

# A cost capability maturity analysis of the US and European costing communities

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***Abstract** - 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 be confident 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 (CEHC) is used as a capability benchmarking tool to identify improvement opportunities within our clients' cost estimating capability, enabling them to focus on areas that have the potential to increase their competitiveness.*

*The 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 (KBE) philosophy comprising Data, Tools, People and Process, with additional consideration given to cultural and stakeholder assessments.*

*QinetiQ conducted a 'lite' version of the CEHC at the ICEAA 2014 workshop in Denver and compared the results to those gathered in Europe. The output is a limited commentary on the capability of the US and European costing communities and an identification of the lessons that each can take from each other's methods and approaches to costing.*

## 1 Introduction

In these austere times decision makers are finding the financial impacts of their decisions coming under increasing levels of scrutiny by shareholders, chairmen, public accounts committees and other august bodies. But as decision makers typically do not generate the cost information on which they base their decisions, how can they be confident that the cost information that they are being provided with is of a quality appropriate to the decisions they inform? Within the public sector there have recently been a number of notable high profile events where the cost estimates being used to make decisions have been found to be significantly lacking in quality - for example in awarding the franchise for train operations on the UK's West Coast Main Line. How can such situations be avoided in the future and how can decision makers act to protect themselves and their organisations from cost estimates of questionable foundation?

In response to this situation, QinetiQ [Ref: 1] has developed the Cost Engineering Health Check (CEHC). The CEHC has the express aim to aid decision makers such as project and programme managers, Managing Directors, Chief Executive Officers and so forth to evaluate their organisation's cost estimating capability. By evaluating their organisation's cost estimating capability relative to both best practice and their industry peers, these individuals can gain confidence in the information that they are being asked to base their decisions upon, or, where their organisation's capability is found to be deficient, put measures in place to improve it .

## 2 Knowledge Based Estimating (KBE)

QinetiQ cost forecasts and estimates are underpinned by its philosophy of Knowledge Based Estimating (KBE) (Figure 1). This values the importance of knowledge and understanding for generating credible and justifiable cost estimates. The building blocks that form the foundation of Knowledge and Skills are Data, Tools, People and Processes.



Figure 1 – QinetiQ's Knowledge Based Estimating (KBE)

Within the context of QinetiQ's 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. It also includes information about 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 and to create cost estimating relationships (CER), such as statistical tools. It also includes bespoke and commercial off the shelf tools that enable the application of CERs 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 formal qualifications to justify their professionalism and effective interpersonal communication skills to elicit the data from finance, project staff and customers.

Finally, 'Processes' are necessary so that that people conduct an estimate in a rational, repeatable way, ensuring that the outputs are traceable to source data and assumptions.

This KBE philosophy is used as the basis and cornerstone of the CEHC.

### 3 What is the Cost Engineering Health Check?

The CEHC is a set of 60 questions/indicators that help characterise an organisations costing capability in relation to the KBE building blocks of Data, Tools, People and Process. CEHC recognises the importance of the less tangible aspects of Culture and Stakeholders on costing capability, where Culture is considered to be the environment in which cost engineering is taking place and Stakeholders refers to anyone who has a vested interest in the inputs or outputs of the estimating process. The CEHC assesses these less tangible aspects of capability indirectly, using answers provided to the Data, Tools People and Process capability indicators.

The CEHC is implemented in QinetiQ’s AWARD environment [Ref: 2]. AWARD provides a web-based user interface that enables the logging of evidence used to underpin the CEHC capability assessment, an analysis interface for the reporting of CEHC results, and the ability to track capability improvement as development measures are put in place.

