

Asset Management – a science emerging!

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Introduction

The secret of management success might be described as "*choosing the right direction despite the uncertainties and conflicting stakeholder expectations, and taking the whole organisation with you*". This is also the heart of good asset management – a blend of directional clarity, optimal cost/performance/risk compromises, good organisational alignment and real motivation of the workforce.

Over the last 15 years or so, some remarkable transformations have occurred in the integrated management of complex infrastructure assets. We have seen a joining-up of disparate specialisms and the total has proven greater than the sum of the parts. After several cycles of temporary enthusiasm for a variety of component 'best practices' (Total Quality Management, Business Process Reengineering, Just In Time, Reliability Centred Maintenance etc), a maturity is emerging – the selective and sustainable *combination* of various elements according to an overall roadmap. We are not all there yet, but the demonstrable benefits of developing such a roadmap are clear. BP and Shell, for example, have achieved remarkable results in the North Sea. Unit production costs have been reduced from around \$15/barrel in the late 1980's to just \$2/barrel now (and current production is from the marginal, difficult access reservoirs). And this performance improvement has not been at the expense of safety or social impact – integrity indicators and environmental compliance have both improved substantially at the same time.

Temporary enthusiasms

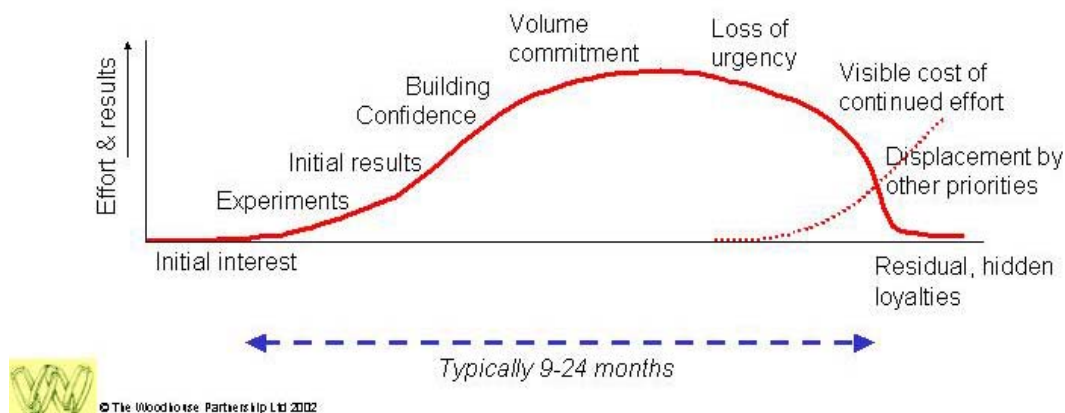


Figure 1. Life cycle of a temporary enthusiasm

What is the secret, therefore? How do we break the habit of lurching in the direction of the latest fad, getting some initial results, then running out of steam and dashing off in another direction? I believe the answer lies in the choice, and clarity of articulation, of the business objectives. Without such achievable, stretching and commonly understood goals, the silo-thinking and wasted energy will continue. Once the goals are clear, and expressed in terms that the workforce can truly relate to, people have the uncanny ability to work out for themselves the best way of achieving those targets. Given a bit of improved business awareness, and some freedom to make the right decisions for themselves, the cumulative effect of creativity from many hundreds or thousands of people is unstoppable. As BP now says (in hindsight), their radical improvement did not come from any single radical change; it flowed from thousands of small incremental good ideas, evaluated according to a consistent 'total impact' criterion and implemented correctly.

