Evaluating cost effectiveness and risk of third party support

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BIBLIOGRAPHY

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At the Seventeenth Annual International Logistics Symposium, he was the first non-US citizen awarded a prestigious Field Award ‘In appreciation for and recognition of his contributions in the area of Life Cycle Management’.

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ABSTRACT

We are always striving to maintain, or improve operational effectiveness, whilst looking for innovative ways in which to increase the cost effectiveness and minimise the risks of poor logistic support. The potentially high cost for maintenance and support often comes together with poor operational system performance. In such situations we find ourselves constrained by the poor evaluation of the alternatives between the system itself and the support system and the data to support that evaluation.

This paper aims to show how data and analytical tools can be used decision support aids to evaluate logistic support options, including third party options such as Contractor Logistic Support (CLS) and Augmented Logistic Support (ALS). It proposes a simple process for consideration that can be adopted at any stage during the life cycle from very early analysis to contract performance verification.

This process and the tool set is already successfully being utilised by organisations to determine the cost effectiveness of third party support.

1. INTEGRATING LOGISTICS SUPPORT ANALYSIS WITH SYSTEMS ENGINEERING PROCESS

1.1 Introduction

The situation of evaluating and determining support alternatives such as third party support occurs as a result of forced compromises, involving what can be afforded and what can be tolerated. Further more it is becoming more complex as the environment may not be constant but subject to change. In retrospect it is often easy to identify say four or five of the most important factors causing the problem. However we often do not perform any analysis until it is too late to find economically feasible or sustainable solutions.

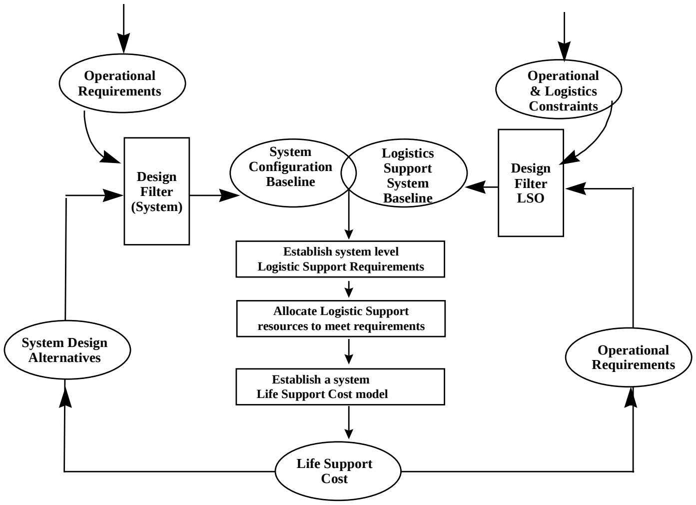
To prevent this from happening analysis needs to become an integrated part of the evaluation process at a very early stage. This analysis must also be through life in the sense that the same process and tools can, and should be used to modify the initial analysis and to verify the performance of the chosen support alternative once in service. The process is not a ‘one-off’ and should be used in a continual iterative approach. In spite of good intentions or even firm requirements for such integration it often does not happen.

We will describe a process, which can be utilised at any point in the life cycle to not only analyse and evaluate alternatives but also that can be used for verification of performance. The basis of this process is to keep the tool set constant whilst the data can vary from estimates to accurate. This is important, as the benefit of each support alternative must be demonstrable and measurable, and its risks evaluated. The risks that are evaluated are the support organisation failing to perform and the effects on operational availability or cost, for example increased repair turn around times or increased repair cost.

It is extremely important that any decision aids or programs that are used are:

- Extremely fast in their execution, including the running of many iterations to provide statistically significant results
- Provide easy interfaces to the transportation of data between databases and programs

1.2 Iterative process



The systems analysis and the logistics support analysis must be iterative and interactive covering the following:

