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## CHAIRMAN'S ADDRESS



Happy New Year and welcome to our first newsletter in 2015. I trust you enjoyed the festive season; yep, the holiday did go fast didn't it!

Well like you the SCAF committee has started back at work. On the 6<sup>th</sup> January we had our first meeting and continued to plan the SCAF year. My first duty was to update the committee with progress on the memorandum of understanding (MOU) with the Association of Cost Engineers (ACostE). You will recall that we recently signed a MOU with the International Cost Estimating and Analysis Association (ICEAA). Well as you can see from the picture this has now been followed by signing the same MOU with the ACostE. Why? Because we wish to provide more value for our members.

The goals of the cooperation between SCAF and ACostE / ICEAA are:

1. To share, to elaborate, and to develop analysis methodologies in the area of cost engineering.
2. To facilitate professional networking opportunities between SCAF and ACostE / ICEAA memberships.
3. To promote and to develop educational programs in the area of cost engineering.

The MOU will be reviewed by all parties each year. We believe that it will bring network meetings, seminars, educational programs, and other relevant activities to the attention of SCAF members.

To this end, once a year SCAF and ACostE / ICEAA will jointly organise a seminar on a theme of mutual interest. We are looking forward to working with both the ACostE and ICEAA.

Over the Christmas holiday I started the SCAF awards assessment. The SCAF committee will be reviewing the newsletter articles and presentations for last previous year and judging them against our SCAF award to be presented in July. Don't forget to send Arthur your newsletter articles and Neil your presentation ideas. Who knows you could be receiving an award?

We look forward to seeing you all at the SCAF events throughout 2015. Have a successful and prosperous New Year.

Pictured below with Dale is Alan Barltrop, President of the Association of Cost Engineers.



*Dale Sherman* SCAF Chairman

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## Next SCAF Workshop

### “Cost Analysis and the Strategic Defence and Security Review”

Tuesday 3<sup>rd</sup> February 2015

The Royal Institution of Naval Architects, London

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The Comprehensive Spending Review of 2010 was described as the biggest budget cuts since World War 2. The review proposed an £81 Billion cut in public spending in the remaining 4 years of the parliament with an average departmental cut of 19%. The MoD faced expenditure cuts of around 8%. Given the magnitude of the budget crisis facing the MoD one of the underlying goals of the Strategic Defence and Security Review (SDSR) was to drive cost down without compromising capability. However, because of persistent failure to accurately predict costs, senior decision-makers in government have taken a more acute look at affordability as part of the MoD’s attempts to streamline procurement and support processes. The next SDSR will potentially be held in 2015. With unfinished business from its 2010 predecessor the 2015 review is likely to be contentious. As we prepare to support activities that will form part of the review we can only surmise on the potential changes that it will bring. Our speakers include:

- **Andrew Barnard**, Defence Economics – *“The Economic Case for Defence”*
- **Arthur Griffiths**, Past Chairman, SCAF – *“Economics, Cash Profiling and Financial Balance – are we expecting too much for Defence in 2015”*
- **George Crockford** and **Mathew Hemsley**, National Audit Office – *“In Defence of Forecasting and Forecasting in Defence”*
- **Bob Mills**, Jaguar Land Rover – *“Parametric Thinking”*
- **Charlotte Watson**, Arke Ltd – *“Quantifying the Costable and Non-Costable Impact of Programme Changes to Defence”*
- **Andy Nicholls**, PRICE Systems – *Cost Modelling Considerations when dealing with creation or alterations to Force Structures”*
- **Plenary Session**

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### Registration and Costs

Registration and coffee will be available from 09.15. The Workshop will commence at 10.00. The costs for the workshop is £80.00 per delegate. A 10% discount is available for group booking of 5 or more delegates and a 15% discount is available for group bookings of 10 or more delegates. These costs include all refreshments, a buffet lunch and **FREE** attendance to all future SCAF organised events until August 2015.

Further details can be found on the SCAF website ([www.scaf.org.uk](http://www.scaf.org.uk)) or by contacting the Secretary, Neil Morrill by email at: [ndmorrill@dstl.gov.uk](mailto:ndmorrill@dstl.gov.uk) or call **030 6770 3450**

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## Letter from the Editor

By Arthur Griffiths, SCAF Newsletter Editor



Well 2015 has certainly started at pace. With many members enjoying a Christmas and New Year break of some two weeks getting back to work became a chore for many. Our first committee meeting of the year was held on the 6<sup>th</sup> January (first week back in work!!) and gave everyone the opportunity to reflect on an excellent 2014 and renewed enthusiasm in planning the 2015 and even some of the 2016 programme.

We are delighted to announce that our 2015 Annual Conference in September will be held at the Queen Elizabeth II Conference Centre in London and that all the other venues around the country have now been confirmed. The exception being the Summer Reception and Awards Banquet where the venue is still to be agreed.

Our thanks to all the speakers and organisers for your support in 2014 and would like to take this opportunity to wish all members the very best for 2015.

Our first workshop of the year will be held at RINA, London and the issue of economics, budgeting and forecasting could not be more topical. The General Election is on May 7<sup>th</sup> and, no doubt, will be closely followed with a Spending Review and Departmental planning to align anticipated programmes with the funding available. I am sure that the workshop held in November 2014 and the one in February 2015 will be of great benefit to members who will be involved in the related supporting studies.

### Where are we competition?



It looked like everyone had fallen asleep at this one. My congratulations to **John Yeaman**, BMT Hi-Q Sigma and **Tim Brogan**, Jaguar Land Rover who correctly identified the picture as the Eastgate Clock at Chester. The clock stands on the site of the original entrance to the Roman fortress of *Deva Victrix*. It is a prominent landmark in the city of Chester and is said to be the most photographed clock in England after Big Ben.

This month's front cover photograph is of a well-known village where goods are still transported on sled's and traffic is thankfully non-existent but where are we?

Please forward your answers to [editor@scaf.org.uk](mailto:editor@scaf.org.uk). All the correct answers will be put in a barrel and the winner will be published in the next newsletter and provided with a small prize.

## Bridging the gap between Chaotic and Controlled software project estimating

Charles Symons, Co-founder and Past President, COSMIC (the Common Software Measurement International Consortium)

It appears at first sight that there are two worlds for software project estimating which, for simplicity, I will call the 'Chaotic' and the 'Controlled' worlds. The Chaotic world is characterised by the majority of organisations whose projects frequently over-run on time and budget, or that fail completely. The Controlled world has a very much smaller population of exemplar organisations whose projects are claimed to be delivered to time and budget routinely. The interesting question is why organisations in the Chaotic world do not or cannot simply learn and copy the behaviour of those in the Controlled world and save themselves a lot of money.

