CASE STUDY: APPLICATION OF A MODEL-BASED ASSET MANAGEMENT SYSTEM FRAMEWORK

ABSTRACT

This paper discusses a novel approach to structure and leverage existing asset information to produce tailored documentation for asset managers. The case study involves a major hydroelectricity generator developing Asset Management Plans (AMPs) by asset type and geographical location. The project served as the first trial of the approach, aimed at verifying its capability and furthering research and development of model-based Asset Management Systems. Through collaboration with the asset owner, the project focused on the restructure of asset management planning across the organisation, and better understanding the risk profile and composition of the asset portfolio.

Based upon a Model-Based Systems Engineering methodology, the Asset Management System Framework (AMSF) provides a structured model to capture asset information. From this, the complex relations and dependencies within a dispersed yet connected asset base may be understood. Storing asset information within a database allowed it to be viewed through multiple lenses using different slices of the information, producing three separate data-driven documents relevant to different audiences. Documents produced included a Turbine Asset Type Management Plan and an operational area AMP.

The framework provided a structured method for data collection; provided traceability between data elements and sources; enabled more effective configuration management; and created a current common understanding of the asset base. The project achieved the intended aims through the application of the AMSF, producing a suite of AMPs from a repository of information. The project highlighted the importance of information quality and maturity to produce an accurate depiction of current asset management practices and to understand risk to target preventative maintenance activities to improve asset value.

INTRODUCTION

Problem background

This case study concerns a major hydroelectricity generator in Australia with a multi-billion-dollar asset base, spread over a variety of locations. A common view of the management and maintenance strategy of these assets is difficult to keep current due to this size and location distribution. Figure 1 shows the multiple views of asset information that is required to make strategic decisions for the business concerning the assets. This information is typically presented in either of these views, via a set of asset management plans. It is then difficult to translate to the alternate view and maintain consistency of information.

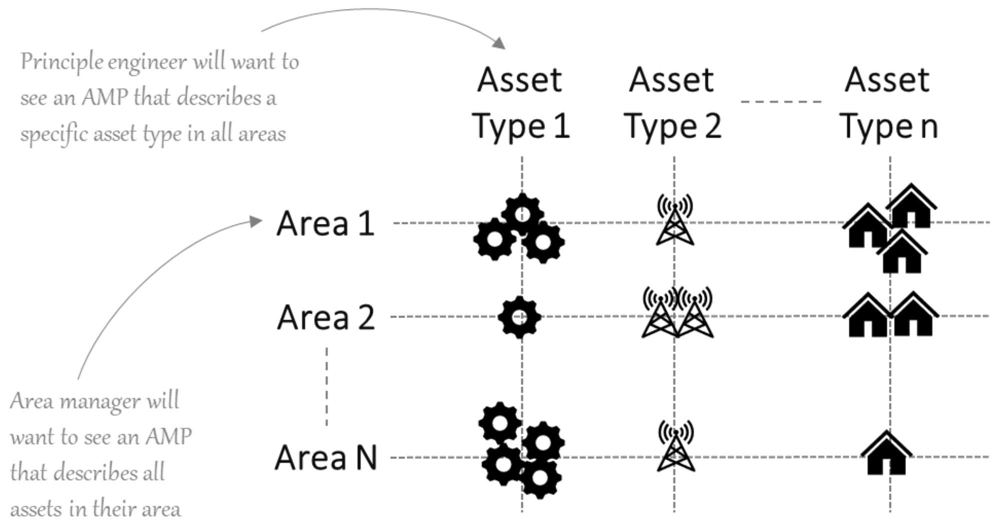

Figure 1. Different views of the asset base

It is difficult to consolidate the required information as it exists in multiple systems, registers, and in the brains and know-how of staff. A solution is needed to enable the data to be visible and digestible so that company decisions can be well-informed and impactful.

AMSF overview

Shoal has developed an Asset Management System Framework (AMSF) which is based on a structured information model using systems engineering design tools, defining a structured way to collect data; providing traceability between data elements; enabling more effective configuration management; and creating a single source of information that can be viewed through multiple lenses. The AMSF is an information meta-model, a set of processes and a collection of templates.

The main premise of the AMSF is that an organisation's asset management information is captured in an information model rather than a set of documents. This shifts the focus of Asset Management System (AMS) implementation and management from document-centric to information-centric, allowing for a greater focus on information quality.

