CREATING INDUSTRY 4.0 DIGITAL SHIPBUILDING CAPABILITY IN AUSTRALIA

Summary Report

SUMMARY

Next-generation digital technologies are enabling the creation of 'Digital Shipyards', with potential to bring about improvements in productivity, accuracy and repeatability, traceability, visibility and health and safety across the entire shipbuilding value chain.

Digitisation of naval shipbuilding requires structured processes and practices consciously aimed at driving technological improvement and innovation along the value chain. Human Factors and Ergonomics (HFE) provides a framework for achieving this.

1 The entire naval shipbuilding ecosystem is becoming a focus for digitisation
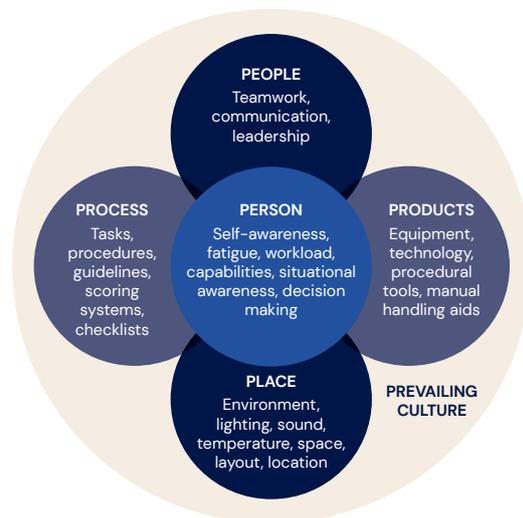
Naval shipbuilding is one of the most complex and knowledge-intensive value chains of industrial activity. Demanding lead customers drive technological improvement and innovation, while their suppliers feed back issues and potential opportunities. These often include new products, processes, technologies and organisational innovations.

LEAD CUSTOMERS (PRIMES)
Set requirements and specifications

SUPPLIERS (TIER 1 AND SMES)
Feed back issues and potential opportunities
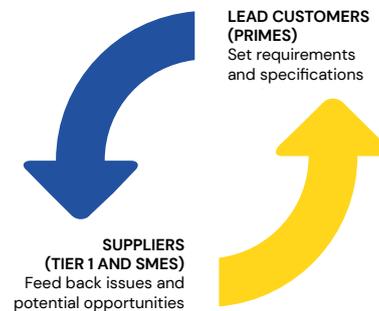
2 Digitisation of naval shipbuilding is dependent on a range of human factors and ergonomics considerations

Capturing and disseminating beneficial spillovers from the naval shipbuilding industry's constant process of iterative problem definition and problem solving requires structured processes and practices aimed at driving technological improvement and innovation along the value chain. Human factors and ergonomics (HFE) provides a framework for achieving this.

HFE considers a range of factors including:

PEOPLE
Teamwork, communication, leadership

PROCESS
Tasks, procedures, guidelines, scoring systems, checklists

PERSON
Self-awareness, fatigue, workload, capabilities, situational awareness, decision making

PRODUCTS
Equipment, technology, procedural tools, manual handling aids

PLACE
Environment, lighting, sound, temperature, space, layout, location

PREVAILING CULTURE

3 There are steps shipbuilders can take to incorporate HFE as part of their digitisation journey

1. Focus on process rather than specific technologies
2. Apply technology to enhance the role of people, not to replace them
3. Prioritise data-driven services and smart products
4. Scale projects from smaller to larger
5. Support organisational change
6. Build strategic alliances.

AUSTRALIA'S SHIPBUILDING INDUSTRY HAS THE POTENTIAL TO BE TRANSFORMED THROUGH DIGITISATION

Australia has a bold vision for building sovereign naval shipbuilding capability – with the Australian Government investing significantly in shipbuilding modernisation and transformation.

Digital technologies will take on special importance in the modernisation and transformation of Australia's naval shipbuilding industry:

- Shipbuilding has the added complexity of being technology intensive and requiring deep experimentation and near-concurrent design, testing and production of components.

- The life of a warship is measured in decades, with through-life sustainment and technology upgrade costs typically being triple the value of the initial build.