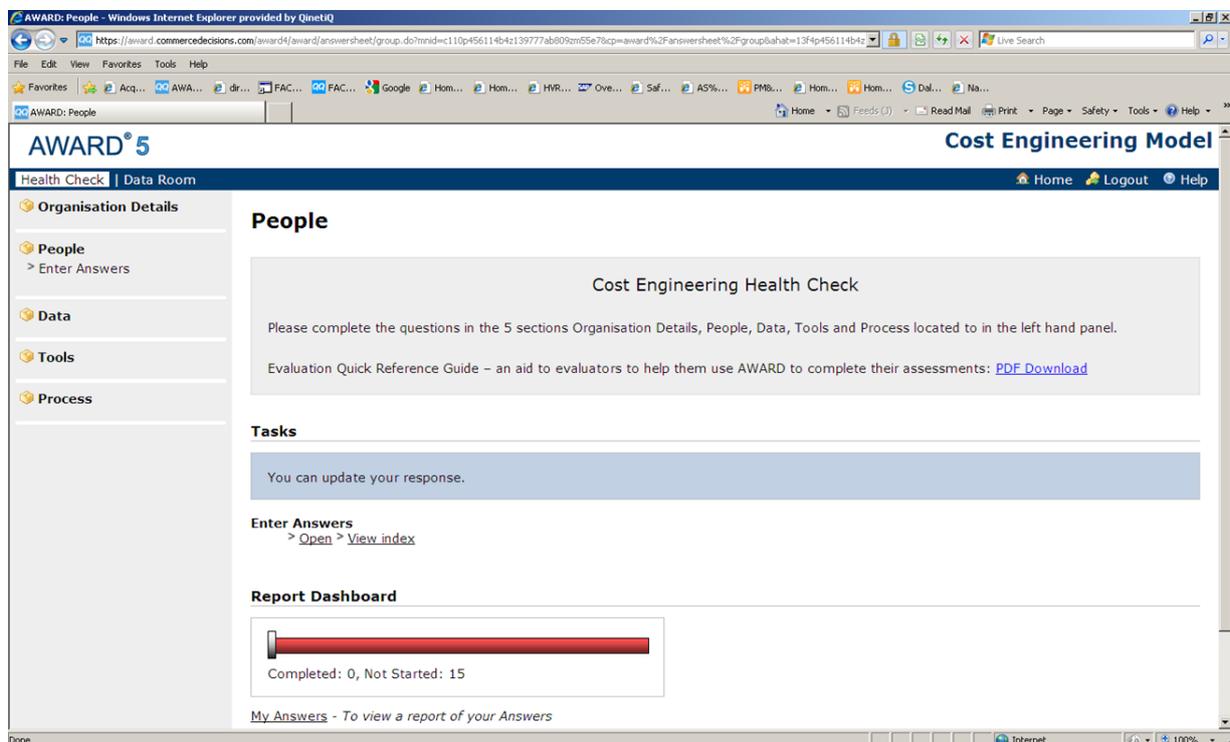


Figure 2 – CEHC in QinetiQ’s AWARD Environment

### 4 Why Conduct a Cost Engineering Health Check?

QinetiQ have been conducting maturity assessments on the risk management capabilities of organisations for many years using the QinetiQ Risk Maturity Model (RMM) [Ref: 3]. It has been demonstrated through use of the RMM that for projects that benchmark their capabilities to understand their risk capability weaknesses, and then take action to improve upon these weakness, that they perform significantly better than projects that do not. An analysis of the National Audit Office (NAO) report on MOD’s major equipment projects [Ref: 4] identified overspend as a percentage of original estimate for a selection of projects as shown in Figure 3. This clearly showed that projects with a higher level of maturity in the area of risk management were less likely to deviate from their original cost forecast than projects with lower levels of maturity.

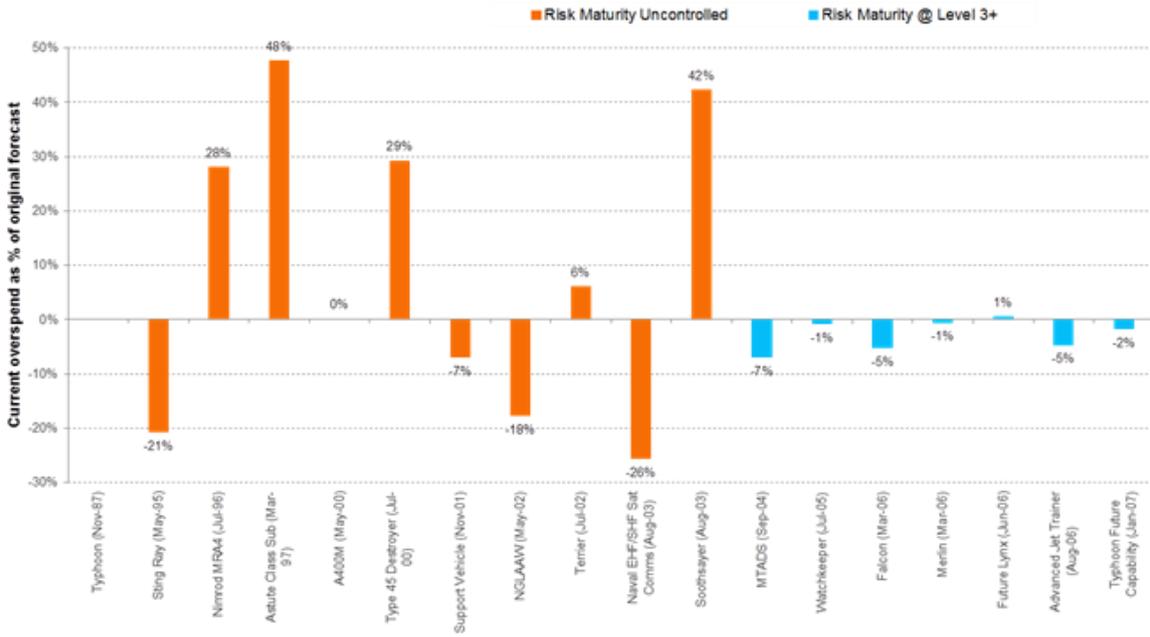


Figure 3 – Results from the QinetiQ Risk Maturity Model (QRMM)

The authors of this paper realised that there was a need for a similar assessment technique in the cost estimating, forecasting and analysis community. In the last dozen or so years there have been numerous instances in which the capability of the costing community has been questioned, and the need for an ability to benchmark costing capability against best practice and international standards has been raised, as illustrated by Figure 4. To this end the authors developed the CEHC.

Another problem is the significant capability deficiencies in the IPT..... In particular we found insufficient financial skills. The costing and estimating groups had been cut down to save money...

I would have liked to have the time resources to do more international benchmarking on a quantitative basis..... some quantitative measurement may have flushed out some further efficiencies

**Bernard Grey , UK MoD Chief of Defence Materiel, in *An expert view on Defense procurement*, McKinsey**

Defence sectors: cost growth since approval

Average cost growth across all 73 projects is largest in the ships, combat air and submarines sectors

| Defence sector              | Average cost growth (£ million) |
|-----------------------------|---------------------------------|
| Ships                       | 673                             |
| Combat air                  | 263                             |
| Submarines                  | 182                             |
| Helicopter                  | 109                             |
| Air support                 | 108                             |
| Information systems support | 0                               |
| Land equipment              | 0                               |
| ISTAR                       | -6                              |
| Weapons                     | -13                             |

Source: NAO Major Projects Report 2013

Poor forecasting is an entrenched problem, leading to poor value for money and taxpayers bearing the costs. Since 2010, over 70 of our reports have identified forecasting weaknesses

there is insufficient information to assess the quality of departments' forecasting.....teams lack a consistent approach to assess and compare the quality of programme forecasting.