The information model structure allows for traceability between various elements of the AMS: for example, the development of an organisation's asset management policy and asset management objectives should be based on the organisation's mission and objectives, and they are linked in this way using the AMSF. Also, intervention strategies for an asset should be based on the required functions and failure modes of that asset, and they are linked in this way using the AMSF

THE CASE STUDY

Objective

The objective of this AMSF application was to demonstrate that two separate artefacts can be output from a central information source. These artefacts were:

- Scheme Asset Management Plan (ScAMP) focussed on a single geographic area; and
- Asset Type Management Plan (ATMP), focussed on a single asset class.

The information contained within each of these artefacts needed to be different as the purpose of each document was different. The ScAMP was designed for the operations team to have a holistic understanding of the objectives, risks and activities relevant to their area. The ATMP was designed more for the engineering teams to have a holistic understanding of the risks, failure modes and intervention strategies relevant to the asset class.

Methodology

The methodology used to develop the information model and output artefacts used an iterative approach to each step in the understanding of needs, information mapping, information processing, and output design. This process is shown in Figure 2.

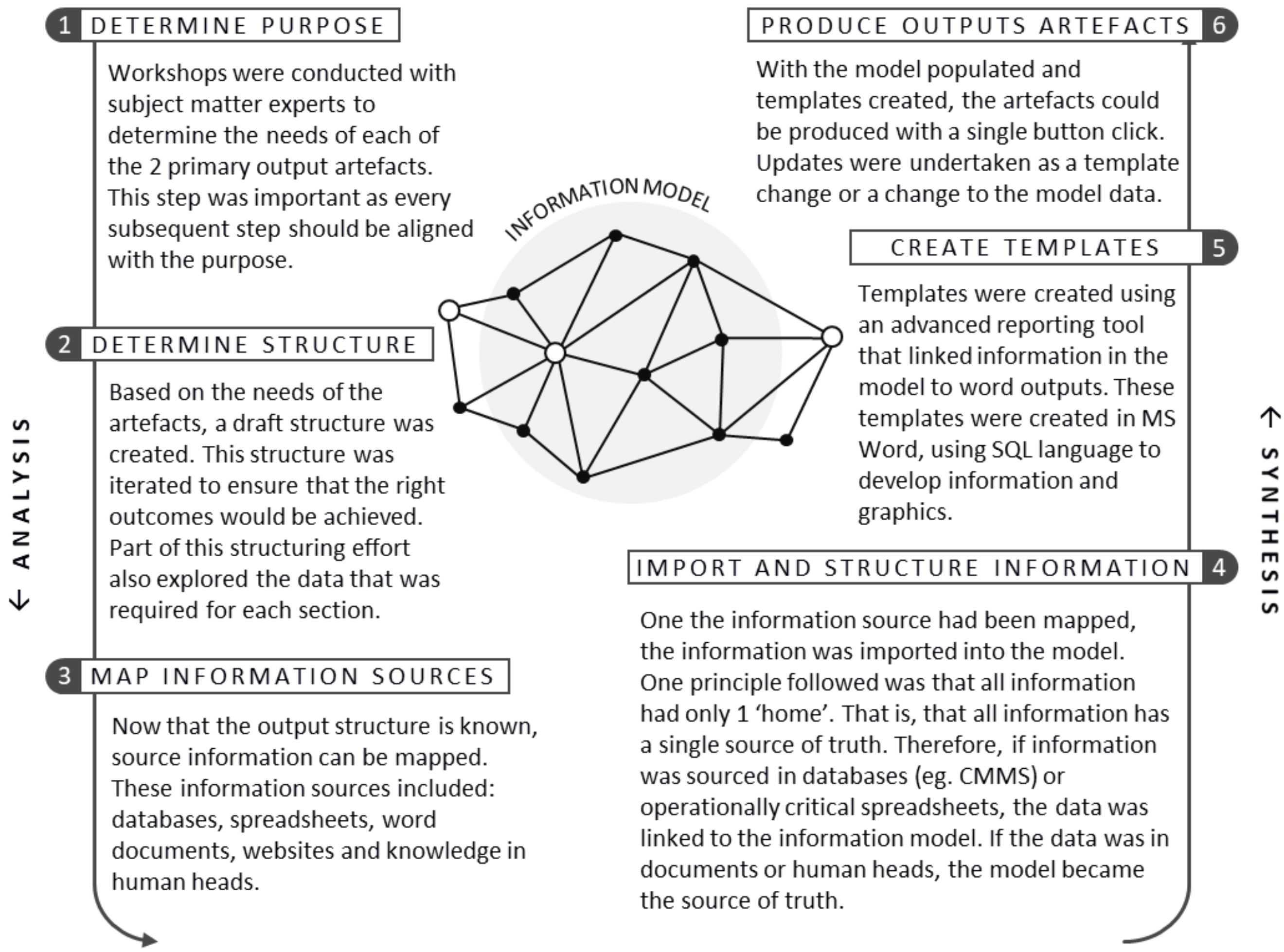

Figure 2 - MBSE methodology used

Information model

The information model is the instantiation of the AMSF meta-model in a relational database. This model was designed to structure information into approximately 30 interconnected element types, across 6 broad categories. These categories are: organisational context; guidance; AMS structure; assessment and auditing; asset portfolio; and interventions and activities. For this implementation, only elements in the guidance, AMS structure, asset portfolio and interventions and activities were used, as these are the most relevant for tactical AMPs. The information in the model came from a variety of sources, including databases, spreadsheets and word documents. Figure 3 shows the information source that were imported to the information model.