The convergence of a range of advanced manufacturing and digital technologies is now making it possible to overcome some of the unique challenges faced by the shipbuilding industry. Next-generation digital technologies will enable the creation of 'Digital Shipyards', with the potential to bring about improvements in productivity, accuracy and repeatability, traceability, visibility and health and safety across the entire shipbuilding value chain.
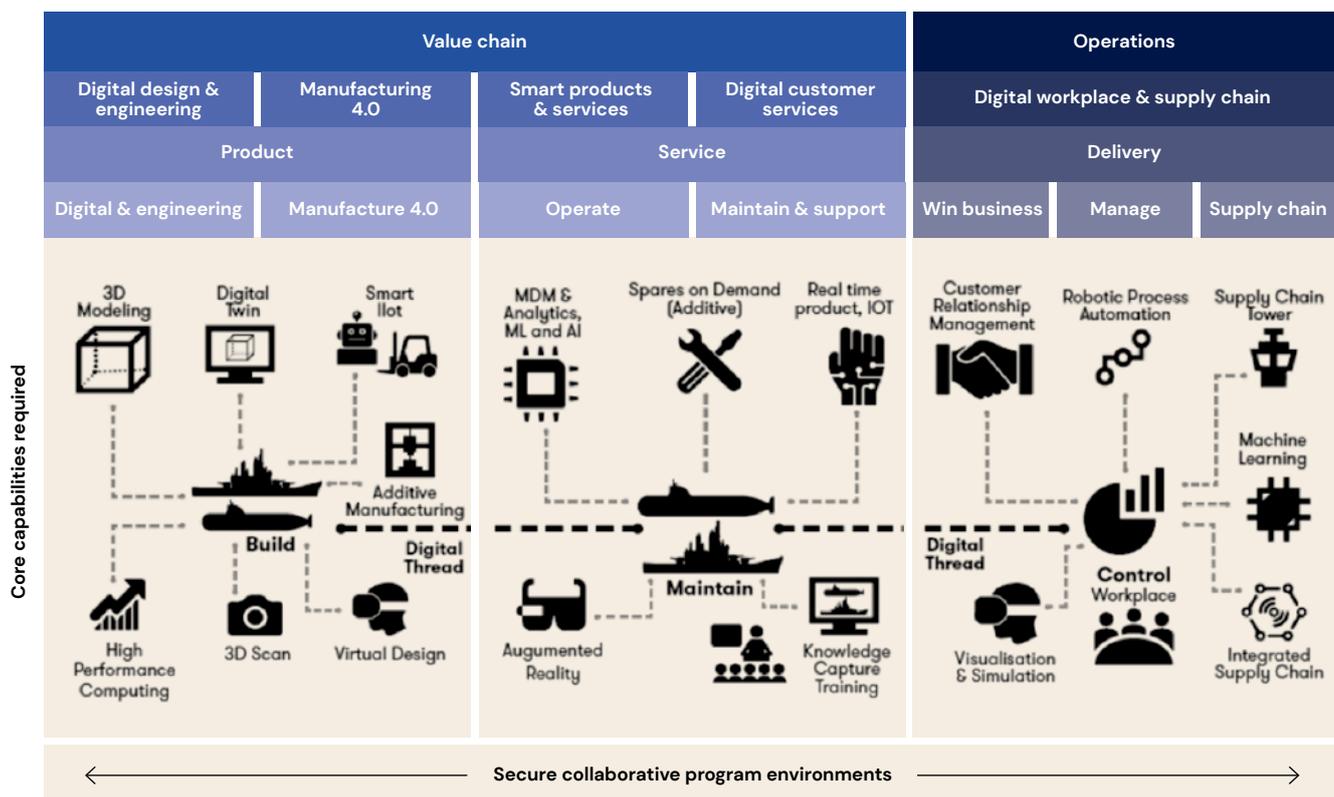
Source: Ash, B. (2018). 'Digital shipyard sounds great but what is it?'
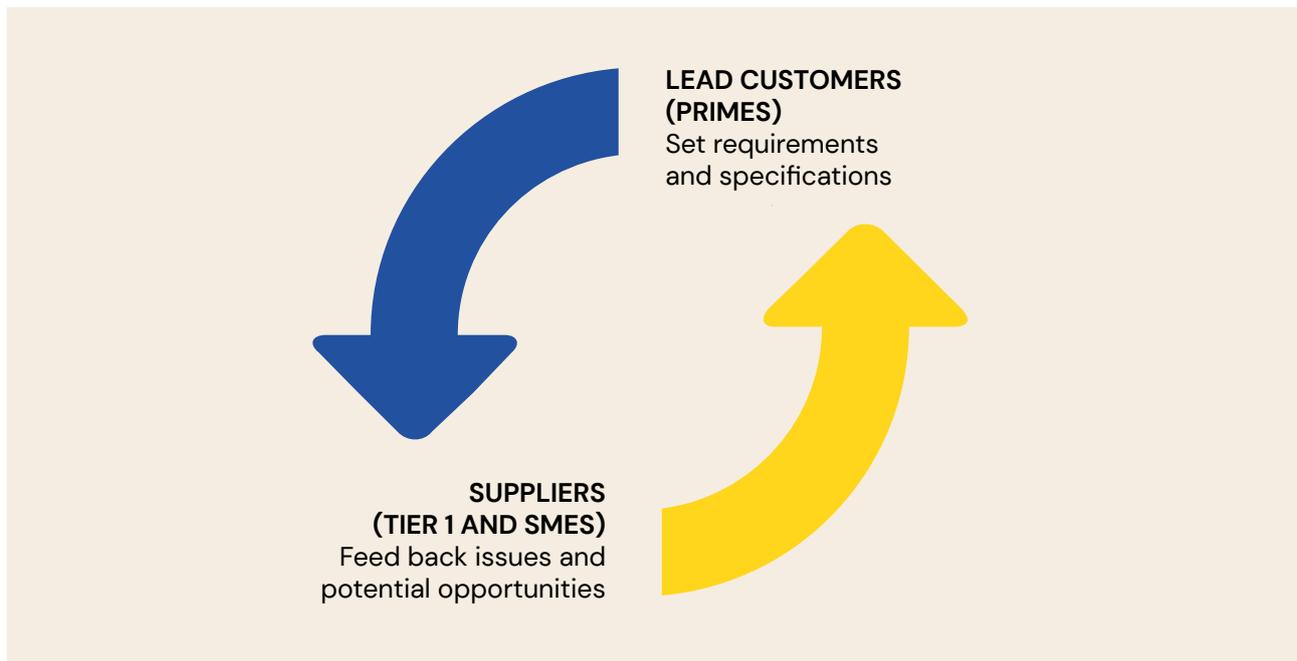
From the array of next-generation technologies, those most relevant and with greatest utility in naval shipbuilding are robots (including cobots), additive manufacturing, AR / VR and digital twins. These technologies offer benefits in shipbuilding including capacity to:

