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Portfolio analysis: estimating the UK defence Budget

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Abstract

The government budget in the United Kingdom (UK) is too large to be managed as a whole; therefore it is divided into departments of state by HM Treasury. The Ministry of Defence (MOD) is one such department, but even this is too large to control, hence it is allocated to programmes and those are broken down into projects. At this level the funding lines are estimated forecast and monitored.

The big picture is needed to ensure that the individual budget lines do not exceed the overall funding available. QinetiQ has been working on the big picture and generating the UK MOD total budget to establish the portfolio picture. This has utilised both micro and macro parametric cost modelling to their best advantage. This paper will explore the cost modelling techniques applied for the in-service capabilities and the future capabilities.

Establishing the UK defence budget is the first step, after this the real fun begins. We are able to ask question such as; how can the portfolio view be used to influence industry strategy? What are the capability gaps? Is the portfolio balanced? How do we consider balance of investment decisions? What are the cost drivers? And many more.

This paper will use the UK MOD as an exemplar, but the process will be equally applicable to any nation or governments.

Keywords: Portfolio analysis, MOD, cost model, macro-parametrics.

Introduction

This paper will consider how decision makers can be helped to make big picture decisions in the defence domain through the implementation of portfolio analysis and the application of macro-parametrics. The utilisation of parameter based cost modelling can aid complex decisions through the analysis of effects caused by the changes to the input parameters generated by the complex decisions that are posed. QinetiQ has a consulting business called Advisory Services (AS) which promotes the application of cost engineering and other disciplines related to complex decision making.

QinetiQ was formed in July 2001, when the UK Ministry of Defence (MOD) split its Defence Evaluation and Research Agency (DERA) in two. The smaller portion of DERA was rebranded

Dstl (Defence Science & Technology Laboratory) and this remains part of the MOD. The larger part of DERA, including most of the non-nuclear testing and evaluation establishments, was renamed QinetiQ and prepared for privatisation. QinetiQ became a public private partnership in 2002 [1.].

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

Portfolio analysis

In the world of Commerce portfolio analysis is defined as "*an analysis of elements of a company's product mix to determine the optimum allocation of its resources*" [2.]. The key theme in this application is optimisation; ensuring that the business resources are maximised to gain market share or growth in the rate of market share.

When considering portfolio analysis in the Securities domain it is defined as "*an analysis of an investment portfolio relative to an idealized balance of holdings, used as means of optimizing allocation*" [2.]. In this definition the key theme is the ideal balance; there should not be excessive exposure any single holding, but a spread of holding with a variety of risks.

So what does portfolio analysis mean in the Defence domain? In the Cost Assurance and Analysis Service (CAAS) definition it means "*The application of modelling, analysis and supplier insight, to understand the financial impact of a change in the composition of the portfolio or decisions on a strategic investment or divestment*" [3.]. The focus in this definition is the understanding the financial impact; the appreciation that a decision has a cause and effect. In this case the cause is likely to be the emergence of a capability gap and the effect is a change to the budget profile. However, the first two definitions are also relevant. The outcome of the defence portfolio analysis should result in an optimised use of taxpayer's resources to ensure value for money (VfM) and also a balanced force structure such that one of the armed forces does not dominate the others to cause an imbalance, but a mix of capabilities required to meet defence objectives.

The problem

The difficulty in defence is defence inflation which is recognised as the increase in equipment costs beyond simple inflationary pressures [4.]. As a result of defence inflation our defence budgets are constantly under pressure to achieve value for money and there is a need to demonstrate affordability of the acquisitions being made. It is not a simple task for decision

makers who are required to juggle the needs of the service personnel, at the bottom of the defence hierarchy, with the budget provided by the government at the top.

To appreciate this conflicting top-down versus bottom-up pressure, it is worth considering the hierarchy in more detail as shown in Figure 1 below.

