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A model based approach to the

LHDSPO Sustainment Plan

September 2011

PHM Technology Pty Ltd

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Contact

PHM Technology Pty Ltd

Name: Mr Chris Stecki

Address: 9/120 Queens Parade

Office: +61 (3) 9482-2007

Mobile: +61 (4) 0941-9246

Email: cstecki@phmtechnology.com

Reference documents

1. Defence Simulation Strategy and Roadmap 2011 – ISBN: 978-0-642-29741-9
2. Plan to Reform Support Ship Repair and Management Practices – Paul Rizzo – July 2011
3. US DoD Weapon System Acquisition Reform, Product Support Assessment – November 2009

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Executive Summary

	Key Point	Summary
1	Model based analysis (simulation)	Model based analysis provides significant cost and quality benefits to the analysis required to support development and planning of sustainment activities and is consistent with Defence policy
2	Configuration Management of analysis	Model based approach to analysis to support the sustainment program enables traceability and effective configuration management of the engineering analyses performed and enables on-going analysis to be based on operational data (not theoretical or expected performance)
3	Knowledge capture and transfer	LHDSPO requires access to relevant operational data to enable it to retain important system knowledge and continuously analyse and optimize ongoing sustainment requirements
4	Integrated tool sets for technical analysis	Reducing the number of tools required for analysis of sustainment reduces the cost and complexity of the analysis process
5	The MADe solution	MADe resolves the issues identified above and meets the stated goals of the Australian Department of Defence and DMO in relation to the use of simulation to reduce cost and improve efficiency

1. Model based analysis (simulation)

PHMT believe that the introduction of model based technology to conduct the analyses provides the most cost effective and efficient means of carrying out these tasks and provides the following benefits:

- Formalisation of the engineering analysis methodologies and information structures to support sustainment of the LHD
- Optimize technical integrity based on consistent engineering analysis (including the ability to conduct analysis of any specific maintenance deferral or engineering changes that reflect the system / platform level implications)
- Enable "what-if analysis" for the LHDSPO and the CSC to understand the potential operational and sustainment impacts of proposed engineering changes
- Enable effective knowledge capture and transfer for both LHDSPO and the CSC (for further details see sections below they deal with these issues)

The Australian Department of Defence has consistently advocated the introduction of appropriate simulation capability to ensure that it can "analyse and fully understand the cost of ownership of capability; and provide enhanced decision support to decision makers in a cost effective and efficient manner".

The sustainment of the LHD program envisions a continuous improvement process that will see engineering changes to the platform over an extended period (20 years +).

These two factors indicate that the sustainment activities for LHD (in particular the determination of Maintenance Requirements for Preventive Maintenance) will require on-going analysis of the impact of any changes to the configuration of the functional equipment on the reliability and availability of the platform and their expected cost implications based on accepted engineering analysis (including Failure Modes Effects and Criticality Analysis (FMECA), reliability analysis, reliability centered maintenance (RCM) analysis and Testability analysis).

Currently the industry standard practice is to employ spreadsheets (primarily Excel spreadsheets) to conduct these analyses and this generates a number of significant issues for the LHDSPO and the CSC, including:

- Cost of conducting analysis (spreadsheets are labour intensive)

- Quality of the data (spreadsheets were not specifically designed or developed to perform specific engineering analysis and require the manual mapping of dependencies between different functional elements in the system / platform; spreadsheets do not enforce consistency of the terms used to develop functional models)
- System level analysis – historically individual technical risk assessments associated with the deferral of maintenance or acceptance of technical defects are conducted in isolation and therefore do not take into account the potential dependencies across the system / platform that could lead to either safety issues or equipment breakdown
- Scheduling – spreadsheet based analysis is time consuming and therefore usually not performed concurrently during the design process but retrospectively – limiting the capacity of the LHDSPO or CSC to understand all of the sustainment implications of any proposed engineering change until the end of any design or re-design process

2. Configuration Management of analysis

If a model based architecture is employed to conduct the analyses required to generate and then continuously improve the sustainment strategies for LHD this will provide the ability to align the models that are utilized with the specific configuration of the platform – aligning with and supporting best practice configuration management principles.

Furthermore, a model based approach enables the LHDSPO to update the models used for analysis based on actual data (i.e. field data from maintenance activities conducted) to update the models used for analysis and conduct analysis based on operational performance rather than expected (theoretical) reliability of the system / platform.

The LHD program will see the involvement of many generations of ADF, DMO and CSC staff during its expected life. It is imperative that the LHDSPO has the ability to maintain traceability of the analyses that are performed through this period to provide the data required for benchmarking and review of the decisions that are made for sustainment.

It is commonly accepted in industry that spreadsheets are difficult to transfer between users (this point has been discussed and acknowledged by various Australian / international industry contacts and DMO personnel with PHMT).