This article explores the two worlds and aims to explain the differences which are partly intrinsic and to a degree unavoidable, and partly due to a mixture of cultural, process and technical factors, several of which can be overcome with enough effort and perseverance.

First, the evidence for the two worlds.

### 1. The Chaotic world

There have been several surveys, e.g. [1], [2], [3], covering the outcome of thousands of software projects<sup>1</sup>, mainly in the US and the UK and mainly of projects from the domain of business application software, in the public or private sectors. The results vary but indicate that between 10% - 30% of software projects fail completely, i.e. they are stopped before delivering anything useful. Another roughly 50% overrun on time and/or budget by at least 10%. This leaves only 20% - 40% of projects delivered on time and budget. However, these figures do not reflect the fact that many projects deliver less functionality or business value than was originally planned. Further, an unknown proportion of those projects that finished 'on time and budget' may well have been over-estimated in the first place so could have been delivered faster and at less cost. Abdel-Hamid observed [4] that Parkinson's Law applies to software projects just like any other activity, i.e. work expands to fill the time made available for its completion.

The cost of these over-runs and failures is enormous. A well-documented analysis [5] of 105 contracted software projects completed over the ten years up to 2007 between UK public sector customers and external suppliers had a total value £29.5 Billion. Of these, 30% were terminated, 57% experienced cost overruns averaging 30.5% (totalling £9 Billion of overruns), whilst 33% suffered major delays. An important point to note is that all these projects were undertaken by external suppliers that operate world-wide and would

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<sup>1</sup> Strictly-speaking we should refer to 'software-intensive system projects', since for many such projects the delivery of the software is only part of a project that must deliver a hardware/software system and often organisational change as well. I use 'software projects' for simplicity.

claim in their marketing to be 'world-class'. Further, the suppliers' profit margin on the contracts was almost always over 10%, ranging up to 25%.

The same reasons for these failures and over-runs are cited repeatedly, going back at least 30 years [6]. They fall into two main groups.

- Lack of senior management commitment and user involvement, resulting in unclear objectives, which leads on to stakeholder conflicts, and unclear and shifting requirements;
- Poor project management (e.g. in the management of progress and changes), staff inexperience, especially when new technology is involved, and staff turnover.

Whilst the *cost* of the failures and over-runs may be heavily weighted by write-offs on hardware, the cost of employing extra staff, lost benefits, etc., the *causes* are almost invariably due to problems with specifying and developing the software.

In all the various analyses of why software projects fail or over-run, it is uncommon to see 'poor estimating' listed as one of the causes. This is not surprising for the projects that fail. A poor estimate seems an unlikely cause of abandoning a project. More likely it was stopped because priorities changed since it started and it will no longer deliver anything useful, or it has gone on for so long beyond the original budget that management decides to cut its losses. But if, say, 57% of all software projects over-run by on average over 30%, one must ask 'is there something systematically wrong with the estimating process in these environments?'

## 2. The Controlled world

From time to time we get glimpses of this other world when an organization publishes results showing its successes in software project estimation. The exemplar I will use is Renault, the French vehicle manufacturer, which has published its progress in successful software project estimating, most recently in 2014 [7].

A modern average family car has roughly 50 Electronic Control Units (ECU's), small processors that form a distributed network to monitor and/or control almost every function, e.g. engine, lights, air-conditioning, tyre pressures, navigation, driver information, etc. The ECU's and their embedded software are mostly bought from component suppliers with their associated sensors, subject to specifications issued by Renault.

Renault has been collecting data on the costs and performance of its suppliers of ECU software for a few years. The process by which it contracts to procure ECU's is briefly:

- Renault software departments, specialized by vehicle functional area (e.g. powertrain), develop specifications for new or enhanced ECU software and store these in the Matlab Simulink tool;
- A Renault-developed tool then automatically computes a functional size of each specification (or the increase in size if an enhancement) using the ISO standard 'COSMIC' method [9];
- Past measurements and statistically-established relationships are used to predict the effort that the supplier will need to develop the software (see Fig. 1) and its memory size (Fig. 2);
- This information is used by the Purchasing Department to negotiate the price for the ECU. Further, the information available to Renault is now sufficiently well-established that it can be used to negotiate annual price changes in the same way that car manufacturers periodically negotiate prices of other materials such as steel, paints etc., and other components. (Fig. 3);
- COSMIC functional sizes are also used to monitor the performance of the internal software department, since Renault has established a specification-size/staff-level relationship for their work.

Renault states that at the end of a new software development, the difference between the initially estimated effort from the established correlation and the actual value 'has to be lower than 5%' (see Fig. 4).