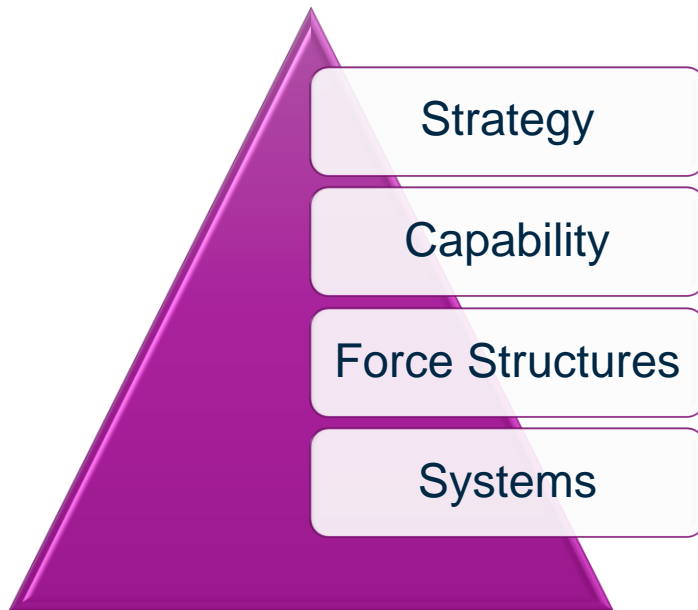


Figure 1: top down analysis

Starting at the top, the government will set out their strategy in terms of defence and what it is required to achieve [5.]. The strategy sets the aspirations of the nation and its place on the world stage which can be influenced by the defence department. Periodically in the UK a Strategic Defence and Security Review (SDSR) is conducted to set Defence priorities. This provides an overall context for the expenditure of budgets against a perceived threat in words that the public can understand and is general enough to enable the threat to be perceived and described as real without the detail that requires security classification. This will be matched by a series of capabilities which are required to implement this strategy. The capabilities will describe the means of generating a desired effect; the outcome will be the achievement of the strategies.

The capabilities will be delivered through a single service or joint organisations formed into a force structure. This force structure will be constructed from a series of systems or platforms that are delivered with defence lines of development (DLoDs)¹ to generate the capability. Ultimately, the systems / platforms and system of systems (S of S) need to be funded and acquired.

¹ Training, equipment, personnel, infrastructure, doctrine, organisation, information and logistics (TEPIDOIL)

Managing the costs, schedule, risks and decisions required to acquire these systems and platforms is necessary at the appropriate level. It is only through this recognition that it is possible to address questions such as:

- How can the programme view be used to influence industry strategy?
- Is the portfolio balanced?
- When does the next project need to be initiated?
- Is an Anglo-American acquisition a good idea?
- What is tradeable?
- Is the programme optimised?
- Who owns the programme budget?
- What are the cost drivers?
- Do the project budgets exceed the government budget?

It is usual for the acquisition budget to be considered at three levels; project, programme and portfolio. Project level analysis will deal exclusively with low level issues and decisions regarding a single project. The focus is seeking to deliver and support a system to time, budget and performance.

Programme level analysis will consider the issues and decisions across an enterprise or business sector. The focus is seeking to maintain an industry sector with the facilities, resources and supply chain capable of delivering systems of systems (SoS) through the provision of a uniform or constantly growing demand.

At the Portfolio level the capability will fluctuate with some force elements becoming obsolete and proving unreliable while others are being commissioned into service with 'infant mortality' issues; thus forming the classic reliability bathtub curve. The focus is providing the nation with a defence force which will be able to execute the will of the government.

So how are these concepts applied to the UK ministry of defence (MOD)?

Budget structure

The Defence Equipment and Support (DE&S) is part of the MOD and is a bespoke trading entity which enables them to operate in a more commercial way to improve the quality of delivery to their customers across the UK military commands and Head Office [6.].

It is allocated part of the defence budget from the UK government and, as shown in Figure 2, this is broken down into programmes called Operating Centres (OC) which are responsible for the delivery of projects. These projects are monitored with governance and scrutiny to ensure that the UK taxpayer receives value for money.

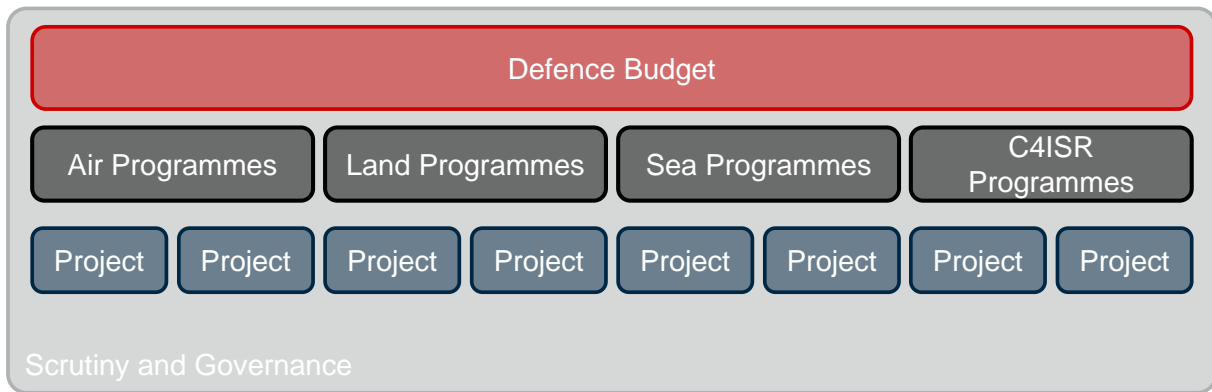


Figure 2: Budgets - the disaggregation of the defense budget

Within government departments it is common to have groups that perform scrutiny roles. They play 'devil's advocate' and are the conscience of the organisation. They will constantly ask 'How is the money spent?' - good examples of this are auditors in the private sector or the National Audit Office (NAO)² or General Accounting Office (GAO)³ in the public sector. In Canada the Parliamentary Budget Office (PBO) fulfil that role.

