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System Supportability Engineering – SMART Integrated Logistics Support

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Abstract

One of the principle tenets of Smart Acquisition is the adoption of a Through Life Systems Approach, which takes account of the whole life costs of a project. In order to respond to this Through Life Systems Approach, applied within the acquisition environment, a process (discipline) of Acquisition Systems Engineering has evolved. Within Acquisition Systems Engineering a number of sub-disciplines interact inside the methodology to provide the design solution.

System Supportability Engineering is an evolving Acquisition Systems Engineering discipline made necessary by the lack of confidence (Industry and latterly US DoD and UK MOD) in the ILS process in isolation, and the perception that ILS can be an expensive programme luxury. System Supportability Engineering begins at the Concept Phase of a programme and is applied throughout the system's life, only concluding at system disposal – a truly 'lust to dust' discipline.

System Supportability Engineering provides the following benefits to the programme:

- *It must educate the design and/or integration process with regard to Reliability, Maintainability, Testability and Supportability.*
- *The ILS process, which underpins System Supportability Engineering, must be cost-effective.*
- *It must provide the foundation for effective and cost-effective through life system support.*
- *The ILS process should guide you to the optimum support solution.*

The above benefits are achieved through:

- *Taking a systems engineering approach to the derivation of a support solution.*
- *Design optimisation – trading off the various design and support characteristics.*
- *Providing assurance that the right support resources will be in place in time to operate the system or equipment.*

- *Providing assurance that supportability requirements can be met through the media of:*
  - *Support solution.*
  - *R&M Case.*
  - *Logistics Demonstration.*
  - *Support System Trials & Evaluation.*

ILS, as a discipline, has a poor reputation amongst the engineering fraternity. Indeed, given the choice, many programme managers would dispense with ILS altogether. Consequently, one needs to examine and comment on the perceptions associated with ILS's poor name. The bad name of ILS centres on poor strategy, the speed of the process or lack of it, ILS programme expense and its prescriptive application.

During the last several years there has been an increasing tendency to include a significant element of Commercial Off The Shelf items in proposed system solutions. There is also an increasing tendency to make the statement, 'It's COTS so we do not need to do ILS'. As System Supportability Engineers we need to address that tendency.

The system manufacturer needs operational information in order to be able to understand system performance in terms of reliability, maintainability, supportability and, thus, operational availability. The equipment manufacturer can then act on this information in an effort to improve the design and its support system – if it is cost-effective to do so. Overall, the understanding of operational availability and how it can assist in the measurement of system performance is lacking in the Defence industry

In the support arena of today, many US and UK Defence Programmes have an element of Contractor Logistic Support (CLS) within them. The common denominator within these support packages is the need for the Customer to be able to recognise and prove that the support solution is value for money. However, arguments continue over what are effective performance indicators and it is still too early in the process for the Customer to be sure of what is to be measured.

1. Introduction

Integrated Logistic Support (ILS) was introduced as an engineering discipline in order to ensure that the necessary support resources were in place when a system entered service. In both the US and UK, standards have been developed that have provided a structured approach to the ILS processes and resulted in satisfactory support solutions. During recent years, however, ILS and ILS practitioners have developed a poor reputation and, indeed, the process has fallen out of favour with a significant number of manufacturers. Anecdotal evidence suggests that if ILS were not a contract deliverable then manufacturers would not undertake it.

The advent of a Systems Approach to Acquisition, especially in the defence arena, has provided new opportunities for the System Supportability Engineer, especially in the area of support solution design and derivation. However, to remain a relevant engineering discipline, it is essential that we understand the erstwhile failings of ILS and what needs to be addressed as we take the discipline forward.

The issue of COTS and Integrated Optimised Support solutions provide additional challenges for the System Supportability Engineer. Inputs to integration solutions and understanding the performance of innovative support initiatives will provide the System Supportability Engineer with the necessary future challenges but advice will have to be delivered quickly and accurately in order to influence the final design and support solutions.

This paper examines the recent necessary re-packaging of ILS within the Systems Supportability Engineering discipline and looks at how this essential discipline must evolve to remain relevant in the modern acquisition environment.

2. Acquisition Systems Engineering

The Strategic Defence Review (SDR) [1] heralded the advent of the Smart Procurement Initiative (SPI) as the basis of acquisition within the UK Ministry of Defence (MOD) and resulted in a change of emphasis within the MOD acquisition community. The aim of the change was to deliver equipment programmes in a shorter timescale, lower cost and providing improved capability and this resulted in the banner headline of 'quicker, cheaper, better'. The thrust of SPI was to guide the Defence Procurement Agency (DPA) and the Defence Logistics Organisation (DLO), the two organisations responsible for acquisition and support of UK defence equipment, to take a holistic through-life view of purchasing and supporting a capability. Thus, one of the principle tenets of Smart Acquisition is the adoption of a Through Life Systems Approach, which takes account of the whole life costs of a project.