- Operational requirements; given from outside the project it will contain both technical performance parameters like range, speed etc. as well as RAM oriented measures.
- Operational and logistics constraints; in the development of a new system or modification, there are a lot of existing resources that will have influence like manpower, skills, facilities etc.
- System designs filter; represents the technical pool of expertise about the system.
- Logistic support organisation designs filter; represents the technical pool of expertise about the support organisation and alternatives.
- System configuration baseline (system baseline); a faked description (at the Line Replaceable Unit (LRU) level) of the system with unit costs and demand rates. This description may or may not be supplemented by the information needed for LCC input. It is normally sufficient to support the use of an analytical tool or programme.
- Logistic support system baseline (LSO baseline); a description of the LSO with stations, links and times. It is normally sufficient to support the use of an analytical tool or programme.
- Establish system level logistic support requirements; the transformation of the operational requirements combined with the operational and logistics constraints into requirements that can be dimensioned e.g. Mean Down Time (MDT), Operational Availability etc.
- Allocate logistic support resources to meet requirements: the use of optimisation models for repair level analysis and sparing to assess each LSO that will fulfil the system level logistic support requirements and the relevant operational requirements. This will determine such attributes as manpower, facilities, test equipment etc.
- Establish a system life support cost model; generate a top down bottom up model i.e. a set of equations that will reflect upon the aspects of life support cost (LSC) that is needed to be studied.
- Life support cost; calculate the LSC. Not only is the figure of interest but the relationship between the various cost elements and are of immense interest. It is our experience that the achievement of LSC results is the key factor and it will irresistibly fuel the improvement process.

- System design alternatives; improvements in system design e.g. a more reliable LRU will update the system baseline.
- LSO alternatives; improvements in logistic support will update the LSO baseline.

2. NECESSITY OF A BASELINE

It should be obvious that the entire systems engineering approach to logistics will fall apart if established baselines for system configuration and logistics support organisation are not available. In this case there will be no credible logistics support requirements and feedback of alternatives will have less meaning. It is important to realise that establishing baselines early enough in a project, to allow the interaction, in most cases will imply a drastic change in engineering management policy. The traditional engineering process with a top down gradual systems definition, eventually revealing a system design and LSO, simply doesn't work here. *"Can't give you any data. The design is not frozen yet."* Will in a microsecond switch to *"Can't change anything. The design is frozen".* This situation must be avoided.

Systems operations modelling, requirements analysis, logistics support and cost analyses require data to be meaningful. These efforts have to start up front to have an impact, which of course is the reason for it in the first place.

Baseline management is not only a matter of engineering policy. It also involves the practical management of systems and logistics engineering data and the decision process of updating and sharing such data.

It is difficult to get data early. Bearing in mind that its is only in this early phase that the possibilities for effective influence are open we have to accept that challenge and adapt our methods and mentality to this. It is a challenge but remember:

- No system design or LSO start totally from scratch, a lot is actually known or fixed
- It is better to do something with uncertain data than to wait, when good data becomes available it is far too late

3. USE OF A DATA GENERATOR

3.1 Data Generation

Data, or more commonly the lack of it, is continually put forward as the main reason why decisions cannot be made or have to be delayed until data is available. In practice the delay does not guarantee that data will be available but that the decision is delayed until any potential benefits are much reduced. Data can be available from many sources for instance from common source databases or shared data environments, much of which has been promised by various IT solutions in the United Kingdom. In practice the benefits of these systems have only been partially materialised and the availability of good data remains a constant problem area. However much data does exist in perhaps disparate databases and even in the heads of experts and practitioners. All the data can be used as long as there is some intelligence applied, for example we aim to maintain consistent data definitions, allow granularity to increase as the life cycle progresses, is it a good or bad estimate and apply the appropriate confidence limits to the data etc.

The lack of data can be overcome by estimating, perhaps from a variety of sources including a panel of experts and applying confidence limits to that data. This will allow any analysis to produce results using sensitivity analysis on those confidence limits.

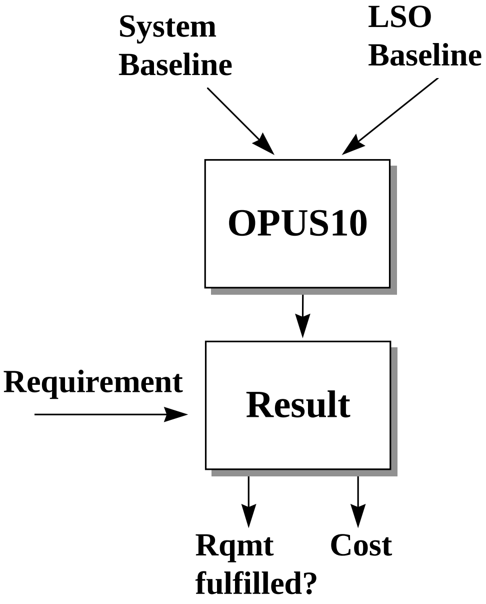
One of the most important tasks when performing the analysis is to get the necessary bridge, not only between

