Spring 2012 Newsletter

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CHAIRMAN'S ADDRESS

Spring is nearly upon us and the Daffodils and Tulips are just starting to bloom here on the South Coast. The start of 2012 was certainly met with a cold snap but this did not deter the 80+ delegates that attended the SCAF February workshop. However, it is with a heavy heart that we learned of the passing of Steve Book of MCR . Steve was a luminary in the field who has served ISPA and SCEA for years as an active member and co-editor of the Journal of Cost Analysis and Parametrics. He was a regular speaker and visitor to the UK and Europe and was highly regarded by everyone in the community. He will be sorely missed.

Much is being written about the state of the European economy and the current volatility on the stock markets in the UK and Europe does not look like changing. The last quarter for 2011 was recorded as the worst quarterly performance since 2002 and the fourth worst performance since the FTSE 100 index was launched in 1984.

This volatility affects everyone and businesses are concerned about the state of the UK economy in general which is not immune to what is happening within the Eurozone and in the US.

Not surprising then to hear so much talk about cost reduction and value improvement. Cranfield University has just announced a new short course for 2012 that provides an appreciation and hand-on training on how to achieve cost savings. Other areas of industry and government are taking more decisive action by reviewing current opportunities for cost reduction and efficiencies within their contracting mechanisms.

The SCAF workshop on "Through Life Costing" held in February demonstrated how costs saving measures were being encouraged in the acquisition and support phases of a programme. More details on this workshop are given at page 5.

The International Centre for Complex Project Management (ICCPM) recently published a Task Force Report entitled**: Complex Project Management: Global Perspectives and the Strategic Agenda to 2025.** The publication was officially launched by the Right Honourable Francis Maude MP, UK Minister for the Cabinet Office in December 2011.

The compendium of working papers was contributed by world class theorists, academics and practitioners in the field of Complex Project Management. **Dale Shermon** (SCAF Committee Member) contributed to Chapter 2 – Decision Making in Complex Environments. His paper is shown in full at page 6.

Looking forward to 2012 our next event is the annual cost estimating challenge in April and the international conferences in Brussels in May. The venue for the summer workshop and reception is in the final stages of planning and we look forward to seeing you at our events throughout the year.

Arthur Griffiths SCAF Chairman

SSCAG/EACE/SCAF INTERNATIONAL MEETING

The meeting will be held on 17-18 May 2012 at Sheraton Hotel, Brussels and follows the ISPA/SCEA conference being held at the same venue (see notice on page 18). This provides a unique experience and opportunity to meet with professionals and friends around the world. The cost for the meeting is €150 and completed registration forms should be forwarded to: dpine2@cox.net; arthurgriffiths@das-ltd.co.uk; herve.joumier@esa.int Hotel rooms are available at €130/night via the ISPA website www.ispa-cost-cost.org

Next SCAF Workshop

Tuesday 24th April 2012

The BAWA Centre

Filton, Bristol

CALL FOR TEAMS

SCAF Annual Cost Estimating Challenge

At the April 2012 Workshop the SCAF committee propose to set a challenge for the costing community. We will run a participative training session in cost estimating based upon the International Society of Parametric Analysts (ISPA) conference Renew Your Training (RYT) format. The challenge should be conducted by professional teams from Academia, Industry, Government, Tool Vendors and Consulting Organisations. The workshop will have the added benefit of top-level critique from senior government and industry executives. The programme will be instructive, entertaining and suitable for a wide interest audience (estimators as well as managers). The workshop ethos will be:

- Presentations will be conducted in a non-hostile atmosphere.
- All observations will be focused on the methodology and approach, rather than the absolute cost accuracy.
- This is a learning exercise for the Teams and the audience.
- Teams should always seek ways to demonstrate its innovation, experience and presentation skills.
- It is SCAF's preference that **younger members of staff** are used for the exercise, rather than 'veterans' of cost estimating, to provide a valuable opportunity for the next generation, to gain experience.

The Challenge

You are the Chief Cost Estimator at an automobile company and have been gathering technical and price information on cars for a number of years. You have been approached by the head of sales and marketing with a request to produce price information quicker. The company has a strategy to produce more tailored vehicles for the consumer and, as a result, would like to equip forecourt sale staff with a quick pricing tool rather than the price list that is presently used. The case study brief contains technical and price data for the challenge and the objective is to prepare a parametric model for the estimation of commercial vehicles.

Interested team leaders should contact Dale Shermon at QinetiQ (DShermon@QinetiQ.com) and Arthur Griffiths (chair@scaf.org.uk) by Friday 9th March 2012 if you plan to enter a team.

New Inaugural Honorary SCAF Membership

Towards the end of 2011, the SCAF management committee agreed to introduce a new "Honorary Member" position. This would be an invited title and would recognise past members that had retired and had made a significant contribution to the affairs of the Society over many years. We are delighted to announce that all those invited to this inaugural position have accepted the invitation with wholehearted enthusiasm. The new "Honorary Members" are listed below in alphabetical order and we look forward to making them welcome to our future events.

David Daniel: Former Head of the Directorate of Project Time and Cost Analysis (DPTCan), Director of the Operational Analysis Centre (DOAC) and Chairman of SCAF.

David Faddy: Honorary visiting Fellow, Centre for Defence Economics, University of York, Former Head of DPTCan, Director of DOAC and Chairman of the International Symposium of Military Operational Research (ISMOR) and Chairman of SCAF.

Joe Harland: An aeronautical engineer and former Head of Cost Analysis at the Defence Evaluation and Research Agency (now known as the Defence Science and Technology Laboratory (Dstl)) and former Chairman of SCAF. On retirement from the Civil Service Joe has used his degree in the History of Fine Art to carve himself a new career as a guest speaker onboard cruise liners around the world which he continues to do today.