In order to respond to this Through Life Systems Approach, applied within the acquisition environment, a process (discipline) of Acquisition Systems Engineering has evolved. Clearly, at this juncture this emerging discipline needs greater definition; thus, the aims of Acquisition Systems Engineering are, as follows:

- Acquisition systems engineering is an interdisciplinary approach to evolve and verify an integrated and life cycle balanced set of product and process solutions that satisfy stated customer needs.
- A total system design would include product hardware, software and planned support (logistic) resources.
- This structured approach should integrate the essential elements and design decisions of interrelated design efforts to support the CADMID equipment life cycle.
- The result is a balanced total system solution to meet the operational need (and other programme objectives).

3. The Acquisition Systems Engineering Process

Within Acquisition Systems Engineering a number of sub-disciplines interact inside the methodology to provide the design solution. At the top-level, the elements that comprise the Acquisition Systems Engineering process can be viewed as detailed in Figure 1.

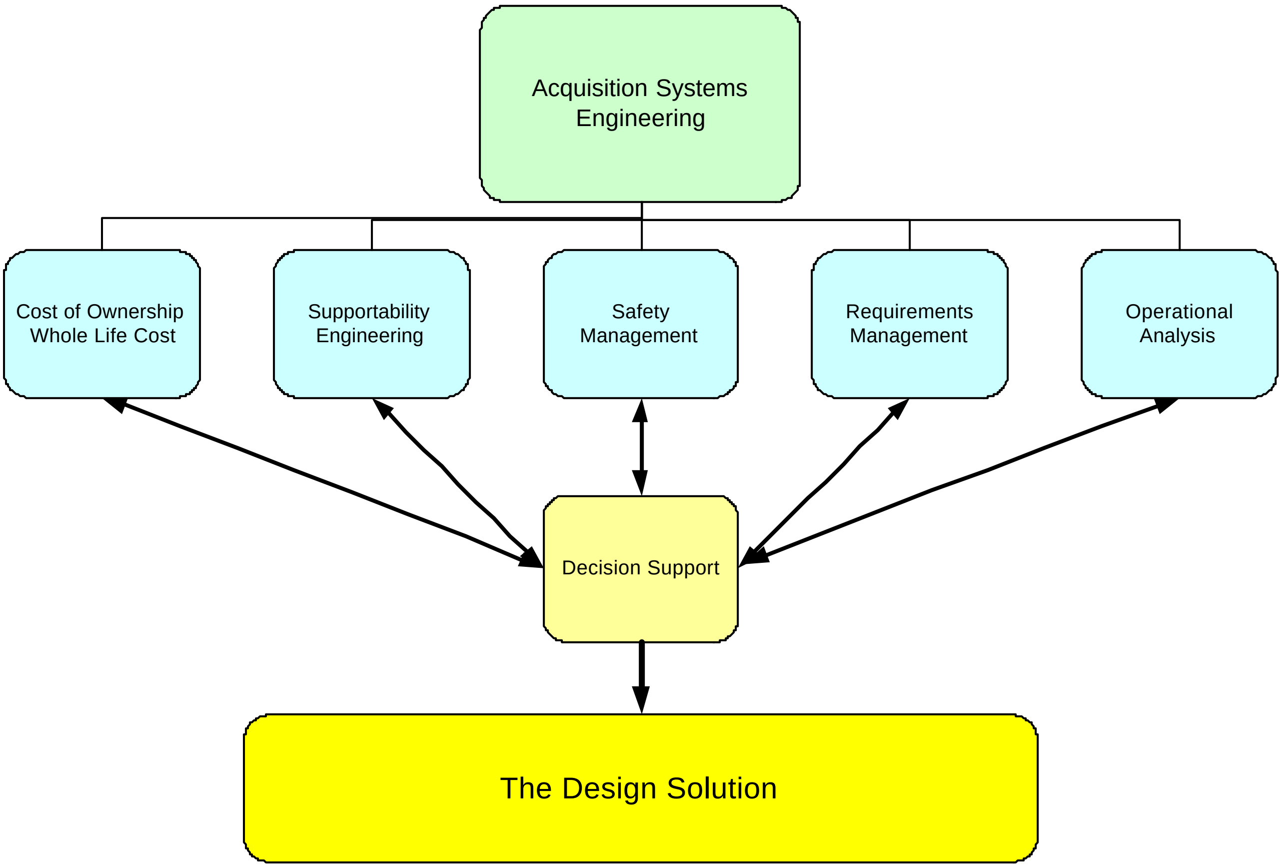

Figure 1 Top-level Acquisition Systems Engineering Elements

As can be seen from Figure 1, the key elements of the methodology are Cost of Ownership/Whole Life Cost, Supportability Engineering, Safety Management, Requirements Management and Operational Analysis. These sub-disciplines interact through the use of decision support tools to affect the necessary trade-offs that enables the Design Solution to emerge. For the purpose of this paper only the System Supportability Engineering element will be examined further.