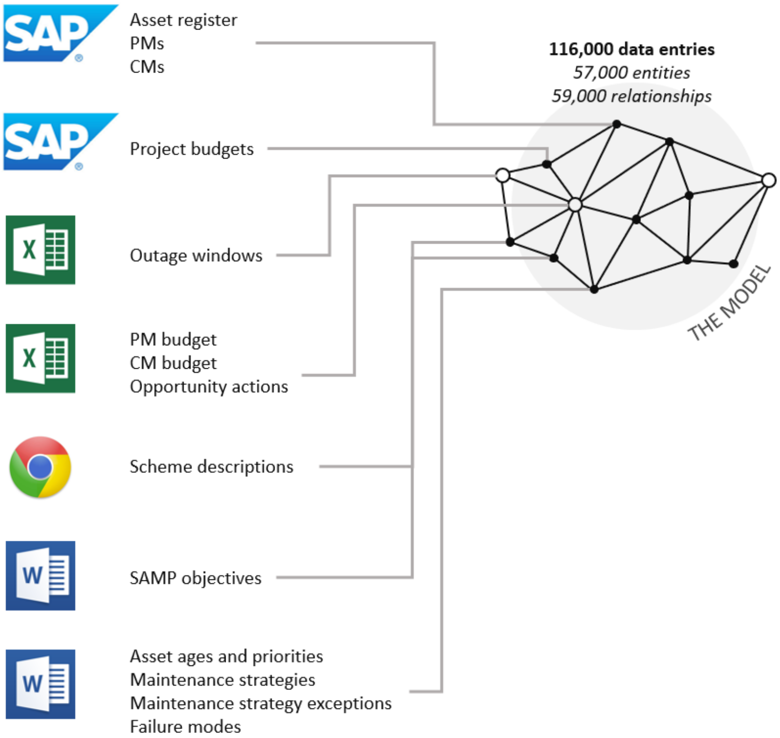

Figure 3. Information mapping

In total, more than 57,000 information elements were imported into the model. Whilst having all of this information in a single model was a significant step in creating the AMPs, the true value was in the way the information was connected. Every element was connected to at least one other element in a logical way that ensure the AMPs could be automated from the model. The result was more than 59,000 relationships were created, tangibly linking the information from the different sources. Most of these relationships were created using algorithms based on common points of information (such as an asset tag), but many relationships were manually created if a human decision was needed.

Outputs

The first step in creating the outputs was determining the needs of the output documents and what their structure should be. This was an iterative process that involved input from various stakeholders. Once a first draft structure was conceptualised, a template was created using the AMSF reporting tool and linked to the source information through SQL scripting. This enabled the automated export of AMPs from the model, in 3 formats: an ATMP, a ScAMP, and a ScAMP on 1 page. The ScAMP on a page was not initially part of the scope but was added to demonstrate that many different artefacts could be created for different purposes, based on the same information.

OUTCOMES

Through the application of the AMSF, the organisation is equipped with an ATMP for an asset classes and ScAMPs by geographical area, originating from the same existing information, drawn together from disparate sources. Generating ScAMPs and ATMPs from the same set of information reduces manual overhead and ensures all documents are consistent and aligned. This case study shows that the organisation had all the asset information it needed, but due to a lack of structure, couldn't produce the artefacts it required without significant manual input. Applying a framework provided a structure that allowed the organisation to produce a suite of documents without additional data collection or further manual effort. This process has furthered the research and development of model-based Asset Management Systems and confirmed the suitability of MBSE methodologies to Asset Management.

The AMSF uses a relational database to structure asset information, allowing it to be interrogated and viewed through multiple lenses using different slices of the information. This allowed separate data-driven documents relevant to different audiences to be produced. Consequently, all documents were aligned and resulted in a current common understanding of the asset base. The ability to present information in tailored ways for different stakeholders allows more informed decisions to be made and facilitates a better understanding of the complex relations and dependencies within a dispersed yet connected asset base.