These groups are the eyes and ears of the taxpayer and ensure that they are getting value for money. At a more local level the public sector might have 'policemen' to provide oversight and guidance for example the Office of Cost Assessment and Program Evaluation (CAPE)⁴ in the USA or the CAAS⁵ in the UK. These organisations will validate cost data and models to ensure that they are appropriate for the use that they are being employed and verify that the cost models are error free and function according to their specification and design.

Typically the organisation will have a planning cycle that will match the lower level project expenditure to the top level. This periodic, usually annual, cross check is important to audit the expenditure of the budget, which is cascaded down to the projects, with the detailed commitment of funds that have been allocated by the project. It is necessary to conduct different levels of analysis at different levels of an organisation, as shown in Figure 3 below.

² www.nao.org.uk

³ www.gao.gov

⁴ www.cape.osd.mil

⁵ www.gov.uk/ministry-of-defence-commercial

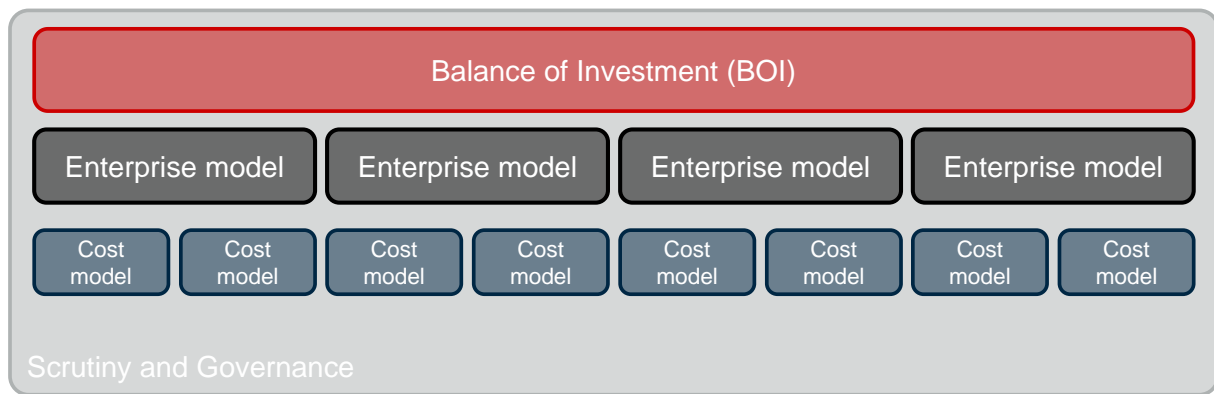


Figure 3: Analysis - how the analysis methods match the budget structure.

At the top level a Balance of Investment (BOI) or strategic model will consider the overall size and shape of the enterprise. In the defence world this will consider the force mix or force structure. For example, should you have 10 destroyers, 40 aircraft and 100 tanks or 5 destroyers, 20 aircraft and 300 tanks?

The BOI activity will provide a high level strategic cost model delivering the capability audit. It will check that the armed forces are balanced in terms of capability requirements. In other words you do not have a huge navy that is vulnerable from the air if you have little or no aircraft. The BOI step of the process is important as it will ensure that there is a suitable capability mix relative to the perceived threat. This step in the process is important as it addresses the questions "Do the armed forces meet the defence needs?"

At the programme level the emphasis is on the need to sustain the relevant capability over the longer term. For this reason it is common to deploy an Enterprise model. This cost model is aimed at considering the industry capability and sustainment of the capability. If the programme board are going to be able to deliver military capability for the longer term then it is important to consider the capacity and development for the relevant industry. It could be appropriate to support export initiatives from the industry to ensure that it remains healthy, but not all at the taxpayers' expense.

The programme board can be responsible for the investment in appropriate new technology and research. This can be aimed at nurturing strategic, national industry to enhance its capability and remain ahead of the threat. This pure and applied research will need to be introduced into a balanced portfolio of projects some with cutting edge capability while some remain the life blood of the capability.