4. System Supportability Engineering

System Supportability Engineering is a management process designed to ensure the in-service support of a system in the most cost-effective through-life manner. Integrated Logistic Support (ILS) and its subset Logistic Support Analysis (LSA) are structured disciplines that support the overall System Supportability Engineering process. System Supportability Engineering begins at the Concept Phase of a programme and is applied throughout the system's life, only concluding at system disposal – a truly 'lust to dust' discipline.

System Supportability Engineering is an evolving discipline made necessary by the lack of confidence (Industry and latterly US DoD and UK MOD) in the ILS process in isolation and the perception that ILS can be an expensive programme luxury. In reality, ILS can cost between 10 &

20% of the initial acquisition cost of a system. Overall, System Supportability Engineering should be applied within the framework of the systems approach to acquisition.

5. The Standards And The Gurus

5.1 Military Standard 1388

The US approach to ILS was based in Military Standard (Mil Std) 1388 parts 1A and 2B [2]. However, in recent years this Standard has fallen into disrepute mainly under pressure from US Industry. The perception from US Industry is that ILS implemented within a Mil Std 1388 structure is too prescriptive and the programme benefits are difficult to quantify. On both sides of the Atlantic the acquisition communities have adopted a 'systems approach' to acquisition and it has become clear that Mil Std 1388 does not align itself easily with that philosophy. The systems approach requires a more flexible methodology that enables a variety of support options to be explored in the pursuit of cost-effectiveness. Recently, Mil Std 1388 Part 1A has been replaced by Military Handbook 502 – Acquisition Logistics Handbook.

N.B. The US move from a Standard to a Handbook is significant in that it moves from the mandatory application of a Standard to the guidance offered by the Handbook.

5.2 Defence Standard 00-60

Defence Standard (Def Stan) 00-60 [3] is the current UK equivalent of Mil Std 1388. The Standard is still in use and invoked by many if not all of the UK MOD acquisition contracts; however, it is also heavily criticised by Industry for being too prescriptive, expensive and unwieldy. The systems approach to acquisition did not in itself undermine the credibility of Def Stan 00-60 but the document is now the subject of proposed revisions as a result of the Product Life Cycle Support (PLCS) initiative. PLCS will impose defined data exchange standards on defence contractors and it is still unclear if those new standards are compatible with the current Def Stan 00-60 processes.

5.3 ILS

One of the accepted leaders in the field of ILS is James V Jones and his Integrated Logistics Support Handbook [4] is the reference book of choice for many ILS practitioners. The approach expounded in the handbook is structured and there is no doubt that if it were followed then all ILS issues would have been addressed by the time the system or equipment is brought into service. However, Jones pre-dates the tendency to include Commercial Off The Shelf (COTS) items in design solutions, Contractor Logistic Support (CLS) as a support solution and appears to apply ILS without taking a realistic commercial view of the implementation costs.

5.4 Systems Engineering

The leading systems engineering 'guru' is Benjamin S Blanchard, Professor Emeritus at Virginia Tech. He has shaped systems thinking through his books System Engineering Management [5] and Systems Engineering and Analysis [6], which he wrote in conjunction with Walter J Fabrycky. Much of the systems thinking being applied within MoD today originate from these two reference volumes.

6. What Should System Supportability Engineering Bring To The Programme?

System Supportability Engineering provides the following benefits to the programme:

- It must educate the design and/or integration process with regard to Reliability, Maintainability, Testability and Supportability.

- The ILS process, which underpins System Supportability Engineering, must be cost-effective.
- It must provide the foundation for effective and cost-effective through life system support.
- The ILS process should guide you to the optimum support solution.

The above benefits are achieved through:

- Taking a systems engineering approach to the derivation of a support solution.
- Design optimisation – trading off the various design and support characteristics.
- Providing assurance that the right support resources will be in place in time to operate the system or equipment.
- Providing assurance that supportability requirements can be met through the media of:
    - Support solution.
    - R&M Case.
    - Logistics Demonstration.
    - Support System Trials & Evaluation.