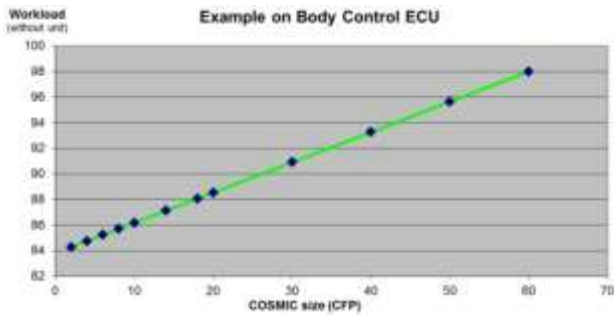


Fig. 1 Effort vs COSMIC size for an ECU software

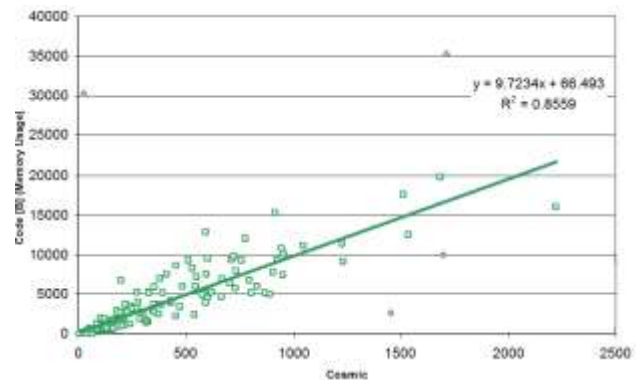


Fig. 2 Memory usage vs COSMIC size



Fig. 3 Purchase Department negotiation

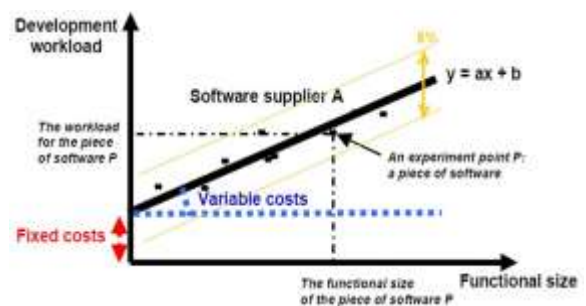


Fig. 4 Control of precision of cost estimates

### 3. Differences between the Chaotic and Controlled worlds of software project estimating

In the following, since whole-life project estimates are required whatever the project management approach, I will use a waterfall model of project phases for convenience. Differences when using an iterative or agile model will be mentioned as they arise. We must also assume that in the comparisons of the Chaotic and Controlled worlds, the organizations in both worlds have reasonably repeatable processes and use technology with which they are reasonably familiar, i.e. we will ignore environments where process immaturity and the risks associated with using new technology leave little chance of developing any accurate estimating methods.

**Different conditions for the estimating.** In one sense, it is unfair to draw any comparison between the two worlds as there are a few intrinsic differences between them.

The first and most obvious difference is that in the Chaotic world, a whole-life cost estimate is usually needed for a business application project early in its life, before the requirements are known in detail, in order to inform the cost/benefit analysis for the software.

In contrast, estimates-to-complete projects in the Controlled world of Renault are not made until the software design is completely specified, i.e. they are not really whole-life estimates. By this stage, estimates can also be made at a low level of decomposition (Simulink blocks in Renault's case) before aggregating to the cost of the whole ECU.

Clearly one would expect the Renault estimates to be much more accurate than those made in the early stages of a typical business application project. Having said that, it is then legitimate to ask why estimates made so early in a project's life, when there is still so much uncertainty, become accepted as fixed such that overruns are frequently experienced. Further, on-going maintenance and support costs that contribute to the business case often turn out to be much higher than forecast at this early stage.

**Cultural differences.** A study of estimating practices by Jorgensen [9] tells us much about the culture of the Chaotic world. His research found that 'expert estimation' is the dominant strategy for estimating whole-life development project effort. He defined expert estimation as 'work conducted by a person recognized as an expert on the task, and that a significant part of the estimation process is based on a non-explicit and non-recoverable reasoning process, i.e. 'intuition''. Although this research was published in 2004, Jorgensen recently told me that he knew of no published data that altered this view that expert estimation still dominates project effort estimation.

In contrast, my informal observation is that the organizations in the Controlled world that publish data indicating high accuracy for project estimates are mostly hi-tech manufacturing companies, often producing safety-critical or mission-critical software. These projects require great attention to quality, so they start with the benefit of a 'real' engineering mentality, relying on data rather than just judgement.

These cultural differences affect the accuracy of project estimating. Daniel Kahneman, a psychologist who won the 2002 Nobel Prize for economics describes [10] two ways of human thinking, intuitive and rational. Most of the time we think intuitively; it requires real discipline to think in the rational mode. His most important finding relevant to estimating is that intuitive thinking is almost always optimistic and tends to ignore statistics and past experience (e.g. believing 'this time we'll get it right'). He recommends that final predictive decisions should be left to formulae, and preferably simple ones with few variables.

Applying this recommendation to a project cost estimate based on intuitive thinking, e.g. by analogy, suggests that if the environment has the track record cited above for UK public sector projects, then the business case should consider the 30% risk of total failure, and any intuitive cost estimate should be automatically increased by 15% - 20% with a corresponding increase in the uncertainty.

Kahneman has other recommendations that are significant for estimating when hard data are lacking, e.g. the use of processes such as wideband Delphi (or 'Planning Poker' in the agile world), rather than relying on an individual's expertise.

**Understanding the roles of the various players involved in estimating.** The responsibility of an estimator is to produce a project effort figure based on the best available data, with an appropriate statement of the range of uncertainty of the estimate. That's all.

It is the manager's job to understand the estimator's assumptions, assess the risk and uncertainty, and ultimately to decide on the project budget. If the manager's mentality is to rely on the estimator and to



ignore risk (e.g. with the attitude of Dilbert's manager of 'just give me a number') the project is doomed to miss its budget.

Further, when a customer issues an ITT to procure software from an external supplier, the customer must understand other factors that affect how a supplier arrives at his estimates and bid prices.

Suppliers of outsourced software systems depend on reliable estimating for their survival – and we noted above that they normally have a good track record on profitability. They therefore normally take very seriously the collection of software metrics and their use for estimating, far more so than does a typical in-house IT department or a customer's retained IT function that manages its outsourced IT suppliers.

In a supplier, the cost estimate based on the requirements information contained in the customer's ITT is converted by its sales team into a price-to-win. In this process, they will take into account many obvious factors such as the anticipated customer's budget, the probable competition, future cash-flow, desired profitability, etc.

Two other less-appreciated but important factors are also considered. First, as the project progresses, the customer will inevitably think of new or changed requirements which can be charged extra beyond the bid price. Second, the winner of the initial development project is best placed to win the on-going maintenance and support work over the life of the system. Both these additional and on-going activities can be much more profitable than the initial development work. Consequently, a supplier may bid low for the initial development to ensure a win.

Unfortunately, when the first big wave of UK public sector IT outsourcing started over twenty years ago, most of the experience of software metrics and estimating was outsourced to the suppliers under long-term contracts. This has led to severe 'information asymmetry' between customers and their suppliers and is almost certainly a major cause of the high level of budget over-runs of UK public sector IT projects.

For a car manufacturer, purchasing is one of its most important functions. In the case of UK public sector IT procurement, effectively the gamekeeper handed over its metrics expertise to the poachers.

Another cause of project over-runs can arise in the way contingency reserves are managed. These should be held by a manager at the project portfolio level and released to project managers as needed, rather than being allocated to individual projects at their outset. First, knowledge of the contingency included in an estimate gives comfort to the project manager and Parkinson's Law ensures it will be used. The same goes for an outsourced relationship, where Kahneman quotes 'a budget reserve is to contractors like red meat to lions; they devour it' [10].

