A Strategic Approach to Obsolescence Management in the Digital Age

Jo Hursell* CEng CIRM

** BMT*
** Jo.Hursell@bmtglobal.com*
* Co-Authors
Matthew Jones, BMT
Carl Hall, BAE Systems Maritime Services
Sally Derrick, UK MOD, Defence Equipment & Support (DE&S)

Synopsis

A step change is required in the approach for managing obsolescence to meet the growing obsolescence challenge to the sustainability of complex systems. The rate of obsolescence is accelerating with increasing complexity and the abundant use of off-the-shelf digital technology. These factors increase system availability risks, and design changes often become the most practical solution.

This paper defines obsolescence, the challenges now and in the future, and the need for a strategic approach. A description of the strategic approach is provided, which manages the most significant obsolescence risks. The paper includes a case study “Portfolio of Complex Warships”, that demonstrates this approach for large scale systems across a portfolio to generate design change resolutions managed from a high level in the system architecture. The cost and schedule for each design change is estimated, accounting for when obsolescence will impact, and assesses technical and financial maturity for resolutions. To reduce overall costs, resolutions are aligned with planned capability upgrades in a technology refresh plan.

The paper brings obsolescence management formally into the engineering community to benefit the resilience and sustainability of future systems and improve asset related decision making.

Obsolescence can lead to a significant amount of waste, which could significantly increase with the accelerating rate of obsolescence; therefore, this paper also discusses the need to ensure obsolescence management is environmentally sustainable, introducing Circular Economy principles to reduce, reuse and recycle more resources.

Keywords: Obsolescence, Circular Economy, Technology Refresh

Biographies:

Jo Hursell has over 10 years’ experience providing OM support to MoD/Industry. Has developed a strategic approach for managing obsolescence for military platforms, which is being implemented on Type 45 and QEC. Is a UK expert for IEC 62402 OM Standard and co-chair of DE&S Joint Obsolescence Management Working Group.

Sally Derrick is an ILS Manager within the Ships’ Domain of DE&S. Sally leads the complex warship OM working group, designed to manage obsolescence at the system level, seeking to move obsolescence to a proactive cross platform approach affording Navy Command the opportunity for equipment consolidation, enabling efficient and cost-effective resolutions.

Matt Jones is a consultant at BMT with over a decade of engineering experience. Matt is focused on obsolescence engineering for complex systems, supporting development of processes, understanding risks, and obsolescence planning. Matt has experience leading concept developments, defining customers' requirements, assessing technology options, and produced long term programme plans.

1. Introduction: What is obsolescence, the challenges, and the need for a strategic approach

Obsolescence referred to in this paper is defined as ‘the transition of an item from available to unavailable from the manufacturer in accordance with the original specification’ [BSI, 2019].

A hardware asset being obsolete may not be a problem if there is not a requirement to replace the asset (e.g. due to failure) or if there is an effective through life support solution in place (e.g. the ability to repair is made available). Whereas software becoming obsolete is more complex as the need to update or replace software may come about not only because of the inability to make required updates, but also due to:

- Compatibility issues due to changes in hardware (e.g. drivers for peripherals).

- Dependencies with application software.
- Information assurance where software is required to be supported.

Rapid changes in technology, changing legislation and increasing system complexity are resulting in a greater obsolescence challenge. This is experienced in our everyday lives in the rapidly developing digital World for example self-driving cars, Internet of Things (IoT) and Cloud technology. Environmental protection legislation such as the Restriction of Hazardous Substances (RoHS) Directive and net zero emissions law, is increasingly driving reduced or even complete removal of components and assets that contain or emit hazardous substances and replacing them with alternatives. In the Author's opinion this trend is expected to continue for a significant time.

The factors identified in the paragraph above are making it more difficult to resolve obsolescence with full or near parametric substitutes, particularly for tightly coupled systems that are sensitive to change. When substitution is not effective, design change resolutions become necessary, which often take significantly more resources and require greater planning. As a result, in the Author's opinion, traditional obsolescence management practices using component-level risk assessment and monitoring are becoming less effective and a new complementary method is needed.

For more information on obsolescence and the challenges, see the International Institute of Obsolescence Management [IIOM].

2. Strategic approach

To get in control of the ever-growing challenge of obsolescence, a long-term, holistic approach to managing obsolescence is required that identifies and manages the most significant obsolescence risks and considers obsolescence management as an engineering problem. The three elements of this approach are shown in Figure 1, which are described below the figure.

