Enabling, Equipping and Empowering the Support Enterprise through Digital Transformation

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Synopsis

Existing digital technology is transforming adjacent industries and will transform the Maritime sector. Increased data integration, exploitation via applications and use of mobile technology will enable the realisation of benefits, particularly in the management of material state and design change. Improvements to the way we store, share, manage and act upon information will ensure decisions are based upon the best, most accurate and timely information available shared across the Support Enterprise. It will also reduce time taken for maintenance by better understanding the maintenance requirement and avoid unnecessary cost by reducing the need for 2nd, 3rd and 4th line support. All of this should lead to a greatly reduced safety risk and increased platform availability. Furthermore, these improvements will enable the Royal Navy (RN) to further empower its maintainers, improving efficiency, productivity and job satisfaction. These personnel are at the heart of the Support solution and are of vital importance not least because platforms are complex but also because conduct of operational engineering, by RN personnel at reach, in adversity, ensures the Service is always ready to fight and win.

The RN is embracing Digital Transformation (DX) as the means to deliver maritime support improvement and specifically safety, availability and productivity benefits. Navy Command has developed the Maritime Support Information Exploitation (MarSIX) strategy and model to drive the development of a single configured, assured, inter-related data set that can effectively exploit information across the enterprise and ensure the RN maintainer is firmly positioned at the heart of Support. Vital to the safety argument and meeting availability requirements, the approach is part of a journey towards a future Support Network that recognises the unique maritime operating environment and the close relationship between front line engineering and the enterprise that supports it.

Keywords: Digital Transformation; Data and Information Exploitation; Maritime; Support; Benefits; Improvements.

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1 Introduction

A combination of social media, cloud computing, mobility and advanced data analytics is revolutionising the way society approaches future opportunities in the business space. It is also important to recognise the benefits that can be realised within more complex activities, such as Asset Management, that have always required the use of data standards but with a largely analogue approach. A digital approach has the potential to benefit the support of the Royal Navy's (RN's) latest platforms, which have been designed for the first time using digital processes. As such, they have digital information that is vast in volume, varied in format and contracted against many differing specifications. Future platforms will make extensive use of digital configuration records, modelling, monitoring and recording capacity as an integral part of the design and will integrate build and Support data to smooth the transition into service and understand, with a better level of confidence, through life costs. This will impact on all technical information and see an increased integration of condition information and Integrated Logistic Support (ILS) to constantly refine the Support solution and should serve to prime future acquisitions to follow a similar approach.

Authors' Biographies

Capt Matt Bolton is the Deputy Assistant Chief of Staff (Engineering Support) in Navy Command Headquarters with responsibility for engineering doctrine and policy, operational engineering capability, engineering Support innovation and information exploitation. His Naval career spans 4 decades and has encapsulated numerous Operational, Training, Acquisition and Support roles, including secondment to industry.

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This paper describes a near future where RN engineers and technicians are appropriately enabled, equipped and empowered to undertake their role safely and efficiently as a result of effective training and experience in operational roles, benefitting directly from Digital Transformation (DX) enabled by technology, improvements to data quality and integration and coherent delivery at the point of need. These improvements will reinforce the position of the RN maintainer and how they interact with their physical and information environment both in harbour and at sea. Intelligent use of data in such an environment should greatly reduce unnecessary maintenance, increase platform availability and reduce the safety risk, which in turn improve job satisfaction and the so-called engineering 'lived experience'. To support this DX, Navy Command has developed a Maritime Support Information Exploitation (MarSIX) operating model with associated benefits to improve the delivery of Information and Knowledge Management (IKM) and Information Exploitation (IX) in a manner that can provide a data foundation able to provide clear improvements in information to the RN maintainer and the related Support Enterprise (that comprises the RN, Defence Equipment & Support (DE&S) and Industry Partners). This paper presents this approach including the model and benefits resulting from this activity.

2 The Goals and Benefits

There are many improvements sought from an organisation that undertakes DX. Improved task management via access to the right technical information, data visualisation, data sharing and peer-to-peer networking will improve the effectiveness and competencies of engineers and technicians. Access to accurate technical information in the right place at the right time, along with the spares and tools needed, will all improve productivity (including reducing 'motion waste'). Analytics and diagnostic aids will improve decision making, test and evaluation and accelerate repair times, reducing the need for physical intervention by 2nd, 3rd and 4th line Support. Accurate, timely maintenance and repair feedback will provide insights to system health and maintenance optimisation. The organisational ability to develop tacit and explicit knowledge from generated data and information for training and technical documentation is also important. The availability of an integrated data set has the potential to streamline the assurance process and reduce unnecessary administration by removing the creation of duplicate data for the convenience of the assurer. Provision of a shared understanding of the material state, compliance with safety arguments and appraisal of risk will enable the consistent application of judgement.