**Estimating techniques.** Much software project estimating in the Controlled world, as exemplified by Renault, attempts to answer the dominant cost-driven question of 'how big is it?' by making experience-based estimates of counts of source lines of code (SLOC). The well-known COCOMO II estimating method and most of the commercially-available estimating tools have been calibrated using SLOC sizes as input. In spite of the many, oft-publicized disadvantages of SLOC sizes, estimation accuracy based on expert judgement from detailed designs is typically claimed to be accurate to within 10% at the component level.

In the Chaotic world, if more than intuition or expert judgement is needed for estimates when only outline requirements exist, it is most common to first estimate the size of the requirements using Function Point Analysis (FPA). Size is then converted to effort using productivity benchmarks derived from previous similar projects. Albrecht's original FPA idea in the late 1970's of proposing a measure of the size of a software system based on its functional requirements was a brilliant piece of lateral thinking. But this method, now developed and supported by the IFPUG organization, is showing its age.

The COSMIC method [8] used by Renault was designed by an international group of software metrics experts to be applicable to business, real-time and infrastructure software, based on fundamental software engineering principles [11]. Variations of the method to produce approximate sizes are available to measure requirements before they are known in sufficient detail for a precise measurement, and the method has or is being automated by various means [7], [12], [13]. (Automated measurement is critical for Renault; manual counting would be too slow for their development process.) The method is ideally suited to measuring requirements at any level of aggregation in agile developments, e.g. User Stories. Iterations, releases, etc., and for the components of distributed systems.

An example of a problem that can be avoided by using the COSMIC method arose in a major European pension fund that had used the IFPUG FPA method for sizing as a basis for estimating. The FPA scale offers only a narrow range of sizes for transactions; the COSMIC method measures on a ratio scale with no upper limit. One project was investigated to find out how it had been seriously under-estimated. Some transactions that scored the IFPUG maximum of 6 or 7 FP's were re-measured using the COSMIC method and were found to be over 60 COSMIC FP's. The transactions with size over 40 COSMIC FP's accounted for almost 80% of the budget overrun.

#### **4. What can be done to bridge the estimating gap from the Chaotic to the Controlled world?**

Jorgensen's advice [9] on how to get the best out of expert judgement estimating is strongly recommended and Kahneman's observations on forecasting based on intuitive judgement must be taken into account. But if the Chaotic world is to bridge the gap, it must do more than rely on intuitive estimating. It must collect hard performance data on completed projects and develop simple estimating methods using modern methods of measuring requirements. If buying from an external supplier, customers must learn how suppliers determine their bid prices.

Even with these steps, there remains the intrinsic problem in the Chaotic world that estimates are often required and budgets must be established early in a software systems' life before the requirements are known in detail. At this stage an estimate must inevitably have a very wide range of uncertainty. So what can be done to mitigate the effects of this challenge?

The answer is a process that was developed 15 years ago by the Government of the State of Victoria in Australia but has never been widely applied.

In simplified outline, when a customer issues an ITT with an initial statement of requirements, suppliers are asked to estimate the eventual total size and to bid a fixed price per unit functional size. The total bid price is then the product of these two factors. When a contract is awarded and as the requirements evolve, the unit price remains fixed, but the total price will vary in proportion to the size of the requirements. The actual size is monitored by an independent Scope Manager, a 'quantity surveyor' of software. The customer therefore bears the risk of varying the size of the requirements; the supplier bears the risk of bidding the right unit price based on his knowledge of the customer's needs and of his own capabilities. With this process, the information and risk asymmetries between customer and supplier are vastly reduced.

The Australian process has been refined in Finland where it is known as 'Northern Scope' [14]. It is being applied or trialled in various countries. Proponents of the method claim that cost over-runs can be reduced to within 10%. But the biggest benefits claimed are very substantial reductions in the unit costs of software and of improvements in the speed of delivery of software projects [15]. The ability to measure requirements plays a wider role here than might be imagined, namely as a quality control factor. If requirements are not precise enough that they can be measured, the software certainly cannot be reliably built and tested!

It will be seen that both Renault's process for managing the supply of embedded software for its ECU's and the Northern Scope process rely on software unit pricing as a key feature.

In conclusion, the tools are available for the Chaotic world to largely close the gap with the Controlled world on software project estimating. But there are no silver bullets, no quick and ready answers. An engineering mentality and a readiness to invest in gathering and analysing actual performance data are essential.

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## Affordability, Value for Money and Decision Making

### Joint SCAF and the OR Society (Defence Special Interest Group) Workshop

November 2014, The BAWA Centre, Bristol

Affordability and Value for Money are some of the key elements in today's Decision Making process. Whether we are considering investment in a new capability, transition programme or optimising in-service support services – the issues remain the same.

But do we understand what they mean? How do we do the assessment and evaluation? How do you make an appropriate judgement? What are the key critical components to examine?

This joint workshop was opened by **Arthur Griffiths**, on behalf of SCAF, and **Alan Robinson**, on behalf of the OR Society Defence Special Interest Group (OR DSIG). They noted that although the two groups have common interests, this was the first joint workshop and welcomed feedback on holding more joint events. Arthur facilitated the morning session and Alan the afternoon. Our workshop presenters – from both SCAF and the OR DSIG – provided the audience with a diverse and interesting set of presentations on the topic.

The keynote address was given by **Dr Syd Morley**. Syd heads up a scrutiny team with responsibility for advice to the MoD's Investment Approvals Committee on the cost effectiveness and technical integrity of business case decisions for acquisition of equipment, infrastructure and support services. His presentation was entitled ***"Evidenced based decisions and the Holy Grail !"*** and took the audience through the MoD's approach to the scrutiny of the analytical evidence, stressing that robust analysis has never been more important than in this austere financial climate. He acknowledged the difficulties faced by lack of good historical data and the lack of context for data that does exist, particularly when the case for outsourcing is being considered. However, there are opportunities and challenges with the growth of electronic data capture – sometimes less is more and there is a need to look at the big picture. He illustrated data issues with an amusing tale of how a question to elicit evidence – in this case by a lost balloonist on his whereabouts – had not only a very different answer from an engineer than from a manager, but that he remained lost....

**Dr Dave Exelby**, a Director of Decision Analysis Services Ltd, has been involved in both SCAF and DSIG over the years. He has extensive experience in the application of Systems Thinking approaches and has applied these and other analysis techniques to traditional defence OA as well as cost forecasting challenges. His presentation was entitled ***"Strategic thinking – and the need for decision making tools without the stovepipes"***.