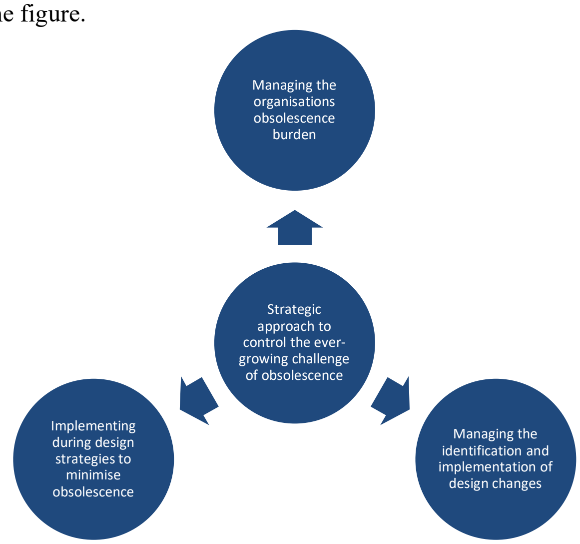

Figure 1: Elements of the Strategic Approach

The first element relates to reducing the overall level of obsolescence to be managed by an organisation (referred to in this paper as the obsolescence burden). An organisation such as the Ministry of Defence (MoD) is continually procuring and updating multiple systems and platforms. Any new or unique asset could increase the overall obsolescence burden to the organisation. The size of an organisation's obsolescence burden could become unmanageable not only because of cost, but also the time and resources required to implement changes to manage the obsolescence. Section 2.1 introduces steps that could be considered to minimise an organisations obsolescence burden.

The second element is designing systems to minimise the likelihood of obsolescence and to make it as simple as possible to resolve. Not only introducing methodologies to select equipment that is less likely to become obsolete but also designing equipment to minimise the extent of the change required when obsolescence occurs. Section 2.2 introduces the design strategies to minimise obsolescence.

The third element is to efficiently and effectively manage the identification and implementation of design changes required to manage obsolescence. Section 2.3 explains the Systems Approach to Obsolescence Engineering (SAOE) used to develop a technology refresh plan.

2.1. Managing an organisation's obsolescence burden

A reduction in an organisations obsolescence burden can be achieved by utilising shared infrastructure for networked digital systems and more broadly converging systems across a Fleet of platforms.

Shared infrastructure provides a computing environment that hosts software from multiple systems, which are accessed through a common suite of consoles.

System convergence migrates systems using different technology and equipment for the same functions toward a single or few technical systems. Historically, systems have been designed for a Class of platforms, as such the costs of technology refreshes across the Fleet are duplicated. The vision for system convergence is to employ commonality across the Fleet, by minimising bespoke equipment designs for a Class and converging equipment. By treating the Fleet as a portfolio of capabilities with many overlapping equipment needs, a significantly smaller number of distinct equipment types can be employed to deliver the same capability, and thereby reducing the cost and complexity of managing their obsolescence while increasing their environmental sustainability. It is noted that the requirements for equipment may not be identical, therefore some Class's may have additional capability to that required.

The benefits of shared infrastructure and system convergence are as follows:

- Fewer distinct equipment or system assets resulting in less obsolescence to manage.
- Reduction in space and power needed for computing equipment.
- Reduction in the carbon footprint of the supply chain and training facilities.
- Consolidated training, documentation, and spares provision.
- Reduced management overhead - cost and time savings.
- Maintainers able to operate across multiple complex systems.
- Economies of scale from batch procurement.

2.2. Design strategies to minimise obsolescence

Influencing systems during design can minimise the later effects of obsolescence and increase sustainability. It is well established that a large majority of life cycle costs are committed by decisions taken in the early stages of development [INCOSE, 2015] and obsolescence is no different. Figure 2 gives an overview of activities where explicit consideration of obsolescence would be of benefit, which are described below the figure. These design strategies are shown arranged according to ISO/IEC/IEEE 15288:2015 process groups [ISO, 2015], indicating the breadth of actions that can be used to minimise obsolescence.

