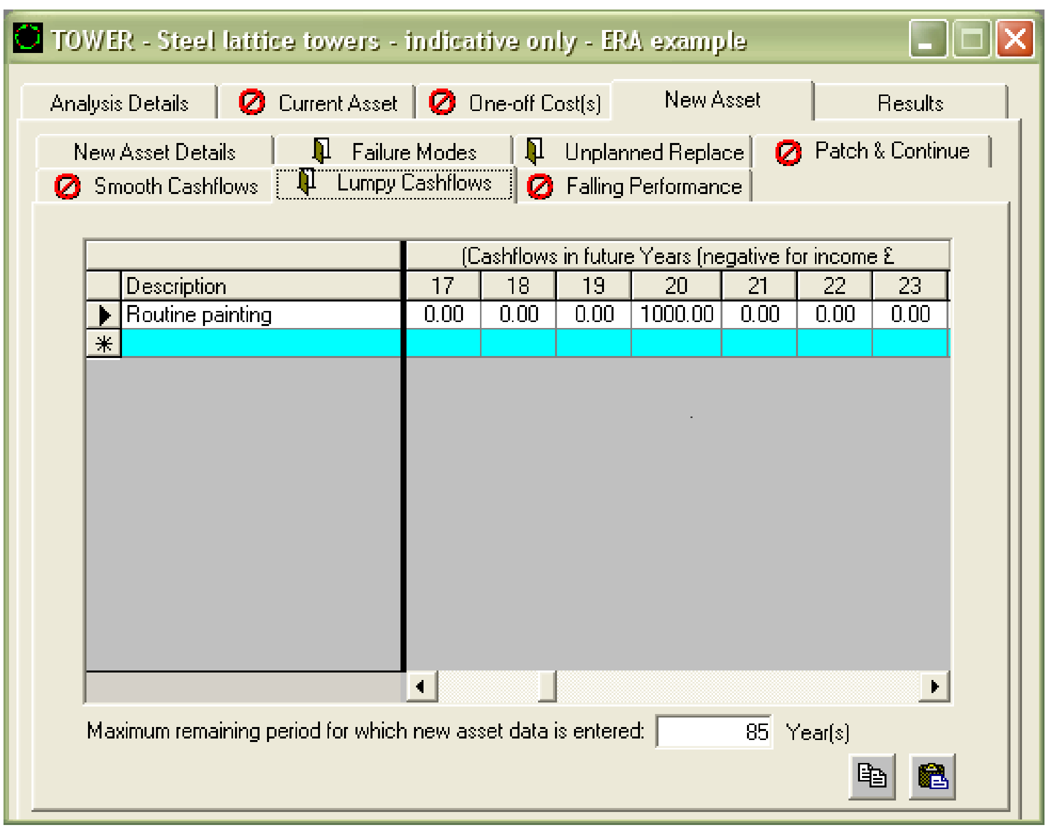


Fig 11

Fig 11 Modelling the actual painting costs. Screen shows only part of the lifecycle, expenditure input at 20 year intervals.