**National Audit Office 2014, *Forecasting in government to achieve value for money***

The Department should ensure all project teams are applying good practice in cost and risk modelling to help develop its understanding of aggregate risk across the Equipment Plan.

**Public Accounts Committee , 2014. *MoD Equipment Plan 2013-2023***

Figure 4 – Need for cost capability benchmarking in the UK [Ref: 5, 6, 7, & 8]

The objective of the CEHC is not to determine the accuracy of a cost estimate; this can be determined through uncertainty analysis and Monte Carlo techniques to enable you to state that an

estimate is X with an accuracy of +/- Y%. The objective of CEHC is to examine the work that underpins the estimate. The CEHC assesses the quality and consistency of the cost engineering, supports the improvement of cost estimating and forecasting, and thus enables better informed decision-making. It acts to identify and facilitate communication on common costing issues across an organisation so that measures can be taken to address them.

## 5 The CEHC Process

In order to make an accurate assessment of the maturity of an organisation’s capabilities one needs to review tangible evidence that demonstrates an organisations costing capability. Such evidence can take the form of process documents, personnel training plans and qualifications, evidence of toolsets in use, guidance on application of various different costing techniques, cost reports etc. QinetiQ typically initiates a CEHC study by identifying and reviewing the key pieces of evidence offered forward by an organisation in relation to its capability.

Additionally QinetiQ also engage with the individuals within an organisation to elicit their views on application of such documents. QinetiQ’s experience in conducting CEHC assessments indicates that it is necessary to canvas the views of a broad range of disciplines within an organisation to have confidence that the CEHC assessment provides a true picture of costing capability maturity from all perspectives. Disciplines that should ideally be canvassed include: organisational management, project management; commercial; technical (engineering disciplines), finance, and representatives of the cost engineering function itself.

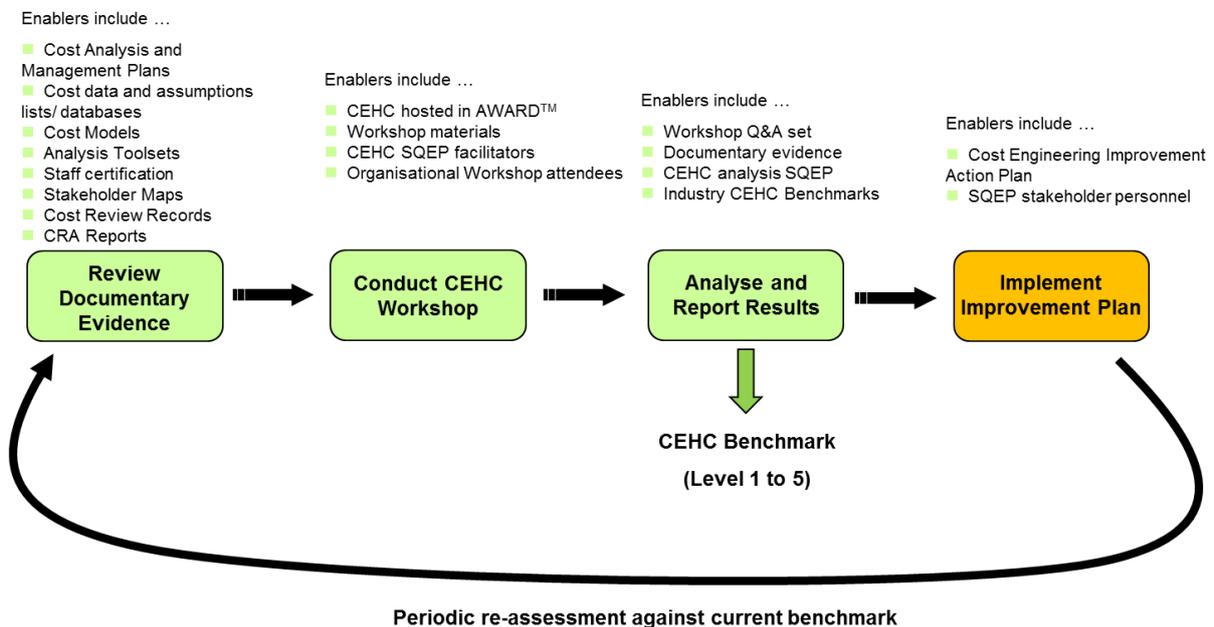


Figure 5 – Typical CEHC Process

An effective way of capturing the views of these various functions is through electronic voting (e-voting) within a workshop setting. E-voting is a well-established method of Group Decision Support. The technique is used in the Operational Analysis (OA) domain for the elicitation of opinion and has been adapted for the CEHC. Representatives from each of the various different organisational

functions are invited to a workshop where they use a small hand-set, similar in size to a mobile phone, to register their views in response to the capability questions posed by a QinetiQ facilitator.

The workshops proceed using a Delphi technique:

1. A costing capability question/indicator is posed to the workshop;
2. The workshop participants are given an opportunity to think! They consider the question/indicator and context;
3. Participants express their understanding of their organisations capability with respect to the question/indicator;
4. The workshop leader facilitates a discussion based upon the live voting results that are presented. Salient points are recorded for analysis and reporting. There is a record of the consensus view;
5. If necessary, there is a re-vote and a record the subsequent consensus view

The expressed views are captured anonymously, but participants can register the handset if they wish to have a record of their personal voting. The primary interest is the reasoning underpinning the view; not the view itself. An experienced facilitator controls the pace of the workshop and acts to stimulate discussion. The e-voting approach provides a mechanism to consider arguments before recording a consensus capability assessment. The views of the stakeholders are then compared against the earlier evidence based assessment and the results moderated to arrive at a resultant capability measure.