Iterative improvements

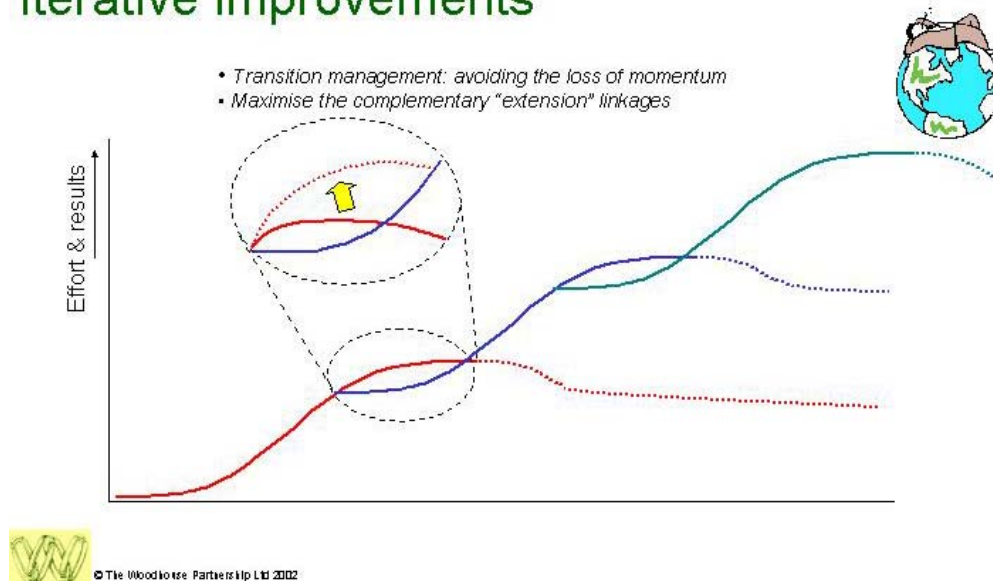


Figure 2. Cumulative, complementary improvements

What are the features of 'getting it right'?

If we look at the most successful asset-performance-centred organisations, certain key features emerge. Very few, if any, companies have mastered all of the elements, and there remain some clear barriers, particularly in the network/utilities sector. However the groundwork for connecting overall business aspirations with the day-to-day activities can be laid. The checklist looks something like this:

Asset definition: understanding the boundaries, service or performance dependencies and *system* functions, instead of asset-type specialism. Many organisations are still structured along discipline lines, whereas the core of the business (infrastructure network or production system) is a complex of different

asset types working together. The industry leaders have mapped the hierarchy and interdependencies of their functional systems (there are tools to do this), and used this map to set performance responsibilities. With a clearer asset definition, resource and budget responsibilities can be allocated in line with the performance accountabilities – the concept of (aligned) mini-businesses within the total business.

Language: in most companies, there is a substantial gulf between the business language and the delivery activities. The engineers do not talk the same language as the finance director. Good asset management involves teaching business and communication skills to much more of the organisation (this seems more economic and achievable than updating the senior management on all the technical issues, tools and jargon).

Compromise: conflicting objectives are inevitable. Perhaps the most important feature of success full asset management is the identification of the optimal blend of regulatory compliance, service performance, financial success, safety and environmental priorities. Fact-based, risk-based, quantitative methods are making a radical difference to this area, and revealing massive improvement opportunities.

Budgeting: capital investments and operating costs cannot be managed as if they were independent. The leading players evaluate the asset whole life cycle costs and budget for risks and downtime 'cost opportunity' costs to evaluate the net effect and priorities for their activities – and then defend them to the hilt.

Education: there is a big gap between the *training* skills requirement to do a good job, and the context *education* that enables people to challenge and improve what is done. The leading players are investing heavily in the latter awareness – and it is proving a very high-return investment.

Cross-functional teams: collaborative working practices are certainly needed to find the optimal compromises between, for example, capital costs and subsequence operability/performance, or system availability and preventive maintenance activities. Yet localised performance measures often reinforce inter-departmental conflict. Good organisation design, physical location, team-based performance rewards and the management style have been shown to a profound beneficial effect.

Criticality: the backbone to prioritisation is a suitable weighted and comprehensive definition of criticality. There are many simplistic attempts 'going the rounds', and much management confusion as to the right weightings to be applied to, for example, safety, service provision, costs and public image. However the best practices manage to achieve both stakeholder endorsement and workforce credibility with a formula that captures both the hard data and 'tacit knowledge' in a structured manner.

Key Performance Indicators: few have really resolved the fundamental challenges here. The Balanced Scorecard takes companies the first step – ensuring that today's results are on track and that stakeholder focus is reflected in appropriate processes and ongoing innovation. However it is a misnomer – it provides no balancing mechanism (e.g. are the short-term successes worth the cuts in research & development?).

