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## **What does a mature cost engineering organisation look like?**

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### **Abstract**

*Dale's first book was the Systems Cost Engineering book [1.]. Cost Engineering Health Check; How good are those numbers? is Dale Shermon's second book and co-authored with Dr Mark Gilmour [2.]. The presentation will consider what a mature cost engineering organisation looks like? It will cover the essential requirements for a credible and justified cost forecast. This paper will cover some elements of the book and emphasis why benchmarking is important for the maturing of a cost engineering organisation.*

**Keywords:** cost engineering health check, benchmarking, maturity, CEHC, knowledge based estimating, QinetiQ.

### **Introduction**

QinetiQ was formed in July 2001, when the UK Ministry of Defence (MOD) split its Defence Evaluation and Research Agency (DERA) in two. The smaller portion of DERA, was rebranded Defence Science & Technology Laboratory or Dstl and remains part of the MOD. The larger part of DERA, including most of the non-nuclear testing and evaluation establishments, was renamed QinetiQ and prepared for privatisation. QinetiQ became a public private partnership in 2002.

In 2003, QinetiQ signed a 25-year long term partnering agreement (LTPA) under which we provide the UK MOD with innovative and realistic test and evaluation of military and civil platforms, systems, weapons and components on land, at sea and in the air.

As a people based business, our service offerings account for the majority of sales. In addition our products division provides technology-based solutions on a global basis including offices in Australia and Canada. Through their technical expertise, know-how and rigorous independent thinking, our engineers and scientists are uniquely placed to help customers meet challenges that define the modern world. These challenges include affordability and seeking value for money (VfM).

### **Cost modelling capability: Knowledge Based Estimating**

High quality cost estimating gives a business leader confidence to make rational financial decisions. Whether you are a business leader or a cost estimating manager, you have a vested interest in understanding whether you can depend on your organisation's ability to generate accurate cost forecasts and estimates. But how can business leaders have confidence that the cost information that they are being provided with is of high quality? How can a cost estimating manager be sure that their team is providing high quality cost information?

QinetiQ's Cost Engineering Health Check is used as a capability benchmarking tool to identify improvement opportunities within their clients' cost estimating capability, enabling them to focus on areas that have the potential to increase their competitiveness. High quality estimating leads to accurate budgets, a reduced potential for cost growth, accurate evaluation of risk exposure, and the opportunity to implement effective earned value management (EVM).

Cost Engineering Health Check employs a standardised competency framework that considers all aspects of cost estimating capability, and provides an objective assessment against both best practice and the industry standard. This framework is based on QinetiQ's long established, tried and tested, Knowledge Based Estimating or KBE philosophy comprising Data, Tools, People and Process, with additional consideration given to cultural and stakeholder assessments.

Within the context of the KBE philosophy Data is defined as any information, both cost and technical, concerning historical projects that will be used as the basis for future estimates, whilst also extending out to information in relation to the technical or programme characteristics of future projects or services. Tools are defined as the software systems that help cost engineers to interpret historical data, such as statistical tools, that can be used to create cost estimating relationships (CER), or other tools that allow the application of such relationships to generate estimates.

People within KBE are recognised as being needed to interpret historical data and predict the concepts for the new projects and services that will satisfy the perceived capability or requirements. Cost engineers need qualifications to justify their professionalism and skills to elicit the data from finance, project staff and customers. Finally, processes are necessary to ensure that people conduct an estimate in a rational, repeatable way, ensuring that the outputs are traceable to source data and assumptions.

The following sections will discuss a sample of the KBE maturity criteria used in the cost engineering health check.

### **Data gathering, normalisation and application**

The process of collecting cost data usually concludes with its manipulation to make it fit for purpose through normalisation for currency and economic base year. The critical aspect to this activity is maintaining complete transparency while conducting this normalisation. You need to be able to trace the outcome back to the original source information. In a good example of data gathering, normalisation and storage, during the manipulation of data the source data was stored in a Microsoft Access database to ensure that a third party could trace the output back to its origin in terms of the data source and the persons involved.

A mature cost engineering organisation will not just store cost data, but other data such as:

- Technical Data
- Historical Schedule
- Risk Register
- Cost-to-Completion data
- Inflation / cost trend indices

An experienced team will understand that it is typically necessary to manipulate, or normalise, all sourced data prior to being able to use it. The typical kind of attribute that sourced cost data must be normalised for includes:

- Attribution of overheads
- Outturn versus constant cost
- Quantity effects
- Fixed and variable
- Recurring versus non-recurring
- Currency
- Imperial to metric
- Questionnaire of method of allocation of costs (QMAC)
- Number of users
- Schedule durations

A mature organisation will have established processes regarding how data should be normalised, and these will be applied uniformly across the business.

In the absence of data the mature cost engineering organisation will make robust assumptions, but, as shown in Figure 1, this should migrate from assumptions to data over the course of the project.