Experience suggests that limiting discussion before voting to points of clarification streamlines the process. The facilitator ensures that participants fully understand the questions and supporting narrative prior to them expressing their view. The facilitator will support an understanding of how the question and context relate to the organisation. Divergence in votes thus provides additional insights into the issue under discussion, rather than resulting from uncertainty regarding the process. Our experience has shown that providing adequate definitions and scope at the beginning of the workshop, and throughout it is essential to ensure its success. The participants need to have the workshop placed in context for them, particularly:

- ‘Owning Organisation’ - Who are you conducting the CEHC for?
- ‘The Project’ - Is there a project or programme focus?
- ‘End Users’, ‘External Customers’ or ‘Lead Customer’ - Is there an ultimate customer organisation for this project or programme?
- ‘Main Estimators’, ‘Cost Analysts’ or ‘Cost Forecasters’ - Who is the provider of these cost forecasts or estimates?
- ‘Stakeholders’ - Which are the public and private organisations involved?
- ‘Senior Management’ - Who is the named internal customer receiving this financial information?

Through analysis of the data gathered during the workshop weaknesses in an organisation’s cost engineering capability are identified and suggestions made as to how the capability can be improved upon. QinetiQ work with clients to prioritise those actions that will have greatest impact on improving their costing capability and which are easy and quick to implement.

## 6 A typical CEHC Organisational Output

The cost engineering maturity assessment that results from this activity provide an objective assessment against both best practice and industry standards. In the workshops each of the CEHC capability areas are assessed to determine the maturity of the organisation. The assessments are broadly ranked into five categories as listed in Figure 6.

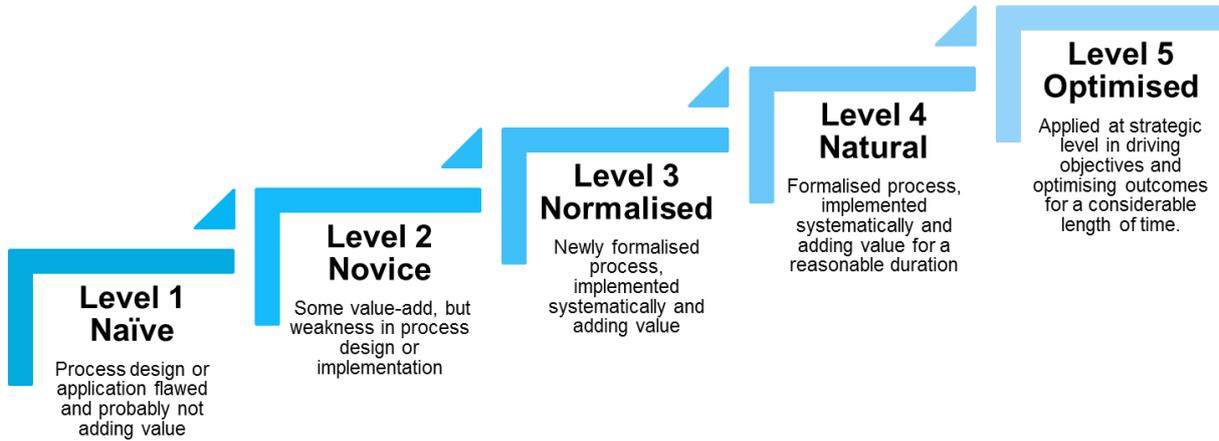


Figure 6 – CEHC Maturity Levels

When the CEHC assessments for each KBE building block are compared to each other, such as in Figure 7, it is easy to establish the categories that are lagging in terms of maturity. In this example, it would suggest that Data and Stakeholders are areas of weakness that should be examined in more depth, whilst People, Process and Culture, are relatively of less concern.