At the project level the analysis that is relevant will justify the expenditure of the budget on the most cost effective solution. The case has already been established for the need for a capability against a threat in the BOI. The case has been further developed by enterprise cost modelling to justify the typical solution to the capability incorporating the necessary technologies. Now at project level the release of funding is sought through the analytical modelling leading to a business case.

Options analysis will be considered in the next section of this paper, but will need to include the Combined Operational Effectiveness and Investment Appraisal (COEIA). The case will need to be made for the expenditure and release of budget through a financial analysis (FA) demonstrating the affordability of the solution, and the economic analysis (EA) which will demonstrate that the option selected offers the best value for money.

At the project level a number of analyses will be used on an on-going basis to control the progress of the acquisition. Problem can be resolved through risk analysis of a project risk register using Monte Carlo analysis. Cost and schedule will be controlled through the application of Earned Value Management (EVM) techniques.

The projects can be modelled using a macro-parametric model. The platforms or systems life cycle costs (LCC) will vary depending upon the value of the input parameters that are used to establish the performance, design, technology year and so forth.

Case study: UK Defence Budget

A rigorous process of analysis is necessary to support the acquisition of any capability either in the public or private sector. Shareholders and taxpayers are not amused when funds are squandered on unnecessary or frivolous purchases. The process described below is an example of a defence acquisition process that would withstand subsequent scrutiny. In this case study public domain information has been used to create the UK defence budget for example Jane's Defence sources [7.]. In Figure 4 it is possible to establish the systems and platforms that are currently deployed in the UK Army. Similar information is also available for the Royal Navy (RN) and the Royal Air Force (RAF).

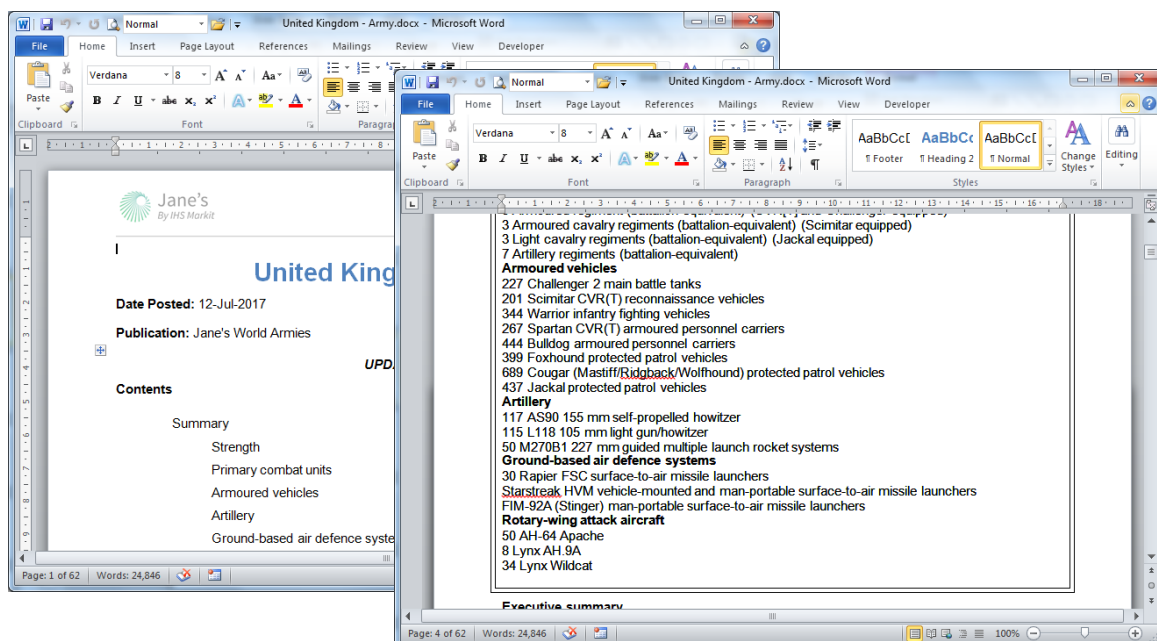


Figure 4: Systems – the current number of platforms and systems in the UK Army.

From this information it is possible to start a force structure of the UK military. Using a product breakdown structure (PBS) is possible to create a programme through the grouping of the systems as a folder. This PBS has used cost objects from the True FACET macro-parametric cost model from PRICE Systems [8.]. Each cost object represents a difference platform or system which can be influenced by the entry of different input parameters to represent a number of different project budgets.



Figure 5: Force Structure for UK Defence

Each of the cost objects has a limited number of high level input parameters which are combined with the algorithms of the macro-parametric cost model to generate the life cycle cost, schedule and uncertainty outputs. The values to populate the inputs can be found in the

public domain from a variety of sources, but the preference is to apply an authoritative source such as the Jane's Defence by IHS Markit, for example, All the World's Aircraft, Land Warfare Platforms, or Jane's Fighting Ships.