Dr David Kirkpatrick: Emeritus Professor, Head of the Defence Engineering Group, University College London, Former Head of DPTCan, Director of DOAC and Special Advisor to the House of Commons Defence Committee. Former Chairman of SCAF and author of several publications on aeronautics, defence acquisition, defence economics and military history.

Terry Proffitt: Former Head of Cost Forecasting and Deputy Director Pricing and Forecasting Group (now CAAS), Ministry of Defence, Subject Matter Expert to the NATO Research and Technology Organisation and author of specialist papers on life cycle costing.

Phil Wardle: Former Engineering Manager at BAE Systems (Mission Systems), Operations Manager, Nortel Networks and Director at Microelectrics Research. Specialist in performance improvement initiatives on project delivery, estimating techniques, commercial and project management processes.

"Through Life Costing"

SCAF Workshop, 7th February 2012, BAWA Centre, Bristol

The first workshop of 2012 proved to be excellent event. Thanks to a group of experienced speakers from Industry, Academia and Government. This, together with imaginative presentations, an interactive and large audience was regarded by everyone as being a very rewarding and informative day.

The workshop opened with a presentation from **Dale Shermon and John Scire, *QinetiQ*** who discussed the principles of Performance Based Contracting and used a case study to demonstrate the linkage between measurements of Key Performance Indicators- Payment Mechanisms and Cost Forecasting.

This was followed by **Tom Tiner, Cost Assurance and Analysis Service, *Ministry of Defence*** who presented an update of the previous analysis (conducted as part of the Gray Report (published in 2009) on Schedule and Cost growth in military projects. The results showed that growth in terms of cost and schedule was still endemic and significant and that sustaining any headroom within the MoD budget will be an enormous challenge.

Next came a change of emphasis as **Sirish Parekh, *Rolls-Royce Submarines*** spoke about the utilisation of Integrated Logistic Support (ILS) information as source for cost estimation. After explain some of the principles of ILS he used a case study to show how alternative design options presented different views dependent upon the design perspectives being considered.

The final presentation of a very busy morning came from **Dr Linda Newnes, *University of Bath.*** Linda's presentation provided a view of the current status of a collaborative project to research novel approaches to predict the through life manufacture and repair costs for long-life avionic systems under availability contracting. An excellent insight into the challenges and opportunities highlighted from this research.

Following a buffet lunch **James Fiske, *Franklin+Andrews Mott MacDonald*** gave an enlightening presentation on forecasting the cost and lifetime carbon emissions in capital projects. James introduced us to the new regulations set by the UK and how they should be measured in terms of carbon, costs and social impacts to meet HM Treasury Green Book investment requirements.

Andy Nicholls, *PRICE Systems* introduced us to the various challenges in data gathering, modelling techniques and data interpretation when addressing in-service costing.

Tony Hargraves, *Atomic Weapons Establishment* then posed the question: can cost management methods improve through-life benefits management? Tony explained the need for corporate governance, the pressure to identify and realise opportunities and benefits in a sustainment programme lasting many years.

Our final presentation of the day was given by **Jon Rees, *Rolls-Royce*** who explained how a RAMS-Centric forecasting capability is leveraged as the decision-support heart of service management.

Our thanks to all the speakers and their companies for supporting the event and making this a very worthwhile workshop.

The Impact of Complexity on Project Cost and Schedule Estimates – *Dale Shermon, Principal Consultant, QinetiQ*

Introduction

This paper aims to provide advice for management and senior practitioners about how their projects' complexity will influence their cost and schedule estimate. The thought that budgets need to be defined early with confidence is worthy of serious discussion, setting realistic, justified budgets earlier in a project's life cycle will greatly ease the financial processes of the project. An attitude of "entry-ism"[1] when establishing the cost and time budget at a politically acceptable level, rather than an appropriate level, will pave the way to financial problems which will emerge later in the life cycle. The estimating methodology of parametrics being a function of size, productivity, and complexity as independent variables and effort (and therefore cost) as a dependent variable is discussed.

The top-down parametric estimating process involves a number of steps including data gathering, normalization, determining cost estimating relationships (CERs) using statistical analysis, testing a hypothesis, and finally applying the model. Historical trend analysis (HTA) is an application of parametric estimating in the context of business case (BC) approval including economic analysis (EA) in the form of investment appraisals (IA) and affordability. To exemplify these principles cost growth in defence programs is the topic and a case study for this chapter.

The Business Case

Engineers and designers have had brilliant ideas; throughout history, they have created products and systems that have changed the world. Initially, hardware and more recently software systems have transformed our world and have even enabled us to travel beyond our world. However, none of these innovations would make it off the drawing board without the benefit of a business case. In early years, these were informal understanding between people that investors would recover their capital or investment because of an innovation. Nevertheless, currently this business case is a more formal affair. Investors seek a business case that determines the return on investment (ROI), internal rate of return (IRR), net present value (NPV), cash flow, etc.

It is not just the private sector that requires this level of analysis. The public sector will also stipulate a number of hurdles, gates, or milestones through which a project must successfully navigate or cross before the program has a release of public funding. In some cases, these obstacles to funding will require a business case to be generated or a similar type of justification to precede the launch or kick-off of a project.

This can be mystifying for the engineer or designer who can see nothing more than the brilliant innovation or system that they have nurtured like a loving parent from an inspiration into a fully engineered design. It can be difficult to persuade some of these geniuses that their "baby" is not going to leave the drawing board until a business case has been established. They are so blinded by the brilliance of their creation that in some instances they never make it past the drawing board stage because they are unable to articulate the benefit and value to the wider population or at least to investors in such a way as to attract investment.

[1]The phenomena in projects of setting the budget low to get approval and then growing the budget once accepted.