Long-termism: business planning horizons are often distorted by city expectations (annual accounts), regulatory reviews, license terms or natural resource constraints. UK companies appear to be splitting into two camps: those who take such horizons as the primary optimisation objective (resulting in short-term success but cumulative nervousness), and those who set their own agenda on performance and sustainability, and then negotiate the impact of such constraints against the value-for-money benefits of their plans. The latter approach is more characteristic of leading asset management organisations.

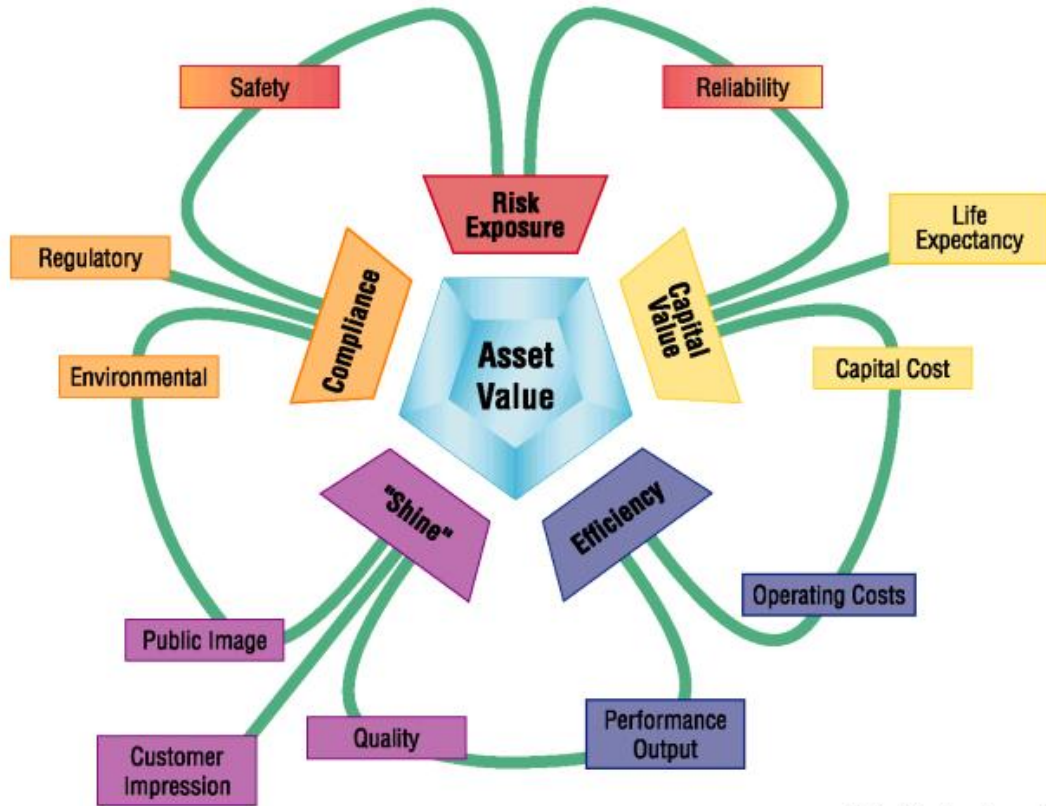
Setting the business objectives

So much depends on the goal, and on the winning of hearts and minds to that goal. Yet many organisations duck the issue and describe their objectives in loose, confusing terms. A typical 'mission statement' reads as:

"We aim to be the number one service-provider in our sector, offering excellent shareholder returns, high performance standards, world-class safety and environmental responsibility while recognising, valuing and investing in our high calibre staff, and being a good neighbour to local society".

This is not good enough – it is merely a statement of the conflicting aspirations and does not really help the organisation or other stakeholders to know where they are going. It needs to be translated into tangible, achievable, quantified and suitably weighted specific targets. To set priorities, achieve alignment of understanding, and define the best compromise for component optimisations, we need to complete the sentence: "which means that...." *in numbers*. The credibility of the company largely rests on this sentence and the achievability of the quantified 'stretch' targets. To set a realistic target, however, we must understand the relative importance of the conflicting components. How much is downtime worth? What price would we pay for how much additional safety? This area of quantifying the intangibles, and determining a rational combination of objectives, was tackled head-on by the European MACRO project¹. This 5-year government-backed initiative has made some substantial advances in helping people to ask the right questions, and quantify/explore the trade-offs to find the optimal blend (particularly when hard data is limited or unavailable).