As seen in Figure 6 it is possible to store the source document with the cost estimate to provide complete traceability.

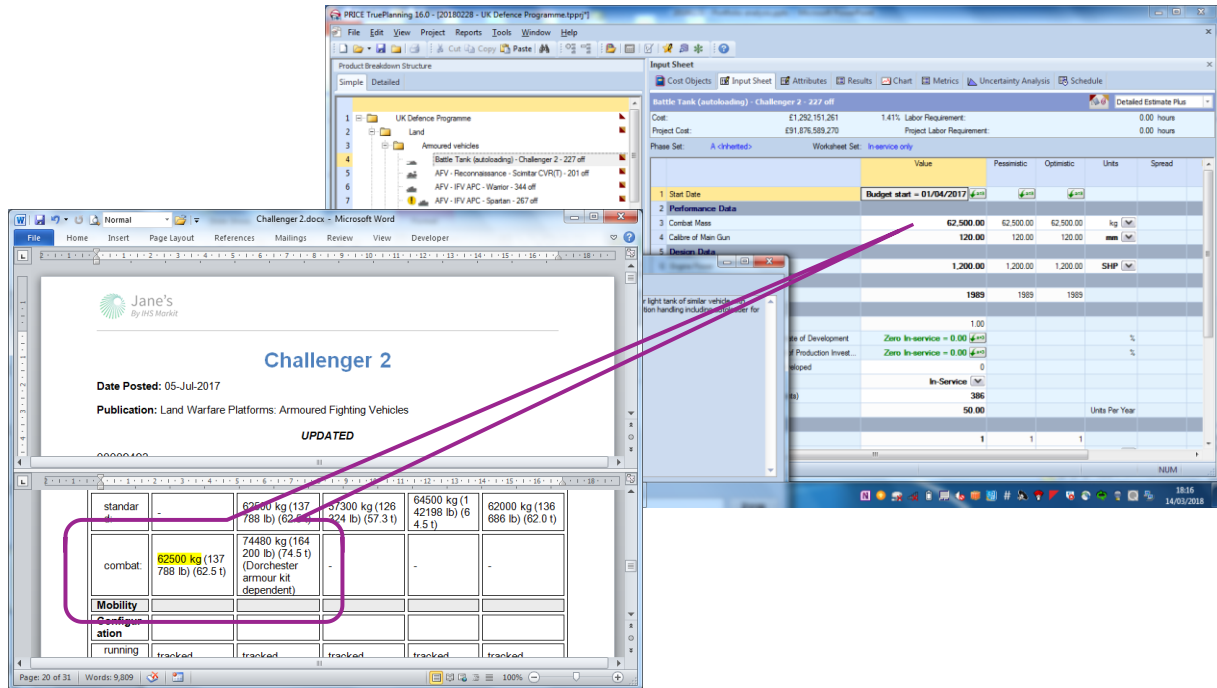


Figure 6: Data source – the traceability of the data sources to the input parameter.

Once the input parameters for a project have been populated it is possible to generate the estimates cost. In Figure 7 it is possible to see the operating and support cost for the Challenger main battle tank with the effect of inflation. This is an example of a single project within the land programme which is made up of numerous projects; both existing and being acquired.