Dave explored the need for strategic decision makers to be able to assess a wide range of potential options against benefits, costs and timeliness from the outset – when precision is usually not the issue, but the ability to compare, debate and evolve these options rapidly is. He presented on the use of novel toolsets that are cross disciplinary in nature – providing "right-sized" models to support the strategic analysis, using three cases to illustrate their application. The first concerned Defence affordability – a very current topic with SDSR and an election in 2015. He explained how this model was used to show the impact of 'what ifs' such as a potentially worsening geopolitical situation in Eastern Europe in the shorter term and of the political appetite for defence spending. His second case focused on capability/affordability trades for the New Zealand Defence Force, where Equity proved to be very useful. His third case explored the 'use case' for

strategic portfolio planning models and concluded that a full toolbag of techniques across decision making was critical to support such models.

The next presentation was entitled *“The use of cost data in support of Whole Force Analysis”* and was given by **Arjun Madahar** of Dstl. Arjun is a Senior Analyst on the Whole Force Analysis project and has worked for Dstl for 6 years, on projects primarily focused on Balance of Investment decisions and using optimisation techniques.

The presentation discussed the uses of a suite of tools that provide differing but complementary insights on the capability, capacity and affordability of proposed Force Structures to meet UK Defence and Security policy and help identify Force Structures that are both affordable and offer value for money. Arjun explained the complex issues that are involved: interlinked capabilities, future predictions of the national security situation and UK industrial sustainment concerns. He went on to outline each of the tools: the Strat Bol Linear Programme, the Concurrency Analysis Tool (CAT), the Force Cost Affordability Simulation Tool (ForCAST) and the Force Structure Cost Model (FSCM). The analysis process is then an iterative process using these tools – colloquially referred to as the ‘wheel of death’ ! Arjun went on to talk about conducting sensitivity cases illustrating with a number of examples.

The morning session was completed by a presentation by **Andy Nicholls** of PRICE Systems. Andy is a Principal Consultant with a long (38 year) career in the UK defence environment, the majority of which has involved cost estimating and forecasting complex projects/ programmes. His presentation was entitled *“Factoring in the ‘Cost’ factors that are least Controllable”*.

Andy’s presentation discussed how cost estimates for Platforms and/ or Systems that often have to cover many years of acquisition and in service life of may be influenced by choice of escalation, currency exchange rates and PPP factors and illustrated it with some examples. In contrast to the presentations on strategic decision making, this presentation was focused on ‘devil in the detail’ issues that could significantly skew analysis results and conclusions if not treated correctly and consistently across the data set. Andy took the audience through normalisation explaining Purchasing Power Parity (PPP), the ‘Law of One Price’, exchange rates and PPP exchange rates, timing implications – using the Big Mac and iPad indices as examples. His key message was that macro factors are often subject to external perturbations that are outside the control of a single Nation or even a group of co-operating nations such as the EEC, and analysts must ensure they apply the correct treatment to ensure consistent normalisation of data.

Before lunch, Arthur announced **The P G Pugh award**. This is SCAF’s most prestigious award and has not been awarded since 2012. In 2014, it was highly competed between a number of very innovative and thought provoking presentations given throughout the year. The winner is **Mark Jones (pictured right)**, an Industrial PhD Research Engineer, who has been working in collaboration with Cranfield University and Airbus, resulting in the development of a manufacturing framework and model for Technology Maturity Cost Benefit Forecasting. Mark has recently joined KPMG Management Consulting and we wish him well in his career.



The afternoon was kicked off with a presentation by **Andy Nolan**, a Lead Consultant at Rolls Royce. Andy joined Rolls-Royce in 1989 as a software engineer and has spent over 20 years managing and improving projects. He is a six sigma Black Belt and has used this to improve and develop Rolls-Royce's estimation capability. His specialism is in process measurement, estimation, risk management, project management and improvement. His presentation was entitled ***"Requirements uncertainty: analysis, defining, measuring, mitigating and optimising"***. Andy gave a lively presentation on how uncertain requirements are until late in a project in the project life, and that anything of any size or complexity will have requirements change but we act as though they should be certain. He challenged the audience by stating that there are no exceptions so if anyone was not uncertain then why not? He presented data on 10 projects showing that the number of requirements that changed after the Critical Design Review, which is quite late in the project ranged from around 25% to nearly 70%. He then described technique requirements uncertainty, scoring the metrics of: impact, volatility, time criticality and precedence – which are then used to derive a maturity index that can be tracked to negotiate, prioritise, plan, estimate, etc. He went on to talk about the use of the information by project managers and the effect of their competence on the return on investment of using the technique.

A presentation entitled ***"Management information toolset to support evidence-based decisions for Defence Evaluation Capabilities"*** was then given by **Steve Rowley** of QinetiQ. Steve is a highly experienced defence acquisition Consultant with an aeronautical engineering background. From a beginning in OA modelling of defence equipment, he is now involved in providing evidence based decision support for many projects across the defence domains and also in non-defence situations and provides supervision and direction for a wide range of qualitative and quantitative operational and business analysis studies conducted within QinetiQ.

Steve's presentation was focused on the need for timely and effective decisions on defence evaluation capabilities, which spends upwards of £1Bn a year on activities and facilities. It described the challenges associated with the development of a simple but powerful toolset to conduct analysis of the evaluation requirements and capabilities in terms of potential gaps and future opportunities. Steve took the audience through the approach to selecting the toolset and the use of data maturity metrics. He stressed that the toolset is designed to directly inform and support the decision maker and increase their confidence and to do so avoids 'black box' logic or mathematics.

**Colin Sandell**, also of QinetiQ, followed with a presentation entitled ***"Economic Value Chains: an innovative approach to analysing the cost impacts of decisions"***. Colin is a senior consultant at QinetiQ and an Operational Analyst with 22 years of experience, initially in government defence organisations and latterly since 2005, QinetiQ. Colin's background is in cost, effectiveness, Balance of Investment and COEIA related studies covering Aircraft, Weapons, Ships, Navigation Systems, Fuel, Logistics, Army recruitment and Cyber security.