7. Where Does System Supportability Engineering Fit Into The Programme?

7.1 Concept

During the Concept Phase the Customer's Programme Supportability Engineer (PSE) should begin to formulate the overall supportability strategy. As part of this thinking the issue of logistic analysis should be considered and, in particular, how the analysis process needs to be tailored to achieve the programme aims at minimum cost. The derivation of the overall supportability strategy should begin cognisant of the Use Study. However, the Customer (DPA) does not have a good record of providing the Use Study in a timely manner or usable format.

7.2 Assessment

7.2.1 FMECA

One of the most important elements of the System Supportability Engineering process is the Failure Modes Effects and Criticality Analysis (FMECA). Again, this element has fallen into disrepute because it is seen as manpower intensive, time consuming and very expensive. However, in an attempt to obtain meaningful results in a timely manner during the assessment phase, the FMECA can be tailored to provide a functional level analysis. The aims of the functional level FMECA are, firstly, to give the design team a top-level appreciation of where the design issues might lie; secondly, to provide early failure information to enable the establishment of the R&M Case; and thirdly, to provide functional level information to the safety engineers to enable the early safety analysis to begin.

7.2.2 Logistic Support Plans

During the assessment phase the Customer logistics managers should be developing their view of the system supportability strategy. Often these early views are poorly defined but they do guide the potential contractor to gain a limited understanding of the potential support solution. Very often heavy hints are given which can guide a contractor; however, one should never fall into the trap of offering a type of support solution, e.g. CLS, just because the Customer has hinted that this is its preferred solution. In the final analysis the support solution has to pass the Main Gate affordability test. The selection of the support solution must always be made on the basis of cost-effectiveness within a support strategy – there is more than one way of delivering CLS.

The MOD output at the end of the assessment phase is an ILS Plan. The contractor will be expected to respond with an Integrated Support Plan supported by the necessary ILS element plans. This is the point at which the contractor can be very smart. The ILS plan will give the MOD view of how the supportability engineering programme should be put together; however, by skilful and careful tailoring the contractor can offer alternative (and less expensive) ways of meeting the requirement. For example, the MOD may request a Logistic Support Analysis Record (LSAR). If uncontrolled the LSAR can become a millstone around the contractor's neck and there is a particularly bad example of a US contractor losing $110 million on a programme through a poorly designed LSAR. The key is to understand fully the role of the LSAR and how it will be managed in-service. The decision can then be made whether to invest in software-based tools like Eagle and SLIC or to utilise a simple spreadsheet approach.

7.3 Design

One of the biggest challenges for the System Supportability Engineer arises in the design phase. As stated previously, the prime aim of System Supportability Engineering is to arrive at the most cost-effective support solution. In order to achieve this aim the supportability engineer must carry out his analysis and provide his input to the system design in a timely manner – the project manager will not allow the designer to hold up the design process while he waits for the last piece of the jigsaw from the supportability engineer. Consequently, the advice to the supportability engineer should be work quickly, accurately and effectively in order to match the pace of design progress – it is better to have some influence on the design than none because you were too slow.

Other activities that can be carried out in the design phase are as follows:

- Refine FMECA to system level. This can further assist the R&M and Safety Cases and assist the Reliability Centred Maintenance (RCM) analysis.

- The RCM analysis provides information to the Maintenance Task Analysis, Training Requirements and Documentation Requirement.

- The FMECA provides information to the Level of Repair Analysis (LORA), which assists Support Solution derivation through trade-off studies to provide maintenance policies, tools and test equipment and facilities plans.

Finally, some consideration should be given to how the system is to be disposed of at the end of its service life and how obsolescence is to be managed.

7.4 Manufacture

Prior to the design review process the bulk of manufacture effort would be in any prototyping required. However, as the design begins to 'chill', as it progresses through Preliminary Design Review (PDR), the System Supportability Engineering effort increases in intensity. The major effort is in the refinement of the ILS element plans as some of the support solutions emerge. The supportability engineer should aim to have between 75 and 80% of the support solution defined by the Critical Design Review (CDR) and for it to be 95% complete by design freeze. Beyond CDR, the effort should be directed at implementing the ILS element plans and formulating the System Support Plan. The System Support Plan should contain all of the key supportability elements of the ILS plans. Whilst a System Support Plan is not defined precisely in any textbook, this is the opportunity for the System Supportability Engineer to demonstrate how effective his supportability planning process was.