¹ For MACRO project details, see websites www.twpl.com and www.aptools.co.uk



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Figure 3. The outer ring of performance aspirations, and inner measures of how much they are worth.

Crystallising the message of where we are going is clearly vital – so is the delivery of this message to those who will have to produce the results. And this communication needs to be in language that each individual can understand (rather than the overworked boardroom and management consultant-speak of 'world-class', 'return on capital employed', 'optimisation' or 'stakeholder satisfaction'). In fact the leadership qualities that go with good asset management appear to be mostly communication skills – bridging the business objectives language and the terms recognisable at tactical, operational levels. Correspondingly, the MACRO project found that this bridge can also be built from the operational side – by equipping engineers and operational staff with the tools and language to express their ideas in total business impact terms.

Relating the investment and maintenance to total impact

EU MACRO project summary & update

Objectives: Research, collate and develop best practice in Asset Management decision-making, particularly where hard data is not available or adequate.

Scope: 42 areas of asset management decisions, of which examples included

- *"When is the optimal time to replace this equipment?"*
- *"What is the optimal inspection or maintenance interval?"*
- *"Is it worth holding a strategic spare, and if so, how many?"*
- *"Which asset is best to purchase - the high cost option with better performance and longer potential life, or the cheaper but lower performance/more uncertain option?"*
- *"What is the optimal implementation sequence for a list of very dissimilar tasks or projects?"*
- *"What shutdowns are worthwhile, when?"*

Sponsors & participants:

DTI, Yorkshire Electricity, National Grid, Norske Shell, Halliburton Brown & Root, The Woodhouse Partnership, PSVSA Intevop, Det Norske Veritas, Anglesey Aluminium.

Deliverables:

7 suites of decision-support methods, training modules and software tools (Asset Performance Tools or APT) that enable fully quantified description, "what if?" evaluation and optimisation of cost/risk/performance trade-offs.

Project update, October 2002

Since project completion in May 2000, over 250 licenses in the analytical tools have been issued in over 20 countries. A training and certification programme for asset managers and for consultants/ facilitators has been established with a number of industry specialists and international support locations (UK, France, Holland, South Africa, South America, Australasia). Companies have moved from localised specialist usage to corporate standard procedure. The fourth largest oil company in the world published their overall results recently – net benefits worth over US\$230million/year compared to 'engineer judgement' and other decision-making processes. Severn Trent Water have assessed the combined impact of RCM/MACRO procedures as saving over 30% of total maintenance costs. Yorkshire Electricity (now Northern Electric) found a 2-4x opportunity to extend testing intervals on protection relays. The National Grid has radically changed maintenance regimes for circuit breakers. In fact the MACRO techniques has consistently yielded payback within 6 months for the necessary training and software tools implementation. The following is just a very small sample of the procedures and the results.