On the other side of the business case, the investors are rightfully sceptical about any or all cases that they review. Many investors fund projects, which promise high returns, just to find that the project absorbs more and more funding without any sign of the return that was envisaged. Now this is not necessarily the fault of the engineers. Engineers, by their very nature are optimistic people. Engineers need to be optimists. They are challenged by difficult, tricky, complicated problems to solve; if they were easy, it would not require an engineer. Such people wake every morning and go to work with a “can do” attitude, no setback is going to stop them from solving the complex problems of the day.

It is also these optimists who are asked to estimate the cost and schedule of projects!

It is therefore little wonder that many projects are blighted with cost overruns and schedule slippages. The engineers optimism at the bidding stage will inevitably mean that they will consider all projects achievable and conceive a solution to the most difficult problems at the outset which in reality will not be the final solution.

So how do project managers of complex project ensure that they do not suffer the frustrations of inadequate budgets and unrealistically short program durations?

Estimating and Parametrics

There are three recognized estimating techniques; analogy, analytical, and parametric. At different times in a project’s life, these estimating techniques are appropriate. At the earliest point of the project life, when the budgets are being set, the parametric estimate is the most appropriate methodology.

Parametric estimating provides an estimate of cost and schedule based upon a historical database of past projects, which have been normalized. This database has then been analyzed to determine the technical design and performance characteristics that are cost and schedule drivers. From this point, a hypothesis needs to be tested, and a statistical analysis can be conducted to prove that hypothesis. The results of this testing is a set of algorithms known as cost estimating relationships (CER) and schedule estimating relationships (SER) that represent the database of past projects. To demonstrate accuracy of the estimating relationships they can be used to predict those historical projects based upon their historical parameter values. These CER and SER can then be put to new usage with future projects parameter values to determine the cost and schedule of future complex projects.

Typically, parametric models will contain hundreds if not thousands of CER algorithms. They are combinations of lower level models that are brought together to form the big picture. It is common for the core algorithm to consider independent variables of size (e.g. volume, weight, Software Source Lines of Code [SLOC]), productivity (e.g. variation from industry norm, tooling, labour skills), and complexity (e.g. technology, application, environment). The complexity aspect of a parametric model will be considered later in this chapter.

Why is this useful? A parametric model is not optimistic (or pessimistic); it is just a representation of the past which can be used to predict the future. Using a parametric model to set the budget for a complex project will ensure that the budget is adequate and the schedule realistic. Because it is a top-down methodology, nothing is omitted or duplicated. **Figure 1** shows the difference between top-down and bottom-up estimating methodologies with the parametric advantage occurring when there is little information, which is generally the case at the start of a complex project. It is possible to estimate the cost of new complex projects without the need to ‘tease’ an estimate (staff hours, material, and other direct costs) out of a designer or engineer.

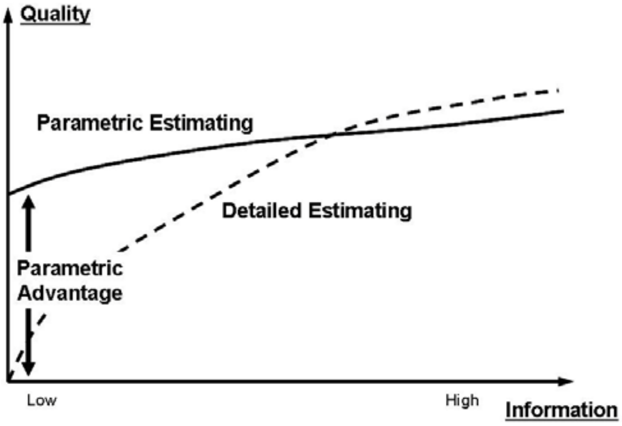

Figure 1: Parametric estimating advantage

But, has the problem just been moved from one area to another? Although the estimate is not coming from the engineer or designer, we will need them to quantify the parametric inputs, which represent the likely solution to the complex problem they have been set. We will require their view of the performance or design parameters, which are the cost and schedule drivers. Again, these could be biased or optimistic.

So how does a project manager of a complex project ensure that the parameters are free from optimism?

Capability and Design

There is often a misconception that it is possible to estimate the cost (and schedule) of a set of capabilities or requirements. Project sponsor's often have a desired capability that they wish to acquire often expressed in terms of a set of requirements and a need for an indication of the cost and delivery date. For example, I have a need to transport and contain a gin and tonic, what is the cost?

Now the problem here is that cost cannot be related directly to the capability or requirement. The requirement needs to be interpreted into a design, and it is the design which is given a cost and delivery date. In my example, the design envisaged could be a plastic cup and hence the cost would be less than one cent or penny. The naïve project manager would accept this as a realistic budget for the complex project.

A common problem is that the engineer's optimism that a simple solution is sufficient does not become reality. The plastic cup becomes a lead crystal glass because the solution is always a glass of some description and the plastic cup was never going to be a satisfactory design. The cost consequences are many multiples of what the original budget was conceived to be, but by this time, nobody can remember why the estimated cost (of the glass) and budget (of a plastic cup) are so far apart?

The problem is not requirements creep; this can be managed by a project manager by monitoring changes or alteration to the requirements. Here, the problem is conceiving an early immature design when only the requirements are articulated. Therefore, we toil for many days and nights to accurately predict the budget for the wrong design. This example is very simple, when the level of deviation between initial and final design is translated into complex real life projects there are serious financial consequences.

Advanced application of parametrics will include an extension to the cost and schedule parameters into the requirements space. It is possible to create a knowledge base or expert system, which will compare the capability and the proposed design early in a project life cycle, when a complex project is having its budget set. In a more practical example of a complex project, it would be possible to avoid the highly accurate cost and schedule estimate of a 20,000-ton aircraft carrier, which would be completely incapable of satisfying the requirement to fly 70 aircraft from its flight deck. An advanced parametric model would highlight the need either to increase the size (displacement) of the aircraft carrier, and thus the budgeted cost, or to reduce the capability or requirement (number of aircraft).

