Why is it so difficult to influence defence equipment design from a supportability and through-life cost perspective?

Introduction

This short brief offers an opinion about the challenges associated with influencing defence equipment design from a support perspective. It is a UK based opinion from an individual who has attempted to achieve this objective whilst mainly working with the defence industry over the last 35 years (see the author profile at the end for further information).

For reader time consideration the brief is purposely succinct. The author would be happy to debate any of the points made and provide further details on each.

Executive Summary

In a recent article, the US Airforce identified the F35 aircraft's poor reliability and subsequent maintenance as a key contributor to the $36,000 average cost per flying hour. Additionally, the US Navy announced they were willing to pay more for maintainable ships upfront if it means saving on maintenance and personnel costs throughout the life of the program.

There is of course nothing new about the objective of establishing 'supportable' equipment in the defence domain. Integrated Logistic Support (ILS) and particularly Logistic Support Analysis (LSA) are techniques that have been in place since the 1970s to accomplish this objective.

So why does it seem to be so difficult to influence equipment design from a supportability perspective and apply the processes identified in the ILS and LSA standards and specifications?

To reduce risk, the UK defence customer trend is to seek Commercial Off The Shelf (COTS) or Modified Off The Shelf (MOTS) solutions. This approach results in very few projects where an opportunity to influence design exists.

If the UK defence customer did pursue a new design, several circumstances would need to be in place to enable effective supportability influence in the design process.

1. The project is not COTS/MOTS, and the customer can be involved with and influence the industry at the early design phases of the lifecycle.
2. The customer equipment user organisation can generate user requirements that are not primarily focused on operational performance and include through-life support considerations and supportability requirements.
3. The customer can perform supportability tasks, at the right time, to help the defence industry with supportability design influence.
4. The defence industry has an appetite for supportability design influence which is a key part of its design processes, and it has appropriate supportability competence and authority to do this work.

In some commercial equipment manufacturing domains all these factors are in place and align. In some of these domains, this is driven by 'servitization' and the concept of the manufacturer supporting the product through-life. For manufacturers of complex equipment, the adoption of a servitization ethos becomes the driver for a supportable through-life product.

Context

F-35 Aircraft

In a recent Thomas engineering and design article the Air Force tacitly admitted that the F-35 fighter jet was a failure. A very expensive, time-consuming failure. The F-35 was supposed to be a low-cost, lightweight fighter jet. But with a cost of around $100 million per jet and project delays now stretching into double digits, the F-35 is one of the most high-profile failures in the history of military procurement.

What was originally conceived of as a solid, reliable, versatile fighter jet has turned into a premium, complex design stacked full of expensive tech. The way the F-35 has evolved has made it virtually unusable for its intended purpose. The F-35 isn't enhanced to perform for long distances, nor is it equipped for close-range air to air combat. All this tech requires expensive maintenance, too: for each hour an F-35 is flown, it costs an average of $36,000. That makes the F-35 at least three times more expensive and hour to fly.

The Air Force Chief of Staff Charles Q. Brown Jr. summarized the problem nicely in a statement announcing the exploration of other fighter jet options: “You don’t drive your Ferrari to work every day, you only drive it on Sundays. This [the F-35] is our ‘high end.’ We want to make sure we don’t use it all for the low-end fight.”

Future Maintainable Ships

In a recent Defence News article, the United States (US) Navy announced they were willing to pay more for maintainable ships upfront if it means saving on maintenance and personnel costs throughout the life of the program.

Tom Rivers (the head of amphibious, auxiliary and sealift programs), whose programs fall under the Program Executive Office (PEO) for Ships, said “design for maintainability and flexibility” is one of the top focus areas for PEO Ships. He said it will influence how the Navy pursues several upcoming new programs, including the light amphibious warship (LAW), the next-generation logistics ship, a new submarine tender, a new ocean surveillance ship and the next-generation destroyer.

“LAW is a good example for the design for maintainability,” he said during a panel discussion at the Navy League’s annual Sea Air Space conference. “Having reliable equipment that does not require a lot of operator action to maintain will enable LAW to handle reduced manning, which, that’s the goal. It may require a larger upfront investment in higher-quality equipment, but we’re willing to do that to offset the sailor cost in the future.”

LAW is envisioned to have a crew of about 40 for the small ship that would haul about 75 Marines around remote areas as they hop from one temporary base to another.

Rivers added that LAW will include sensors and monitors enabling not only conditions-based maintenance, through which maintainers can see how well a system is running and conduct maintenance guided by performance data but also remote condition-based maintenance. The small crew may not be the recipient of the data, but maintainers in regional hubs could receive the data remotely and help schedule maintenance periods into the ship's operational plans.

Supportability - Modern History

There is of course nothing new about the objective of establishing ‘supportable’ equipment in the defence domain. Integrated Logistic Support (ILS) and particularly Logistic Support Analysis (LSA) are techniques formally codified by the US Army in 1973 with the issue of Military Standard 1388-1 to help achieve this objective. The ILS process plans and directs the identification and development of logistics support and system requirements for military systems, intending to create systems that last longer and require less support, thereby reducing costs and increasing return on investments.