During the manufacture phase is the time to look forward to the system entering service. The MOD will be seeking proof that the equipment is as reliable, maintainable and available as specified in the requirements documents and predicted in the R&M plan. Consequently, it may be appropriate to consider how the in-service data is to be gathered and analysed in order to provide the necessary level of assurance. Failure to consider this process may lead the MOD to invoke and In-service Reliability & Maintainability Demonstration (ISRMD), which is carried out at the contractor's expense and can become very costly.

7.5 In-service

As the system enters service the System Supportability Engineer can now reap the rewards from the early system supportability planning effort. In-service data should be analysed to ensure that R&M predictions are being met. Moreover, where mission failures have been experienced, the reasons for these failures must be established. Furthermore, the performance of the support solution should be confirmed by monitoring operational availability, off the shelf satisfaction rates, AOG, VOR rates etc. The Customer will challenge the availability figures if there is a perception that the system performance is below par so it is important that the Supplier understands fully how well the holistic (operational and support) system is performing.

As can be seen from the foregoing paragraph provision of in-service data is paramount to understanding system performance. Historically, in-service data, especially that provided by the MOD, has been unreliable. Consequently, Original Equipment Manufacturers have not been able to access sufficiently reliable data to enable them to make system improvement decisions. The advent of Product Life Cycle Support (PLCS) with its associated data exchange standard (ISO 10303 AP239) should provide the future basis for efficient data exchange within Shared Data Environments. It is still very early to judge the effectiveness of PLCS - but the aims are laudable.

7.6 Disposal

The oil industry and nuclear power are two examples of how costly it can be to dispose of systems at the end of their service life. Much of the cost of disposal centres on satisfying the legislative requirements of system disposal and, as legislation is evolutionary, disposal costs are increasingly difficult to define. Consequently the best advice that can be given to a manufacturer is to plan for disposal at the design stage of the programme and attempt to include indicative disposal costs in the through-life management plan; however, keep your disposal strategy under constant review in light of legislative changes.

7.7 The Process Model

Figure 2, below, draws together the elements of the System Supportability effort from FMECA, with its outputs to the AR&M and Safety programmes, to the LSA element plans and the development of the System Support Plan.