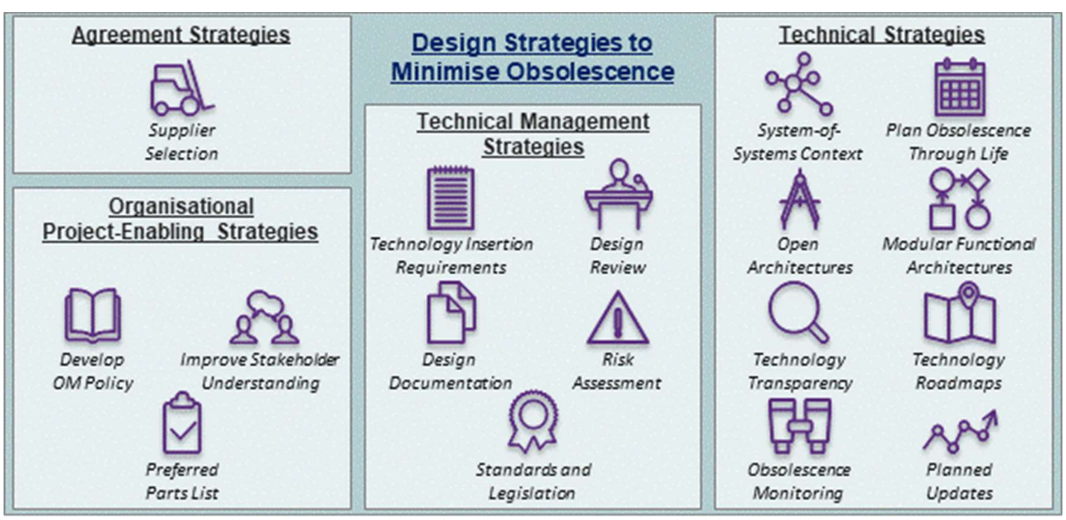

Figure 2: Design Strategies to Minimise Obsolescence

2.2.1. *Agreement Strategies*

Suppliers are selected based on a product service history that demonstrates commitment to managing obsolescence and supporting obsolescence resolutions.

2.2.2. *Organisational Project-Enabling Strategies*

OM policy for an organisation is clearly articulated, and briefings, training and working groups are established to ensure the responsibilities of stakeholders and the management of communication across the organisation are integrated.

Implementing a preferred parts list across an organisation (minimising equipment for the same functions toward a single or few technical systems) reduces the obsolescence burden (see Section 2.1).

2.2.3. *Technical Management Strategies*

Design documentation and reviews demonstrate that obsolescence has been sufficiently considered in the design and where appropriate predetermined points during the life cycle are identified when the design of a system will be brought up to date by replacing obsolete assets or assets at risk from becoming obsolete.

Obsolescence information is obtained, following which the risk of obsolescence (taking account of the impact of future changes to standards and legislation) and the scope of management activities are determined.

2.2.4. *Technical Strategies*

To improve efficiencies in implementing obsolescence resolutions, open architecture systems are used to reduce the use of proprietary applications and the extent of product "lock-in". The application of common standards / modularity for architecture and design, allows a degree of interchangeability with substitute items from different suppliers. Understanding the detailed specification of interfaces will also enhance the ability to use substitutes.

A systems-of-systems approach determines whether an item requiring a resolution is used across a portfolio of assets and determines whether a resolution can be developed for all applications.

Monitoring the status of equipment and developing roadmaps for technologies support obsolescence risk assessments by understanding the availability status and development path for assets, identifying emerging technologies that could supersede existing technologies or identifying regulation changes that could disadvantage existing technologies.

2.3. *Developing a Technology Refresh Plan*

A SAOE is a process that treats obsolescence as an engineering challenge to produce a Technology Refresh Plan. The approach considers complex systems, platforms, or multiple classes of platforms together and assess architectural hierarchies ‘top down’ to identify the priority obsolescence challenges.

The Technology Refresh Plan presents an auditable long-term rolling forecast (of at least 10 years) for the predicted cost for design changes. The plan is produced utilising obsolescence risk and implementation assessments, and stakeholder engagements to build up a project log of obsolescence resolution activities requiring design change. Costs are scheduled based on the support programme, technical maturity and funding status of the resolution, and the date when obsolescence is predicted to impact. The projects are also presented within a Gantt Chart. The Technology Refresh Plan should be of sufficient data integrity to support financial planning and therefore enable proactive management. Figure 3 shows the SAOE process which is described below the figure.