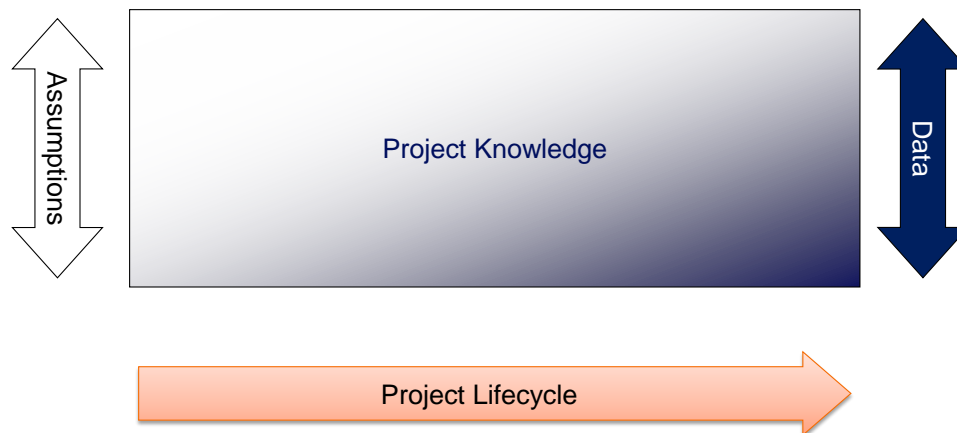


Figure 1: Data poor

QinetiQ has a P3+ Observatory, see Figure 2, which is a collaborating environment for the storage of data and information. Our consultants are encouraged to seek information from this rich data source and, importantly, to contribute to the data source.

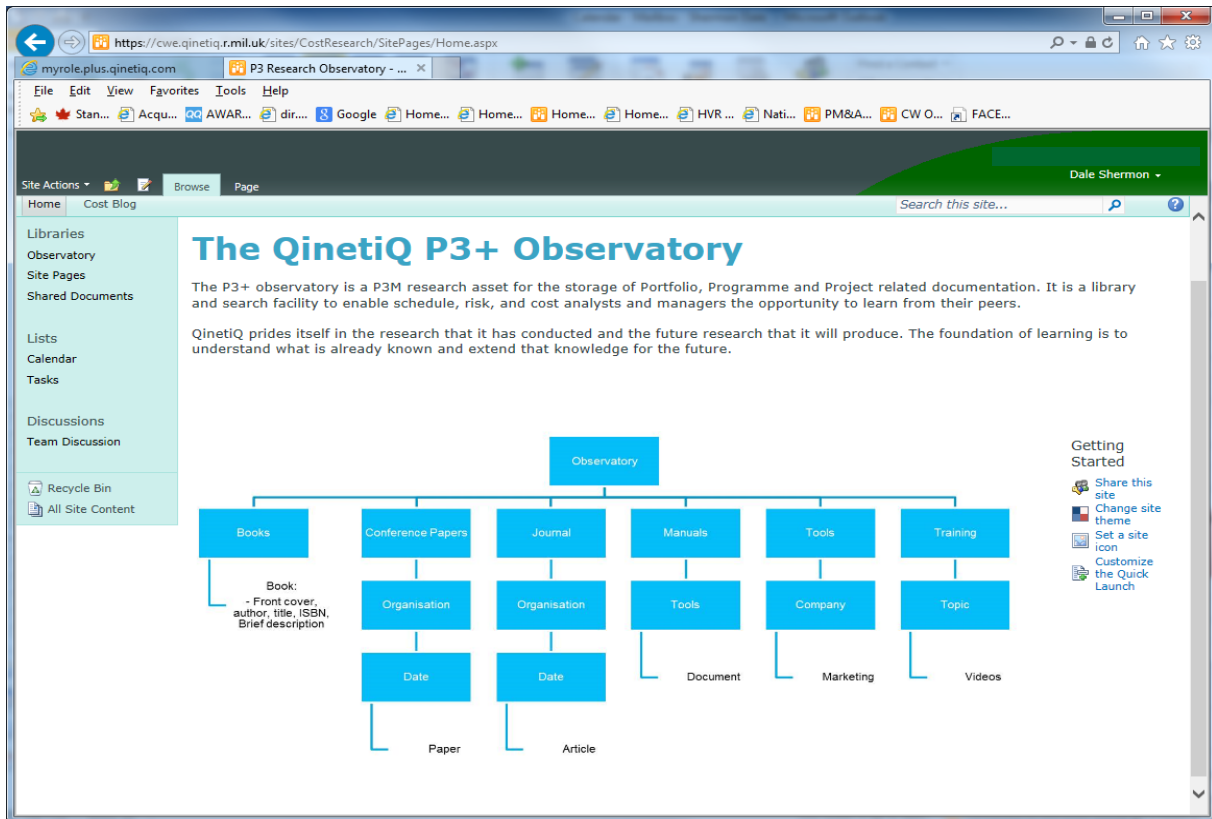


Figure 2: P3+ Observatory

At the present time the QinetiQ P3+ Observatory has more than 2,300 papers and presentations on P3M topics including risk, schedule, project control, cost forecasting, project management, benefits and so forth. We have access to the information through a full literature search capability.