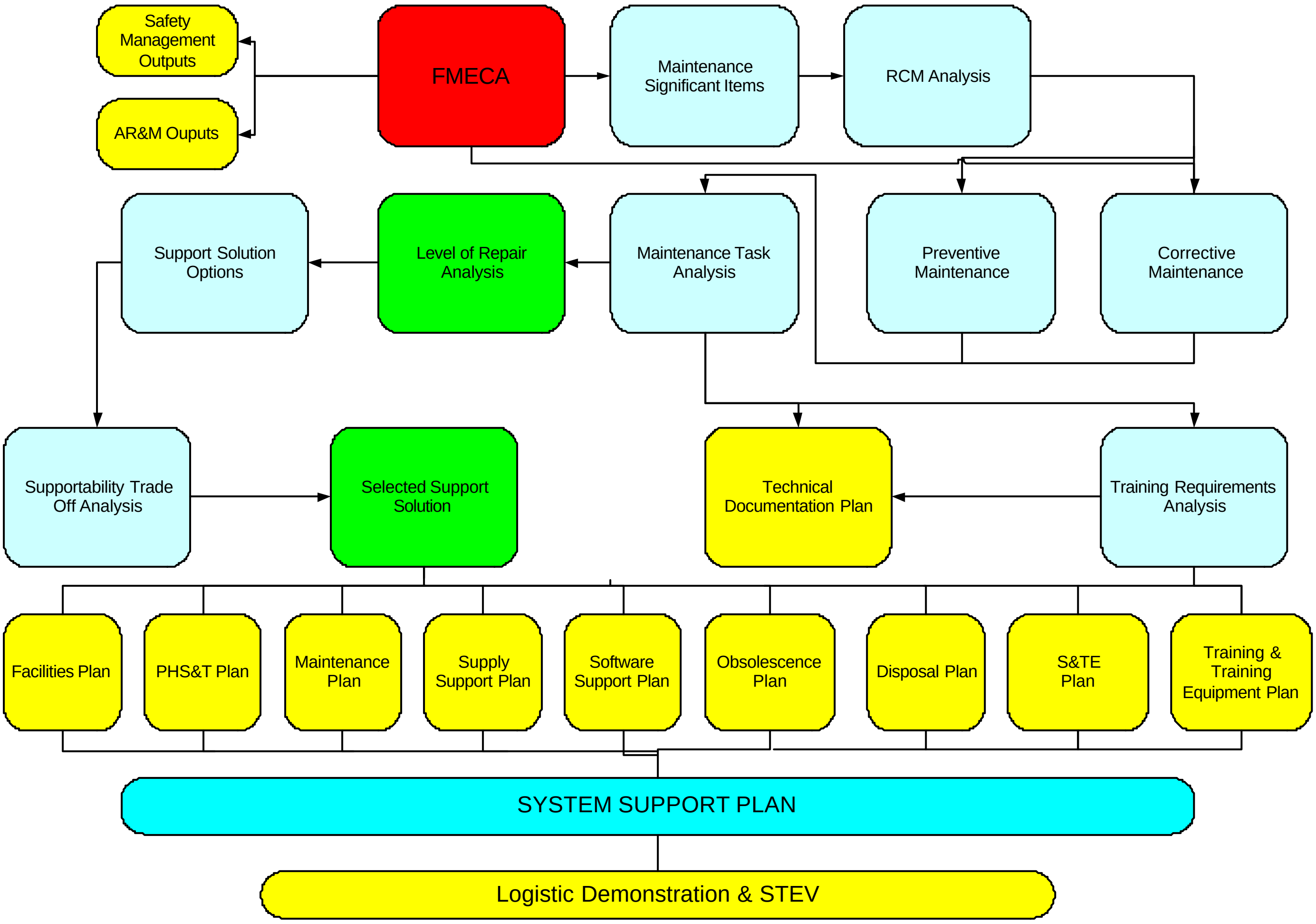

Figure 2 – The System Supportability Process Model

8. ILS's Bad Name

ILS, as a discipline, has a poor reputation amongst the engineering fraternity. Anecdotal evidence suggests that it can be a career-limiting move to simply admit to being an engineering logistician. Some programme managers see ILS and its associated analytical effort as an unwanted programme overhead that brings little benefit to the programme. Indeed, given the choice, many programme managers would dispense with ILS altogether. Consequently, one needs to examine and comment on the perceptions associated with ILS's bad name.

8.1 Strategy

Jones [4] is clear that ILS should be developed against the background of an overall programme strategy. The origin of the programme ILS strategy should be twofold – the Customer and the Supplier. Following the purist approach, the Customer should develop the ILS Plan during the Concept and Assessment Phases of the project. The Customer's ILS Plan should be submitted as part of the Invitation to Tender (ITT) documentation to the potential Suppliers. The Supplier should respond with an Integrated Support Plan (ISP), which addresses all parts of the ILS Plan, as part of the Tender submission to be negotiated prior to Contract Award.

In reality, the MOD ILS Manager breaks out a 'boilerplate' ILS Plan, makes little, if any, project specific adjustment to it and submits it with the ITT. In response, the potential Supplier reads the

boilerplate LS Plan and then provides a boilerplate ISP with supporting boilerplate ILS Element Plans, which it is hoped will satisfy the MOD ILS Manager. At the Tender Assessment, the Supplier has satisfied the 'exam question' so gets full marks for his submission.
The result of this lack of a strategic view of the ILS programme is one that evolves as the programme progresses rather than the ILS effort properly feeding the design and trade-off processes. It is due to this unstructured approach to ILS that it becomes the expensive 'add on' that programme managers dislike so much.

8.2 Speed

A justified criticism that is levelled at ILS is that the process is too slow. In reality, it is the ILS practitioners that are too slow. ILS is a data-hungry process and many practitioners will not make the necessary decisions until all of the data is available and can be thoroughly analysed. Against a background of tight programme timescales, it should come as no surprise to the ILS engineer that the designer would not be permitted by the programme manager to wait for the ILS input before progressing the design. Consequently, if the ILS engineer wishes to influence the design to make the equipment more supportable, he must respond quickly - better a less than perfect input than no input to the design.

8.2 Expense

One of the major criticisms of the ILS process is that it is too expensive. Indeed, it is not unusual for ILS to cost between 15 and 20% of the acquisition cost. However, it is in the area of cost that the ILS engineer can show his true worth. For instance, an extensive component level FMECA would be a very costly and time-consuming undertaking. Whilst the results would feed the safety programme, R&M programme and the LSA process the level of detail may not be appropriate to the stage of the programme. By tailoring the FMECA to provide functional level information, the safety and R&M programmes can still be initiated (at the functional level) but, more importantly, the LSA process will begin to reveal issues and feed the design at an earlier stage. Should it be beneficial to the programme the FMECA can be carried out at increasingly detailed levels to fit the available budget or timescale.

8.3 Prescription

On both sides of the Atlantic the application of ILS has been perceived by Industry as being too prescriptive and this has led to increasing pressure from Industry to address the problem. Jones [4] allows for tailoring of the ILS process to suit the programme and, indeed, actively encourages it. Consequently, there must be a reason why ILS is applied in too prescriptive a manner.

