Swinburne Research Institutes

Manufacturing Futures Institute Themes for Interdisciplinary Seed Grant Funding:

1. **Industrial automation**
2. **Industrial internet**
3. **New manufacturing processes for next generation materials**
4. **Design driven manufacturing innovation**

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1. Industrial Automation

Industrial automation is achieved by various means, including mechanical, hydraulic, pneumatic, electrical, electronic devices, sensors and computers. Modern factories typically combine all these technologies. The advantages of industrial automation includes cost reduction, high productivity, high and uniform quality, potential of high flexibility and increased safety for workers.

Our research particularly targets methodologies related to the fourth industrial revolution (Industry 4.0), focusing on flexible automation solutions that can provide product customisation under the condition of mass production. This research is focused on Cyber-physical systems, the Internet of things, Information and Communications Technology, Cloud computing, Big data and standardisation of machine interfaces, but also targets research into what is required of the workers in tomorrow's manufacturing industries.

Key areas include:

- Automation solutions for novel processes: Although many manufacturing industries, such as automotive, have developed highly sophisticated solutions for mass production, there are others where mass production is still in its infancy. This institute is particularly focused on developing solutions for mass production of carbon composites.
- Robotics: We focus on developing robot solutions for novel application. This includes researching robots with higher speed and acceleration, higher accuracy and improved stiffness, in addition to low-cost robotics. In relation to our Industry 4.0 research, we also have a strong focus on collaborative robots providing increased flexibility and ease of use.
- Sensor integration: Adding automated data collection to collect key production information is essential to modern manufacturing lines, providing the information required to tweak the process. Our interest in this area includes sensor fusion and the efficient use of large amount of sensor data.
- Standardisation of machine interfaces and machine to machine communication: Communication between machines is an essential component of the Industry 4.0 vision.
- Automatic control: Utilising all the sensor information for feedback and feedforward to the various equipment in a manufacturing while avoiding stability issues and related problems requires in-depth knowledge of control theory.
- Cyber physical systems or digital twins: Ongoing advances in science and engineering continually improves the link between computational and physical elements, leading to dramatic benefits in terms of adaptability, autonomy, efficiency, functionality, reliability, safety, and usability of such systems.

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2. Industrial Internet

The industrial internet or the "Internet of Things" (IoT) for manufacturing is a new Internet evolution that involves (i) incorporating potentially millions of industrial machines, sensors, cameras, displays, wearables, smart phones, and other smart communicating devices (which are collectively referred to as IoT 'things') into the internet, and (ii) harnessing their data and functionality to manufacture products and provide related services that benefit many areas of the manufacturing businesses, and related supply chains. In particular, the industrial internet theme is exploring the development and use of IoT technology in enhancing the automation and efficiency of manufacturing plant operations, improving the quality of products, increasing ability to respond to changing customer demands and supply, and expanding to new markets for their products. IoT-based productivity, quality, safety and the ability to respond quickly to changing conditions are essential to maintaining the industry's competitiveness.

Key areas include:

- Real-time Data: Capturing, integrating, sharing and analysing data generated by millions of industrial machines, cameras, sensors, RFIDs, smart phones, wearables, meters, vehicles, and displays in any plant and also across related supply chains
- Process: Understanding, automating, and improving production processes
- People: Enhancing workers' performance by providing timely and easy-to-use information that is relevant to their current task and role
- Things: Developing new, more advanced internet-connected machines, devices, sensors, wearables, augmented reality displays, etc., to enhance manufacturing capability.
- Robots: Robot and IoT integration, and collaborative robots within the IoT ecosystem.
- Industrial cyber Infrastructure: Doing all the above in the cloud, securely, and on the move.

3. New manufacturing processes for next generation materials

Advanced material development represents one of the most critical steps for technological progress and future manufacturing. It helps to solve a wide range of problems for industry and society by introducing new technologies, techniques and systems. Materials science and engineering are integrated concepts encompassing many disciplines, including chemistry, physics, biology, engineering, information sciences and mathematics. We are seeking innovative ideas to target the challenges in developing high-performance materials with diverse applications across many industries; minimising the environmental impacts of material sourcing, manufacturing, use, recycling and disposal and catalysing new industries in Australia that capitalise on the country's expertise in materials characterisation and processing. We aim at creating new industrial opportunities and links through materials design, demonstration of feasible industrial materials production and innovative processing and analytical techniques.

Key areas include:

- Innovative methods for designing advanced materials
- Advanced graphene and composite materials for aerospace applications
- Advanced energy harvesting and storage materials
- Advanced materials for biomedical applications
- Advanced materials for optoelectronics
- Advanced materials for agriculture
- Innovative manufacturing process for advanced materials

4. Design driven manufacturing innovation

Design driven manufacturing is a critical component to understand the feasibility of what is created through this institute. The design, development and manufacturing of products shows commercial merit for the advances in science and technology generated from this institute. This presents the complete process from innovative science executed in successful product outcomes – Tangible examples to validate the importance of the research conducted within this institute that links to industry needs.

Design Driven Manufacturing Innovation seeks to work closely with all areas to promote commercial product development with a focus on industry partnerships. The core skill this area brings is to move a project from an idea through to a manufactured outcome that will add value to all. This is where product development fits within the greater context to help implement opportunities to a commercial level.

Key areas include:

- Innovative product development
- Market awareness and gap identification
- Manufacturing efficiencies through detail design and engineering
- Commercialisation
- Advanced product design
- Design process – Research, concept generation, refinement and manufacturability
- Industry/university engagement
- Advanced prototyping and product development.