Parametric Estimating

There is a number of commercial parametric cost estimating models available or it is possible to create and research your own. This section will consider the option to build your own parametric model and then we will review a commercial system. As already stated a parametric model can contain thousands of variables or cost drivers. This example will be a multiple variable model that can be applied across many projects at a high level early in the project life cycle (Shermon, 2009).

The steps in creating a parametric cost model are as follows (International Society of Parametric Analysts, 2008);

1. Determine the requirements for a parametric cost model and the return on investment (ROI)
2. Determine the boundaries and assumptions
3. Gather historical data of past relevant projects including cost, schedule, technical and design data
4. Normalize that data for currency, economics, quantities, production rate, units of measurements (metric or imperial)
5. Identify likely cost drivers (independent variables)
6. Formulate a hypothesis regarding the independent variables and the cost or effort (dependent variable)
7. Test the hypothesis statistically to determine its significance
8. Document the cost estimating relationship for future usage.

In this simple parametric case study there has been a database created and normalized. In this example, aircraft data has been normalized to U.S. dollars ($) at constant 2006 year of economics and reduced to the theoretical first piece (T_1) of the production run. The T_1 is theoretically the first item of a production quantity, which exhibits the learning phenomenon and is therefore the most expensive. The first hypothesis considers the increase in cost with the increase in weight (see **Figure 2**). This is a reasonably intuitive hypothesis, if something is larger then it will require more raw materials and more processing hence more labour content, therefore “the more the system weights the more it costs.”

However, this simple hypothesis is not likely to satisfy all the historical data points or projects. These will be a level of ‘noise’ in the data, which means that the line of best fit does not go through all the historic projects. In statistical terms, this is considered a random error term, which can be represented as a positive or negative residual.

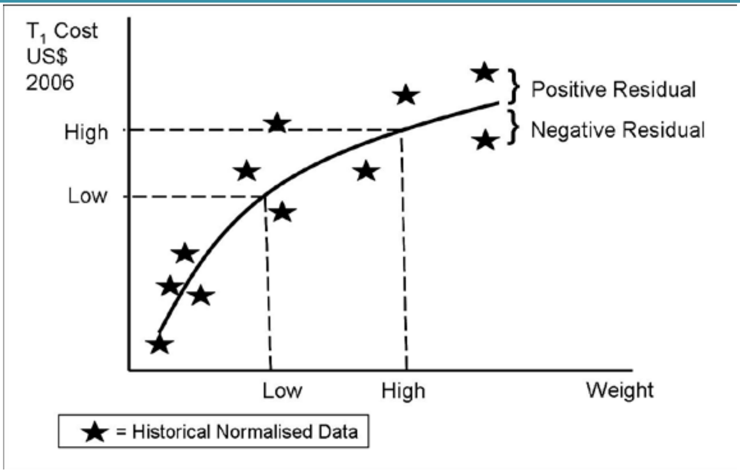

Figure 2: Cost versus weight.

If these residual figures are plotted against another variable, for example a performance characteristic, then a second parameter becomes part of the cost estimating relationships. In many systems, the residual can be plotted against a time axis (see **Figure 3**) and it becomes apparent that there is a relationship over time. This can be most likely explained as representing the technology influence isolated from the overall weight effect. As time passes, technology becomes more complex.

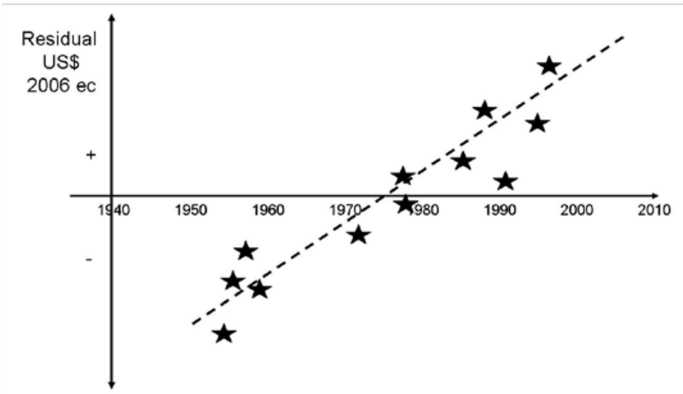

Figure 3: - Residual cost versus time.

This addition to the CER can be justified with the hypothesis that as time passes the complexity of the systems increases. It now becomes apparent that newer systems will cost more than older systems, after their weight has been normalized out of the data. If you consider this hypothesis for many systems, it is true. For example, in the early days of aircraft, they were made from wood, canvas, and wire. This has evolved through to today when the technology is more advanced in term of materials and manufacturing processes adopting composites, electronics, and software.

Figure 3 in turn will have residuals, which can be calculated, plotted, and statistically analyzed and rationalized with hypothesis to develop the CER further. A parametric model does not need to be difficult to understand, but the number of CERs will grow to accommodate more hypotheses observed in the real world. These hypotheses are nominally the cause of residuals and explain why one simple CER will not completely model the cost of a complex project.

When a parametric cost model is used to normalize the cost there are a number of CERs that are applied. One of these sub models is the technology maturity model. **Figure 4** shows graphically the theory behind this model based upon a constant industry or operating environment. Naturally, if the industry or operating environment is changing the maturity of the technology will change.