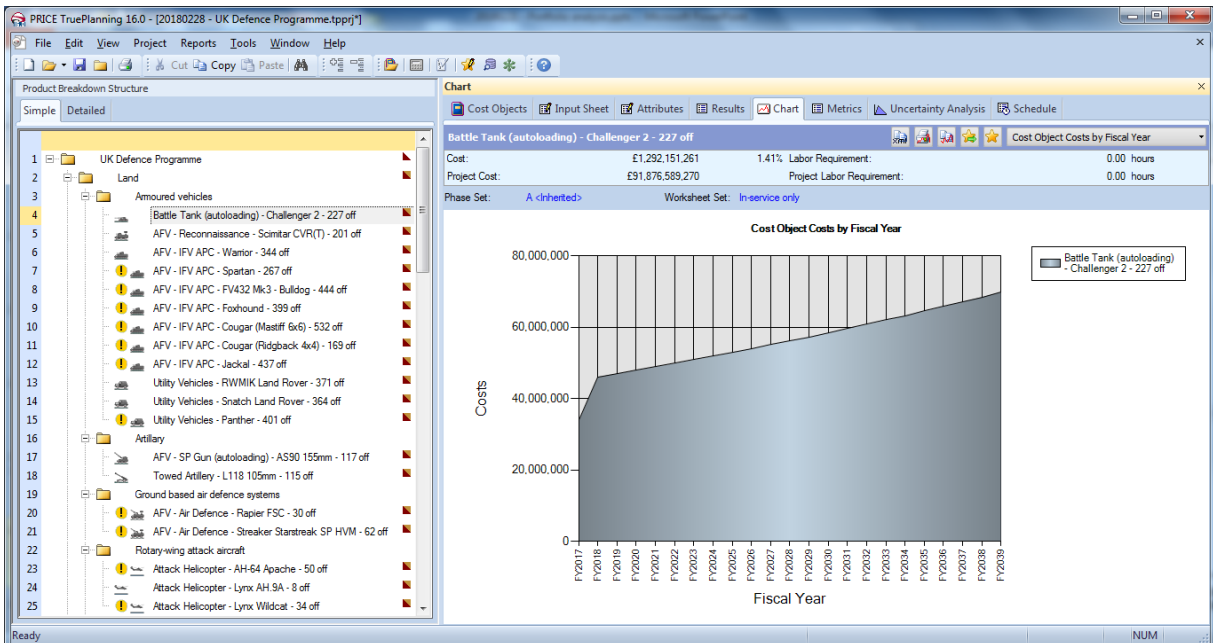


Figure 7: Project - Challenger 2.

It is possible to see in Figure 8 that a silt chart can be produced to aggregate the projects into a programme, for example this is the estimated Air Programme. This approach could similarly be used to group the projects into capabilities, if this was the desired output.

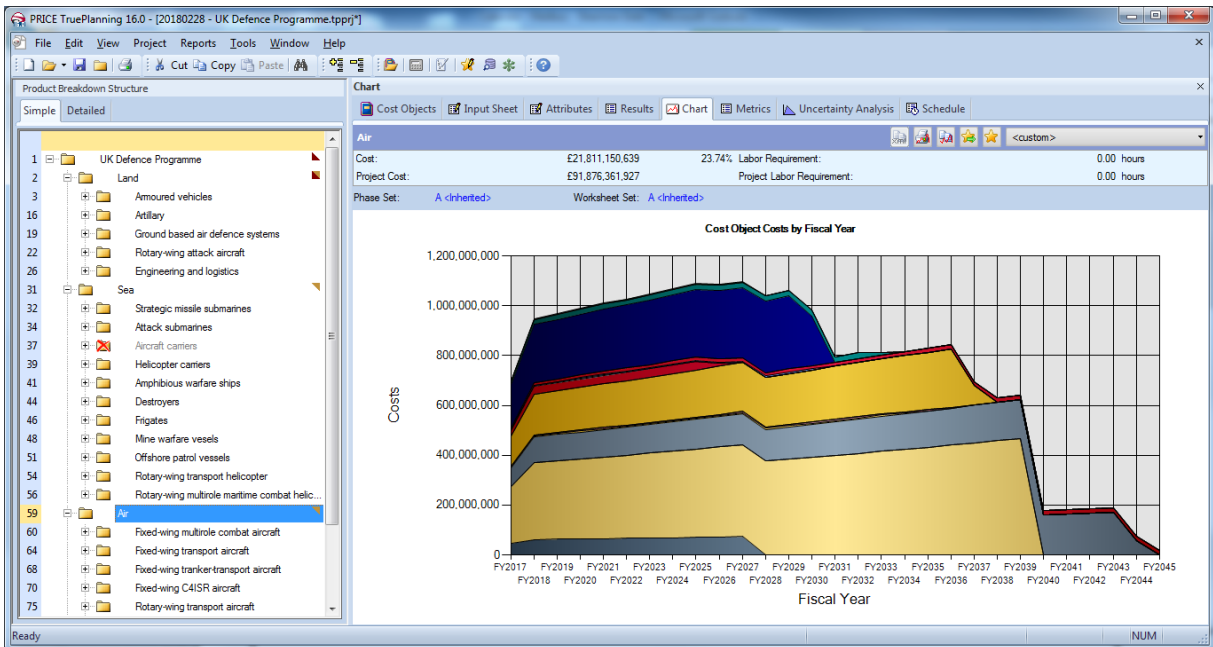


Figure 8: Programme – the aggregation of the air projects.

It is a simple extrapolation to extend this to the whole of the defence budget, as seen in Figure 9. This provides a portfolio view of the estimated defence budget, but most importantly it provides a link between the input parameters (the design, performance, year of technology, programmatic and production quantity figures) to the output costs.

