Moving Toward Next Generation Asset Management

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Abstract Asset owners and operators face many pressures that challenge the status quo and their traditional operating models, including:

- Increasing pressure to defer capital expenditure.
- Reducing operational expenditure in response to budget reductions.
- Maintaining a social contract with customers to deliver sustainable, efficient services.
- An increasing shift from physical to digital assets to make better informed decisions regarding sustainability, compliance, cyber security and customer satisfaction.

An organisation that has a clear vision for its future is well positioned to manage these challenges and pursue opportunities as they arise, especially when considering investment decisions on the adoption of new technologies and practices. Next Generation Asset Management has the potential to address these challenges and generate savings by increasing operational intelligence to supplement existing asset management and service delivery methodologies. However, the risk to many asset owners and operators is that they fail to realise the potential of Next Generation Asset Management as they are unclear where to start, lack clear commercial and technical leadership, are unable to secure the right resources or are unsure of its impact on existing arrangements for asset management, O&M and ICT. This presentation discusses strategies asset owners and operators can use to establish and operationalise Next Generation Asset Management and includes significant insight from Ventia's experience in supporting critical public and private assets and infrastructure across Australia and New Zealand.

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1 Introduction

Next Generation Asset Management (NGAM) may sound like a buzzword, but the opportunities presented by a new way of working within asset management are entirely real.

The factor that separates NGAM from traditional asset management techniques is simply **data**. Ubiquitous, cheap data. While traditional asset management techniques have always relied on data in various forms, from handwritten measurements to highly accurate process data received from SCADA systems, the technology advancements and lower cost of data collection tools including lightweight, battery-powered sensors has dramatically increased the availability of data and therefore the possibilities of what can be achieved with that data (Microsoft Dynamics 365, 2019).

NGAM systems let us unlock the insights in our new wealth of data to allow us to meet the ever-present challenges of asset management in new, more efficient ways. This paper reviews the components of these systems and presents a framework for beginning to implement or extend an NGAM system and discusses some of the best practices and pitfalls faced in implementing the components.
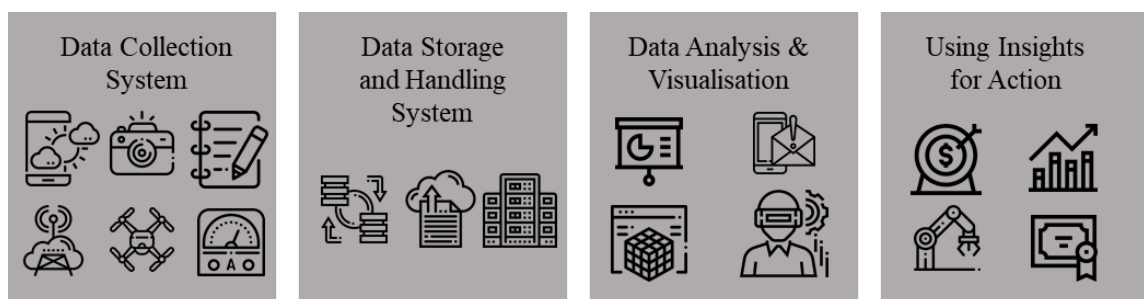

Figure 1: Data functions in NGAM

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The ideal NGAM system is heavily integrated end-to-end, however here we will focus on four broad functions of the system.

The first function to be considered is collecting the data, which thanks to cheaper sensor networks, is an ever-decreasing challenge. (Water Source, 2017; LoRa Alliance, 2022). Once the data is in hand it must be handled and stored for ongoing analysis, which by comparison is one of the great *emerging* problems of NGAM and will be the focus of much work and innovation in the near future (Latham, Barbu, Spark, Liu, & Dacre, 2021). With the data secured it requires analysis, which is where NGAM combines the insights of traditional operator/maintainers with the latest in computing power and machine learning. Finally, once the analysis reveals insights about the asset, the final (and perhaps most crucial) function is to turn those insights into action.