To ensure quality control QinetiQ has the concept of a Knowledge Manager, a single point of contact to ensure the quality of the P3+ observatory contents. Consultants can offer internal QinetiQ or external information to the P3+ observatory, but the Knowledge Manager will validate and verify it prior to uploading it. Being a web enabled collaborative environment QinetiQ is able to secure the information while offering access through structured searching or key word searching.

### Tool development and usage

When engineers think of cost models they immediately reach for Microsoft Excel, but this is not the only option. A mature cost engineering organisation will have a rich variety of cost models to call upon that support their processes and manipulate their data including aggregation models, parametric models, statistical models, Monte Carlo analysis capability and so forth.

A mature cost engineering organisation will realise that jumping straight into Microsoft Excel and spreadsheets is not the solution. Although some see this activity as the sexy part of the cost engineering task, it needs to be planned and organised with the same rigour as any other project. The Systems Engineering approach is recommended as best practice with a requirements document, design, testing and validation & verification, as shown in Figure 3.

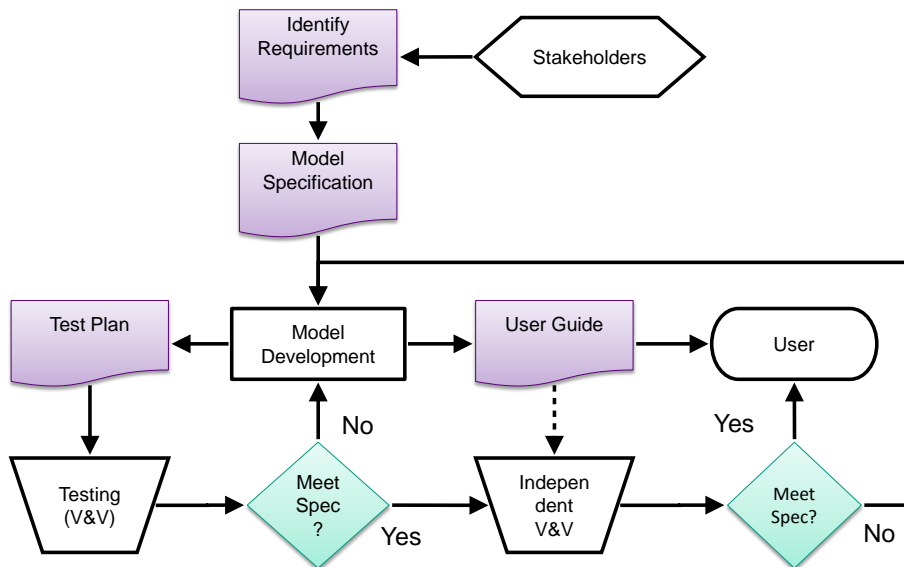


Figure 3: Not sexy, but essential

As a mature cost engineering organization QinetiQ has a number of models that they call upon during the execution of consulting tasks including:

- Generic Cost Model – This universal cost model uses individual components to build options. It then calculates deterministic cost estimates for Whole Life Cost (WLC) covering all phases of the project lifecycle and the capability costs. This tool also aids the identification of cost drivers, performs cost trade-offs and captures procurement costs. With the addition of quantified risk register data the model is able to produce costs in Constant cost, discounted cost and Then year cost.
- Family of Advanced Cost Estimating Tools (FACET) – a primarily Defence-based parametric cost model. It rapidly enables economic decision makers to estimate the through life costs of procuring equipment, ensuring correct decisions are made very early on in the project life cycle. FACET is uniquely positioned to provide these estimates through its ability to use performance characteristics to calculate future costs.

### People's skills, professionalism and knowledge

A mature cost engineering organisation will recognise the need for skilled practitioners or experts. Awareness is essential, but staff with the correct maturity and competencies is ultimately needed. As shown in Figure 4 the experienced cost engineer will be able to communicate with junior and senior staff equally. They will have an appreciation and understanding of many engineering disciplines, but a deep understanding of their own discipline including the following competencies:

- Organisational experience
- Technical experience
- Mathematical & statistical skills
- Commercial experience
- Finance experience
- Communication and interpersonal skills
- Computer and IT skills
- Principles of Project Management