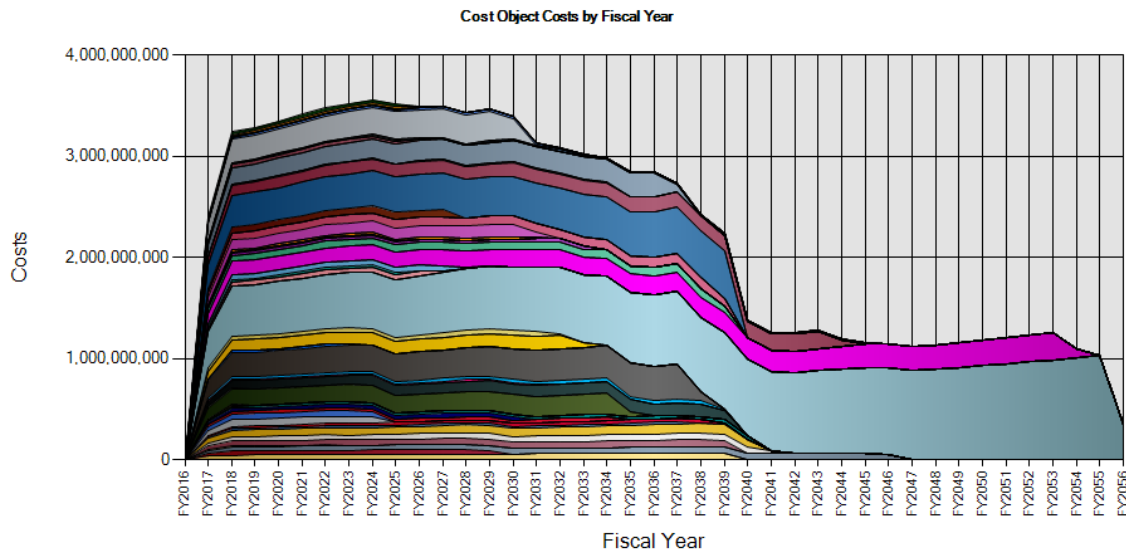


Figure 9: Portfolio – the total defense picture

Should a Capability Gap arise, either from the identification of a new threat or the current capabilities becoming obsolete then this can trigger the acquisition process. These requirements can be generated by a change of priorities at the highest level, for example the defence capability audit indicates a change of policy – we will only acquire nuclear-powered submarines. Generally the capability gap can be easily identified by a system being scheduled to go out of service. The more difficult capability gap to anticipate is the new threats, such as terrorism or cyber.

Having identified the capability gap, there is a perceived need to do something about it; but what? It is necessary to determine the exam question. A simply constructed, easy to articulate statement that encapsulates the reason for venturing down the road of an acquisition. For example, “the nuclear deterrent has been extended beyond its original out of service date without the capacity for further life extensions; with the defence policy for a nuclear deterrent a replacement programme is necessary”. This can be the introduction to a Concept of Analysis (COA). The purpose of the COA is to establish the exam question and document how the argument is going to be developed. The purpose of the document is to ensure that all stakeholders agree on the process and analysis so that when the outcome is presented nobody can argue that the process was not correct. It will describe the analysis methodology and outline the options to be considered within the option space.