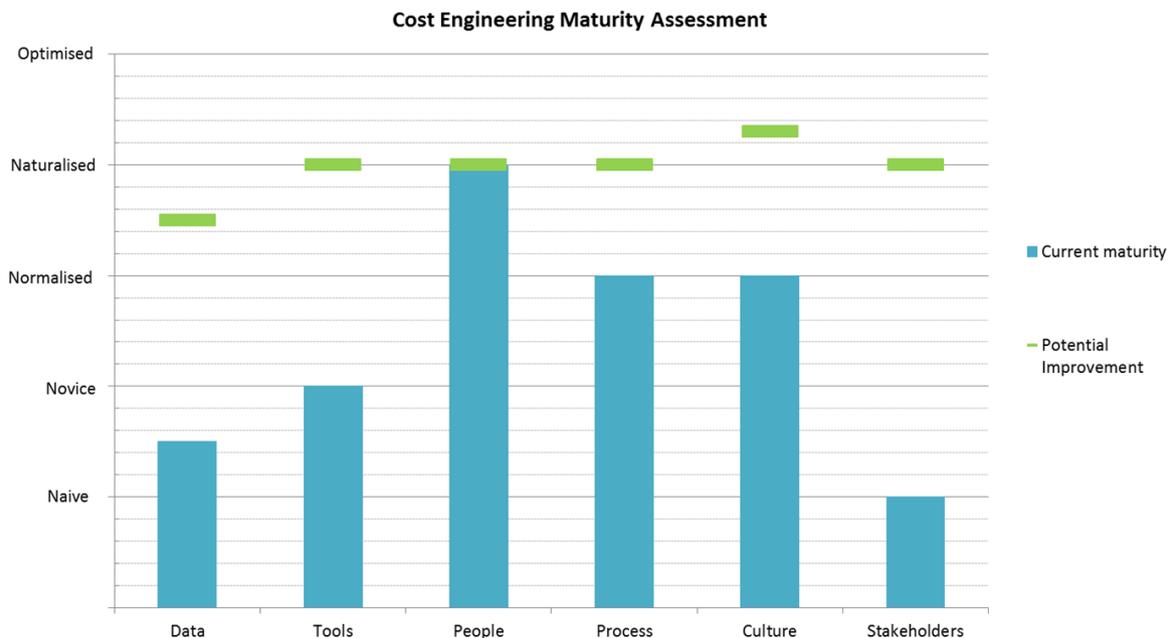


Figure 7 – CEHC assessment and identification of areas of weakness

QinetiQ has conducted a number of CEHC sessions which enables them to place a organisation’s capability assessment relative to its industry peers. The approach then also assists in the identification of the actions an organisation needs to take to improve its capability, either to align

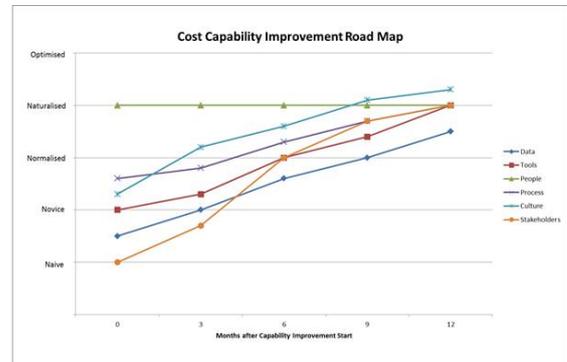
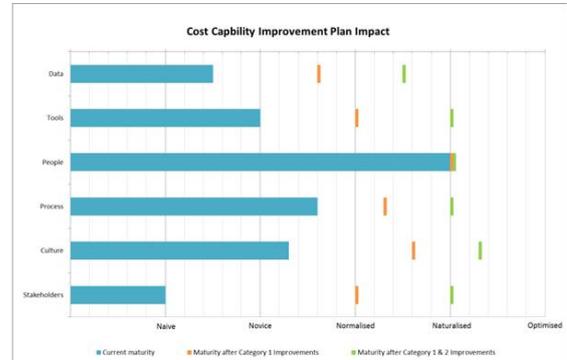
with best practice or the industry standard. On Figure 7 the green lines represent the capability an organisation could attain in each of the KBE building blocks should it put the identified improvement measures in place.

**Category 1 Recommendations** - these will act to support a Cost Engineering Capability that's enables the development and generation of credible estimates

| ID   | Recommendation   | Difficulty to Implement | Impact on Capability |
|------|--|-------------------------|----------------------|
| R1.2 | Provide staff access and training to commercial parametric models  | Medium                  | High                 |
| R1.2 | The organisation should mandate a consistent approach for including of cost and schedule risk within their cost estimates                          | Easy                    | High                 |
| R4.3 | The organisation should develop a data dictionary for use in archiving historic costs and technical information                                    | Easy                    | High                 |
| R3.1 | The organisation should recommend an authoritative source for escalation rates (or develop their own authoritative source).                        | Easy                    | High                 |
| R1.4 | The organisation should create an independent cost model verification and validation cell for the review of all costs being provided to management | Medium                  | High                 |

**Category 2 Recommendations** - these will act to support a Cost Engineering Capability that enables the development and generation of credible estimates, has the confidence of management and wider stakeholders and is posed to avail of best in class engineering approaches and new evolving principles.

| ID   | Recommendation  | Difficulty to Implement | Impact on Capability |
|------|---|-------------------------|----------------------|
| R3.2 | Expose key customer to cost approach and methodologies  | Medium                  | Medium               |
| R1.6 | Encourage staff to participate in professional costing organisations conferences and international conferences  | Medium                  | Medium               |
| R2.3 | Ensure interfaces between the organisational cost analysis process and other analysis process are clear and sufficient for the transfer of information                                  | Easy                    | High                 |
| R1.1 | Stakeholders should be engaged to understand to fully understand the types of decisions that they are using cost information to inform, and costing outputs should be aligned to these. | Easy                    | High                 |



**Figure 8 – Example Capability Improvement Actions, their prioritisation and a roadmap for implementation**

Figure 8 identifies how the actions can be prioritised, and how a roadmap for capability improvement is identified and used to benchmark and monitor the success of the capability development activity.

## 7 Comparing ICEAA with Europe

QinetiQ was given the opportunity to conduct a CEHC-Lite assessment at the ICEAA 2014 workshop in Denver. This involved putting to the ICEAA audience nine of the sixty CEHC questions/capability indicators and capturing the views of the audience via electronic voting. The results were compared against the database of previous CEHC assessments, all of which were undertaken in Europe. Comparison of the results consequently gave:

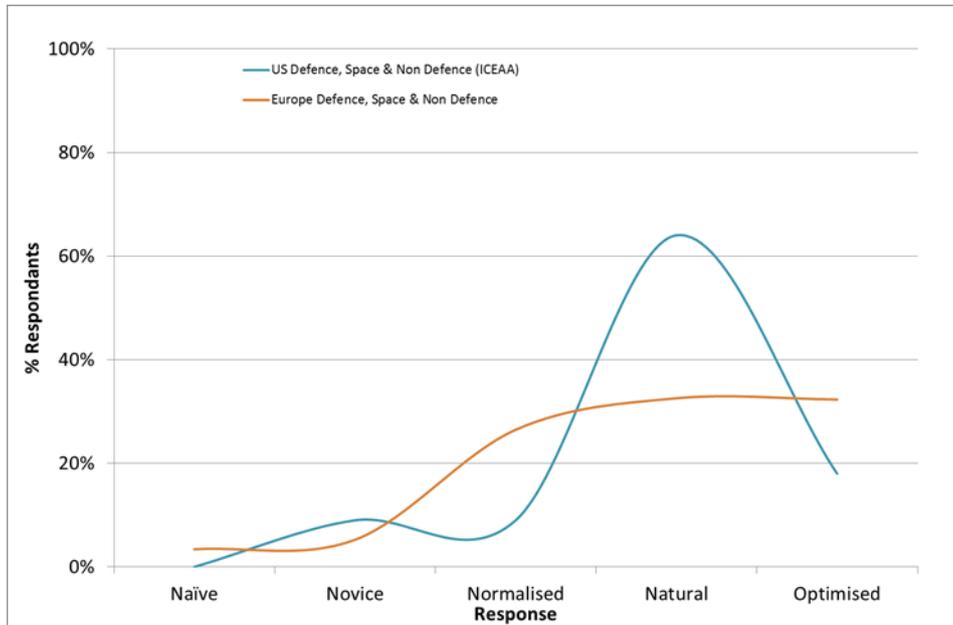
- a view on how individual attendees views at ICEAA compared with that of their European colleagues, and,
- how the average ICEAA score for each indicator compared against the average organisational score within the database of European organisations.

All results were anonymous. The following analysis provides a summary of the responses to three of the indicators considered, and enables some conclusions to be drawn concerning the comparative strengths/weaknesses of the US and European costing communities.

## 7.1 ICEAA Individual Perspectives (compared with Europe)

### 7.1.1 Management Engagement in Cost Engineering

With respect to management engagement in cost engineering, a greater percentage of ICEAA attendees report a higher level of engagement than their European colleagues. 82% of the ICEAA attendees considered the level of management engagement to be ‘Natural’ or ‘Optimised’ as compared with 65% of their European Colleagues (Figure 9).



**Figure 9 – Comparing ICEAA against Europe responses – Management Engagement in Cost Engineering**

Discussion by the ICEAA attendees highlighted that the ICEAA responses were primarily reflective of the level of management engagement displayed by government defence bodies like the DoD. They discussed their expectation that had there been greater industry representation (rather than government) that the responses would likely have been lower and more aligned to that of their European colleagues. None the less the clear recommendation in this instance is that European managers should be looking to their US counterparts for an example on how best to engage with the cost engineering process, and how to provide their estimators with greater direction on how they want their estimates conducted.

### 7.1.2 Storage of Technical Data for Cost Estimating Purposes

ICEAA attendees again presented a more mature picture than their European colleagues with respect to the storage of technical data for cost estimating purposes. 37% of respondents rated their organisations as ‘Natural’ or ‘Optimised’, whilst for Europe it was just 9% (Figure 10).

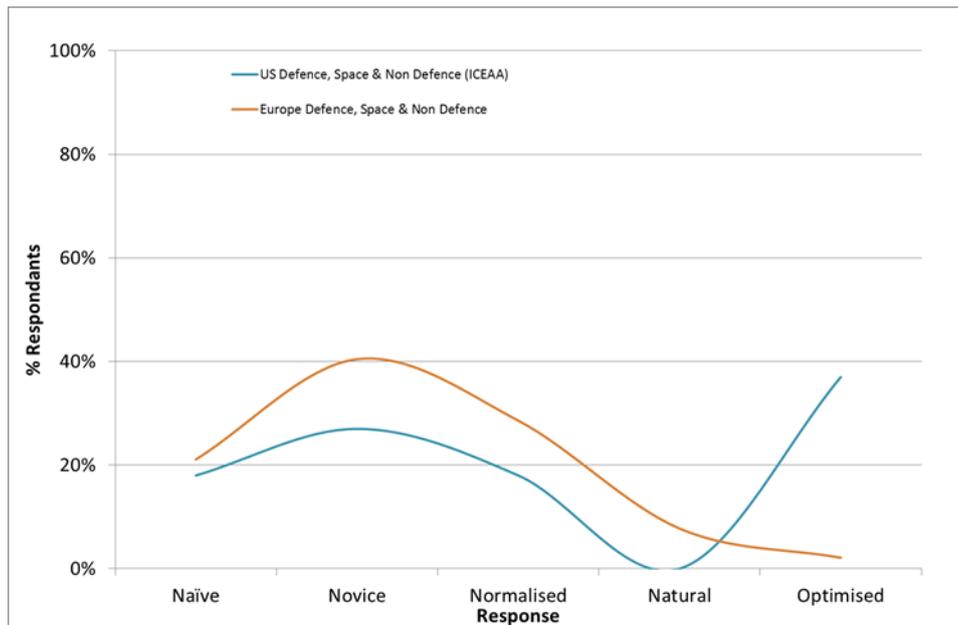


Figure 10 – Comparing ICEAA against Europe responses - Storage of Technical Data for Cost Estimating Purposes

Most ICEAA respondents thought that technical data was widely available via corporate systems but that it would require some ‘leg work’ to secure the right type of technical data for use in estimating. Concern was expressed with respect to the rigour around the technical specifications taken from such data sources. Within the DoD discussion was had concerning the equipment type and the type of typical contract arrangements that would make it easier/more difficult to get access to the required technical data; for example with regards naval systems such as ships, the DoD pays for data rights as they have responsibility for ships maintenance; the same access to data may not be available within the air domain, where maintenance is typically outsourced. These results and highlighted concerns indicate that both European and US organisations need to do more to provide estimators with the ‘raw materials’ to create credible estimates.