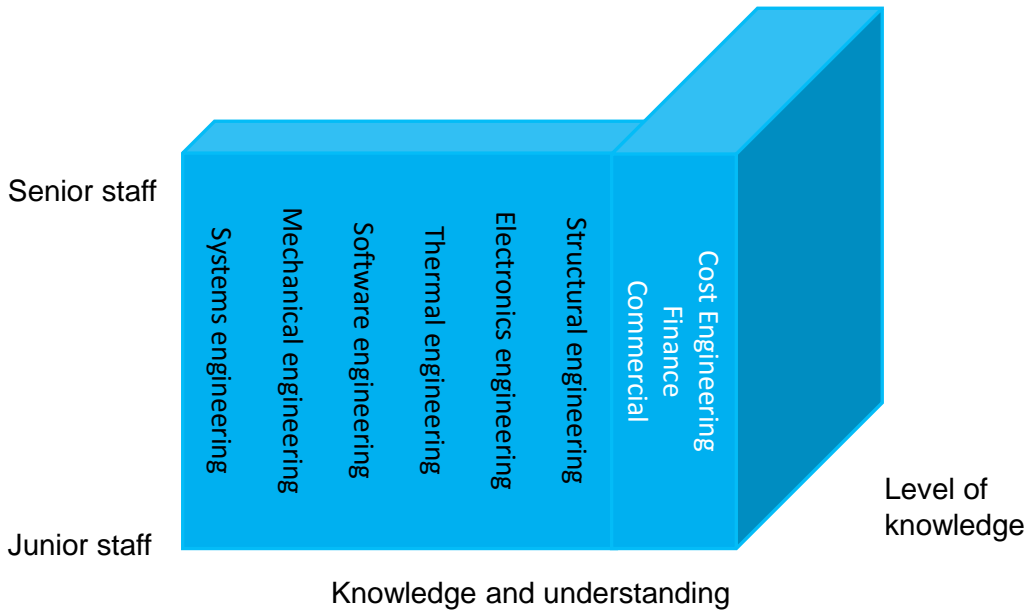


Figure 4: Knowledgeable people

The breadth of knowledge and topics understood by a cost engineer, relative to their competencies, is represented in the cost engineering tube map drawn in Figure 5. A mature cost engineer will apply, teach and understand these fields of business, science and engineering.