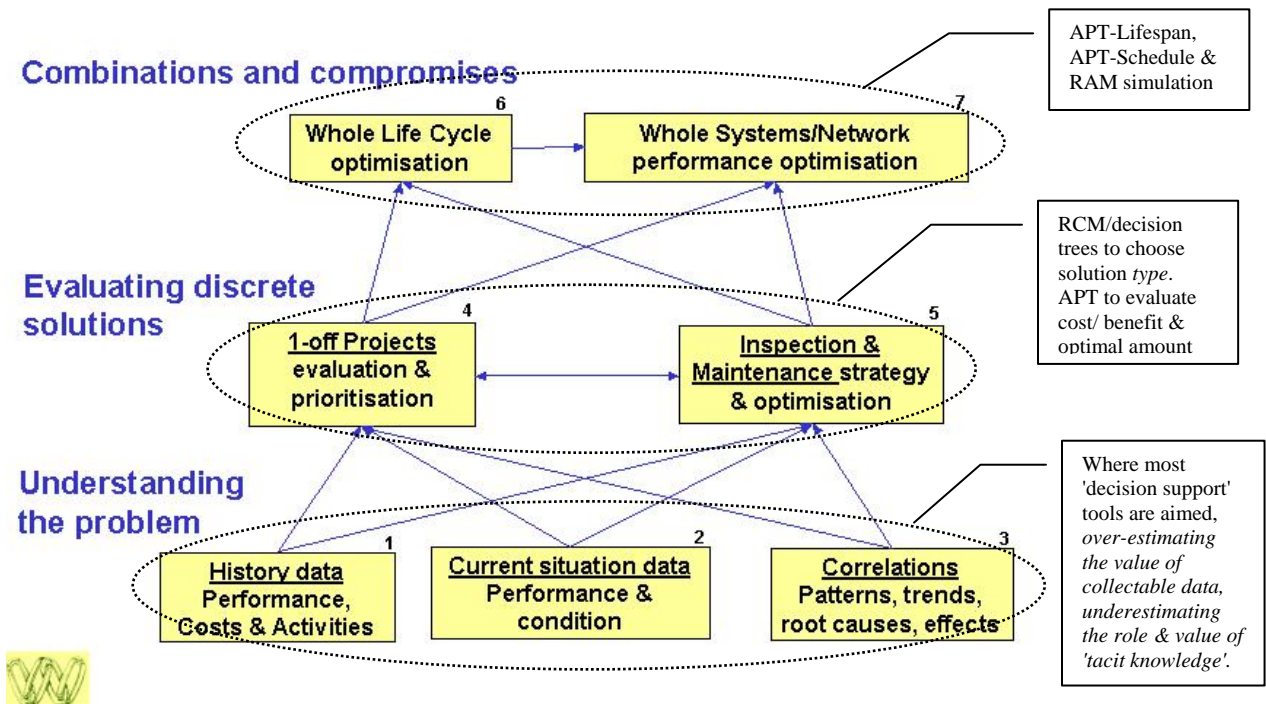


Figure 4. A systematic structure for the decision-support toolbox

Within the individual steps of decision-making, there are two particular important ones:

- a) **Ensuring the right questions are asked** – in a structured, multi-disciplinary manner, including range-estimating skills to compensate for lack of hard evidence. The five primary headings (at the centre of Figure 3) for quantifying total business impact have proven to be a vital starting point, under which specific range-estimating questions can be targeted at, for example, the possible degradation rate, or failure consequences.
- b) **Calculating the total business impact** correctly, including deterioration mechanisms, risks, secondary impact and different 'dosages' of maintenance/inspection/capital investment – including the sensitivity analysis to inevitably data uncertainty.

Putting these two elements together plugs the requirement of linking business objectives to specific inspection, operation or maintenance activities. For example, the competing priorities of projects to raise system performance, or improve safety, or reduce energy consumption, can be evaluated and ranked on a consistent, objective basis. While some companies are spending absurd millions on sophisticated deterioration modelling techniques, the MACRO feedback clearly shows that structured usage of existing operator, maintainer and engineering knowledge is enough to provide a fully risk-quantified and auditable basis for investment and maintenance decisions.

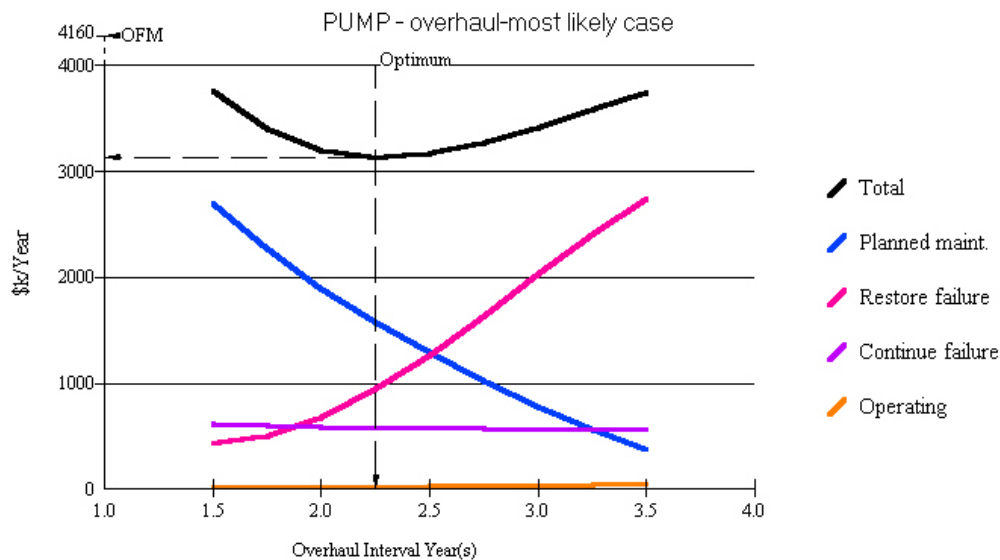


Figure 5. Example output from an APT analysis (maintenance strategy)