Speaking from personal experience as a former MOD Military ILS Manager (MILSM) the tenure of a MILSM is approximately three years. Prior to taking up the appointment operational commitments prevented pre-employment training so it was not until four months into the appointment that I underwent the necessary training. Having been on the receiving end of some poor ILS programmes, I was determined to ensure a sound deliverable; however, because I had not set up the programme, I inherited the programme decisions and had to make the best of them. Clearly, from my inexperienced position, I felt at a disadvantage when speaking to my Industry colleagues – I thought (perhaps mistakenly) that they knew a lot more than I did about ILS. Not being very experienced in the ILS arena, I fell back into the comfort zone of Def Stan 00-60 and followed through with a prescriptive programme – something my predecessor had also set up through his lack of knowledge and experience.

Industry, especially in the US, has a culture of giving the Customer what he asks for – almost without questioning the requirement. Consequently, when presented with the Customer's ILS Plan the Contractor responded with a compliant ISP. No attempt was made by the MOD, through lack of knowledge, or by the Contractor, through wishing to please the Customer, to tailor effectively the ILS programme. Consequently, another prescriptive, excessive and expensive ILS programme was born.

9. COTS

During the last several years there has been an increasing tendency to include a significant element of Commercial Off The Shelf items in proposed system solutions. There is also an increasing tendency in Industry to make the statement 'It's COTS so we do not need to do ILS'. We need to dispel that rumour here!

When attempting to apply ILS to a COTS-based system solution it is true to say that ILS is unlikely to make a contribution to the LRU design. The LRU will be offered 'off the shelf'; although one would hope that ILS principles had been applied during the LRU design process. However, in formulating a system solution the role of ILS is to influence the integration of the COTS items into the system – and this is very important.

9.1 When It Went Wrong

There is a well-known example regarding the manufacturer of Generating Sets. Whilst fulfilling a contract for a customer, this manufacturer integrated a range of COTS items to meet the Generator requirement. However, during the integration design little attempt was made to apply ILS principles.

During acceptance trials of the Generator one of the COTS LRUs kept failing. Indeed, later perusal of the R&M information on this LRU showed that it was less reliable than other system LRUs. However, the design team had integrated this LRU in the Generator such that a significant amount of other LRUs had to be removed before access could be gained to the faulty one. The result of this design error was that MTTR requirement figures could not be met and a number of maintenance failures were induced in the erstwhile serviceable LRUs.

Whilst this anecdote may seem minor, the reality was that the Generator had to undergo a complete re-design, which almost bankrupted the Company. The way in which LRUs are integrated into a system can have a profound effect on the performance and the support of equipment.

9.2 COTS Support Solutions

Each of the COTS manufacturers will have a suggested support solution – normally Forward to Deep; however, the system design team must not be fooled into thinking that the COTS support solution is the only one available. The overall support solution must pass the operational availability and cost-effectiveness test. Simply, the holistic support solution must be selected based on the effective use of supportability trade off analyses.

10. Weakness In The Feedback Loop

A common theme that emerges from most equipment manufacturers is the lack of an effective feedback loop to enable system performance to be monitored and system engineering change proposals to be initiated. The manufacturer needs operational information in order to be able to understand system performance in terms of reliability, maintainability, supportability and, thus, *operational availability*. The equipment manufacturer can then act on this information in an effort to improve the design – if it is cost-effective to do so.

10.1 Availability

Availability is the probability that a system or component is performing its required function at a given point in time or over a stated period of time when operated and maintained in a prescribed manner [7]. This top-level definition leads us to the top-level equation for calculating availability:

$$Availibility = \frac{Uptime}{Uptime + Downtime}$$

However, this top-level equation does not portray the whole story. To begin to understand system performance we need to be able to describe the reliability and reparability of the system in availability terms. This is termed Inherent Availability, sometimes referred to as Intrinsic Availability, (Ai). The equation for calculating Ai is as follows:

$$InherentAvailability = \frac{MTBF}{MTBF = MTTR_C}$$

Where MTBF is the Mean Time Between Failure and MTTRc is the Mean Time To Repair (Corrective).

To further understand system performance we need to add the dimension of preventive maintenance. This produces the performance parameter of Achieved Availability (Aa), which is a function of reliability and maintainability, both corrective and preventive:

$$AchievedAvailability = \frac{MTBF}{MTBF + MTTR_C + MTTR_P}$$

Where MTTRp is the Mean Time To Repair (Preventive).