### 7.1.3 Storage of Cost Data for Cost Estimating Purposes

50% of ICEAA respondents thought that their organisations were gathering data for the purposes of cost estimating in a ‘Natural’ or ‘Optimised’ manner compared with 23% of European respondents (Figure 11).

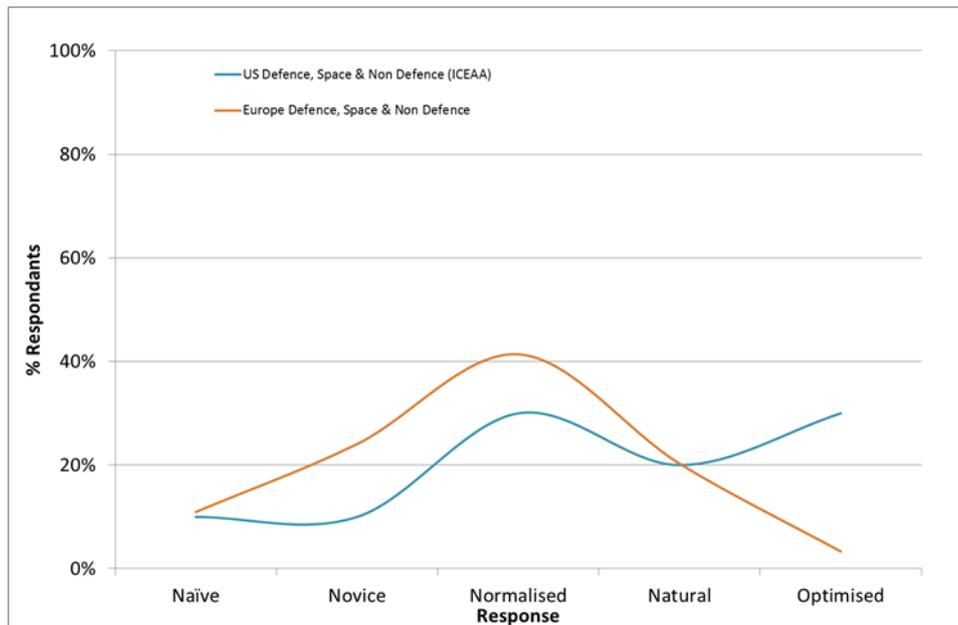


Figure 11 – Comparing ICEAA against Europe responses - Storage of Cost Data for Cost Estimating Purposes

Respondents discussed why this might be the case and they cited the requirement imposed by NASA and DoD to capture this cost information. The question was raised as to how useful the stored data has proved. Discussion was had concerning the ability of the DoD to get the right type of data, with respondents agreeing that whilst the DoD stores cost data it typically isn't of the right format to aid future estimating. It was felt that this contributed to the slight 'double peak' within the spread of responses. Respondents also agreed that the ICEAA assessment would have been more aligned to that of Europe if the study had been run 10 years ago, the difference in this instance being the initiative taken by NASA that has seen greater focus on the storage of data. Evidently this output indicates that European organisations need to do more to recognise the importance of providing estimators with historic cost data to enable them to create credible estimates. European organisations in this instance can also look to the some of the recent US initiatives put in place to better capture cost data and attempt to learn lessons from these.

#### 7.1.4 Software cost estimating tools

ICEAA members report greater level of uptake in software cost estimating tools than their European colleagues with 73% of attendees rating their organisations as 'Natural' or better, as compared with only 33% of their European colleagues (Figure 12).

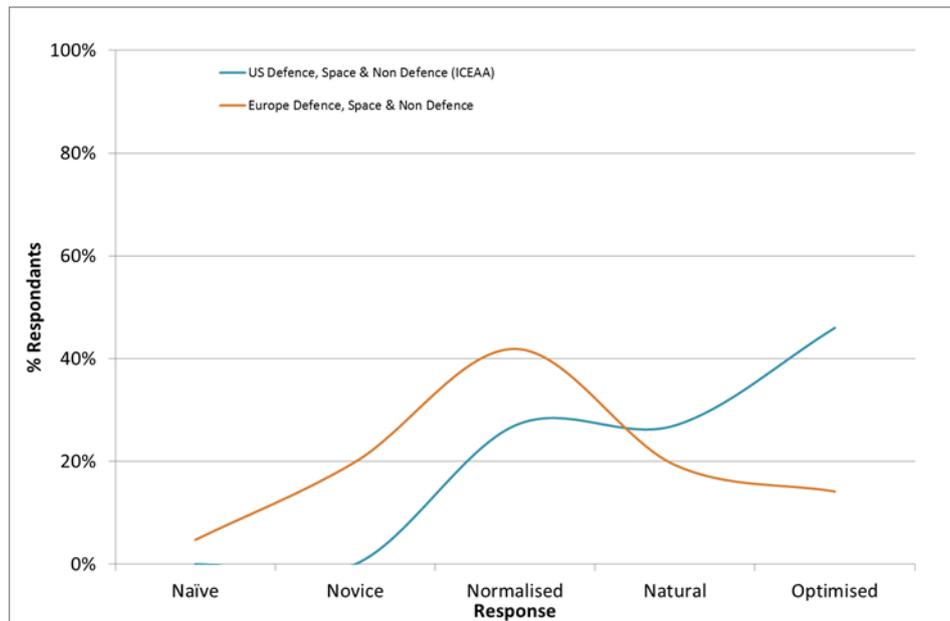


Figure 12 – Comparing ICEAA against Europe responses – use of software cost estimating tools

When conducting the CEHC assessments within Europe there was a definite ‘fear’ of software costing. The fact that software is not something tangible that can be seen or touched makes it appear significantly more difficult to estimate. ICEAA attendees discussed the investment organisations within the US had made with respect to software estimating, but also the failures of organisations to fully appreciate that software is expensive and inherently risky, and that software development and procurement budgets should be set with this in mind. Software within the Space environment was discussed and here it was highlighted that when compared with space hardware software can be considered less critical in space systems as it is easier to modify post launch. The resulting take away message from these results is that both US and European organisations need to be more attuned to how expensive software development and procurement is, and also that European organisations need to place greater emphasis on software cost tools and investment accordingly, thus providing their estimators with the necessary tools to do their jobs.