Spreadsheets require manual data entry to reflect operational performance – a costly and time consuming process that also provides the potential for erroneous data entry.

3. Knowledge capture and transfer

The ability of LHDSPO to make informed decisions on sustainment activities relies on its ability to access and understand the information that is collected and used by the CSC.

It is important that the provision of any data collected by the CSC is made available to the LHDSPO and this should be identified in the sustainment contract to ensure that the data is accessible to the LHDSPO in a timely and consistent process that enables the development of appropriate review methodologies by LHDSPO.

Furthermore, access to the operational data collected by the CSC will ensure that when future CSC contracts are put to tender, the LHDSPO will have a strong basis for understanding the level of maintenance activities that may be expected based on previous operational performance.

A model based approach to system modelling, capture and storage of operational data alleviates the potential issues associated with the use of spreadsheets (as discussed above).

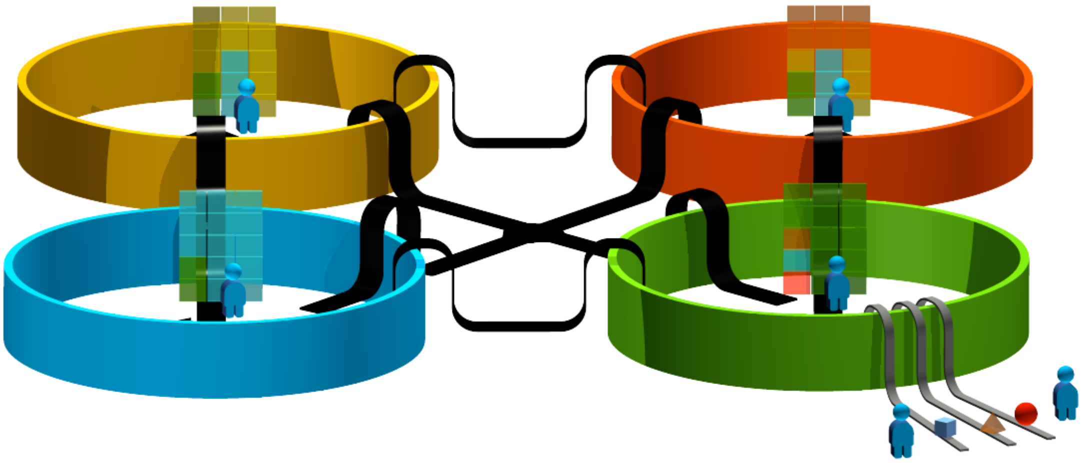
4. Integrated tool sets for technical analysis

The optimal solution for LHDSPO is to have each of these analyses performed on a consistent representation of the system / platform (i.e. a common model – with a consistent information architecture and taxonomy) to avoid the potential of comparing ‘apples to oranges’.

Furthermore, many of the analyses performed can have a material impact on the analysis performed by another group (for example if a change is made to the reliability of a component this can have an impact on the expected availability and safety of the platform – but also potentially to the level of spares or associated maintenance activities in the sub-system or related systems on the platform).

The analyses that support the development of a sustainment program are performed by engineers that traditionally reside in a number of different functional groups within an organisation or supply chain (including systems engineering, design, safety, logistics, etc.).

Historically, each functional group will develop its own model of the system and input / capture / analyse only those aspects of the system that relevant to their required deliverables – which results in multiple versions of the system that are not configuration managed and not directly aligned with the basis for analysis used by other groups (see image below).



The opportunity exists to use a model based approach to the analysis that provides an integrated tool set that offers the specific capabilities required by each functional group – but ensures that the basis for the analysis (the underlying system model) is consistent and can be aligned directly to the specific configuration of the platform for which the analysis is required.

5. The MADe solution

The Maintenance Aware Design environment (MADe) from PHM Technology Pty Ltd offers a commercially available software solution that has been developed specifically to provide modelling, analysis and decision support tools for the design and sustainment of defence systems and equipment.

MADe was originally conceived to enable consideration of sustainment requirements during the design process and facilitate the ongoing optimisation of sustainment based on operational performance of a system.

MADe is an Australian technology which has been financially supported in development by the US Department of Defence via the JSF program and the Australian Department of Defence (New Air Combat Capability team).

MADe offers the LHDSPO the following benefits:

- Integrated modeling tools and analysis capabilities to support system design and the RAM function (FBD, FMEA, FMECA, FTA, RBD, FRA, etc.)
- Integrated modeling and analysis tools for the design, verification and implementation of CBM, PHM and RCM capabilities
- ‘Model-Based’ workflow that facilitates rapid trade studies and verification

- Consistent representation and analysis of the system (standardised taxonomies)
- Continuous improvement of through life support capability based on fleet data
- System knowledge capture in a reusable and extensible model