

Pathways to Manufacturing

The Manufacturability Challenges of Emerging Technologies

Increasing attention is being paid by public funders and private investors to the route towards scale-up of emerging technologies and deployment into a manufacturing environment. The Pathways to Manufacturing programme aims to advance understanding of the manufacturability challenges faced when deploying a new technology at scale. Such an industrialisation and scale-up journey – the **'pathway to manufacturing'** – involves significant uncertainties and risks related to a range of factors, including: production technologies; system integration; supply chains; resource efficiency and sustainability; compatibility with evolving standards and regulations; etc.

Outputs

The work will explore and systematically categorise the variety of industrialisation risk factors that STEM based research efforts might be exposed to on their pathway to impact. This 'manufacturability risk framework' will be able to help researchers consider a wide range of risk factors, helping them to reflect on such considerations when approaching potential partners, developing research proposals to public funders and developing business cases for potential investors. It is hoped the framework will support clear articulation of:

- the anticipated manufacturability challenges
- preliminary plans to address them early in the project
- project management considerations and evaluation criteria
- how your current network, current collaborators and future potential partners can contribute to overcoming these challenges

Impact

The outputs of this programme will inform:

- academic and industrial research project design, management and evaluation
- industry engagement
- public funders and private investors

Research projects

The outputs of this programme will help academic and industrial researchers to anticipate future manufacturability challenges and understand how they might mitigate against these in early stage laboratory research. This approach will inform change the design, development, implementation and evaluation of research projects.

More specifically, the framework will provide guidance on the information researchers can acquire from their current networks and collaborators that can help to mitigate or overcome challenges. Scanning for signals

helps solution identification and flexibility through the timely incorporation of novel information into the research project. The framework can also be used to help identify information gaps in networks and collaborators.

The information acquired from these scans can also be used to inform a plan of the competences needed to overcome particular manufacturability challenges, informing the timely and appropriate involvement of current partners and helping to strategically identify future potential partners.

Engagement with industry & relevant information sources

Such a clear description of information and competence needs required to overcome particular challenges provides a compelling case for partnering to both potential partners and research funders. Furthermore, the anticipation and articulation of challenges could also help structure research-industry interaction by creating a common understand-

ing of the challenges, supporting dialogue and helping to manage expectations.

Research proposals & business cases for funding and investment

From a funding perspective, project funders and investors can use the outputs to inform their decisions to fund emerging technology scale-up research. Using the systematic categorisation of risks factors, investing organisations and individuals can scrutinise proposals more closely and prioritise those which have best accounted for their potential risks.

Demonstrating these have been considered in a systematic way can help build a strong case for and enhance a project's pathway to impact.

The programme

The first phase of the Pathways to Manufacturing programme involves three initial projects:

- Overcoming manufacturability challenges: lessons learned
- Managing lab-based emerging technology scale-up: case studies
- Building a strategy framework for emerging technology scale-up projects

The current project: overcoming manufacturability challenges

The current project is empirically collecting a number of manufacturability challenges faced by academic and industrial researchers and developers. This will be done primarily through interviews. These examples from recent experiences will be used to refine and adapt the U.S. Department of Defense's

Manufacturing Readiness Levels and Risk Threads¹ for use by the broader university and industry research base. The findings from this project will be combined with Lab-based case studies to establish a taxonomy of challenge types that affect the manufacturability of an emerging technology. Interviewees involved in the programme will be provided with preliminary results and the detailed findings of the programme.

Seminars will be held throughout the project to provide researchers with overviews of the common and best practice and current tools being used to manage 'manufacturability risk'.

To narrow the scope of the interviews an initial specific domain of emerging technologies has been selected for the project. The initial domain is the product and process manufacturability challenges for functional materials. The next stage of the project will involve broadening the research domain to strengthen the foundation of the project's findings.

¹ These are used by the US' used by the US' Manufacturing Technology Program (ManTech) and can be found in the Manufacturing Readiness Level Deskbook.

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ABOUT CSTI

CSTI, led by Dr Eoin O'Sullivan (eo252@cam.ac.uk), carries out applied research exploring what makes national innovation systems effective at translating new science and engineering ideas into novel technologies and emerging industries. Key research themes include: economic value capture from industrial innovation systems; innovation system regulations and standards; technological emergence; manufacturing systems; and the public research base and innovation development.

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