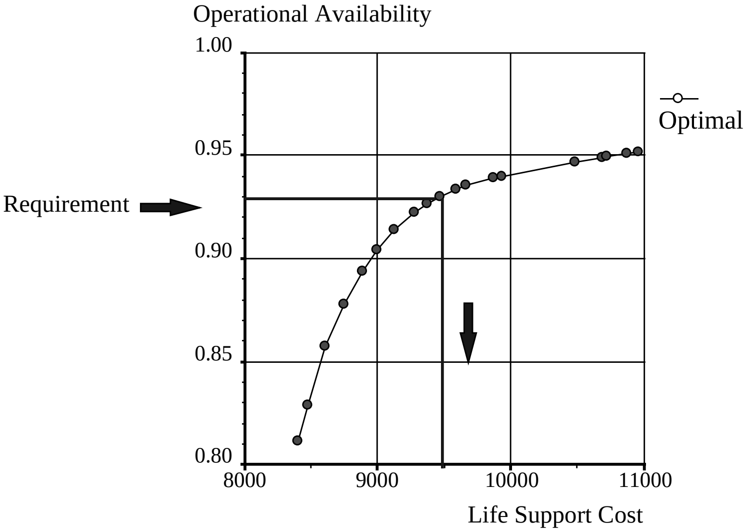
- Technical system and the LSO

But also between

- Requirements fulfilment and cost

This can be illustrated by the following figures.





3.2 Computer tools

We can identify in particular the following functions:

- Materiel data handling/data generation
- Logistic support requirements
- Logistic support and spares optimisation
- LSC

Materiel data handling/data generation

This function generates data to the LRU/SRU level including failure rates, unit cost, repair/replace times etc., especially early in the process when no data is available or it is incomplete. Existing tools such as OPSA enable this generation of a 'ghost' system.

Logistic support requirements

In most cases today, the requirements are generated in such a way that a computer program is needed to analyse the possible requirements fulfilment, for example OPSSIM. These programs simulate the operation of a system and the influence of the support organisation on operational availability. They are invaluable in assessing the support options and must be run for many iterations to ensure that the results are statistically significant. Single iteration models are of little value.

Logistic support and spares optimisation

A number of computer programs exist to support this analysis, such as OPUS10. OPUS10 is a member of a class of programs denominated multi-echelon, multi-indenture level spares optimisation programs. Related models are being developed to enable optimisation of repair philosophies at the system rather than the current item level, such as OPRAL. These optimisation programs are extremely accurate when working with seemingly inaccurate data and can interact with simulations such as OPSSIM.

Multi-echelon means that the spares are stored on more than one echelon. A number of complicating factors pop up like flexible supply, unsymmetrical, item-individual turn-around times and transportation times, forbidden stocks, minimum/maximum stocks, direct routes etc.

Multi-indenture means that spares of different levels of indenture are studied at the same time. Again complications show up like commonality both in systems and on lower indenture items, repairable v non-repairable, partly repairable etc.

LCC programs

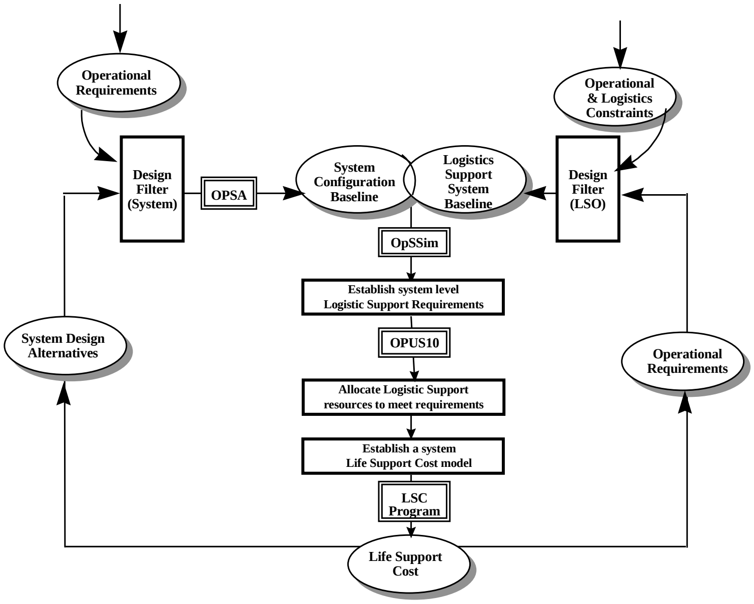
Although the LCC calculation is straightforward and simple (in particular in comparison to spares optimisation) the sheer volumes of alternative calculations make a computer program necessary. It will also permit a number of useful functions like sensitivity analysis etc.