Capital Investment decisions & uncertainty

In the case of capital investment decisions, cost/benefit/risk evaluation (even for regulatory compliance-driven projects) falls into two levels of requirement – those decisions which can be simplified into a 'before-and-after' assessment, and those which are highly timing-sensitive (such as equipment replacement or upgrading, projects to extend operational life or to address some form of deterioration process). The latter decisions represent a significant technical and economic challenge – traditional Net Present Value techniques distort the options by forcing a common assessment horizon, and the optimal life cycle costs are a product of optimal renewal timing. APT-Lifespan breaks new ground here – providing "what if?" analysis of any combination of capital costs, operational characteristics, degradation assumptions, upgrade, refurbishment, repair or renewal options.

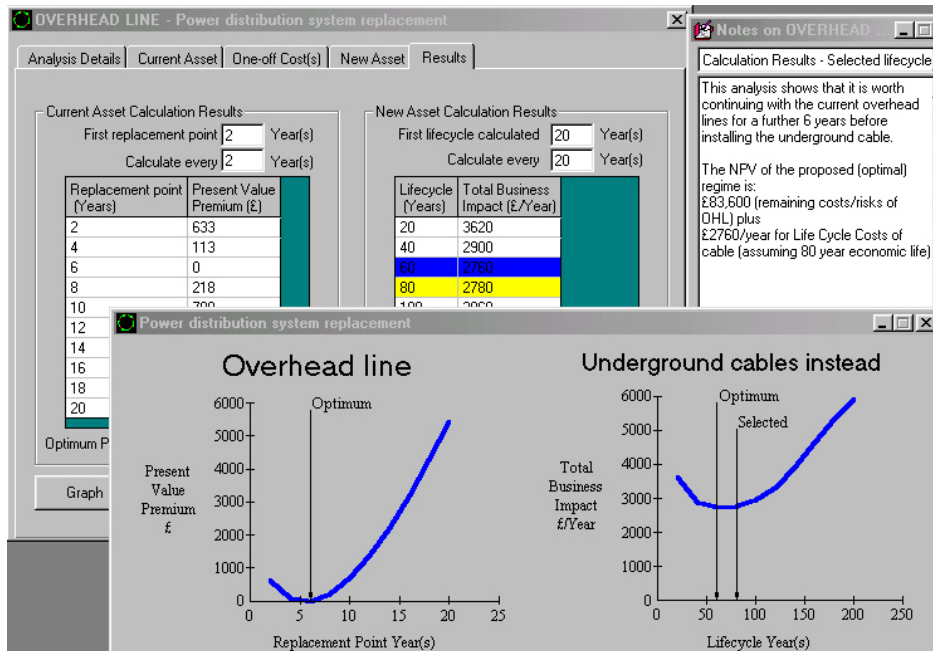


Figure 6. Optimal capital investment decisions, including life cycle costs and risk/degradation projections

Sensitivity testing is the crucial route to identify which assumptions are important – and so justify appropriate data collection efforts in the future. Such "what if?" analysis can even quantify the 'cost' of current uncertainty, and therefore set the maximum worthwhile budget for improving such knowledge.