Colin presented on a technique that was first proposed in response to a Centre for Defence Enterprise call to calculate the financial consequences of cyber 'events'. He noted that the technique was not specific to cyber or the military, using a hypothetical town being flooded to serve as an example. He followed this example through using influence diagrams – progressively decomposing the costs to relevant relative data input nodes – to create an economic value chain which can then be used to explore and quantify cost-related issues and mitigations. The diagram is transparent and completely defines the model (inputs, calculations, output, comments) and Colin went on to highlight the strengths of the approach as well as practical issues – including the wish for a bigger printer !

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Our final presentation of the workshop was ***“Communicating complex cost estimates to senior policy-makers”***, given by **Lucia Retter and Dan Jenkins** of RAND Europe. Lucia is an Analyst on the Defence and Security team at RAND Europe. Lucia has been at RAND for almost 2 years and has worked on a range of studies for UK and EU clients looking at the European defence market, defence acquisition and cost. Lucia is currently supporting RAND’s review of the cost model used in Denmark’s evaluation process of candidates for its F-16 replacement programme. Dan has been a Research Leader with RAND since May 2013. Dan gained his public policy analysis experience during fourteen years spent in government organisations, with particular operational analysis, performance audit and financial experience in the defence and security sectors, including incentivised and partnered contracting constructs.

Lucia and Dan presented on the rationale for the need of good cost estimates in policy-making; sketching out and comparing the different biases in cost estimation and in policy-making and presenting some good practice guidelines for an effective communication of cost estimates to senior decision-makers. They made the point that senior decision-makers are often prone to falling into a conspiracy of optimism and can be fixated on single point costs – people generally dislike uncertainty and avoid it wherever possible – making misinterpretation through poor presentation or misunderstanding a very real risk with possibly significant consequences. Cost analysts must therefore take great care in presenting their information, including how the data is ‘framed’ (positive or negative). They went on to talk about how policy makers view information and provided tips on how analysts should present the information – particularly on risk and uncertainty.

Our thanks to all the presenters for their excellent and well-presented papers, making this well-attended joint workshop very successful. Copies of all the presentations can be seen on the SCAF website: <http://www.scaf.org.uk>.

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## Historical Trend Analysis: The Need for Informed Inferences

Brian Tanner CEng MIMechE FIMarEST

A Historical Trend Analysis is, by definition, the use of historical data the understanding of which can be limited without knowledge, that is, data, be that written records or the musings of people who knew the equipment projects in their much younger days. One simple example comes from Hansard entries:

### Auxiliary Oiler Replenishment Vessels

*HC Deb 19 January 1995 vol 252 c686W*

§ **Mr. Nicholas Brown:** To ask the Secretary of State for Defence what was the total cost to the Exchequer including subsidy and post-acceptance refit costs, of (a) AOR1 and (b) AOR2.

§ **Mr. Freeman:** The total cost to the end of December 1994 to my Department, including post-acceptance rectification work, is £131.130 million and £159.460 million (actual prices) for AOR 01 and AOR 02 respectively. Final costs for both vessels have still to be agreed. An independent assessment of Harland and Wolff's bid for AOR 01 concluded that the bid contained no element of subsidy. Neither was there any element of subsidy in Swan Hunter's bid for AOR 02. The Northern Ireland Department of Economic Development made payments of £53 million to Harland and Wolff as part of the yard's privatisation. These payments were tied to progress in completing AOR 01.

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*HC Deb 23 May 1995 vol 260 c502W*

§ **Mr. Fatchett:** To ask the Secretary of State for Defence if he is now in a position to announce the agreed final costs for AORO1 and AORO2; and if he will make a statement.

§ **Mr. Freeman:** The total cost to the end of April 1995 to my Department is £154.890 million and £204.701 million, actual prices, for AORO1 and AORO2 respectively. Final costs for both vessels have still to be agreed.

So in the space of four months Parliament is told figures which differ by some 20% and 30% respectively. With some 'insider' knowledge, and as given in the text, the first figures are the price in the fixed price contracts while the second set of costs is most probably the total cost of each contract to the MoD, that is, inclusive of inflation payments.

Such variations, if not understood, can lead to incorrect inferences being drawn.

While searching the internet for some information on the real cost growth of defence equipment, the following report resulted:

**DEFENCE ECONOMIC RESEARCH PAPER - INTERGENERATIONAL EQUIPMENT COST ESCALATION**, by N. Davies, A. Eager, M. Maier and L. Penfold

The writings of Philip Pugh and David Kirkpatrick on the subject of Real Cost Growth are well known, so this report was perused with interest, particularly the section relating to frigates and destroyers.

The first half of the following table is a direct copy of Table 1 in the report; the second half is the first half repeated with data from established sources.

Firstly, where did the base data come from? Prior to 1982 all shipbuilding contract costs were reported in the Navy/ Supply Estimates. And what is the price level of those costs? Again with some insider knowledge, comparing Type 22 costs with known contract prices suggests the published figures are outturn. If one were to ask what costs are available in MoD they will be either the contract cost available from contracts



department or the total cost paid by the MoD available from the finance department, that is contract price plus payments for inflation.

Earliest In Service Date	Frigate Class	Unit Cost (£m, 2009 Prices)	Displacement (Tons)	Ship & Delivery Date	Navy/Supply Estimates: shipbuilding Costs £M	Shipbuilding Costs @ 2009 Prices.
1956	Type 14	33	1456	HMS Hardy 8 Dec 55	1.449	30.4
1957	Type 12	62	2150	HMS Torquay 10 May 1956	2.769	59.5
1957	Type 12M	71	2150	HMS Yarmouth 26 Mar 1960	3.505	61.8
1959	Type 81	94	2300	HMS Ashanti 1 Nov 1961	5.315	91.9
1961	Leander	81	2500	HMS Leander 1 Mar 1963	4.63	78.0
1972	Type 21	192	2750	HMS Amazon 11 May 1974	16.8	180.0
1976	Type 22	413	4400	HMS Broadsword 3 May 1979	31.3 <sup>2</sup> 68.6 <sup>3</sup>	261.4 392.5
1989	Type 23	183	4800	HMS Norfolk 24 Nov 1989	66.8 <sup>4</sup>	174.2
				HMS Portland 19 Oct 2001	£85.0	122.9

For the second half of the table, the costs were normalised to the 2009 price level using the GDP deflator, the index for the original costs being taken as the average over the construction period for each ship. The Type 22 entries demonstrate how informed inferences are essential for the use of historical data.

Over the sample period between Type 14 First of Class HMS Hardy and Type 23 First of Class Norfolk the unit cost escalation is 5.3% per annum; on a specific cost basis the cost escalation is 1.87% per annum.