- Support single batch production

- Negotiate small work spaces, common in production and maintenance

- Deliver real-time condition monitoring and predictive maintenance

- Support process simulation and automation.

THE ENTIRE NAVAL SHIPBUILDING ECOSYSTEM NEEDS TO BE A FOCUS FOR DIGITISATION

Naval shipbuilding is one of the most complex and knowledge-intensive value chains of industrial activity, characterised by high levels of organisational, functional and production interdependency within and between firms in the value chain.

In naval shipbuilding, lead customers (Primes) and their suppliers (larger tier 1 and higher tier suppliers together with SMEs) transmit information and their issues, challenges and requirements along the value chain. Demanding lead customers can drive technological improvement and innovation, while their suppliers communicate issues and potential opportunities as well as problems. These often include new products, processes, technologies and organisational innovations. Beneficial spillovers are created by this constant process of iterative problem definition and problem solving.
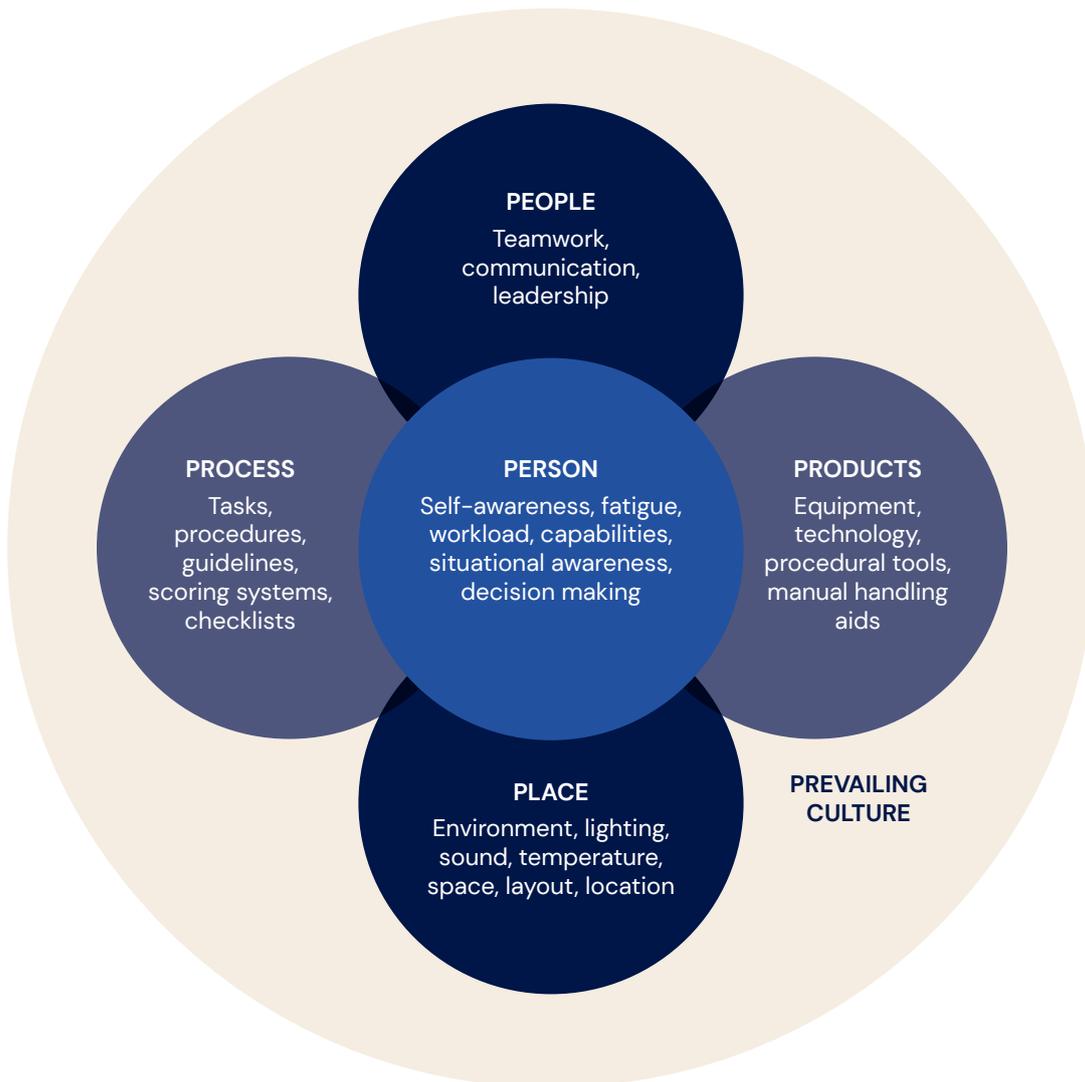
LEAD CUSTOMERS (PRIMES)
Set requirements and specifications

SUPPLIERS (TIER 1 AND SMES)
Feed back issues and potential opportunities

DIGITISATION OF NAVAL SHIPBUILDING IS DEPENDENT ON A RANGE OF HUMAN FACTORS AND ERGONOMICS CONSIDERATIONS

Digitisation of naval shipbuilding requires structured processes and practices consciously aimed at driving technological improvement and innovation along the value chain. Human Factors and Ergonomics provides a framework for achieving this. HFE is a combination of many disciplines such as social sciences (psychology, sociology), health sciences (medicine, physiology, biomechanics) and design sciences (engineering, industrial design, architecture, user interface design). More specifically, HFE is the science of designing a job to fit the worker, rather than expecting the worker to fit the job.

HFE is more than implementing the latest stretching program (although that may play a role in decreasing injuries) or supplying ergonomic chairs; it takes a holistic look at the tasks that are being performed and matches them with the capabilities of the worker to minimise injury risk and stress and maximise quality and efficiency.