A number of programs exist ranging from tailored spreadsheets to programs such LISA, SEALECT and PRICE.

3.3 The Data Generation and Iterative Process

The validity or accuracy of the data will depend on when in the life cycle the analysis is taking place. In the early stages data will be scarce and estimates will have to be made. Whereas in later stages data although plentiful may be no less inaccurate. In all cases the analysis will be formed a number of times to evaluate the sensitivity around the confidence limits on the data.

The process to evaluate alternative support options cannot just evaluate the support but must also include the system and its characteristics and the operational requirement. This evaluation will take place not only when initially evaluating alternatives to identify potential risk areas but also after contract award to verify the performance.



If data exists and can be easily extracted from a database then not all the following steps will apply. However, if data is available from more than one database commonality must be ensured. If data is not available, for example we are looking at CLS for a proposed modification that is yet to be designed then we can generate that data.

The steps in the process are as follows:

- Based on the requirements of the system, estimate
  - Overall demand rate per system
  - Sum of LRU cost (one of each – see note)
  - Number of different LRU’s

Note: The sum of LRU cost is in reasonable relation to the unit cost for the system. This relation has to be assessed by experience from various branches.

- Three parameters of a technical nature must be included
    - Cost spread
    - Demand spread
    - Correlation between cost and demand

- Generate a couple of system baselines using say OPSA and the information produced above. Use a couple of generations to be able to select a typical rather than an extreme result

- Generate one or several LSO's (2 versus 3 echelons, contractor support, transport alternatives etc.). Derive suggestions for Logistic Support baseline

- Run a suitable simulation program, such as OPSSIM, for a number of iterations to ensure statistically sound results

- Run an optimisation program such as OPUS10 on a number of generated data sets and LSO's. This can help to simplify the selection of a typical system baseline

- Select suitable runs and ambition level from each one, you now have an effectiveness level and spares/maintenance information

- Generate a cost model, try and keep it simple use a top down bottom up approach

- Estimate the other necessary inputs; test equipment, preventive maintenance etc.

- Run the LSC program and look at the ranked sensitivities

- Look at possible improvements within the LSO and alternative LSO's

You now have a starting point for:

- Critical cost elements
- LSO
- Operational requirements and if they can be met

Now we can continue the analysis and evaluate improvement activities or alternatives. A question that will often be raised is how accurate are the results? In the early stages of a project the results may not 100% accurate, however they are good enough to make decisions as doing nothing is usually not acceptable. In the later stages the life cycle accuracy will have increased. The use of an optimisation program such as OPUS10 and simulation programs with multi iterations, ensure that any inaccuracy is kept to a minimum.

It is important that all parties use where possible the same data and tool sets. It is of no use using tools that have different data definitions and requirements or measures of effectiveness, as this will make any judgement impossible.

This is of increasing importance when using the process to verify the performance of a contractor after a support contract has been awarded.

3.4 Introducing the OPRAL

As systems grow more complex the question about the LRU repair and the related question of test equipment and repair philosophies becomes more important. A key capability when solving those questions is to be able to analyse those questions in the same context, which means that the spares investment must be optimised in the same run as the location of test equipment is optimised. The location of repair as opposed to level of repair has become the deciding factor. This is done by a techniques that are currently being developed such as those by Dr P Alfredsson, Ref. [Alf 97], and implemented in the OPRAL program (OPRAL = Optimum Resource Allocations). OPRAL uses OPUS10 as the engine to calculate cost and effectiveness for each set of combinations of spares and test equipment.

4. AN EXAMPLE

The following is an example of the early studies of Low Coverage Radar, where the process previously described was used to evaluate the support organisations for the alternative radars.
(Taken from Ref. [PaW 82])

Before submitting the RFP a number of studies were performed with the following scope:

- Validation of the Reliability Performance Requirements in the RFP
- Validation of the LSC model
- Establishment of a reference for the LSC evaluation
- Training of the LSC team

Note: *LSC = Life Support Cost*
The cost elements included are shown in figures 4.1-4.3.

When doing so a dummy radar was invented using historic data as well as technique similar to the one used in OPSA.