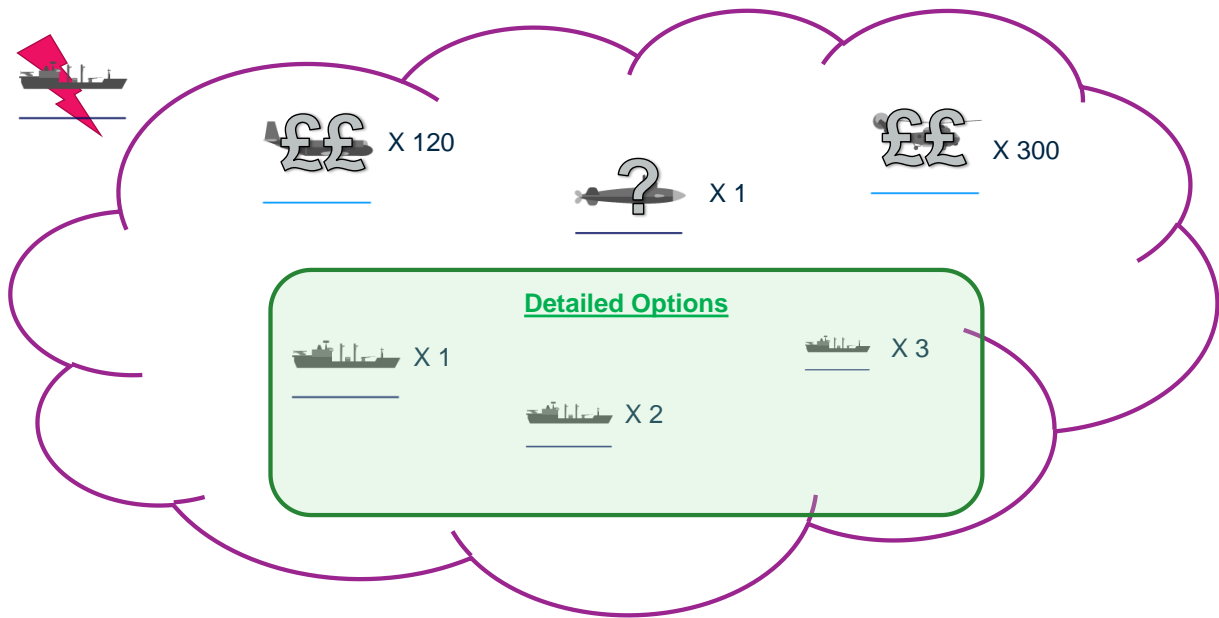


Figure 10: Option space – the down selected options to take into the next level of analysis.

In conclusion, the options can be down selected to a refined set of systems (see Figure 10) that will satisfy the capability needs and a Business Case is produced. The question “*Why are you acquiring this item?*” has been answered in the capability gap analysis. The question “*What options have been explored?*” has similarly been answered in the options identification process. There should be no concern regarding the question “*What analysis was conducted?*” as this would have been circulated and agreed at the beginning of the process. The Business Case will be scrutinised but will present the most cost effective option or options to acquire, which combined with the affordability of those options should make a compelling case. It just remains to make the recommendations regarding the acquisition to be made - confident in the knowledge that there is a robust trail of analysis for the taxpayers or shareholders should they later have any doubts.

Additional scrutiny questions and the approach to consider them are listed in Table 1. These questions were initially introduced in “The Problem” section of this paper, but now that the budget structure and case study analysis have been explored it is possible to consider how they might be answered.

<i>Query</i>	<i>Approach</i>
How can the programme view be used to influence industry strategy?	<ul style="list-style-type: none"> Consider the Production schedules; are they serial or parallel Do they lend themselves to uniform production and labour demand.
Is the portfolio balanced?	<ul style="list-style-type: none"> Quick review of the budget for the land, sea and air
When does the next project need to be initiated?	<ul style="list-style-type: none"> From the capability gap determine the development and production schedule to complete at the out of service date of the obsolete capability
Is an Anglo-American acquisition a good idea?	<ul style="list-style-type: none"> Test the options of a single, two, three nation acquisition and the resulting funding levels
What is tradeable?	<ul style="list-style-type: none"> Consider all the options to replace a capability; not just like for like (a ship for a ship)
Is the programme optimised?	<ul style="list-style-type: none"> Establish if there are any unnecessary peaks or troughs in the budget
Who owns the programme budget?	<ul style="list-style-type: none"> Consider who in the organisation is best placed to control the projects in the programme.
What are the cost drivers?	<ul style="list-style-type: none"> Conduct sensitivity analysis on the input parameters to determine the significant influences
Do the project budgets exceed the government budget?	<ul style="list-style-type: none"> Review the overall portfolio level and compare it to the total voted budget from the government

Table 1: Other questions – questions that can now be considered through this modelling

Lessons learnt

This QinetiQ study has been resourced to explore the possibilities of analysis from portfolio and programme to project level. With relatively minor funds it has been possible to generate a representative defence budget, thus prompting further consideration of wider analysis that could be explored.

What are the limitations of this study that need to be acknowledged? The following is an initial list:

- No calibration has been conducted or cross checks to verify the costs;
- No attrition of fleet numbers have been considered;
- No consideration of project specific risks.

The advantages of the approach outweigh the limitations which have been considered below:

- As a first level ROM analysis the exercise can establish the portfolio picture;
- This high level analysis can directly links the inputs parameters to the output costs;
- The analysis will provide ROM costs for first level assumptions;
- Multiple views of the same information;
- All the models are validated and verified;
- Should result in a suitable capability mix relative to the perceived threat and within the budget;

- The analysis assumptions and input parameters are recorded for future scrutiny and debate.

The most significant benefit is the portfolio, programme and project nature of this analysis. It is the ability of the cost engineer to analyse and drilldown into the budget from the top level to the bottom in a structured, logical and repeatable manner.

Conclusion

This paper has examined the portfolio, programme and project relationship in the defence domain. This leads to the ability to appreciate and understand the current and future defence picture.

Using the example of the UK defence budget it has demonstrated the technique and provided first level costs using a macro-parametric cost model. It has proven the ability to quickly consider this multi-million pounds budget using a data driven strategy. It leads the way to considering other nations budgets both in defence and the civil application.

The approach has been specifically designed to be equally applicable to other domains (civil, space) and would provide the decision makers with the ability to balance their portfolio.

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