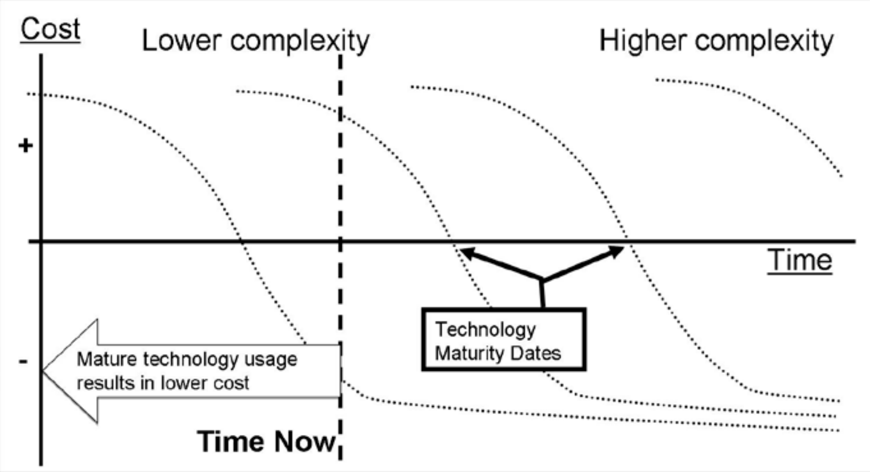

Figure 4: Technology maturity model.

The hypothesis behind this model predicts that as time progresses, technologies are assumed to mature. This is explained in terms of market forces. Due to market forces, immature technologies are expensive owing to the limited number of suppliers of the new material and providers of manufacturing processes. This lack of availability resulting in higher costs due to the demand and the model would generate a positive cost penalty. As time progresses, more suppliers join the market and provide the material and skills. Competition ensures that the costs are reduced, resulting in the application of a cost benefit.

Part of the problem in complex defence projects is that mature technologies are seen as less capable. The services (navy, army, air force) constantly want to move to the next technology to ensure superiority on the battlefield. Equipment would be cheaper if the current generation of equipment were reordered with existing mature technology. However, the admirals, generals, and wing commanders desire the next generation of equipment not the present.

Accuracy

Before there is too much excitement about our ability to predict the cost of a complex project, let us consider the obvious question. How accurate is a parametric model? To determine the relative accuracy, a data set was employed containing more than 90 fighter aircraft. The approach was to normalize the cost and technical data. Costs were normalized against currency, economics, and quantity. The technical data was normalized for metric (kg) versus imperial (lbs) and other such anomalies.

After normalization, the fighter aircraft data was subjected to the analysis process and a simple parametric model was created. The historical projects then had their costs predicted based upon this parametric model. To assess the accuracy of this technique, the predictions were plotted against the historical data and the coefficient of determination (R^2) calculated through a series of the graphs.

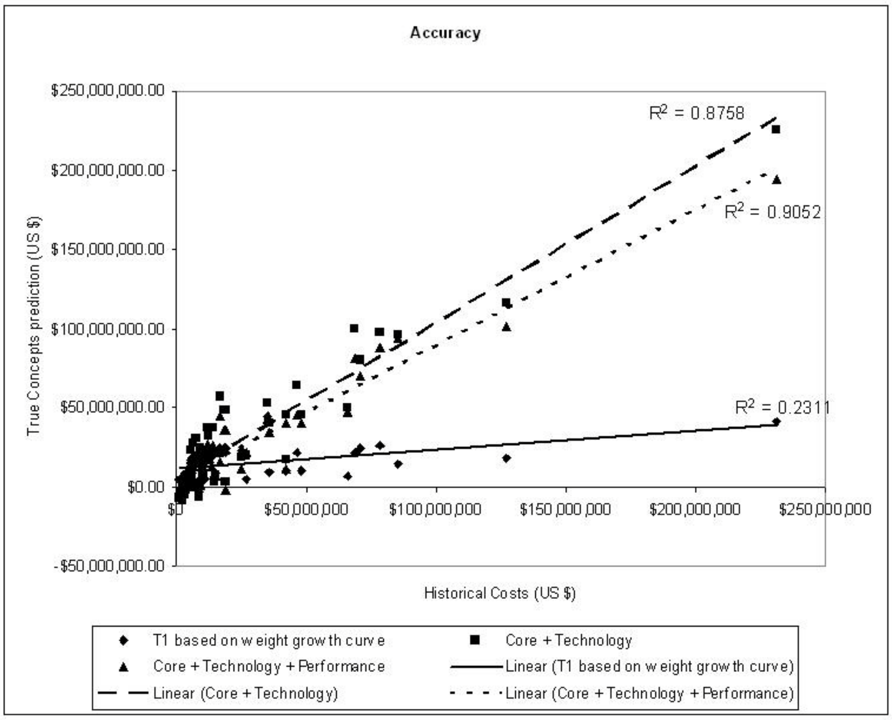

Figure 5: Historical cost versus predicted cost

F**Figure 5** provides a graphical visualization of the fighter aircraft accuracy. A simple, core CER based upon just the weight of the systems provides a poor model (R^2 = 0.23). There is an immediate increase in accuracy when the complexity of the systems, indicated by the time dependent residual, is added to the CER (R^2 = 0.87). This complexity represented the increase in the level of technology introduced over time. Finally, the correlation of the historical costs and the prediction of the CER is refined further (R^2 = 0.90) with the introduction of a performance variable, which will predict the cost most accurately. This model will be used as the basis of a case study at the end of this chapter.

Historical Trend Analysis

There are a number of commercial parametric models on the market, which can be used to estimate cost. One of the oldest models (PRICE Systems, n. d.) has an independent variable term or cost driver called “manufacturing complexity” or complexity for short. The complexity occurs because of comprehensive normalization. The model has numerous sub models and CERs that result in a final representation of the core elements of the product. Complexity is a technology index and, if the technology is constant, it can indicate productivity. This complexity variable leads to many different applications of the parametric cost model including supplier assessment, cost as an independent variable (CAIV), predictive earned value management (P-EVM), and historical trend analysis (HTA). The latter application is useful in the context of predicting the cost of complex projects and setting the correct budget early in the project life cycle when little information is available.