This information challenge is illustrated by the widely used Data, Information, Knowledge and Wisdom (DIKW) hierarchy e.g. in the context of an engineering system condition monitoring generates (Data) and the associated application provides trends (Information) whilst the interpretation of such results can be used to identify the impact to the system as a whole (Knowledge) whereas foresight can predict future failure based on these trends (Wisdom). However, to realise reduced safety risk and Support costs and increased platform availability benefits across the whole Support Enterprise there is a need to improve the translation of Data and Information to ensure that Knowledge and Wisdom is effectively communicated across the business. This will need a framework for expressing Knowledge and Wisdom enabled by decision support and expert systems that make use of cognitive technology (including machine learning, artificial intelligence and big data analytics).

Overall, RN maintainers, the de facto 'Field Service Engineers' of the Support Enterprise, must have access to the best information possible together with the necessary spares and tools, to Operate, Maintain, Diagnose and Repair (OMDR) equipment at reach, in adversity, thereby enabling the Service to be ready to fight and win. This is underpinned through access to timely, accurate and trusted information. Such a modern information capability improves their productivity, job satisfaction and the engineering lived experience. Without this, the Support solution will continue to be driven too heavily by task complexity and limited by information, not skill; as such significant opportunities to improve decision making will not be realised and RN engineers and Original Equipment Manufacturer staff will continue to be drawn into delivering outside programmed Support periods.

Application of the MarSIX strategy will result in the realisation of significant benefits to the Maritime Support Enterprise as a whole in terms of safeguarding safety obligations, delivering greater platform availability, improving operational engineering productivity and reducing Support costs, which are described in more detail below:

2.1 Reduction in Overall Safety Risk

Increased personnel safety due to ready access to technical information, material state picture and Support processes that are comprehensive, current and subject to regular reviews that capture and disseminate accurate and up-to-date information. Decisions across the enterprise will be based on a single set of assured, configured, inter-related information, which, when combined with appropriate management information, incident and event management and hazard analysis, will provide an information architecture for informed, auditable decisions.

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2.2 Increased Platform Availability and Resilience

Increased Platform Resilience and Availability through improved material state awareness due to enhanced data collection and exploitation, improved spares demand signals, technical information, tools and diagnostic aids; all of which enables engineers to OMDR more effectively and increase productivity. Access to timely, assured platform data by engineering authorities across the enterprise will enable Reliability Centred Maintenance (RCM), system performance analysis, remote diagnostics and asset tracking. This will lead to improved system health and performance, platform availability and mission readiness via enhanced planning and recovery, which exploits trend analysis; in turn benefiting Force Generation and schedule predictability.

2.3 Improved Job Satisfaction

Productivity improvement by enabling, equipping and empowering the RN Field Service engineers will increase job satisfaction. Clear and effective improvements to data collection, analysis and use (through DIKW) and the provision of accurate, up-to-date information at the point of use enables RN maintainers to focus their activity more effectively contributing to the retention of key skills within the Service and reductions in unplanned downtime.

2.4 Reduced Support Costs

Through optimised maintenance planning, inspection optimisation, cost and risk modelling and lifecycle cost analysis there is scope for significant efficiency gains. Rapid implementation of engineering change will also be enabled and these changes can be reflected in the on board documentation and configuration records with the minimum of delay. Support costs are further reduced as the reliance on industry to deliver Engineering Support on board is reduced through increased organic capability innovation and technical development in Support.

3 Approach

3.1 Models and Frameworks

Noting the goals and benefits above the approach to DX is driven by a need to:

- Exploit skills and improve the maintainer/operator experience;
- Optimise core operations (Support/'Field Service Engineering');
- Increase coherence across critical Support services and reduce vendor 'lock-in'.

There are numerous frameworks, models and data standards that could be employed to deliver DX at an Organisation level. However, the challenge for the RN, with its extensive Support Enterprise that comprises varying levels of existing digitalisation, is selecting the right approach or combination of approaches. Furthermore, it is always a challenge to secure the necessary level of interest, funding and commitment across the enterprise for major transformations.

In the maritime domain it is anticipated that DX will be an evolutionary process, based around a DIKW hierarchy, during which people and machines become more connected, the organisation becomes data driven and processes are increasingly automated. DX will be enabled through development and implementation of a MarSIX operating model and recommendations developed by Navy Command through engagement with DE&S and Industry Partners. It will seek to exploit opportunities presented by current and emerging technologies such as social media, cloud computing, mobility, advanced data analytics, internet of things and artificial intelligence.