There is room for improvement in all four functions of the system. However, looking forward over the next decade we expect the most significant changes in the first and last functions — how we get our data, and how we use the insights. Data acquisition options are multiplying and falling in cost, opening new opportunities. While the way we assemble and communicate insights is already moving fast with ICT and is poised for an era-defining transformation by the promise of ubiquitous digital twins and Augmented Reality (AR) equipment (Marr, 2017; Rosenberg, 2021).

2   The challenge NGAM seeks to solve

Asset management is no longer about "just keeping the lights on". Asset owners and operators are under increasing pressure from multiple stakeholders to operate efficiently and sustainably, while maintaining regulatory compliance and a maximal return on investment. These pressures are pushed down to the asset management function and must be considered throughout the asset lifecycle.

Through a data-driven approach, asset maintainers are able to conduct **predictive maintenance** based on early warning signs of an impending failure, rather than waiting for a failure or conducting preventative maintenance on a fixed schedule. This allows for better resource allocation and lowers overall cost.

Case study 1: A simple system can be fitted to a vacuum sewer system which detects valve opening and closing events. A range of local acute events can be detected with such sensors. When combined with pressure, a range of network level conditions can also be assessed. Analysis of the data provided for vacuum sewer valves was compared against the failure and service reports for valves. The "simple" on-off data provided enough information to observe the degradation of valve performance over time. The data is robust enough to transition from preventative to reactive maintenance and allow the addition of data-driven predictive maintenance. This indicates which valves are on the way to failure and gives insight into the time available until loss of service, which allows for a planned allocation of resources. This is done in a cost-effective manner for thousands of existing valves due to the relative affordability and ease of install of the after-market wireless solution.

Use of NGAM techniques provides various **Health and Safety outcomes** through more selective deployment of field personnel. Time spent driving between sites for inspections and monitoring is reduced, while exposure to hazardous areas can also be minimised.

Case study 2: A client responsible for the maintenance of refrigerators and provision of food services across many facilities typically dispatches personnel to manually check fridge temperature. This process is expensive, and the data produced is sparse. There is also no ability to be notified in real time of a failure event. A recent failure event (door left open in this case) saw ~$20,000 worth of meat go to waste due to failure to detect the issue. An after-market wireless sensor solution for this fridge system costs approximately $200 per annum and provides near real-time data and alerting. The system response time is well within that required to save the next meat batch. A significant safety improvement outcome of this application is the reduction in kilometres driven for the monitoring personnel.

Predictive maintenance and a high degree of knowledge on the asset base can also allow for **Capex deferral**. This is not necessarily about "sweating the asset" beyond the planned service life but deferring/avoiding unnecessary upgrades to equipment due to optimisation (Boettcher, 2021).

Case study 3: In a region was experiencing rapid population growth, a water meter program using widespread, battery-powered wireless meters was able to identify that the network was experiencing 30% non-revenue water losses, found to be about 15% network and 15% customer property. The devices allowed the locations of the leaks to be easily identified, which allowed rectification of a significant proportion. This significant reduction in water losses allowed for the deferral of capex which would have been required to increase water treatment capacity.

A similar installation at Barwon Water in Birregurra saw significant reduction in water loss, sufficient to offset the project cost in weeks. (Barwon Water, 2021)

Finally, **Efficiency outcomes** are sought in resource use of plant and personnel. Through a higher understanding of the job to be done, resources can be re-allocated to where they are most needed.

> Case study 4: A cleaning contract is required to keep all the rooms in a facility clean. By using cheap and low-invasive sensors the use of rooms can be detected. This is used to optimise the cleaning frequency of the rooms, with heavily used rooms scheduled for more frequent cleaning, and seldom used rooms cleaned on an as-used basis. Additionally, the room occupancy data is expected to allow the asset owner to optimise the allocation of the resources.