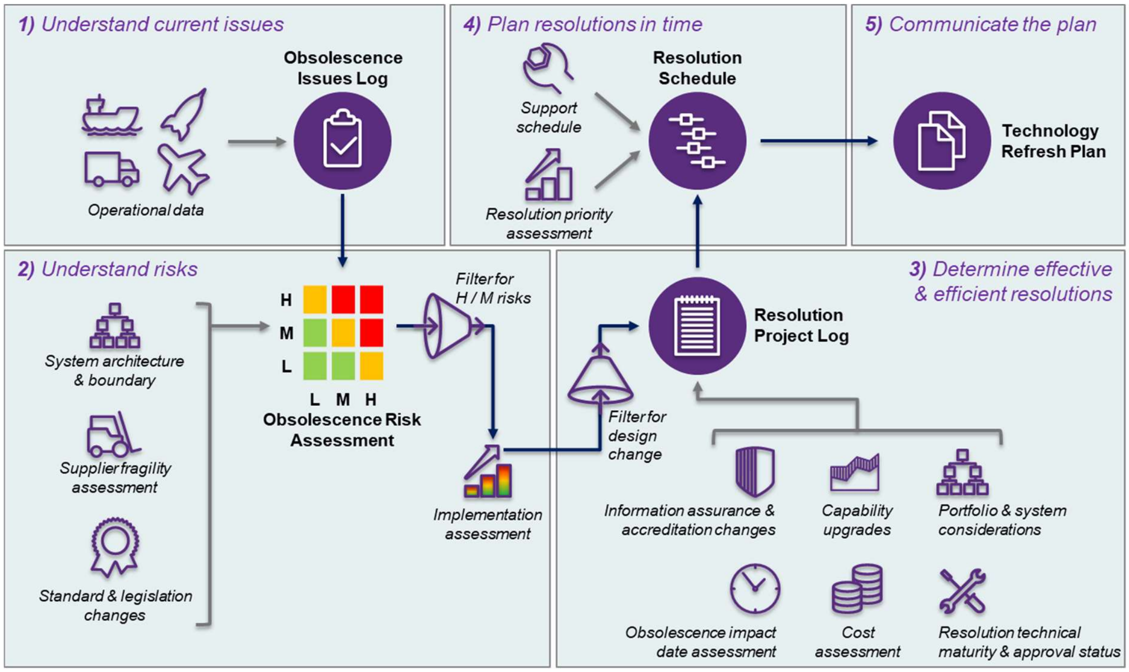

Figure 3: SAOE Process

2.3.1. Understand current issues

A record of obsolescence issues monitors the frequency and type of those that occur. This should consider how issues will be identified, recorded, and communicated. The record builds evidence showing the impact of obsolescence, and over time can measure if the obsolescence impact is being reduced through the implementation of obsolescence resolutions.

2.3.2. Understand risks

The system architecture and boundary are critical for understanding the structure and depth of assessment in the system's hierarchy and to provide a context for the significance of risks and issues. Risk assessment provides 'decision-makers with guidance on the approach to be taken to manage obsolescence based on an understanding of when obsolescence is expected to occur and its likely impacts' [BSI, 2019]. Medium and high-risk system elements are then considered in an implementation assessment that judges how difficult that obsolescence is to resolve. This combination of likelihood and impact (risk), and difficulty (implementation), is effective in identifying the greatest obsolescence challenges for the system.

2.3.3. Determine effective & efficient resolutions

The detail of resolutions requiring design change are identified with stakeholders; cost estimates, maturity, and approval status must be established. These are balanced with portfolio considerations, other planned changes to the system, and the date when obsolescence is expected to impact.

2.3.4. Plan resolutions in time

When resolutions can be implemented may be shaped by a schedule of planned support periods. A timeline of resolutions is developed with a profile of activities and costs, aligned to the utilisation and support schedule for the system. The order in which resolutions are implemented may be adjusted to prioritise near term obsolescence impact dates or other key factors if identified.

2.3.5. Communicate the plan

A technology refresh plan is developed, regularly updated, and published to relevant stakeholders. The plan provides a coherent picture of significant system and equipment change, driving long term planning, underpinning decision making and identifying risk and impact to the platform support programme. One output in the plan is a

Gantt chart showing the obsolescence impact date for each system and the planned design change projects against this event. Maturity of the solution and funding position are representing through colour coding. This presents a complete picture in time and maturity status for all the assessed systems.

2.3.6. Case Study; portfolio of complex warships

This SAOE approach has been developed predominantly through the success of work on Daring Class Type 45 Destroyers and Queen Elizabeth Class Aircraft Carriers. Data for operational deficiencies has been tracked to give a picture of current issues, particularly where these have been temporarily solved by moving equipment between platforms. An architectural breakdown of the complete system has been risk assessed, grouped by related system elements, to determine the most challenging problems.