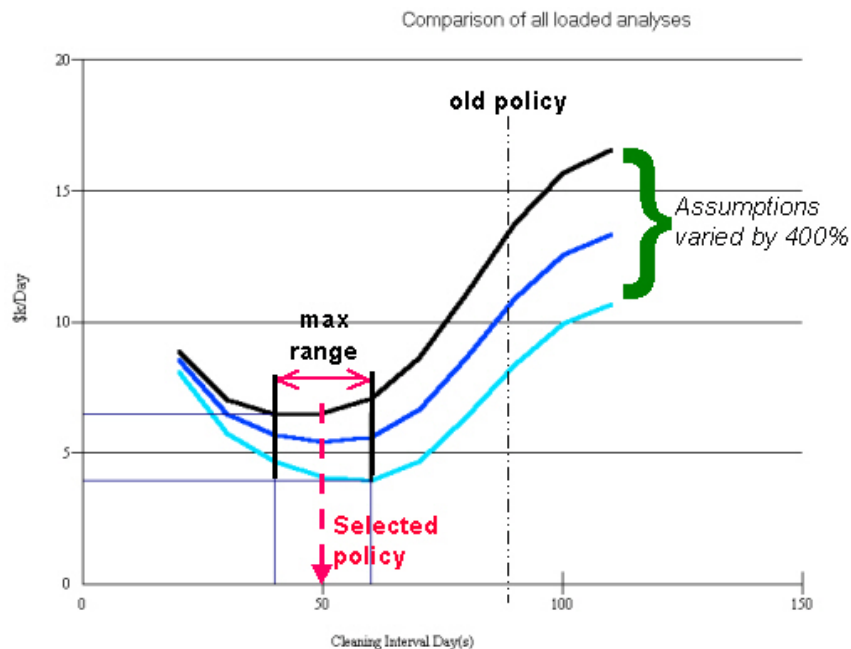


Figure 7. Evaluating the impact of uncertainty – sensitivity testing

Delivery of the optimal programme

Component decisions, evaluated for total business impact, can and are being optimised by leading asset management companies. Such activities may still be fragmented, but the trend is clear, the stakeholder expectations are rising, and the need for auditable, risk-based decision processes can only increase. However individual decisions need to be coordinated, and the coordination process reveals even further opportunities for rationalising of resources, sharing of outages and smoothing of in-house or contractor workflows.

At the last stage of the MACRO project, this subject was addressed head-on and the results have been very exciting. Using some advanced simulation techniques that learn as they experiment ('genetic algorithms' and 'simulated annealing'), computer software can explore different task alignments for cost, outage, risk, performance and other implications, all converted into present value total impact. Monte-Carlo simulation and linear programming techniques cannot cope with the complex risk interaction calculations. These modern 'artificial intelligence' tools, on the other hand, can quantify the total impact almost in real-time, automatically homing-in on the best total work programme of capital projects, periodic inspections and maintenance, and other opportunities or constraints.