The final dimension to understanding system performance is to understand how well the support system has been designed. This completes the picture of Operational Availability (Ao):

$$OperationalAvailability = \frac{MTBF}{MTBF + MTTR_C + MTTR_P + MTTS}$$

Where MTTS is the Mean Time To Support and includes parameters such as Administrative Delay Time and Logistic Delay Time.

10.2 Operational Availability

Having seen how operational availability calculations are derived and how important they are to measuring system performance it begs the question why so few programme managers and ILS managers understand them.

During my time as a Consultant, I have been in receipt of many Invitations to Tender and ILS Plans that call into question how well systems availability is understood:

E.g. 1. The stated Operational Availability requirement for a Command and Control Information System was 99.5% when planned downtime was accounted for.

This requirement is asking for only 0.5% loss of availability due to corrective maintenance (repairs) and the support chain activity – an unrealistic aspiration.

E.g. 2. The following is drawn from an R&M Plan to support a Fuel Tanker programme:

AVAILABILITY REQUIREMENTS

The Tanker Specification document does not detail any availability requirements.

RELIABILITY REQUIREMENTS

Table 1 below identifies the reliability requirements for the Tanker taken from the Specification:

Reliability Requirements
The User shall be provided with a Tanker whose mission reliability is not less than 97%.
The User shall be provided with a Tanker whose Basic reliability is not less than 90%.

Table 1 – Tanker Reliability Requirements

The Reliability Requirements are in a standard MOD format, which have been transposed to provide target MTBFs. The Contractor has, however, been unable to find amongst the ITT documentation any usable definition of Mission and Basic Failure. These key definitions for this Reliability programme have been developed by the Contractor:

Mission Failure

A Mission Failure is any incident that prevents the starting or completion of a refuel mission unless the operator can rectify it (having no specialized training) within 15 minutes from the time the incident occurred, using the tools and spares carried with the vehicle.

Basic Failure

A Basic Failure is defined as any maintenance relevant failure that results in an unsatisfactory equipment condition that requires unscheduled maintenance to restore the equipment to its peacetime serviceability state. It excludes scheduled maintenance actions but includes unscheduled maintenance highlighted by scheduled maintenance. All Mission Failures are also Basic Failures.

Failure Exceptions

The following failure exceptions are offered:

- A failure of a component beyond its specified life;
- A failure caused through misuse, accident, human error or maintenance not in accordance with defined schedules;
- Any use of the equipment in excess of its design limit;
- Secondary failures;
- Failures rectified by adjustment;
- Usage Indicators.

MAINTAINABILITY REQUIREMENTS

The Tanker Specification document does not detail any maintainability requirements. However, there is a maintenance requirement stated as follows:

> *'Other than daily and weekly replenishment and replacement of consumables, the refueller and trailer shall not need maintenance at less than 10,000km or 6-monthly.'*

Furthermore, the Mission Failure definition requires recovery from a failure condition within 15 minutes. However, this value has no relevance in the establishment of Maintainability Requirements except that it is a statement of the maximum permitted recovery time for the Tanker following a mission failure.

The above example is typical of the (operational) availability requirements being issued to Industry to fulfil. No further comment is necessary except to say that a commonly understood approach is necessary and Industry must buy in to the approach.

11. The CLS To ILS Link

In the support arena of today many US and UK Defence Programmes have an element of Contractor Logistic Support (CLS) within them. The CLS package can be delivered either as a conventional CLS solution or it may be a hybrid within the Integrated Optimised Support family that has been born out of '*Partnership*', '*Lean*' or '*Agile*' support initiatives.

The common denominator within these support packages is the need for the Customer to be able to recognise and prove that the support solution is value for money. In the final analysis, the defence Customer has to submit the support solution for scrutiny and it must pass the cost-effectiveness test. To the benefit of the Taxpayer this scrutiny has led to greater understanding of the cost of support and an increasing recognition and appreciation of the cost drivers in the support area.

In reality, the best way to ensure that the Customer is getting good value for money is to set a range of challenging performance indicators. However, arguments continue over what are effective performance indicators and it is still too early in the development process for the Customer to be sure of what is to be measured.

12. Systems Supportability Engineering

The future of ILS lies within the holistic discipline of Systems Supportability Engineering where:

- ILS takes a systems engineering view of the support environment to meet the capability requirements whilst optimising whole life costs.
- ILS looks to respond quickly during the Design Phase to enable supportability engineering to influence design.
- On COTS-based programmes it looks to influence integration.
- Features in the design and supportability trade-off analysis process to optimise the support solution.
- Looks for innovative support solutions.
- Has an operational usage feedback loop to empower and inform the manufacturer to enable system design improvements.
- Interacts in a timely manner with all of the 'design for' disciplines to provide an optimal solution.

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