Daryl Webb (1990) published a series of papers looking at complexity over time. Manufacturing complexity of structure (MCPLXS) is the result of product calibration using the PRICE H model. Webb conducted a series of system level calibrations grouping the systems into product types and plotted the resulting complexity over time as seen (**Figure 6**). In the analysis, there was a consistent upwards trend in military systems.

This approach was made easier with the introduction of the PRICE knowledge management systems, which enabled the consistent storage, retrieval, and analysis of system level programs, such as the future U.K. aircraft carrier (Shermon, 2002).

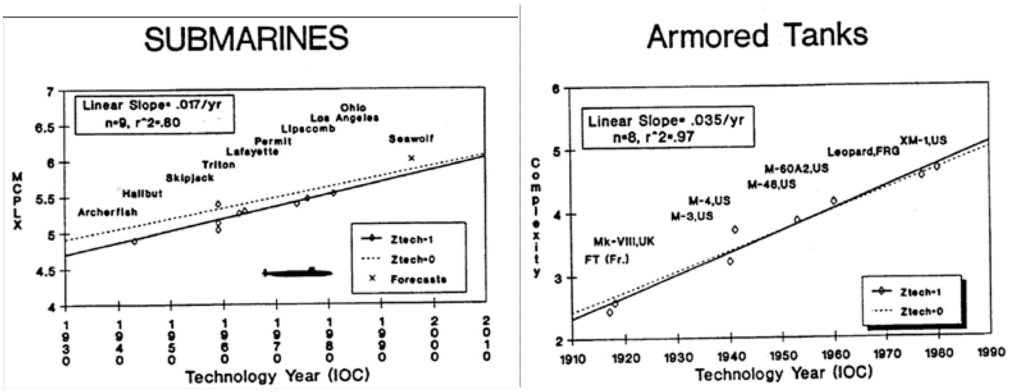

Figure 6: Complexity over time.

However, although most systems demonstrate a trend, not all systems follow an upward trend. Commercial aircraft have become more complex as time has passed, but they have a flat or declining complexity over time when reviewed by aircraft type (**Figure 7**).

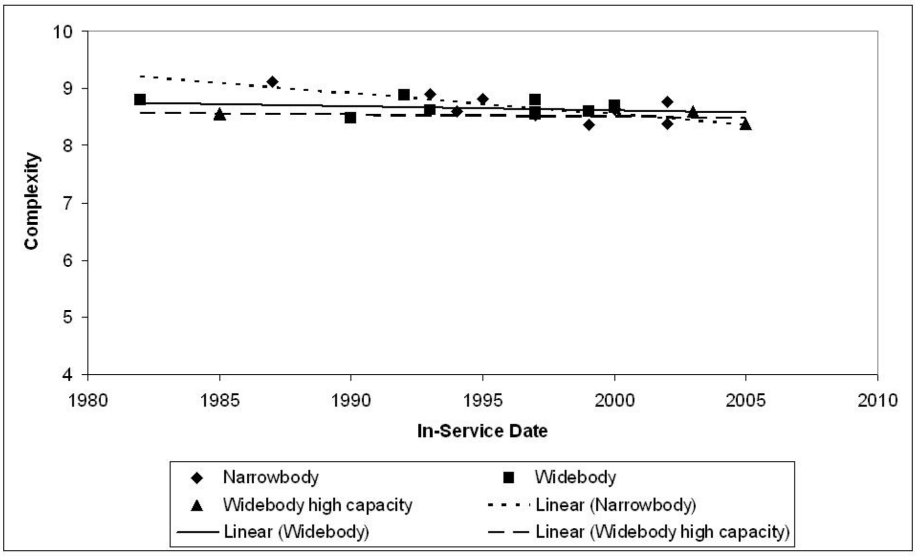

Figure 7: Commercial aircraft complexities by aircraft type.

This picture changes when analysed by manufacturer (see **Figure 8**) and provides an indication of the possible reason for this lack of upwards trend. The duopoly achieved by supplier A and supplier B provides for very competitive environments, one in which productivity is key to survival. As the complexity parameter is an indication of both a technology index and productivity, it is possible to deduce that the productivity in the commercial aircraft environment is divergent to the technology increase.

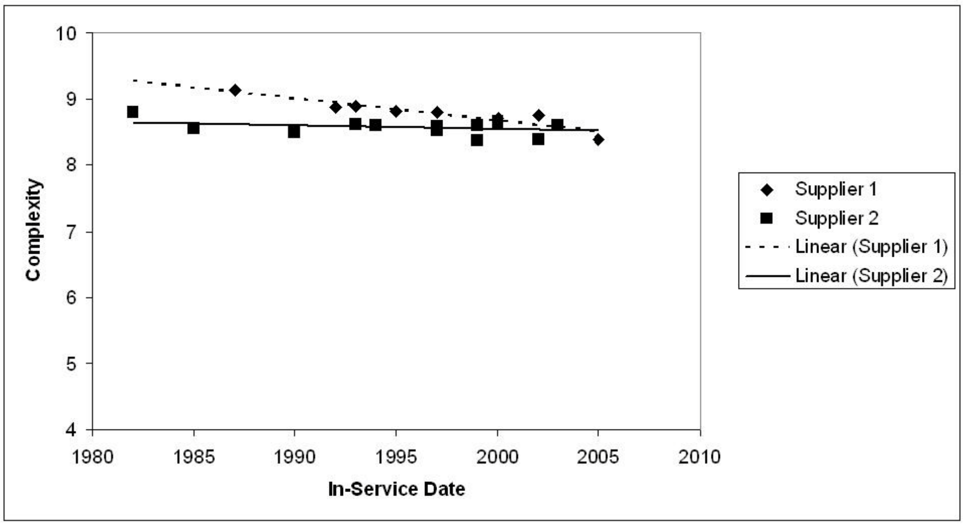

Figure 8: Commercial aircraft complexities by manufacturer.