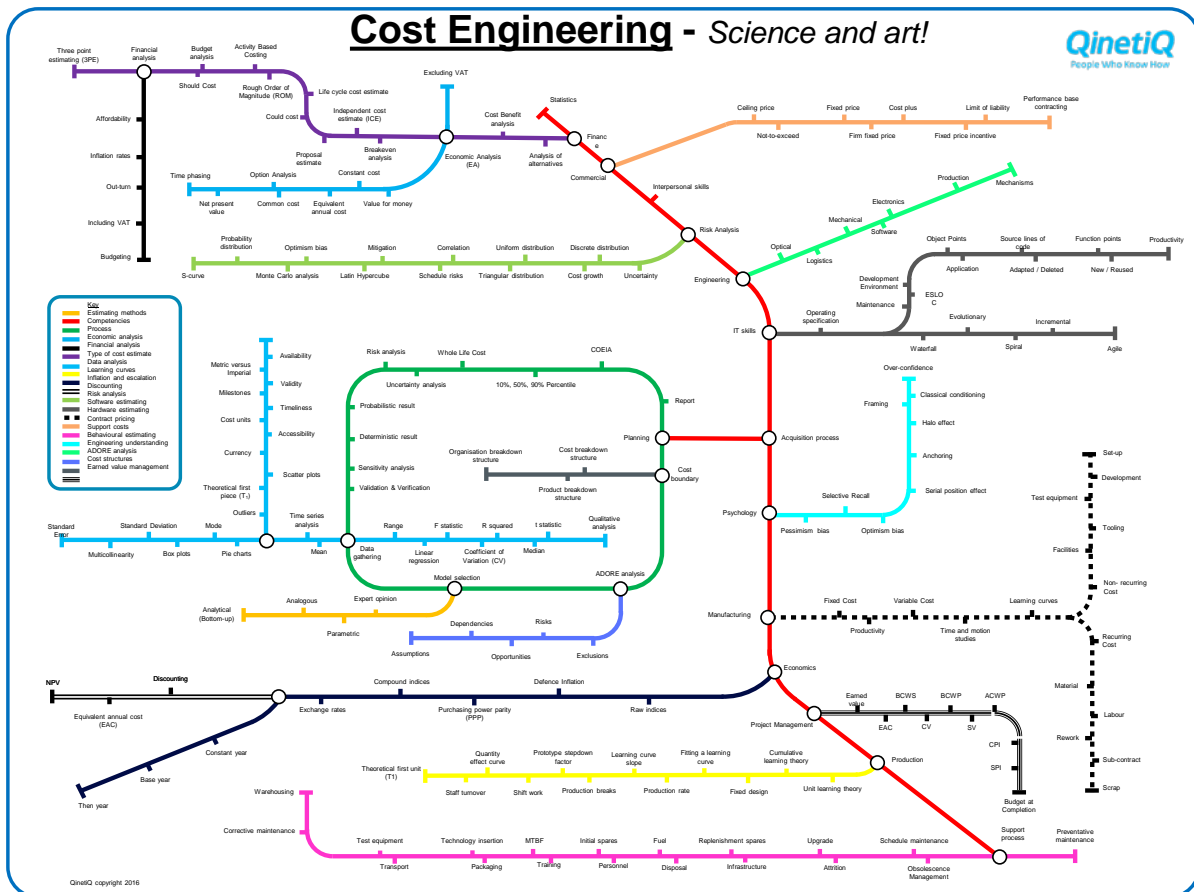


Figure 5: Cost engineering tube map

### Process existence and utilisation

The process needs to begin at the top with an understanding of the total money in the budget. As shown in Figure 6. This will be too large to manage and therefore it will be broken down into programmes and eventually projects that can be managed. The whole process will be monitored by shareholders or other scrutiny organisations.

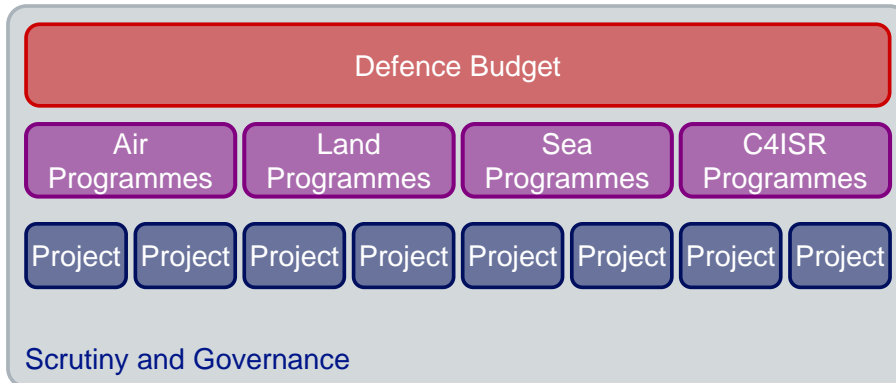


Figure 6: Whole budgets, too large to manage.

Once this is realised it is easy to map the necessary costing process against these levels, see Figure 7. So at the total budget level a mature cost organisation will be involved in balance of investment decisions; how many of each type of asset do we require? In the defence domain this will ensure that the navy and land forces don't grow at the expense of the air force, as an example. It will ensure that the money is equally allocated against the defence requirements. At programme board level the mature cost organisation will conduct enterprise modelling to ensure that the industry partners have a balanced allocation and steady demand thus maintaining a healthy industry base and opportunities for completion. Finally at project level the mature cost organisation will support analysis of alternatives, budget setting and option studies.

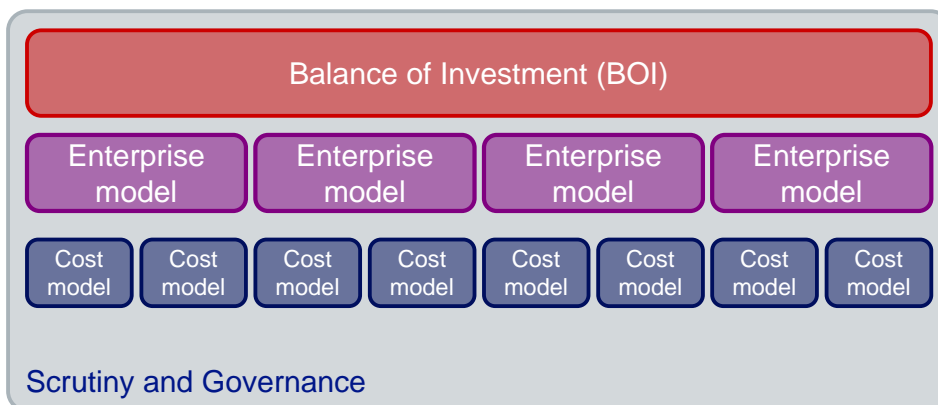


Figure 7: Analysis appropriate to the funding

The decision process at project level is detailed in Figure 8, in a mature cost engineering organisation the recognition of a capability gap caused by the need to replace a system or service will trigger the process. The concept of analysis or COA will communicate the analytical methods being used including the cost methodologies; then the options will be determined. At this point the mature cost engineering organisation will take responsibility for the generation of a whole life cost for each of the options and operational analysis staff will determine the measure of effectiveness of the options. The important feature of these analyses is to ensure that the same assumptions are made for the resulting measure of effectiveness and

investment appraisal (IA). Ultimately, these will be compared in the combined operational effectiveness and investment appraisal or COEIA. Finally, the recommendation will be described together with the evidence in the business case.