3.2 Assumptions

The arguments above assume that data sets are complete, accessible, assured, synchronised and of sufficient fidelity and quality to extract the necessary information, knowledge and wisdom that will generate the insights and foresights introduced later. Advanced data analysis techniques may be able to obtain such benefits from incomplete data sets but there is also a need to understand and manage the data properties in order to have confidence in the analytics, particularly if undertaken by third parties. Where those attributes preserve safety, they must also be identified, verified and validated throughout the life of the platform (Data Safety Guidance, Version 3.0). Also, in the Naval environment, security will be a key attribute, which balances the need to know with the need to share.

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4 Opportunities

4.1 Data Exploitation on and off Platform

The exploitation of data generated by ship systems but analysed both on and off platform represents a significant opportunity. Some of the uses would include, but are not limited to:

- Performance analysis and optimisation;
- Maintenance 'on condition';
- On-board and remote enhanced diagnostics;
- Enhanced material state awareness;
- Improved demand planning and work package optimisation.
- Consistent assessment of risk;
- Enhanced ILS;
- Prognostics to support the maintainer; not to introduce a 'computer says' culture;
- Reduction in through life Support cost through avoidance of unnecessary engineering work.

Notwithstanding the significant challenge regarding the provision of persistent global communications with the required service bandwidth that connects platform systems whilst on operations (neither of which can be assumed in the Naval environment), investment in the appropriate IX will drive both insight and foresight, the benefits of which are explained below:

- **Insight**. Modest improvements to how we store, access and visualise data will significantly enhance decision making and the availability of system derived data from the platform. On-board analytics, diagnostic aids and feedback on maintenance and repair will provide insights into the material state and performance of platform systems.

- **Foresight**. The availability of measured data, in statistically significant volume, variety and velocity will enable the employment of prognostics. Such off-board analytics and modelling in a shared data environment will provide foresights into performance degradation, maintenance, inspection planning and optimisation and root causes, risk and cost. By extension these foresights, when communicated back to the front line, have relevance in future operations by allowing the prediction of the availability of units within the force. This activity requires the use of data science and open information architectures and standards to enable transmission and access to the data 'at rest', 'in motion' and 'in use'.

4.2 Asset Management

There is an opportunity to modernise existing capability to ensure that information is explicitly referenced to the physical asset via metadata and a database of configuration with a degree of assurance to protect it against discontinuance or change. This framework will also allow for association of other information artefacts, such as drawings and supply chain information, with configuration. Ideally, all technical information needs to be electronically linked with supporting configuration such that when one changes the impact to others is understood. This can be achieved through the use of data modules conforming to industry standards and their use to build Integrated Electronic Technical Manuals (IETMs). These relationships are key to providing efficiency across the enterprise and will allow improved automation in maintenance of technical information on board the platform. This data is also the basis of the Digital Twin, which may generate the less-intuitive foresights at equipment, system, platform or class level. A coherent approach to the management of data and its attributes will help enforce existing security protocols and create opportunities for new security controls such as remote access control and anomaly detection.

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4.3 Shared Understanding and Management of Risk

With increasingly complex platforms and an increasing expectation for the management of safety, current practices are inefficient. The data available must be complemented by access to dynamic material state information to generate an assured picture to enable key Support and safety decisions to be made, tested and audited.

5. MarSIX Operating Model

Through analysis of the desired end goals and benefits and available technologies Navy Command developed the MarSIX model, at Figure 1, which characterises the capabilities important to DX. It is focussed on the end user and the introduction of a greatly improved IKM and IX capability for the RN.

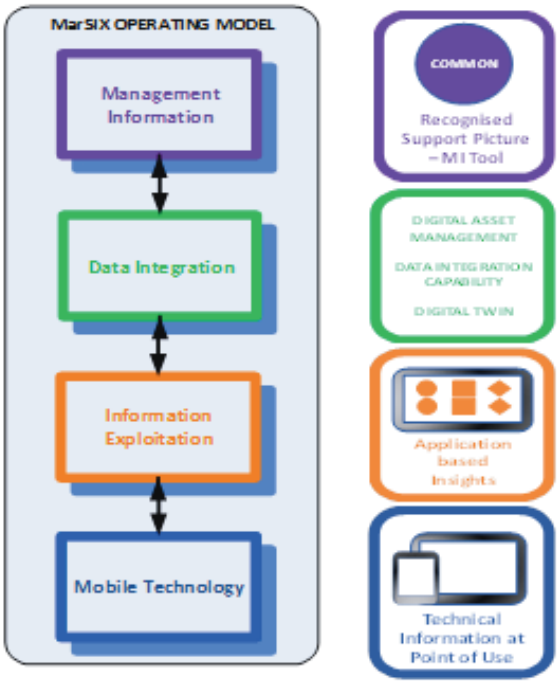

Figure 1: MarSIX Operating Model.