This phenomenon is not just limited to the commercial parametric model. Philip Pugh (2007) also observed a HTA. When considering the unit production cost (UPC) of a system, divide it by a size parameter, such as total unit weight (tons). This cost per unit weight exhibits a strong trend when considered over time. He plotted the historical UPC per unit weight of various complex projects on log-linear graph and observed a growth in system cost over time. Although the trend analysis appeared to be linear, they are curves due to the choice of axis.

This cost per unit weight versus time discovery was implemented by Pugh in the algorithms in the family of advanced cost estimating tools (FACET) model produced by QinetiQ (QinetiQ. n.d.)

Why use the whole weight of a system in a complex project? It would seem logical that any cost growth would be limited to certain subsystems, rather than the whole system? For example, in a destroyer, the significant weight is in the hull and super structure. Surely, this part of the ship, welded steel, has been the same for the last 50 years. If anything, the cost of this part of the system has reduced due to modular construction and other manufacturing techniques. The real cost growth in a complex project has been in the radar, communication, propulsion and navigation systems. Perhaps the focus should be on these rather than the overall cost density.

Case Study

As an example of how parametrics cost estimating can be applied on a real complex project, a parametric estimate will be considered for the Lockheed Martin (F35) Lightning II or Joint Combat Aircraft (JCA).

The current assumptions[2] for the F35 have been taken from public domain sources (F-35 Lightning II, n.d.; Lockheed Martin, n.d.);

- Empty weight = 13,300 kg
- Length = 15.67 m
- Height = 4.33 m
- Wingspan = 10.7 m
- Crew = 1

[2] This case study was prepared in 2009.

- Total installed power = 11,472 kw
- Production quantity = 3,181
- In-service date = 2012

These technical and programmatic details have been used to estimate the production cost of the F35 aircraft, although the development and in-service cost could just as easily have been determined using parametrics. For production, the weight based CER for this parametric cost model is based on the following analysis (see **Figure 9**).

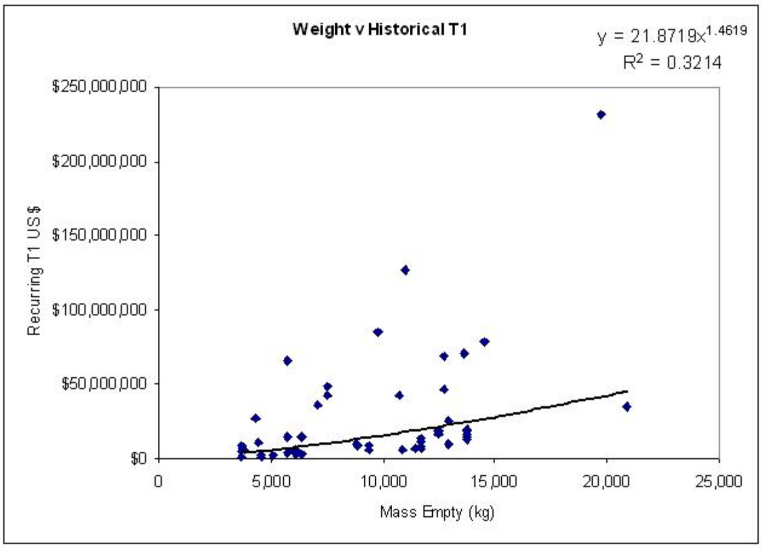

Figure 9: Aircraft weight versus time

This follows the earlier hypothesis that the systems cost more due to their weight. The error in this relationship is the residual, which needs to be explained by some other independent variable. The relationship between the in-service date (ISD) and residual costs can be seen in **Figure 10**, which shows an influence with the passing of time.

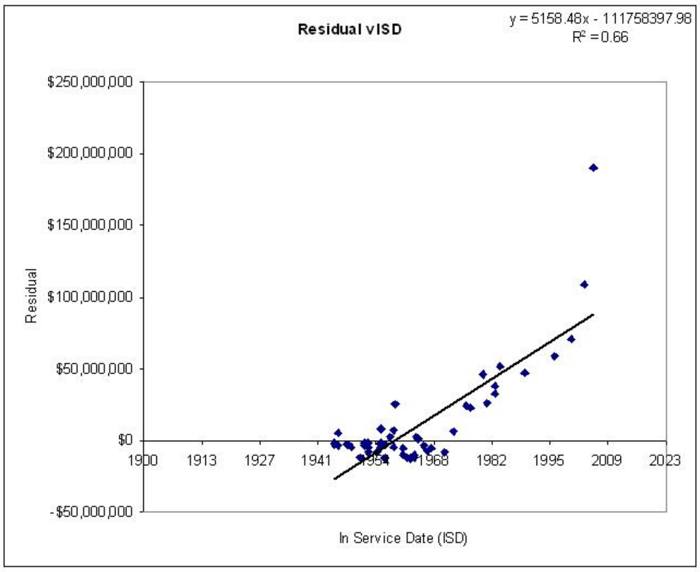

Figure 10: Residual versus time

If the F35 parameters are used in this parametric model, it is possible to derive a theoretical first piece (T_1) of US$147 million that will become a unit production cost of US$135 million based on the 2010 economic conditions.

A recent General Accountability Office (GAO) (2010) report updated the F35 production cost and stated a figure of US$131 million in (out-turn) costs. As the majority of the program extends beyond 2010, this figure would be reduced when considered in constant 2010 economics.