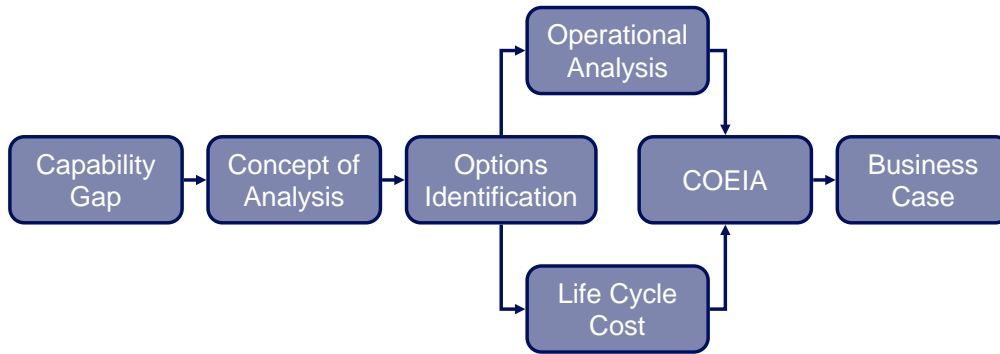


Figure 8: Decision analysis process

To provide confidence in the IA multiple cost estimating methods will be deployed by a mature cost engineering organisation. As shown in Figure 9 the presentation of the different methodologies can reassure the decision maker that the cost engineering organisation is presenting a comprehensive and thorough analysis.

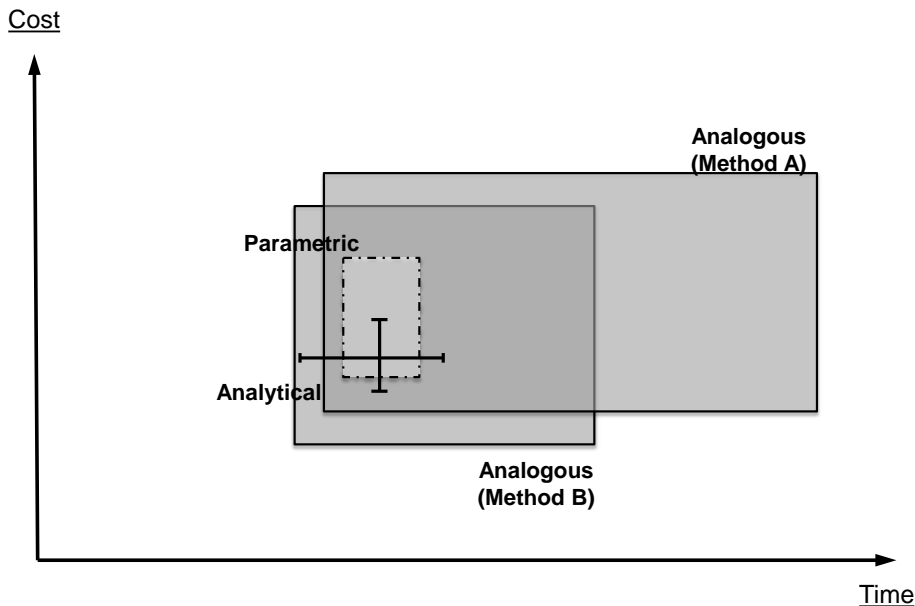


Figure 9: Providing confidence in the numbers

QinetiQ has all its cost engineering processes, tools, templates, process guidance, links and aides stored in our P3+ Wiki website. This site evolves and grows with the knowledge of the team when new, amended or updated P3M resources are generated for QinetiQ consultants. The site has a structured searching capability and is a collaborative working environment being web enabled, as shown in Figure 10.