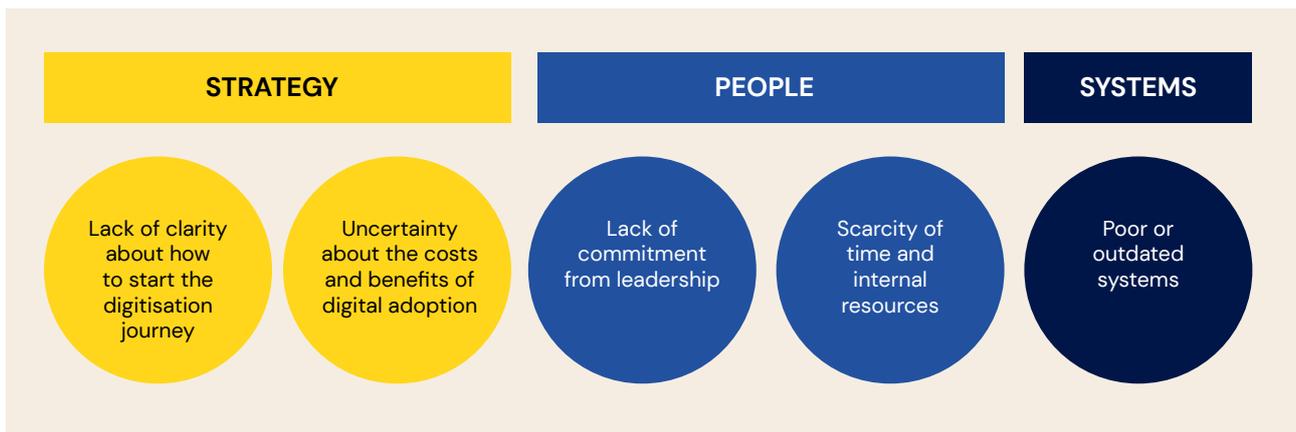**Key elements considered as part of HFE include:**

PEOPLE
Teamwork, communication, leadership

PROCESS
Tasks, procedures, guidelines, scoring systems, checklists

PERSON
Self-awareness, fatigue, workload, capabilities, situational awareness, decision making

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PREVAILING CULTURE

Critical HFE considerations for naval shipbuilding are:

|	
How can physical work processes be adapted to reduce labour intensity and complexity while increasing production scale and customisation?	For example, industrial robots (including cobots) can be deployed to work collaboratively with human operators and reduce exposure to hazardous elements and ergonomic problems.
How can workflows be adapted to improve communication flows across the entire value chain?	For example, digital work management (DWM) tools can provide access to real-time digital data, allowing effective work management and paperless communication that leads to time savings and improved productivity.
How can humans be assisted to improve design and quality?	For example, advances in graphical computation ability makes it possible to create digital twins that simulate entire manufacturing processes in a virtual environment.

PARTICULAR ATTENTION NEEDS TO BE GIVEN TO SMES IN THE NAVAL SHIPBUILDING INDUSTRY, GIVEN THEIR CONSTRAINTS

As the rest of the naval shipbuilding ecosystem digitises, SMEs will need to keep up. SMEs occupy positions in a hierarchy in which they must respond to the demands and requirements of Primes (such as meeting exacting specifications including explicit ISO frameworks largely set by Primes).

Specific challenges SMEs face include:

STRATEGY		PEOPLE		SYSTEMS
Lack of clarity about how to start the digitisation journey	Uncertainty about the costs and benefits of digital adoption	Lack of commitment from leadership	Scarcity of time and internal resources	Poor or outdated systems