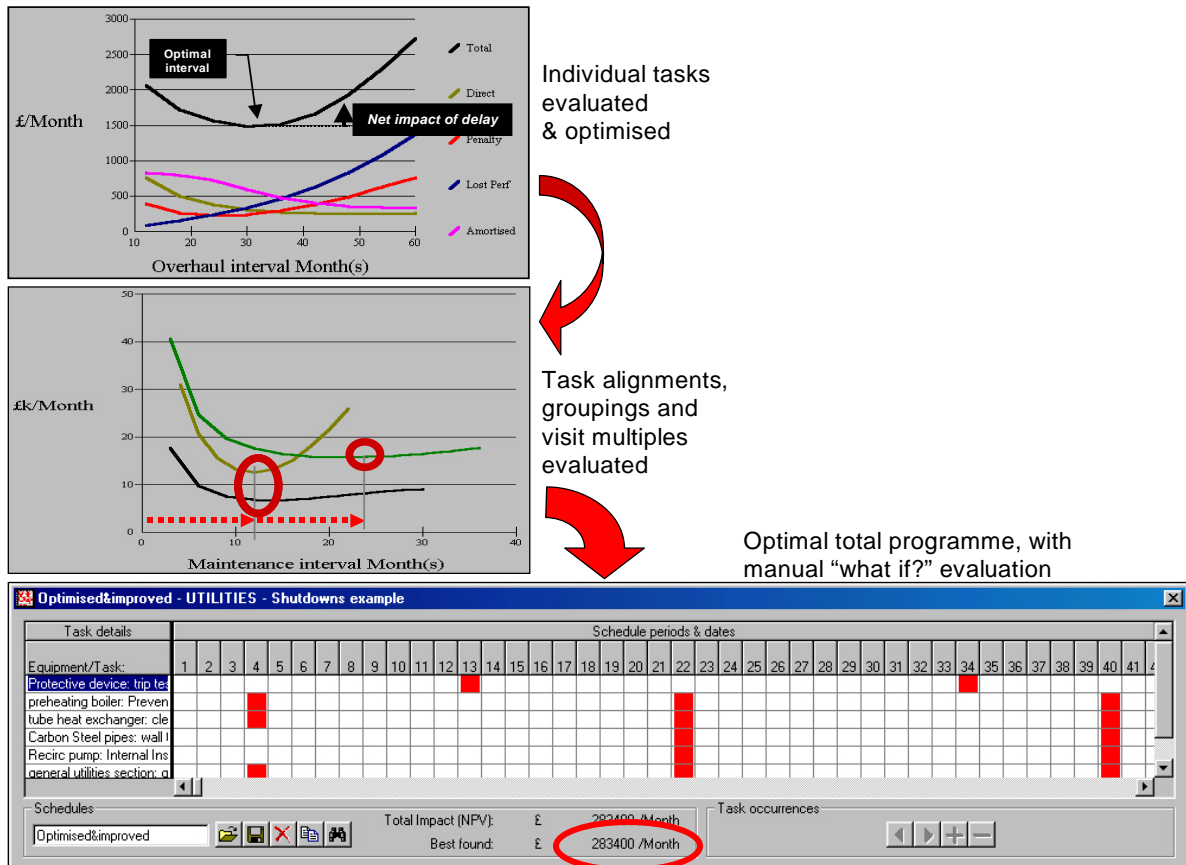


Figure 8. Example optimisation of critical activity programme

The impact of getting it right

So, it is important, possible and extremely valuable to connect investment and maintenance activities to business objectives – even quantifying the degree to which those objectives can be met, at what cost and risk. The following table is a sample of just 6 months of optimisation activities in one district in of the largest companies in the world (they are rolling-out the MACRO procedures company-wide). Notice the total impact, some US\$19million/year net benefits in the first half of this year alone. Notice also the difference between the areas in which big improvements were anticipated (root cause analysis, new technology applications, cross-functional teamwork and systems reliability engineering) were not those who contributed the genuine impact.

Methodology	ANALISES			TOTAL IMPACT (\$K/year)	
	PLANNED FOR 2002	COMPLETED (1st 6 months)	IN PROGRESS at July 2002	VISUALISED 2002	ACHIEVED AT JULY 2002
CRITICALITY ANALYSIS	6	1	9	-	-
LOST OPPORTUNITY ANALYSIS	3	-	3	-	-
CROSS-FUNCTIONAL TEAMS BUILD	1	1	3	4865	350
ROOT CAUSE ANALYSIS	16	1	9	13890	1100
STATISTICAL DISTRIBUTION ANALYSIS		1	-	-	-
RELIABILITY CENTRED MAINTENANCE	14	1	12	888	5269
RISK BASED INSPECTION	7	1	2	600	-
COST/RISK OPTIMISATION (APT)	10	8	9	950	15140
OPERATIONAL IMPROVEMENTS	13	1	10	780	1500
NEW TECHNOLOGY APPLICATIONS	11	1	9	1480	176
SYSTEMS RELIABILITY ENGINEERING	4	1	5	1500	457
	85	17	71	24,953	19,221

Figure 9. Example results from the mixed Asset Management toolbox.

Conclusions

So there really is no excuse any more. A bit of language discipline and quantification can clarify the business objectives themselves. A more sophisticated criticality ranking can set the priorities credibly and 'balance the scorecard' of performance measures. And the skills, procedures and tools for fully quantitative optimisation of investment and maintenance are available and well-proven. The limiting factors are just awareness and conservatism – and time to build confidence in the very new world of risk-based, "what if?" supported investment and maintenance strategies. Fortunately such new practices can be phased in – pilot studies, 'workshops' and short training courses can demonstrate the viability and value of the approach before major commitment is needed. With benefits such as those achieved by BP and Shell, or those achieved by the company illustrated above (Figure 9), *plus* the increasing scrutiny of city analysts, shareholders and regulators, the motivation is certainly there. And there is even a standard emerging to define what is needed – keep an eye on the Institute of Asset Management website (www.iam-uk.org) and/or the British Standards website (www.bsi.org) for more details. Asset Management really is a science emerging – with big benefits.

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