The results achieved during the study phase were later compared with the outcome for the best tenderer in the first evaluation. The agreement is surprisingly good proving that not only did the team do their homework and used solid methods but also that they had been lucky. The following diagrams show the comparison.

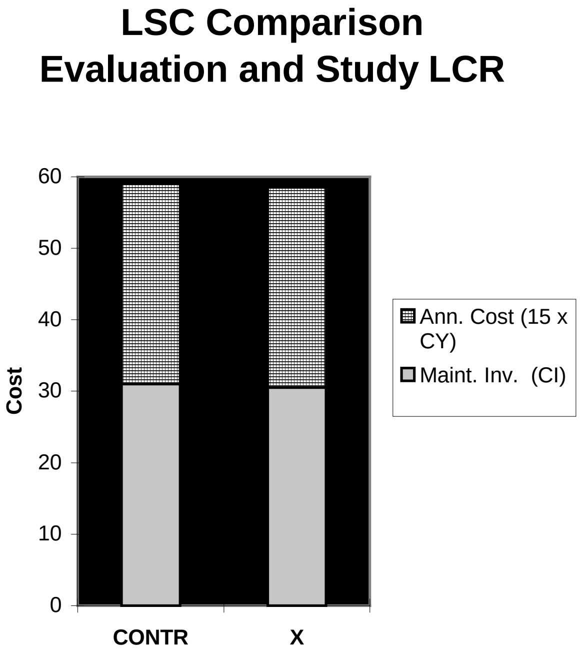


Figure 4.1

Excellent agreement both for investment and the annual cost over 15 years.

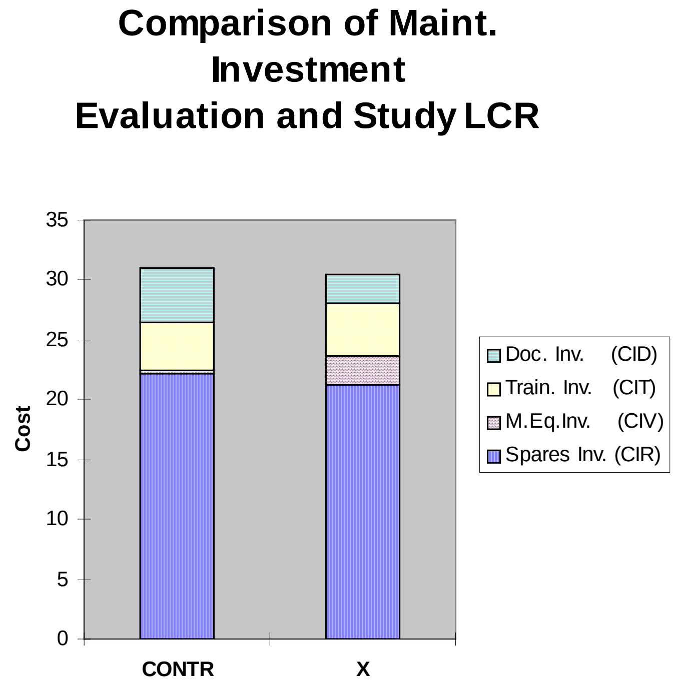

Comparison of Maint. Investment Evaluation and Study LCR

Figure 4.2

Excellent total agreement but here the team overestimated the need for maintenance equipment and the team underestimated the cost for documentation. The terms “underestimated” and “overestimated” are used in relation to what was clarified in discussions. There was a need for less test equipment than estimated by the team and the offered cost for documentation was higher than what the team had roughly estimated. The dominating cost element-investment in spares was calculated by OPUS (at that time OPUS7) and it was surprisingly correct indicating that the method of allocating cost and demand rates to the estimated number of LRU’s was reasonably good.