3   NGAM Framework

Given the expected benefits of a fully integrated NGAM system, asset managers might be tempted to jump in and improve systems straight away. But where can the most value be unlocked? The best next steps are likely to depend on where an organisation is on the journey to an information-rich digital system.

Broadly, an organisation is generally in one of four phases: Exploring, Emerging, Integrated or Leadership. Note that these phases may not reflect how high-tech the organisation is overall, simply how well the various systems are being utilised in adopting and integrating the four functions described above into a cohesive system.

3.1   Exploring

Initially, an organisation's data initiatives are often siloed and reactive. There may be limited understanding and acceptance of new technologies among the leadership team, where the need for data-driven approaches is accepted, but the next steps are not known or agreed. The organisation may need support to document a strategic approach to meet their business needs.

Next Steps for the Exploring Organisation

The Exploring organisation is taking the first steps on their digital journey and the best way to start is by understanding where they are.

- The Exploring organisation should assess their asset base, operational processes and IT/OT infrastructure to determine if there are areas where technology can be leveraged to add value.
- Collect and assess existing OT data to identify areas for improvement.
- Formulate a strategic technology plan.
- Conduct a gap analysis against objectives or standards.

These processes can be assisted by an external organisation who can provide experience and insights not yet internal to the organisation.

3.2   Emerging

Organisation leaders acknowledge and support the need to digitise their asset base and have clear objectives. The basic needs are understood but the next steps, technology choices and integration platforms have not been decided.

Next Steps for the Emerging Organisation

The emerging organisation is looking to proceed with their technology strategy, so it is time to make some first practical moves.

- Conduct market sounding activities for possible approaches.
- Run trials and proof-of-concept projects.
- Select pilot sites/facilities that will act as a testing ground for multiple tools and technologies.
- Design site-wide or organisation-wide systems, particularly at the data storage layer.
- Prepare deployment and implementation plans.
- Engage with technology vendors, potentially running a tendering process.

The organisation knows broadly what it wants to achieve, and it is time to get into the details. An experienced person or team can help identify common pitfalls at this stage. This might be achieved by leveraging an internal team if there is sufficient scope to support it or sourcing an *owner's engineer* to assist in technical decision making.

3.3   Integrated

A formal governance structure is in place, including technology leaders, to ensure consistency in practices and procedures across the asset base. There is ongoing investment and consideration of best practices.

Next steps for the Integrated Organisation

The integrated organisation has the ball rolling on their NGAM system. The steps that are likely to add value at this stage include:

- Looking to select and operationalise a suitable technology stack.
- Integrate and commission functional systems into business as usual.
- Conduct change management within the organisation and actively drive adoption.
- Mature training programs and onboarding of new team members.
- Support the technology by beginning a continuous improvement program.

3.4   Leadership

At this stage we see an organisation that has already digitised a significant piece of their asset base and has a technology strategy and technical team in place. The organisation typically has a distinct culture of innovation, continuous improvement and sound decision-making structures around technology innovations.

Next steps for the Leader Organisation

The leader organisation has strong operational systems in place, so what remains to be done?

- Optimise the existing operation technologies and associated practices – seek to drive down operating costs, remove redundant/superseded components.
- Embed solutions more deeply into traditional asset management systems.
- Challenge the system security to ensure modifications have not compromised integrity over time.
- Strengthen change management as systems become business critical.
- Refine the balance between relying on the NGAM system and more traditional techniques.

4   Best Practice and Potential Pitfalls

The idealised NGAM system, like all best laid plans, must confront the real world, where affordances and compromises must be made to get the job done. Here we discuss some common pitfalls and approaches we might take to overcome them.

4.1   Bridging the owner/maintainer divide when acquiring data

Increasingly, maintenance is outsourced and conducted by a service provider on behalf of the asset owner. Here the maintainer will desire to unlock the benefits of data but faces challenges due to the contracting model. For example, efficiencies gained through data can increase long term competitiveness, but will require sacrifice of short-term gains in cost reimbursable models (McNair, 2016). Two approaches to overcome this issue include setting up innovation funds as part of the service contract, or alternatively setting up KPIs relating to efficiencies throughout the contract in order to align incentives.