The model describes the cross-cutting capabilities required rather than a hierarchical or sequential view of a future architecture. However, it highlights 4 key capabilities that require policy development and investment if they are to contribute to the anticipated benefits:

- **Mobile Technology.** Mobile technology is one of several solutions that could provide Maintenance Information at the Point of Use. Specialist applications for maintenance management, technical documentation, logistics ordering, drawings, workflow and feedback processes (including peer-to-peer networking) will ensure that maintainers can access their information at their precise place of work and potentially interact with the equipment they are servicing.

- **Information Exploitation**. Even greater value must be extracted from the data within our platforms and, where applicable, personnel need to be supported with appropriate applications to enable the derivation of insight based on the data collected by ship systems. Similarly, the same applications should be available ashore but in this case supplemented to ensure that supporting authorities can generate foresight based on volumes of statistically relevant data. IX tools will require consideration to the management of applications across the enterprise including the hosting of services where they are needed, not according to who provides them. Such applications will benefit from agile development and delivery.

- **Data Integration**. Digital Asset Management strategies together with architectures that enable the sharing of data electronically and migration from a managed subset of the platform's data set to a single orchestrated data set, automatically shared across networks, will provide value across the

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Maritime Support Enterprise. Whilst commercial off the shelf Product Lifecycle Management (PLM) software tools may be the first step, for integration, the longer-term success of this approach depends on adoption of data standards e.g. ISO 55000 Asset Management, ISO 10303 Product Model Data and the ASD standards for ILS (including S1000D). Personnel and Resource Planning data may be integrated where there is an argument that it provides broader enterprise benefit. This layer is key to realising the Digital Twin and the benefits/value chain that this provides.

- **Management Information**. Management Information (MI) tools to allow managers across the enterprise to access and visualise information based upon the material state, policy and legislative compliance and examine safety arguments appropriate to the platform to determine 'safe to operate' and 'operate safely' status. Coherent policy for MI will support development of a Recognised Support Picture/Common Material State Picture that will both facilitate a greater understanding of material state risk and readiness by the Operational Commander and provide shared understanding for those across the enterprise responsible for taking corrective action.

5.1 Key Principles

The MarSIX strategy and model are underpinned by a set of key principles:

- Maximum efficiency and safety requires access to assured, configured data at the point of use;
- Effectiveness in the enterprise depends on increased data capture, unobtrusively; in turn, increasing automation will improve maintainer productivity;
- Adopt open standards to increase access to data across the enterprise;
- Wherever possible turn Data to Information, Information to Knowledge and Knowledge to Wisdom (DIKW);
- Develop a common MI policy to improve decisions across the enterprise;
- Analyse data, including historic data, at the point where best value can be obtained;
- Maintain current capability, in particular our Support applications, whenever possible and migrate these as new information capabilities are fielded;
- Design for the Naval environment where connectivity is likely to be discontinuous, constrained and cannot be guaranteed.

5.2 Maritime Support Improvement

MarSIX details the DX 'golden thread' that is central to the Navy's Maritime Support Improvement Programme, otherwise known as Programme Mollitiam (Latin for resilience). It is a journey, not a destination, with work underway to translate the MarSIX strategy into an agreed and prioritised set of projects within Mollitiam that recognise IKM and IX as key to the delivery of integrated Through Life Support. Crucial to this activity will be the creation of incremental improvements enabled by innovation and spiral development, including rapid test and demonstration, to generate either improved or new enabling capabilities. This approach should, whenever possible, be compatible across all platforms both current and future. MarSIX development activity will be closely aligned with Programme NELSON, which seeks to rapidly accelerate the exploitation of advanced data analytics and artificial intelligence in the RN through a common maritime big-data platform.

6 Summary

Adjacent industries are already transforming, embracing social media, cloud computing, mobility and advanced data analytics to improve business performance. The Naval sector must also transform to ensure the delivery of safe, available and capable platforms able to operate in home waters and anywhere else in the world, often far from home and in very challenging environments, within fiscal constraints. With fewer and often more complex platforms at our disposal it is important to better understand the effect of Support decisions and optimise resources to meet safety, availability and personnel obligations and commitments. IKM and IX are essential to these ends as a necessary foundation to improving the way platforms are supported, unlocking the capacity and

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capability of RN maintainers and delivering truly integrated Through Life Support. Whilst equipping, enabling and empowering the RN maintainer is the focus, success will be assured through an enterprise approach centred on the MarSIX operating model and associated benefits. DX must be compliant with future IS philosophies, where possible backwards compatible with legacy systems and exploit new platform solutions that are digital by design.

DX through the application of the MarSIX strategy reflects Navy Command's expectations for development of this IKM and IX capability. It builds upon earlier IKM work, the changing technology landscape e.g. Tablets (today) versus Augmented Reality (future) and PLM software (today) versus Blockchain (future) and is an essential activity on the roadmap to an improved future Support Network. It will require concerted effort across the enterprise in order that the goals can be realised.

Reference

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