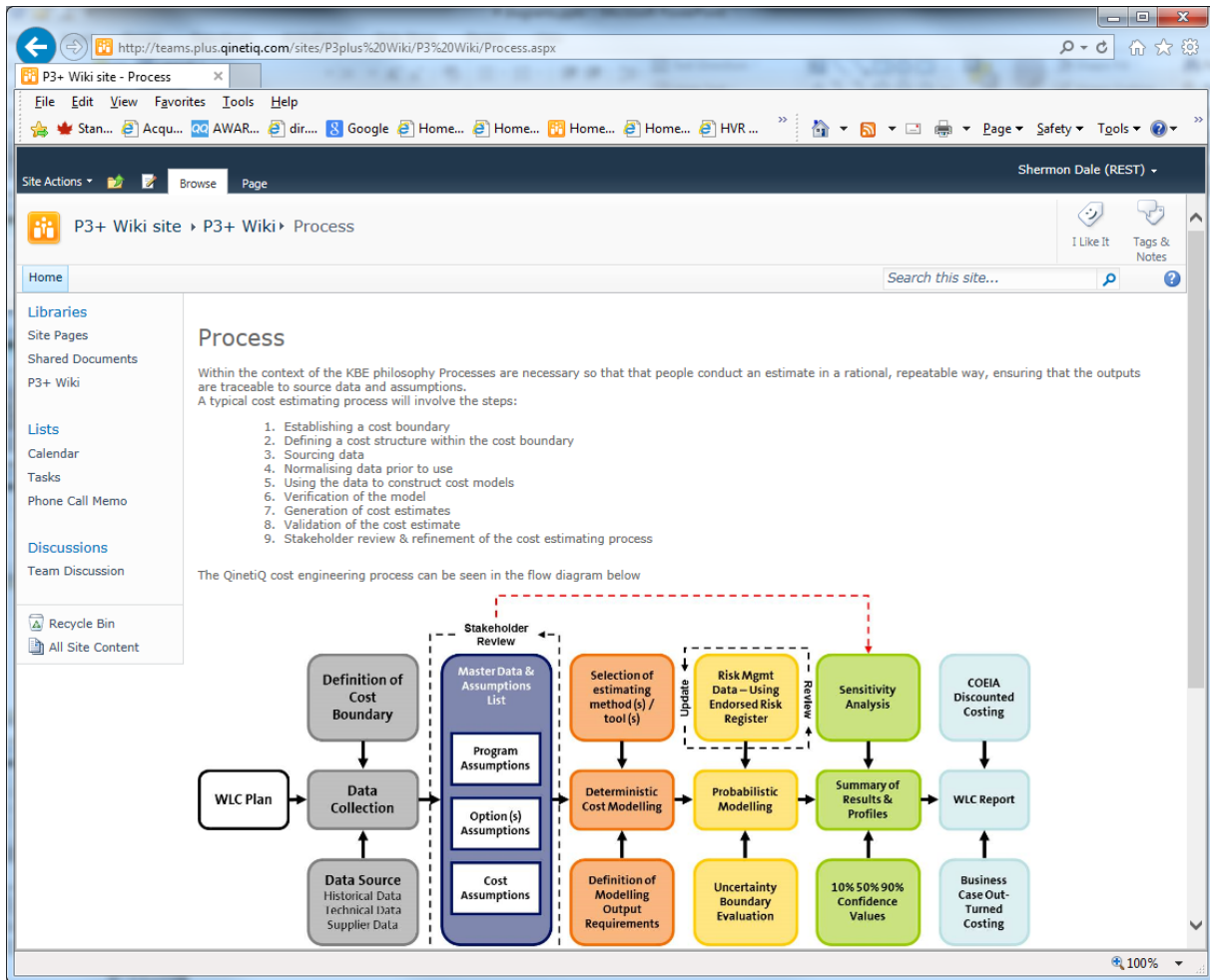


Figure 10: QinetiQ P3+ Wiki

### Culture, leadership and management

A mature cost engineering organisation will be integrated into the other areas of the organisation and their analysis techniques. It will not be considered as an afterthought; now what might that cost? But as an integral part of the overall process, as shown in Figure 11.

The USA initiative that raised the profile of cost known as cost as an independent variable or CIAV is a perfect example of cost estimating being integration within an organisation. Here the initiative emphasised cost as being of equal important to other engineering analysis. As well as considering watts, volts, newtons, kilograms, litres and so forth during the design and development of systems and services the engineers seek to consider dollars, euros and pounds!