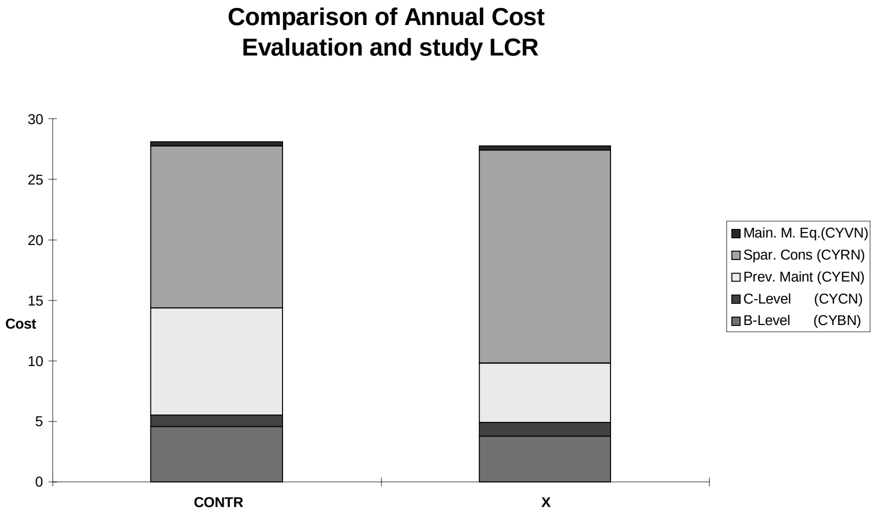

Comparison of Annual Cost Evaluation and study LCR

Figure 4.3

Excellent total agreement but the tenderer overestimated the need for preventive maintenance and the team underestimated the warranted TX-tube life (and as a result overestimated the TX-tube cost over the life).

The process now can move along into
- Tender evaluation (for examples on methods and improvements see ref [PaW 82]
- Contracting (for examples on improvements see Ref [AkB 94] (Rapid Trains) and [Baa 95] (JAS39 Gripen)
- Contracting and verification. See Ref [Waa 82] and [Waa 94]

5. A SWEDISH MODEL

The success of a contract to a large extent depends on its verification once it is being executed. In some cases, like Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR), standards are available, when it comes to supportability and LCC this is not the case. A way of contracting and verification has been developed in Sweden and has since been successfully in a number of cases (see references).

The key elements of verification are:
- Data describing the system
- Data describing the LSO
- LCC model (including use of programs such as OPUS10)

The verification of the LCC then rests on the verification of the contractor delivered input data. It has been found in a number of cases that for a large extent the supportability and LCC verification can rest on standard measures such as MTBF and MTTR (including both the system repair times as well as LRU repair at workshop and/or replacement times).

This approach to verification is useful in the investigation of cost and effectiveness of various LSO alternatives including third party support.

6. FINAL COMMENTS AND CONCLUSION

The method presented in this paper has been applied in a number of acquisitions and evaluation of support policies with good results. It will certainly help to overcome the general problem for logisticians to get in early and get results.

We would now like to act as ‘devils advocate’ and pose a number of questions:

- The solution has to be the most effective from a UK PLC point of view. For all the organisations involved in the process this may not be an easy concept to accept, as it could mean that the ‘traditional’ makers of the ‘profit’, may not do so in the future. How do we manage and communicate this change so that we have a true partnership removing adversarial attitudes?
- How do you determine ‘measures of performance’ that can be successfully contracted for and are also meaningful? What is the baseline for such measures? For example, most operators would like to see operational availability as a measure; most contractors do not because they believe that they cannot control many of the parameters within that measure, for instance the number of hours a system is operated or a mechanic at first line causing so called unattributable failures. Instead, safer traditional measures such as spares fill rate are used. Unfortunately in most instances these measures do not affect the availability of the system.

- How do you incentivise or penalise a contractor? It is easy to have penalty clauses in any contract but what happens if the penalty causes the contractor to potentially go out of business or the contractor is the only one that can perform this contract. In such instances to enforce penalties is highly unlikely and to do so will be a no win situation for everyone concerned. We would suggest that incentives are a much better way forward, for instance a payment if repair turn around times is consistently beaten.
- What is the real risk of a support contract failing to deliver? In peace time not having a system available when required is acutely embarrassing but only marginally affects the capability, in some instances another system can be found albeit after a delay. In periods of periods of heightened tension, policing and war, failure to have that system at the correct time can have severe effects on operational capability. In such instances the risk is totally the MoD's and cannot be shared by the contractor.
- Have we really considered the 'whole picture' concerning the 'improvement' in the system or support organisation? This is a hypothetical example that perhaps illustrates some of the areas we have mentioned. The availability of data to enable the determination of maintenance spares etc. and to forecast potential problems is not currently available for this equipment. It is determined that to fill this gap an on board data collection and monitoring device (DCD) is required. The cost of this modification is justified on the grounds that it will provide savings in equipment maintenance and itself will be supported by a third party, even though the equipment has a finite life of say another 15 years. Even if the DCD could be fitted today, at the present rate of equipment usage it will take 10 years to collect sufficient data, leaving only 5 years in which to achieve the cost savings from this modification.

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