To solve these challenges, SMEs in the naval shipbuilding value chain need a digital strategy – ultimately covering all facets and operations of the business. Commencing this process requires setting priorities alongside pragmatic acceptance that the full strategy can only be developed in stages.
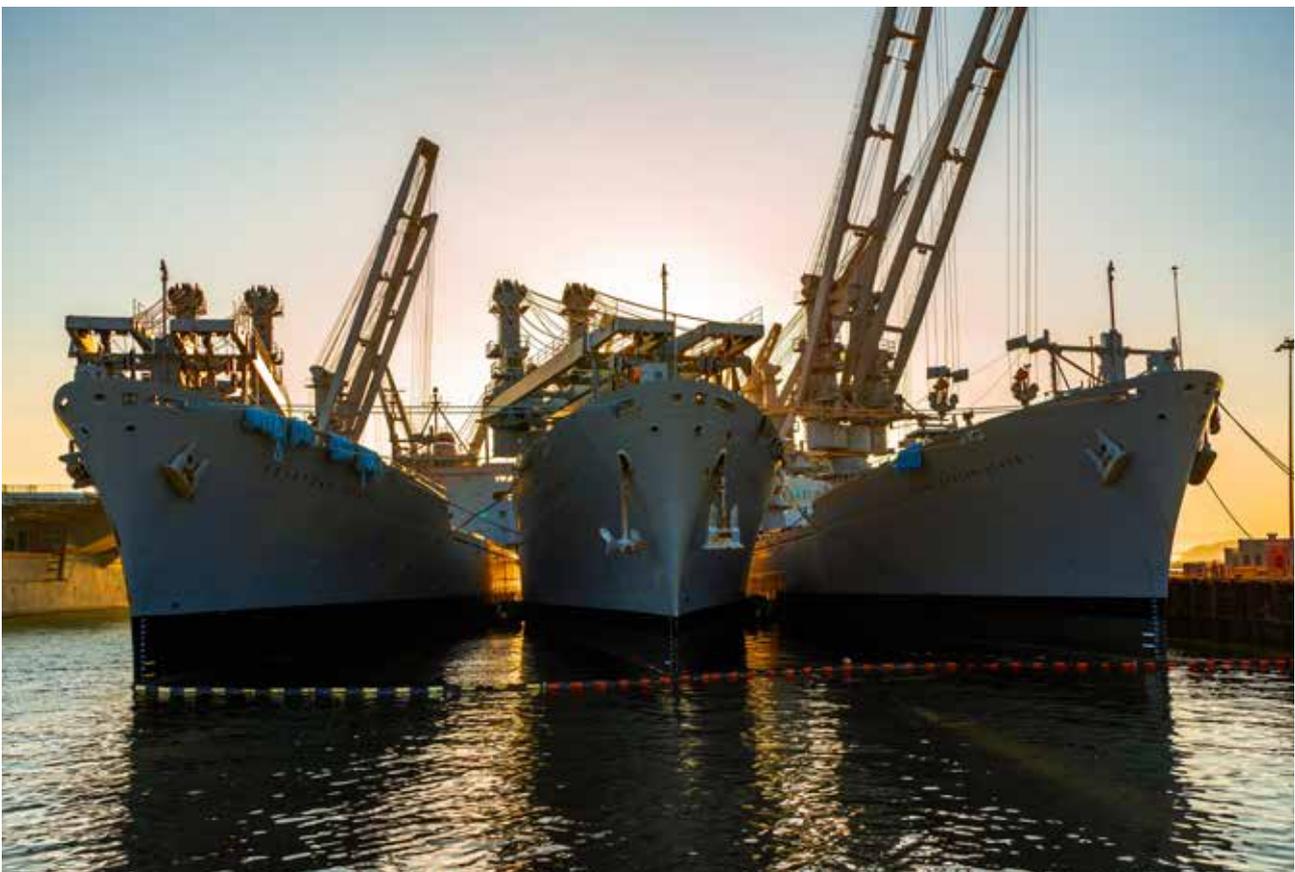
ADOPTION PRINCIPLES FOR INDUSTRY

Every shipbuilding business has a different context with different problems that need solving or areas where value can be added. The digitisation journey that shipbuilders take – and specific solutions that get deployed – will therefore vary from business to business.

To support digitisation of naval shipbuilding, shipbuilders should:

1 Focus on process rather than specific technologies

Understanding current process is the basis for correctly identifying the problem to be solved, and therefore, the technologies and technology roadmaps needed. The potential of any technology cannot be realised concretely without answering: "what is the problem we want to solve"? This is the opposite of identifying a solution looking for a problem, which can all too often be seized on when considering digitisation or Industry 4.0 adoption.

2 Apply technology to enhance the role of people, not to replace them

Shipbuilding businesses will succeed in maximising value creation when digital technologies are deployed to assist the workforce and enhance the role of people, rather than replace them. This is seen in the role of technologies such as AR which enable teamwork, trialing of new ideas and approaches on a smaller experimental scale.

3 Prioritise data-driven services and smart products

Companies beginning to develop their digital strategies, which are typically at a relatively low level of readiness, need to prioritise the development of data-driven services using smart products. These offer companies a good point of departure for participation in the naval shipbuilding value chain. Smart products that provide data on their performance throughout their entire lifecycle offer potential to companies to expand their service offerings into areas such as predictive maintenance, with potential for further expansion over time.

4 Scale projects from smaller to larger

This approach allows trialing of minor changes that will not compromise existing production and revenue, because they are insulated from other parts of the business. It has potential to provide early demonstration of the technological success and potential return on investment of the proposal. In this way, they help build support and momentum for change and enable organisational learning.

5 Support organisational change

Leadership and management of organisational change is critical. Change involving digital adoption in one area will lead to change across the organisation. All parts of the enterprise need to change and adapt, and the flow and sharing of knowledge and information needs to reflect this.

6 Build strategic alliances

Strategic alliances can be critical to adopting digital technologies and solving common problems. The main forms will be collaborative R&D, splitting the risks and costs of investment, and spreading the benefits of such investment by building their scale, significance and ambition.

TAKING THE
WORK FORWARD
and how Flinders University can help

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we can help your organisation.

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