1388 was updated in 1983 with the issue of 1388-1A a Department of Defense (DOD) standard. This update introduced new LSA Tasks to aid supportability influence on the design of military equipment. In parallel, LSA guidelines and requirements were established by DOD Instruction 5000.2, Major System Acquisition Procedures, and DOD Directive 5000.39, Acquisition and Management of ILS for Systems and Equipment. These created a single, uniform approach by the US Military Services to improve the supportability of military weapon systems through a disciplined approach to defining the required operational support and other ILS objectives during the acquisition development phase. 1388-1A was updated again in 1991 before being downgraded from a standard to best practice in 1996 as a part of defence secretary William Perry acquisition reforms.

1388-1A is not and never was a ‘standalone’ standard. As described in the document, it interrelates with a range of other standards. Those particularly relevant to supportability design influence are standards for reliability, maintainability, testability, Reliability Centred Maintenance, Level of Repair Analysis (LORA), Human Factors and safety. The reliability standards include those for performing Failure Modes, Effects and Criticality Analysis (FMECA), reliability prediction, Fault Tree Analysis (FTA) and Reliability Block Diagrams (RBDs). All these standards identify activities, which combined with early LSA Tasks, can contribute to supportability design influence.

In other parts of the western world, during the 1980s and 1990s, many defence customer organisations adopted ILS and LSA for the same reasons as the US DOD. Some of these customers developed their own standards and directives based on the US standards and instructions. An example is the UK Ministry of Defence and Defence Standard 00-60.

Post the Perry reforms, and specifically since 2010, European and US standards organisations have worked together on the development of ILS specifications. The strategic shift is the move from Government organisations being responsible for standards to industry bodies taking responsibility for specifications.

At this time, we have the ASD suite of ILS Specifications which were initiated by the international aerospace and defence community in the late 1990s. ASD is the voice of European Aeronautics, Space, Defence and Security Industries, representing over 3,000 companies and actively supporting the competitive development of the sector in Europe and worldwide.

In July 2010, a Memorandum of Understanding (MoU) was signed between ASD and its American counterpart the Aerospace Industries Association of America, Inc. (AIA) to promote a common, interoperable, international suite of integrated logistics support specifications in the aerospace and defence industries of Europe and the US. To make optimal use of the resources available, ASD and AIA agreed to work in concert on the joint development of the S-Series ILS specifications which includes S3000L for LSA.

Currently, ILS is described as 'a technology in system engineering to lower a product life cycle cost and decrease demand for logistics by the maintenance system optimization to ease the product support'.

Essentially ILS has the primary objectives of:

- Influencing equipment design - from a supportability and through-life cost perspective.
- Designing a cost-effective support system.
- Coordination and creation of the ILS Element products in time for their use when the equipment enters service.
- Maintaining or improving the support system during the in-service phase.

Note: This brief is only addressing the first of the above objectives.

The standards and specifications identified above, whilst extensive and arguably difficult to comprehend for the layperson, provide detailed information on how to achieve these objectives. The processes for supportability influence on equipment design therefore exists and has been in place since the early nineteen eighties.

Challenges

So why does it seem to be so difficult to influence equipment design from a supportability perspective and apply the clearly articulated processes identified in the standards and specifications identified above?

Challenge 1 - Contractual Environment

In the UK all Government departments are required to compete for contracts where feasible. Competition is typically price-focused and is intended to get the best value for money for the taxpayers. Many in the customer domain are not aware of or consider through-life support costs when addressing equipment acquisition cost and price. This drives the industry to minimise the cost of its equipment and omit potentially costly efforts for addressing aspects such as supportability. This would not be the case if the customer included supportability as part of its technical requirements requiring all bidders to cost this into their proposals.

To reduce programme risk, for a long time the general defence customer trend has been seeking COTS or MOTS solutions. When this approach is used there is no or very limited scope for equipment design influence.

Since the mid-2000s, the UK military shifted away from predominantly in-house support, introducing the option for support outsourcing via availability or capability contracts on large equipment projects. This was done to shift or share support risk within the industry, improve equipment availability and reduce through-life cost of ownership. This is achieved by passing the majority if not all of support operation ownership to industry via long-term performance-based contracts. From the limited available research into these types of contracts, this approach has had some success in some domains but has caused unforeseen problems in others.

Overall, this approach was applied to most existing equipment and the defence industry needed to understand its products reliability, maintainability, and produce a maintenance plan to be able to cost its service offer and include an appropriate profit for this support service. Due to the equipment already existing, the logic of design for support was not applied to most of the equipment involved in these projects. Where it was applied, to some degree, it introduced unforeseen issues relating to customer engineering capability and personnel retention, particularly in the Naval domain. Ultimately, whilst the concept that industry would logically design for support due to these types of contracts, the contracts in themselves did not achieve this objective.

In summary, mainly due to the COTS/MOTS approach, there are relatively few UK military projects that have the scope for supportability design influence. Accepting this is the case, on the few projects where this opportunity exists, what is the challenge?

To influence any industry 'new' design from a military customer perspective would require the customer to either, 1 be involved with and direct industry design from the outset or 2 for the defence industry to embed the supportability design influence approach and related processes under its own initiative.