Over the period in which later Type 22s and Type 23 frigates were under construction there was significant change in contract conditions and manufacturing processes. One can assume that, to a first degree of accuracy, the costs for HMS Portland can be a proxy for the first of class built at the end of these conditions. That would result in performances of 3.9% and 0.5% per annum, that is, changes in the shipbuilding industry have countered the increase in ship complexity although this does exclude the inevitable cost growth that will have occurred in the GFE weapon systems.

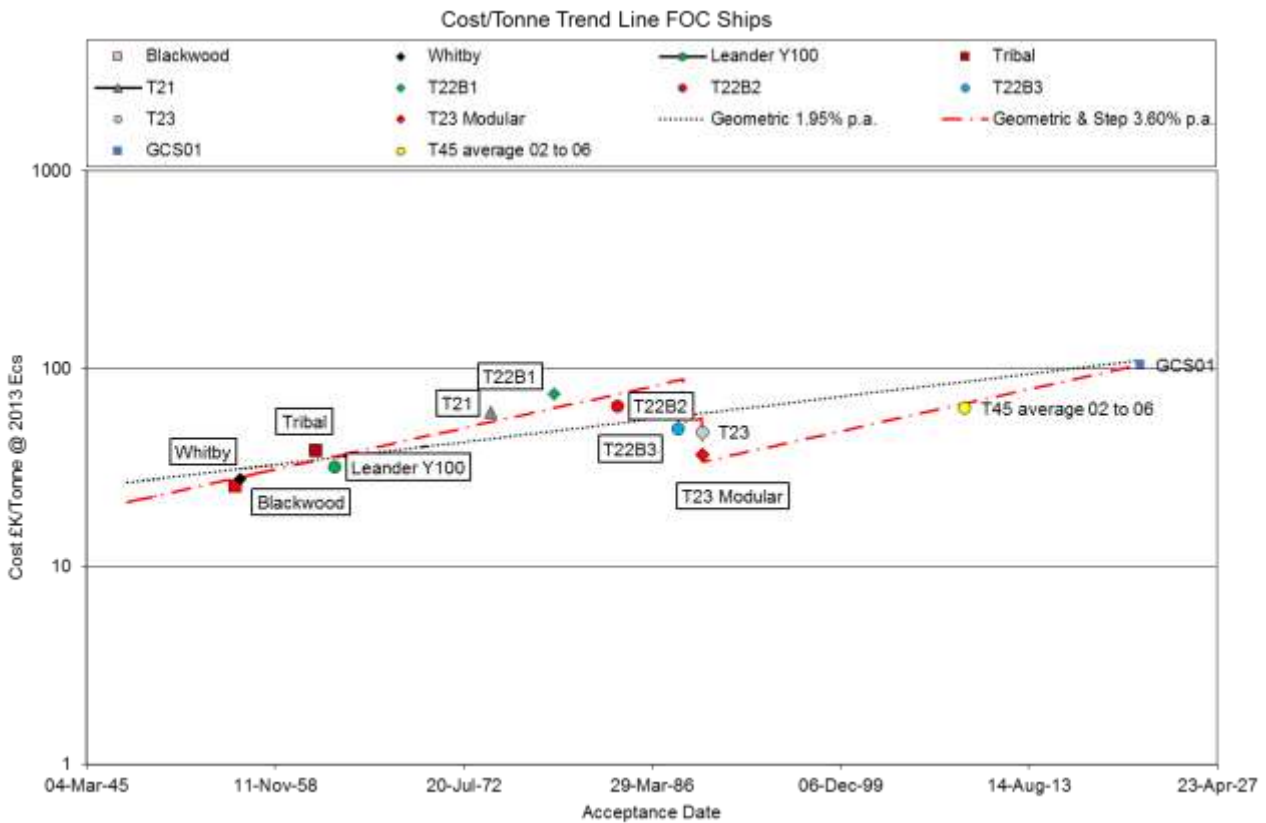
The analysis of real cost growth is usually done assuming a geometric relationship. If such a relationship is applied to all First of Class frigates since World War II, the specific cost is found to increase at 1.95% per annum. If qualitative factors are introduced to represent more rigorous contract conditions and improved

<sup>2</sup> Final Contract Price – probably excluding Long Lead Items – from old SPS (CAAS) database

<sup>3</sup> Supply Estimate Outturn – probably including Long Lead Items

<sup>4</sup> Type 23 data from CAAS data sheet.

production facilities, and Type 45 specific cost used to represent the most recent class of DD/FF, the underlying real cost growth is 3.6% per annum. Here is the graphic:



For the Type 26 Global Combat Ship the regression lines suggest a Cost per Tonne of £105K to £110K per tonne. From a size trend line the Full Load Displacement (FLD) of the Type 26 Global Combat Ship will be some 6250 Tonnes. Using typical Lightship to FLD ratios this suggests a shipbuilding cost of £490M to £515M at 2009 Prices. £530M to £560M at 2013 prices. How close to the truth the estimate is only time will tell, but a rigorous application of regression theory would produce a wide prediction interval due to the small data set.

Referring back to the table there are some observations to be made:

1. Where the costs in the report are similar to those of this paper the differences are probably due to the assumption of the original price levels and the normalisation tables used.
2. After the cessation of reporting shipbuilding costs in the Navy/ Supply Estimates, the provision of information in response to parliamentary questions may have had a different scope, i.e. unit costs rather than platform costs;
3. During the middle of the 1970s when Type 21 and Type 22 frigates were under construction inflation was very high, exceeding 25% in one year. Taking average inflation across any one build period to normalise the costs can be expected to introduce errors.

Perhaps the most important observation is that without good historical data any trend analysis will be subject to uncertainty. Given the frequency of defence equipment deliveries, data collection to the level required for trend analysis should not be an onerous task.

## Events in 2015

**3 February SCAF Workshop Theme: Cost Analysis and SDSR 2015, The Royal Institution of Naval Architects, London.**

Given the magnitude of the budget crisis facing the MoD one of the underlying goals of the Strategic Defence and Security Review (SDSR) was to drive cost down without compromising capability. However, because of persistent failure to accurately predict costs, senior decision-makers in government have taken a more acute look at affordability as part of the MoD's attempts to streamline procurement and support processes. The next SDSR will potentially be held in 2015. With unfinished business from its 2010 predecessor the 2015 review is likely to be contentious. As we prepare to support activities that will form part of the review we can only surmise on the potential changes that it will bring.