## 7.2 ICEAA Average Score (compared with Average European Organisational Scores)

Figure 13 presents the average ICEAA response for each indicator compared against the range of average European organisational assessments. Care has to be had with interpretation of the results as ICEAA members represent a multitude of different organisations. Notwithstanding this, the analysis does in general allow a comparison, albeit crude, between US costing capability as represented by ICEAA members, and European capability, as represented by those organisations currently within the CEHC database.

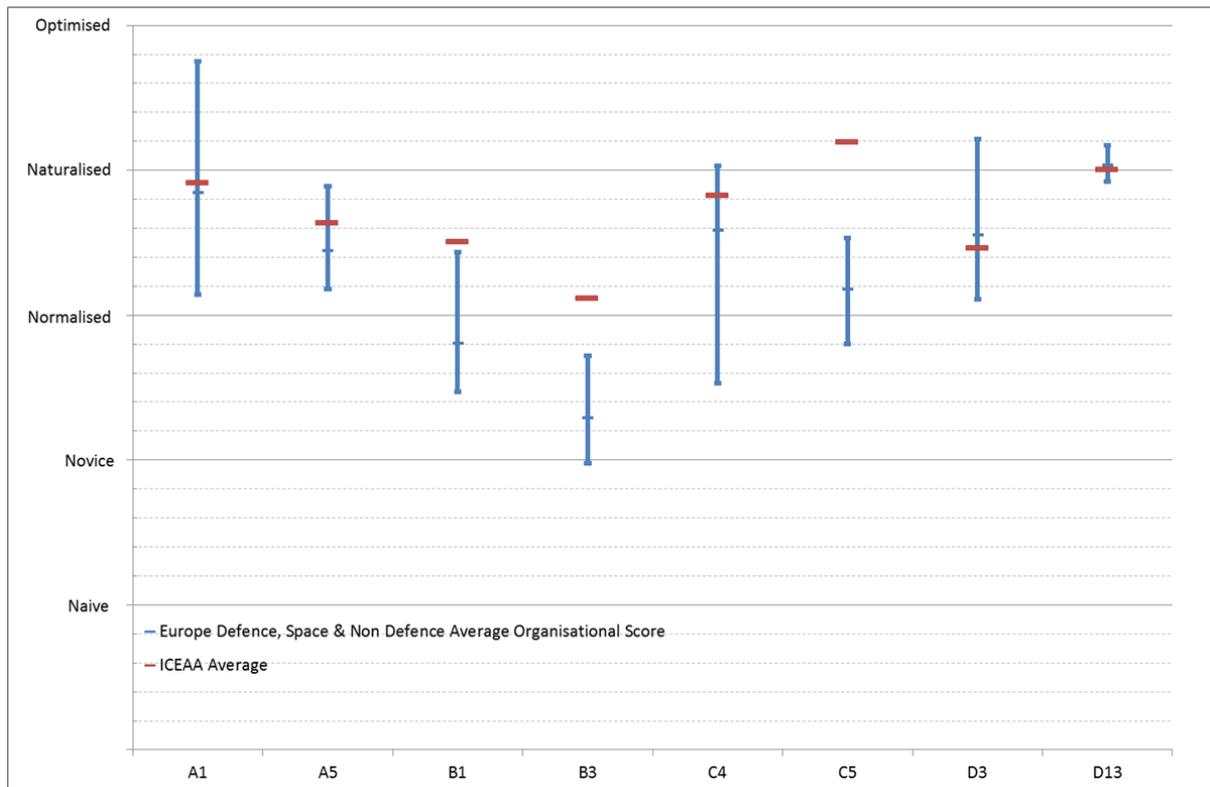


Figure 13 – Average ICEAA score plotted against the range of average European organisational scores

Figure 13 indicates that in five of the eight capability indicators the US (as represented by ICEAA), sits within the range of European organisational averages. In the other three instances the US reported greater average levels of maturity than even the most mature European organisation. These three were for the following areas of costing capability:

- Gathering & storing historic cost data
- Gathering & storing historic technical data
- Application of software estimating

These are the areas that Europe should be looking to the US in order to understand the ways in which it can improve its estimating capability. Perhaps at ICEAA 2016, which is scheduled to be in the UK, these are areas that US ICEAA members could choose to present upon and share some of their knowledge and lessons learnt with their European colleagues!

## 8 Conclusion

This analysis considered only a sub-set of the CEHC costing capability framework and as such only provides a narrow commentary on specific aspects of the capability of the European and US costing community. To gain a fully representative insight a more thorough and structured assessment encompassing all the CEHC capability indicators would need to be undertaken.

Notwithstanding this, the potential value of the CEHC as a costing capability benchmarking tool has been highlighted, and in conducting this very brief study the CEHC has provided insights into the relative strengths/weaknesses of the US and European cost community capabilities. Additionally the

CEHC has enabled the identification of opportunities for future knowledge sharing between the US and European costing communities.

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