Option 1 is potentially feasible if the customer is providing funding to the industry for the concept phase and they possess and have available the skills required to generate appropriate supportability requirements (by performing some of the early LSA, reliability and maintainability design influencing tasks).

Option 2 is feasible if a company has compelling reasons to take this approach.

Challenge 2 - Working Environment

Several circumstances would need to be in place to enable supportability influence in the design process.

In a typical defence industry design environment, the equipment design is directed by a range of 'engineering' specialist areas. These areas have Subject Matter Experts (SMEs) and these SMEs work as part of a design team with each possessing some level of authority in the design trade-off and decision-making process.

Depending on the equipment type, specialist areas could include operational performance, weight, technology, structures, electronics, mechanics, software, safety, human interface, compliance, etc. It is rare to find design teams that include SMEs for specialist areas such as maintainability, testability, supportability, etc. When these specialist areas are included, it is uncommon to find they have any real authority within the design decision-making process. It is also a challenge to have supportability SMEs who are appropriately experienced and qualified to do an effective job as a member of the design team.

Key Factors

Ultimately there are several key factors or conditions which must be in place to enable supportability design influence.

The first of these is the commercial approach i.e., the technical requirements include supportability and through-life cost, it is not a COTS/MOTS project, and the customer can be involved with and influence the industry at the early design phases of the lifecycle.

The second is the lifecycle phase when design can be best influenced. Whilst design can be influenced in all lifecycle phases, as each lifecycle phase from Concept onward is progressed, design influence for any reason becomes more difficult. Ideally, supportability design influence starts during the Concept phase.

The third is a customer equipment user organisation with the ability to generate user requirements that are not primarily focused on operational performance and include through-life support and supportability requirements.

The fourth is the ability of the customer to perform supportability tasks which would help the industry with supportability design influence. This includes some of the LSA 200 series tasks which require some effort with appropriate capabilities to perform these tasks and at the right time to be effective.

The fifth is the industry appetite for supportability design influence which includes its design processes, and its supportability competence. If there is no obvious competitive advantage in creating a supportable product there is little chance of a company focusing on this facet of its design. Whilst reliability is typically a central aspect of most product designs today, maintainability and through life ownership cost may not be. If there is a desire to create a supportable design, the design process must include appropriate supportability SMEs involvement and real authority in design trade-off decision making. These SMEs must also be capable of working within the design team and able to advise and offer options in the design process on how to include supportability. For example, effectively performing some of the 200 series tasks addressing topics such as standardisation, comparative analysis, and technological opportunities.

Servitization

In other non-defence complex equipment manufacturing domains all these factors are in place and align. In some of these domains, this is driven by 'servitization' and the concept of the manufacturer supporting the product through-life. In its simplest terms, servitization refers to industries using their products to sell "outcome as a service" rather than a one-off sale. Netflix and Spotify are probably the most well-known example of this, delivering media as a service, rather than customers buying the records, CDs and DVDs that produce those outcomes. For manufacturers of complex equipment, the adoption of a servitization ethos becomes the driver for a supportable product through-life. There are many examples of companies that have successfully adopted servitization for their complex equipment and their customers.

Due to the nature of defence equipment often being used in a combat domain, servitization is not always a good fit in the defence environment but a tailored approach would be a way forward if the industry was appropriately motivated.

Conclusions

The concept of designing supportable equipment in the defence domain is simple. The conditions which would enable it to happen are not.

Whilst there are standards and specifications which define the appropriate processes, it is rare to find examples of them being used.

This is partly due to the customer COTS/MOTS contracting strategy directing projects away from 'new' designs and, when new designs are feasible, the customer not having the commitment or capability to do what is required.

As often demonstrated, the industry responds to the marketplace drivers and customer technical demands. The industry needs a compelling reason to do anything. As we see in the commercial equipment manufacturing sector, servitization provides this compelling reason and the tools which can help make it happen.

We will see if the US Airforce can address the reliability and maintenance cost of future aircraft and if the US Navy can influence design to obtain 'supportable' ships.

Author Profile

Julian Dayment is a principal consultant at Whitetree Group Limited. His first experience of LSA and ILS was whilst working for Rolls-Royce Defence in the mid-1980s performing LSA tasks in accordance with US MIL-STD-1388-1A. Prior to this, he performed aero-engine maintenance after completing a mechanical engineering apprenticeship. In the 1990s Julian worked for LSC and BMT Reliability Consultants as an ILS and LSA consultant working with both UK MOD and defence companies. From 1999 to 2012 Julian worked as an ILS freelance consultant mainly working with FMV in Sweden, BAE Systems and Rolls-Royce Defence. During this time, he started to specialise in the design of support service solutions for availability and capability contracts. In 2012 he joined Persides (which eventually became RINA) and continued to specialise in ILS and support service design working mainly as a Service Solution Architect for defence companies and the MOD. He joined Thales as their UK Lead Service Solution Architect in 2016 and subsequently joined Whitetree in 2020 where he continues to provide consultancy services in ILS and support service solution design. Julian has been a TDI member for many years and contributes to several TDI working groups.