**14 April The SCAF 2015 Estimating Challenge and Learning Workshop, The BAWA Centre, Filton, Bristol.**

Following the success of the SCAF Challenge last year we are pleased to announce the SCAF 2015 Challenge and Training Workshop. The aim of this workshop is to provide an interactive training session in cost estimating through the presentation of case studies that have been conducted by professional teams from academia, industry and consultants with the added benefit of top-level critique by senior figures in the profession. It is our preference that the challenge is conducted by younger cost analysis staff rather than veterans. The programme will be instructive, entertaining and suitable for a wide interest audience (estimators as well as managers). Details of the case study are now available and interesting organisations wishing to participate should contact the Secretary, Neil Morrill as soon as possible. Teams will be selected at random if more than 7 apply. **Please contact the Secretary if you are interested in providing a Team for this event.**

**2 June SCAF Workshop Theme: Data Maturity and its Applications, Ribby Hall Village, Preston.**

Data quality is an essential characteristic that determines the reliability of data for making decisions. High-quality data is Complete, Accurate, Available and Timely. Business leaders are keen to analyze it to obtain actionable insights and improve the business outcomes. Unfortunately, the proliferation of data sources and exponential growth in data volumes can make it difficult to maintain high-quality data. How best then to use whatever data we can gather in order to modelling objective cost and schedule forecasts. **Please contact the Secretary if you are interested in presenting a paper at this event**

**7 July SCAF Summer Reception and Awards Banquet, The Marriott City Centre Hotel, Bristol**

**15 Sept SCAF 2015 Annual Conference and AGM, The QEII Conference Centre, London.**

For further details on any of the above events please contact the SCAF Secretary, Neil Morrill by telephone on 02392 537 271 or by email: [ndmorrill@dstl.gov.uk](mailto:ndmorrill@dstl.gov.uk)

## Other Related Events

SCAF is not responsible for the content of any external websites published in this Newsletter

27-28 Jan 2015

**11<sup>th</sup> NATO Life Cycle Management Conference & Exhibition, Golden Tulip Brussels Airport Hotel, Belgium**

Networking for the cost estimating and analysis community

With 17 briefings and speakers from Austria, Belgium, Denmark, France, Germany, Italy, Luxembourg, The Netherlands, Norway, Sweden, the United Kingdom and the United States of America **the 11<sup>th</sup> NATO LCM Conference will take place in Brussels on 27 and 28 January 2015** and will address the subject of: **“Smart Logistics – Working Together, Exchanging Information, Building Common Solutions”**.

9-12 Jun 2015

**International Cost Estimating and Analysis Association (ICEAA) Professional Development and Training Workshop, San Diego.**

This Annual Conference has well-known Keynote Speakers and Innovative Panel Sessions, Integrated Training Tracks, Informative Workshops and Exciting Vendor Exhibits. Separate certification exams are offered at the conference for a separate fee. Further details and registration can be obtained from [www.iceaaonline.org](http://www.iceaaonline.org)

21-24 Jul 2015

**32<sup>nd</sup> International Symposium on Military Operational Research (32 ISMOR), Royal Holloway, University of London, Egham, Surrey.**

Attendance at ISMOR offers a unique opportunity to spend four days exploring the application of analysis to practical issues in defence and security with a wide range of colleagues from across the world. As well as inspiring experienced practitioners with exposure to new approaches, innovative solutions and providing informal testing of ideas, it offers excellent development to early career analysts and an opportunity for the users of analysis to understand its potential. Further details and registration can be obtained from [www.ismor.com](http://www.ismor.com)

## SCAF Management Committee Meetings 2014/15

Date	Venue	Focus
7 <sup>th</sup> October 2014	QinetiQ, Bristol	2015 events programme
11 <sup>th</sup> November 2014	BMT, Fareham	2015 workshops content & challenge
9 <sup>th</sup> December 2014	QinetiQ, Bristol	Finalise 2015 events programme and interim 2016 programme
6 <sup>th</sup> January 2015	BMT, Fareham	Finalise challenge
10 <sup>th</sup> March 2015	QinetiQ, Bristol	Discuss awards nominations
19 <sup>th</sup> May 2015	BMT, Fareham	Annual Conference, final details for awards dinner and committee nominations
14 <sup>th</sup> July 2015	QinetiQ, Bristol	Annual Conference final details
6 <sup>th</sup> October 2015	QinetiQ, Bristol	2016 events programme and November workshop
10 <sup>th</sup> November 2015	BMT, Fareham	Ideas for SCAF Challenge and February workshop
8 <sup>th</sup> December 2015	QinetiQ, Bristol	Finalise 2016 events programme and interim 2017 programme

The committee would welcome any suggestions on particular topics that can be developed for debating at future workshops or for round table/panel discussion. We would also welcome any comments on changes or otherwise you might like to see to the workshop structure and content.

Please forward your comments to [editor@scaf.org.uk](mailto:editor@scaf.org.uk) where they can be put on the agenda for committee discussion and action.

Please also remember that the committee works for the members and will do their utmost to address any issues raised to the benefit of the Society.

## SCAF Corporate Membership

Are you a company that sends 5 or more staff to any of our workshops? There are discounts available for block bookings with further flexibility offered for Corporate Membership. Further details can be obtained from the SCAF Treasurer, Dave Hedley email: [dave.hedley@bmrcl.com](mailto:dave.hedley@bmrcl.com)



[www.scaf.org.uk](http://www.scaf.org.uk)



**Bridging relationships in cost estimating**

For over 20 years the Society has sought to illuminate key issues in the analysis and forecasting of project costs—and to promote best practice within the cost forecasting community.

The Society provides a single point of contact for advice to those wishing to address key issues in the analysis and forecasting of costs and timescales of complex programmes.

Workshops and seminars are held at regular intervals throughout the year. A newsletter is published electronically 3 times a year.

Collaborative links with other societies has always been maintained and a library of relevant papers are available. A single annual payment at the Annual Conference entitles members to attend all the years' programme of SCAF events at no further cost. The Summer Reception is also provided free to SCAF members and their guests.

SCAF is committed to providing Continuing Professional Development (CPD) through the provision of its skills workshops and its support to Professional Development courses.

The Society is self-funded and a Not-for-Profit organisation and continues to provide members with exceptional value for money.

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