These platform classes range in maturity, nevertheless prior to applying the systems analysis approach neither had a complete view of the obsolescence risk they carried, the status of those risks, or the full cost of implementing the resolutions. The approach has identified system elements with high or medium obsolescence risks that were previously assumed to be managed by substitution and are now being supported through projects with funding for design changes.

Where obsolescence is identified it is rationalised with digital security changes and capability upgrades to select suitable resolutions without duplicating effort. The process also promotes systems to exploit new technology when implementing obsolescence resolutions, aiding platforms to maintain their tactical advantage, at the same time as reducing the number of design changes required through life to resolve obsolescence and upgrade capability.

3. Sustainable obsolescence management practices

The Earth Overshoot Day for 2021 is 29th July [Global Footprint Network, 2021], this is the date when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year. Multiple strategies have been written to address climate change and sustainability, including the United Nations Sustainability Development Goals [Global Change Data Lab, online]. Sustainability has many aspects, this paper concentrates on those elements most applicable to obsolescence management.

Resolving obsolescence of digital systems often leads to whole systems being removed and replaced with updated systems, which in the Author's opinion is adding to the ever-increasing e-waste problem and use of finite materials.

The UK MoD has developed a Strategic Approach 2021-25 for Sustainable Digital Technology and Services (SDTS) [Strategic Command Defence Digital, 2021]. A guiding principle within the strategic approach is "Reduced Environmental Footprint - to be more economical with the planet's resources". One of the goals to achieve this is to embed a Circular Economy (CE) in digital technology.

CE is described as 'transforming our throwaway economy into one where waste is eliminated, resources are circulated, and nature is regenerated' [Ellen Macarthur Foundation, online]. This transformation requires manufacturers to re-think their products and services across the whole lifecycle to make them more energy efficient, durable, repairable, reusable, upgradable and recyclable. Recycling alone is insufficient to manage the e-waste that is currently produced.

Moving to an optimal level of circular maturity will not be instant, levels of maturity can be described from unformed (limited or adhoc actions), basic (actively exploring opportunities), improving (process improvement to align with CE principles), engaged (product/process innovation to align value proposition to CE principles), to optimizing (fully aligned to CE principles) [BSI, 2017].

Implementing a CE requires several actions and cultural change, including:

- Systems need to be designed so that minimal parts require replacing to address obsolescence e.g. using modularisation.
- CE is potentially in conflict with OEM interests as measures to extend the life of the device and provide ongoing support and repair facilities potentially reduces profits, therefore organisations must work with the OEMs to develop a sustainable economic model.

- To upgrade equipment, OEMs need to offer a take back scheme and remanufacture facility. A cultural change may also be required to accept remanufactured equipment performance as being as good as new equipment.
- To increase re-use, knowledge of surplus equipment needs to be marketed, equipment needs to be able to be transferred between projects and where equipment is no longer useful to project teams a process to re-use outside the organisations e.g. other government department needs to be established. Within CE this is described as a cascade system, where repeated use of a resource is designed in from the start.

The implementation of CE needs to be top-down across an organisation and its suppliers. However, there are elements that can be pursued at the project level. On Daring Class Type 45 Destroyers greater focus is being applied during upkeep periods to carefully remove obsolete parts from systems being upgraded, and for them to be refurbished and returned to the spares pool to support in service ships. Activities are also taking place to consider whether parts can be repaired, rather than choosing the easiest and potentially cheapest option to replace.

4. Conclusions

A step change is required in the approach for managing obsolescence to meet the growing obsolescence challenge to the sustainability of complex systems. This approach should include managing an organisation's obsolescence burden, implementing design strategies to minimise obsolescence and a developing a technology refresh plan using a SAOE.

A SAOE is being successfully applied to a portfolio of complex systems to identify and plan design change resolutions, and to forecast obsolescence costs through life. This approach is dependent on Systems Engineering skills, and engineers should consider obsolescence in the earliest stages of design development to minimise its effects in later life cycle phases.

Resolving obsolescence of digital systems often leads to whole systems being removed and replaced with updated systems, which is adding to the ever-increasing e-waste problem and use of finite materials. The sustainability of obsolescence management could be improved by embedding CE into digital technology.

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