In an alternative commercial parametric model, it is possible to determine the complexity parameter of fighter aircraft and extrapolate the HTA until the F35 ISD. This methodology is presumed more accurate due to the greater level of normalization, which is applied to the raw data. As discussed, there are a number of models within a parametric model such as technology maturity, schedule effects, quantity effects, etc., leading to increased normalization. When the resulting complexity is used to predict the cost, the F35 is predicted to be US$132 million at 2010 economic conditions.

The accuracy of the approach reflects the data that is required. It follows that more information is needed for the commercial parametric model. The complexity versus time approach required more data both when normalizing the cost to derive the historical complexity and when estimating. If this estimating technique is to be applied at the early, pre-concept stages of a project this need for more programmatic and technical information should be considered.

Summary

With the help of this chapter, it is possible to summarize the influence of parametric estimating on complex projects. Not all complex projects experience an increase in complexity in parametrics terms. There are non-defence projects, for example commercial aircraft, which experience a neutral or reducing complexity. It is speculated that this is caused by the rate of productivity reduction exceeding the level of technology growth.

It would seem that the historical trend analysis (HTA) of a complexity parameter could result in an increased degree of accuracy when applied to fighter aircraft. The results would indicate that utilizing a commercial parametric model is an efficient approach to normalizing raw cost data prior to extrapolation of the complexity into the future.

The assumptions for the F35 case study predict the UPC to be in the range of US $132 million to $135 million at 2010 economic conditions. At the early stage of a complex project, an accuracy of 20% is a good outcome and in this case in line with the current authority figures.

Finally, it is recognized that this initial case study demonstrates that parametrics has a place in the initial assessment of complex projects. However, this is only one project type, fighter aircraft, but it is equally applicable to other complex projects in the space, land, and sea domain. Parametrics as an approach to set early complex project budgets is equally applicable in non-defence domains, if realistic budgets are desirable and business cases are going to be successful. Parametrics can be deployed to helping to set realistic budget for complex projects and safeguarding the project manager.

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The Complex Project Management Task Force Report, titled "Global Perspectives and the Strategic Agenda to 2025", was launched by the Hon. Jason Clare MP, Australian Government Minister for Defence Materiel, on 13 October 2011. The Report includes three parts:

Executive Summary

The Executive Summary provides an overview of the CPM Report, summarising its strategic and tactical recommendations for innovative organisational approaches to complex project delivery, across a variety of industries and contexts, and identifies strategic policy actions.

CPM Report

An initiative of International Centre for Complex Project Management (ICCPM) and Global Access Partners (GAP), the CPM Report represents the outcomes of the International Complex Project Management Task Force deliberations. The Report provides a comprehensive overview of current demands and factors critical to the success of complex projects, and offers strategic and tactical recommendations for innovative organisational approaches to complex project delivery.

Compendium of Papers

The compendium of working papers was contributed by world class theorists, academics and practitioners in the field of Complex Project Management. The compendium is an initial effort of developing a comprehensive knowledge resource on complex project management. While it does not pretend to provide all the answers in managing complexity, it does provide insights into areas where government and industry can make short to medium-term investment to gain real improvements in complex project management performance. This includes the paper written by Dale Shermon (QinetiQ).

KT-BOX

Bridging the knowledge transfer gap in services

KT-BOX is an innovative multi-million pound project funded by the Engineering and Physical Sciences Research Council (EPSRC) and has been designed to assist industrial and public sector bodies in the UK tackle a number of strategically important issues. The work should enable organisations to improve efficiency and flexibility and increase competitiveness.

Over the next three years KT-BOX will work with commercial and public sector partners to transform research in the fields of engineering, technology, business and social sciences into practical approaches.

Thanks to the EPSRC funding the University of Cambridge Institute for Manufacturing has formed a consortium aimed at turning the research into tangible economic and societal benefits for the UK. Consortium members include the Universities of Cambridge, Bath, Cranfield and Nottingham.

Collaborating with the KT_BOX programme will be a chance for your organisation to develop tools which will lead to real, commercial and practical advantages. Further information is available from **Chris Pearson, *Programme Manager at Cambridge University*** who can be contacted by telephone on 01223 764 836 or email cp349@cam.ac.uk

Please see below the details of the ISPA/SCEA Joint International Conference and Training Workshop. This will followed on the 17th and 18th by the joint SSCAG/EACE/SCAF meeting that will be held at the same venue. A "Call for Papers" has been distributed for both events. If you plan to present a paper at either event then please forward your details to **chair@scaf.org.uk**

Future Events

SCAF Workshops and Seminars for 2012

24 Apr 2012 **"Annual SCAF Cost Estimating Challenge Workshop",** BAWA Centre, Bristol. Estimating teams are invited to participate in an estimating challenge based on case study information provided by SCAF. Top level critique will be provided by senior government and industry executives. This programme will be instructive, entertaining and suitable for a wide interest audience (estimators as well as managers).

12 Jun 2012 **"Estimating for Partnering and Service Provision",** Ashton & Lea Golf Club, Preston, Lancashire. The workshop will discuss the various estimating practices and commercial requirements to support business decision making processes.

Early July **"SCAF Summer Workshop" (Venue to be determined),** This event will comprise a morning workshop and, in the afternoon, an opportunity for friends and colleagues to gather in an informal environment.

18 Sep 2012 **"SCAF Annual Conference,** BAWA Centre, Bristol. Our annual conference offer a wide range of topics and, over the years, has provided a platform for innovative speaking and thought gathering on current cost related issues.

Nov 2012 Workshop theme, venue and date to be confirmed.

Other Related Events

14-17 May 2012ISPA/SCEA Joint International Conference and Training Workshop, Sheraton Hotel, Brussels, Belgium

17-18 May 2012 SSCAG/EACE/SCAF – International Meeting", Sheraton Hotel, Brussels, Belgium

Networking for the Cost Estimating and Analysis Community

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

Society for Cost Analysis and Forecasting

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 therefore continues to provide members with exceptional value for money.

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