4.2   Invest in upfront data storage and handling

Rework is expensive and work-around solutions can compromise data. Take the time up front and invest in the data storage and handling solution. By giving consideration to the uses that the system may eventually expand to, you cover any pain and money can be saved.

Case study 5: Ventia technicians in NZ are engaged by the utility provider to inspect high voltage power lines for defects. This process was once achieved via helicopter flyover and is now done using drones. These drone flyovers use modern camera equipment, generating vast quantities of data which is slow to move around and expensive to store. Using Computer Vision and Machine Learning techniques, data storage was reduced by 90% by training the model to only extract the power line data and "blank" the rest of the image. This is currently done at the vehicle when the drone returns, but the model has already been optimised to run on a small compute module so that it can be completed on the drone itself.

4.3   Computers aren't magic

Machine Learning, Artificial Intelligence, Neural Networks. To many they may as well be synonyms for 'magic'; but like all technologies they have limitations. Choosing a narrow problem scope will yield the best results when employing these technologies as part of your data analysis system. Attempting to point these tools at broad problems will give messy solutions at best, or possibly even total failure to produce a useful model.

4.4   Data sovereignty and control

It is worth thinking strategically about where your data will go, particularly when engaging with third party services. Data may not be allowed to be stored outside Australia by regulation, by contract, or as a value proposition to customers. It may be necessary to keep business critical data within the organisation's sole control, which may limit the products and services which can be selected. Generally, considered review of third-party usage permissions in contracts is advisable.

4.5   Seek the existing knowledge contained in people

The people who use, operate and maintain our assets are an invaluable source or knowledge on the pain points associated with them. Workshops can be a valuable tool for generating a large list of potential projects. This list can then be sorted and prioritised against project criteria such as cost, time, expected revenue increases, costs reduced, etc.

The people with experience on the assets are also valuable guides for the data analysis and can greatly improve the process of establishing the data systems. Facilitation may be required between potentially dispirit skills sets to get everyone talking the same language.

4.6   Risk based approaches – don't forget the non-financial outcomes

When seeking to justify a project there is more than just the financial bottom line to consider. NGAM solutions are often valuable for driving positive Safety and Environmental outcomes. Where traditional data collection and inspection methods require people, there are often many risks involved, including driving, fatigue from after-hours callouts, electrical, heights and confined spaces. Reduced activity drives down these risks. Similarly, NGAM approaches for environmental risk will typically allow prevention or at worst faster response to negative environmental outcomes. A risk-based approach will often reveal projects with high safety and environmental value.

4.7   Use it or lose it

Particularly in the early stages of system implementation, it is critical to get the system to be actively used. Otherwise, there is a real risk that it will be ignored for traditional approaches and will risk withering and being abandoned completely. This can be combated through thoughtful training and roll-out processes, integrating the system into routine reporting, or involving end users in the design phase to increase buy-in.

4.8   You have to go and look sometimes

Just because your data and dashboards say everything is healthy doesn't mean that something strange hasn't happened. Do not neglect routine physical inspections and maintenance entirely.

5   Conclusion and first steps

It can be challenging to decide where to start down the road to a Next Generation Asset Management system, even when an idealised end state can be easily imagined. The ideal approach for eating this elephant will depend on the size and nature of an organisation, but it is unlikely that a one-step roll-out of a fully functioning mature system can be successfully achieved.

Instead, reflection is required on the current state of the organisation, to determine where the organisation sits on the road to a mature system. There is significant expertise required to engage in the process successfully, so this must either be built and maintained internally, or sought through external advisors/contractors.

Like any good asset management system, the NGAM system will never be complete. It is instead an ongoing program that requires continuous improvement and review to change and remain relevant as the organisation changes.

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