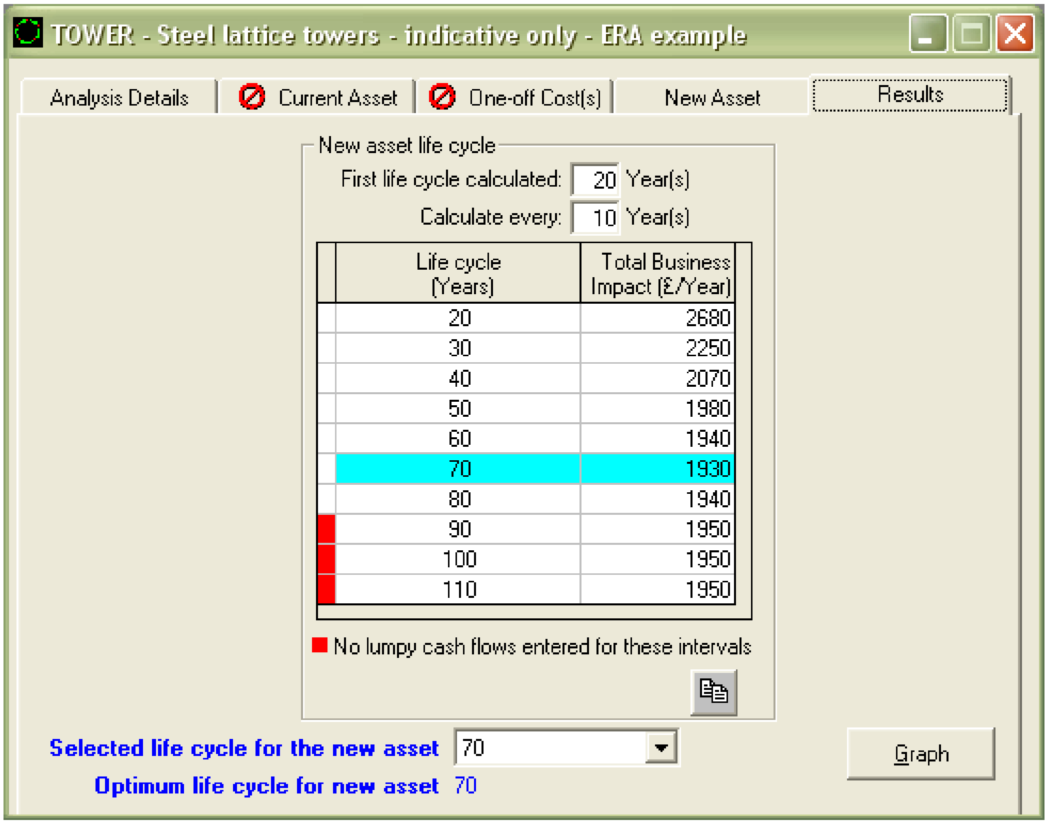


Fig 12 tabular output of calculation – showing equivalent annual cost.

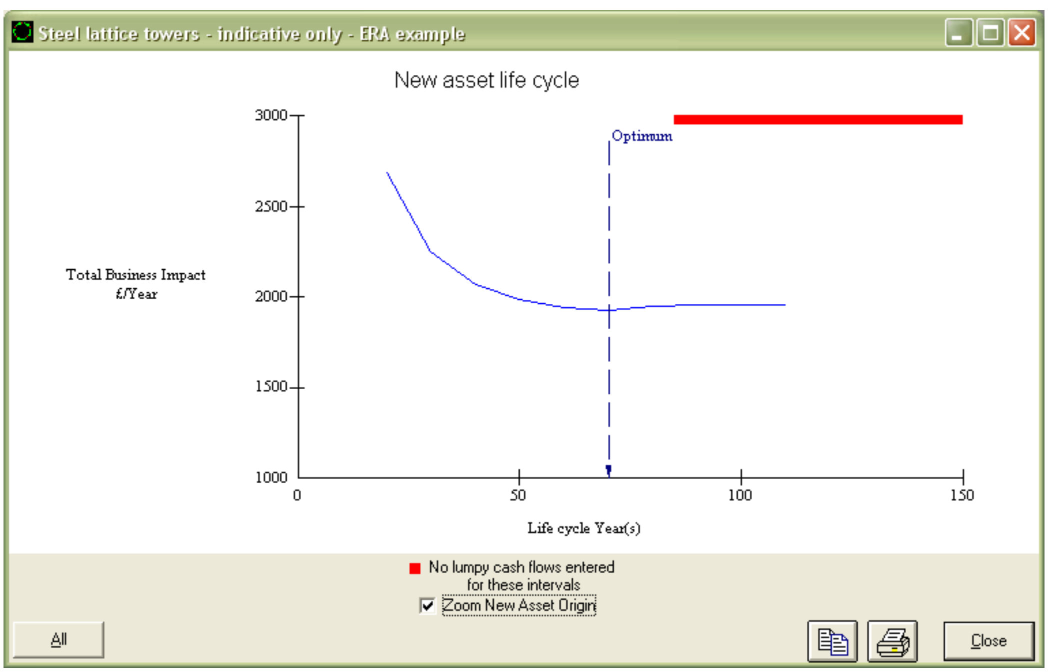


Fig 13 Graphical output from table of fig 12. This can be used to evaluate the optimum time for replacement, and the financial effect of extending asset lives.

Conclusions

The principal output of the actual studies was an evaluation of the options to manage tower condition. A strategy was established to optimally manage the existing population of steel lattice towers. The advantage in painting towers in order to optimise asset life was clearly established and evaluated as part of the strategy of sustainable asset management, and a necessary activity in order to manage risk and optimise the balance between revenue and capital expenditure.

The modelling enabled a number of alternative strategies to be evaluated, from which a preferred option has been established. The work is supported by the continued monitoring of asset condition, from which a detailed prioritised plan of painting and refurbishment is derived.

The studies confirmed the applicability of APT-LIFESPAN and APT-MAINTENANCE as useful and effective tools to support development of sustainable long term asset management strategies. The outputs of the studies provided numerical analysis which enable the appropriate, objective comparison of strategies, and enumerate the true value of operational expenditure to optimise asset life. Savings have been realised which were identified in the early studies, and the studies during 2003 are being used to optimise high value business and risk management decisions.

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