The AMSF facilitates traceability through the whole Asset Management System and demonstrates due diligence in the lifecycle management of the asset portfolio. Previously, the organisation was reliant on static, often outdated, disparate documents, spreadsheets and existing systems. In some cases, each of these artefacts needed manual updates to maintain consistency. This change of paradigm considerably reduces manual overhead to maintain existing infrastructure and ensures informed decisions can be made based on current information, ultimately reducing risk and costs.

The AMSF is information centred, providing traceability between data elements and sources. As a result, data informing business activities such as maintenance schedule, planned spending and risk analysis is more consistent and therefore more reliable, better reflecting reality. Plans for capital refurbishment, replacement and renewal are informed and can be justified, allowing targeted allocation of resources in a timely manner. The organisation can identify which Asset Management objectives to address in the current financial year, with traceability to the activities undertaken which accomplish the objectives. The AMSF gives confidence that the processes are adequate, with alignment at a higher level to strategic plans and at a lower level to the assets involved and resources required for implementation.

This case study demonstrates a path to allow managers and engineers to better focus on information quality and maturity, to produce an accurate depiction of current asset management practices within an organisation. Information quality, completeness and consistency govern the correctness of the documents generated from the AMSF. As such, ensuring alignment between existing Enterprise Asset Management Systems, as well as manually created documents and spreadsheets is integral.

SUMMARY

Lessons learnt

This case study achieved its goal in demonstrating that:

Separate Asset Management Plans for asset type and geographical area can be produced from a single structured information model (the AMSF) with no need to write a document.

In addition to meeting the primary objective of the case study, and number of lessons were learnt that will be carried forward into future work:

- **Tailoring of the framework**
  - The AMSF was developed based on operational experiences of the R+D team and international asset management standards and guidelines. This specific implementation of the framework required some tailoring to ensure that the needs of the AMPs could be met. Additionally, the framework was continually tailored throughout the project, with the refinements getting more specific as time passed. It was important for the AMSF to allow for these changes in structure.
- **Partial use of the framework**
  - The AMSF was developed to capture much more information and produce many more outputs than was demonstrated in this case study. This includes development of a Strategic Asset Management Plan, organisation structure information, ISO55001 compliance information and reports, etc. This case study showed the importance of the AMSF being useful without requiring all the information that it was designed for.
- **Rubbish in, rubbish out**
  - The AMSF was not a silver bullet. The information that was fed into the model needed to be accurate and relevant, or the outputs could not be accurate or relevant.
- **Consistent unique identifiers**
  - On first inspection, the input data across the various systems seemed to be consistent. However, when the information from various systems was combined, there were inconsistencies. Two examples of this are:
    - Some (less formal) systems used nicknames for assets, rather than their actual name in the CMMS asset register. This made for easy reading for staff with the right context, but was difficult when trying to link information across systems.
    - Asset tags were sometime incorrect. This was often as simple as the official asset tag being “GC-PX-001” in the CMMS, but being referred to as “GC-PX-1” in a different system.

Conclusion

This case study is an interesting and informative step on the path of developing model-based asset management systems. The primary outcome was achieved, in demonstrating that different AMPs can be generated from a single information model. Future work will now involve implementing the AMSF across an entire asset base and exploring the benefits of the other aspects of the AMSF including strategic planning and compliance.

BIOS

Nikita Sardesai is a professional engineer with a passion for technical communication and a background in modelling & simulation, capability design, and process engineering. Since joining Shoal, Nikita has worked on various asset management, modelling and simulation, and capability design projects. Nikita also has experience with deterministic modelling and simulation through development and analysis of aerospace flight vehicle behaviour models, and performance analyses of these models.

Brad Hocking leads Shoal's Asset Management Systems program where he combines his experience in systems engineering, asset management, reliability engineering and risk management to address the complexity of our clients' approaches to managing their assets. He has successfully led the design, development, training and implementation of projects for both government and industry, and was previously in charge of our engineering training program. Brad holds First Class Honours in a Bachelor of Mechanical and Aerospace Engineering and is a Certified Practitioner of the Society for Maintenance and Reliability Professionals.

Thomas Jacquier is an engineer currently completing his final year of graduate Honours in Mechatronics Engineering and Computer Science from the University of Adelaide. Thomas's Honours thesis will explore modelling, simulation and prototyping an experimental test platform to explore novel approaches of generating power from ambient vibrations, with applications in powering smart sensors. He has a range of experience in leadership and communication through tutoring at the University of Adelaide and involvement in the Adelaide Mechanical Engineering Students Society (AMESS). While at Shoal, Thomas has worked on a range of projects including Asset Management and Software Engineering and is an INCOSE Associate Systems Engineering Professional.