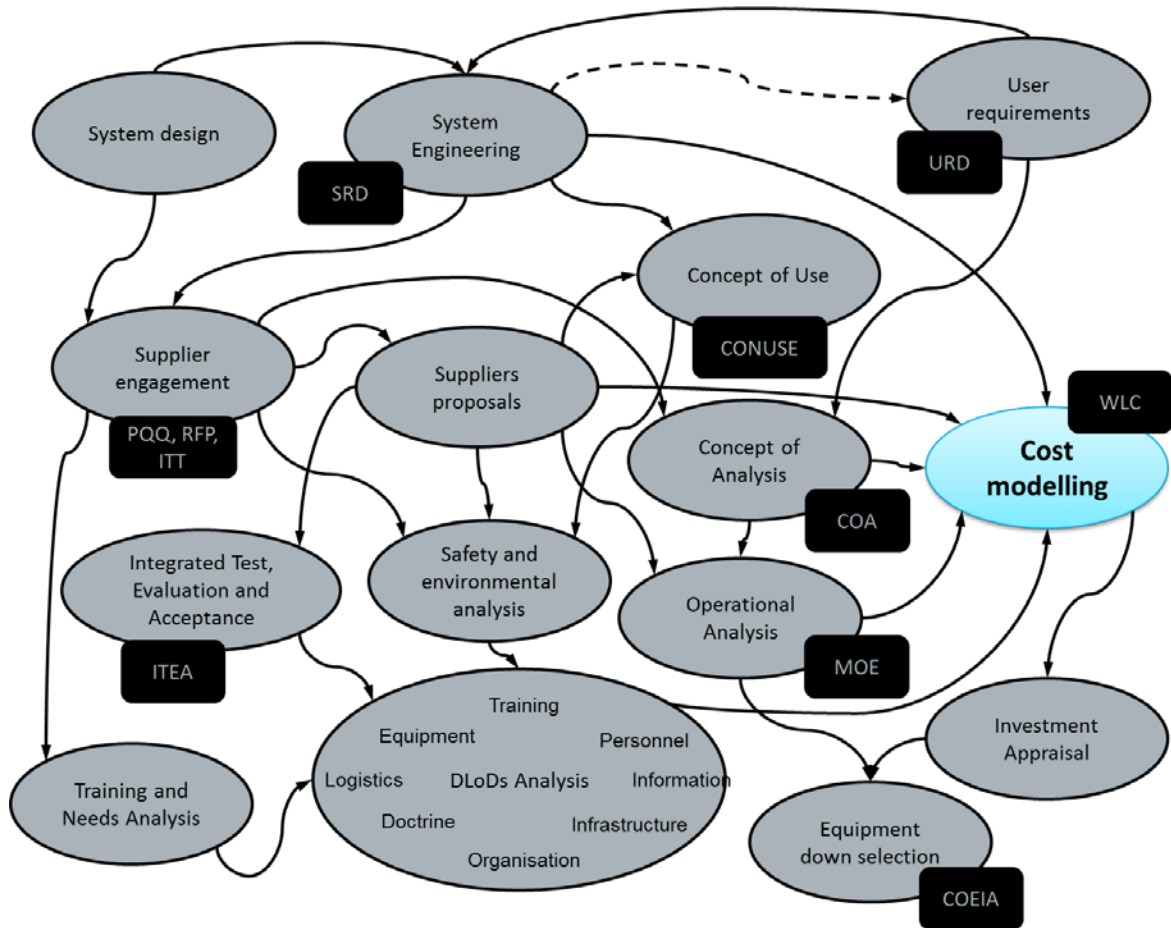


Figure 11: Fully integrated into the business process?

In a mature cost engineering organisation the team will integrate into the project management processes, as seen in Figure 12. This will enable them to learn as their cost estimates evolve into the project actuals. Tracking the earned value management or EVM data gathered against project, they will typically store the information for future application in analogous estimates, generation of cost estimating relationship or sources of detailed bottom-up estimating information.

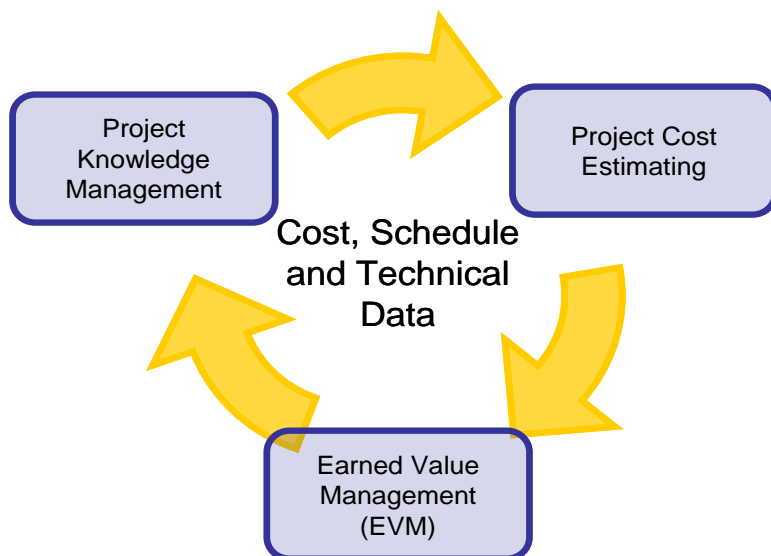


Figure 12: Learning and calibrating

## Summary

So how mature is your cost engineering organisation? QinetiQ has a cost engineering health check that can be used to measure the maturity of projects or departments. From the metrics that are generated we are able to determine the maturity of your estimating capability. It is possible to benchmark against best practice as defined in the cost engineering health check framework and described in the new cost engineering health check book [2].

Once the comparison with peer organisation has been completed it's easy to establish where improvements can be made and determine how to improve. It's then a case of focusing resources towards areas identified as weak to ensure that the increase in maturity is delivered through periodic reassessments.

This paper has examined some of the challenges faced by a mature cost engineering organisation and provided some examples of good practice. Don't delay; the need for credible and justified cost estimates has never been more important for both the private and public sectors.

## References

- [1.]Shermon D. *System Cost Engineering*, Gower publishing, July 2009, ISBN: 978-0-566-08861-2
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