TAMPERE UNIVERSITY OF TECHNOLOGY

Assessment of Smart Machines and Manufacturing Competence Centre (SMACC)

Scientific Advisory Board Site Visit 25-27 April 2018

Assessment Report

1. Scientific ambition, quality and impact

Rating: 3.5

Written statement:
The Smart Machines and Manufacturing Competence Centre (SMACC) has been established in 2015 by bringing together research groups from Technical University of Tampere and VTT to create unique critical mass in the area of smart machines and digital manufacturing. The Centre has rapidly developed as a lean research competence centre and has delivered a number of projects working closely with the local industry. The research agenda of the Centre is broad and all-encompassing including Digital Twins, System Complexity, New Business Models and Integration and Verification methods.

The basic research appears to be conducted by the "back office" mostly supported by TUT academics and researchers with participation of VTT with a focus on generating new knowledge (low TRL). It is difficult to assess how the research challenges are identified and projects formulated to address them. It was also not clear how projects are defined, refereed, reviewed and monitored beyond the requirements of the funders and industry as customers. The translational research is delivered by the "front office" which is led by VTT with participation of TUT. Whilst the structure is logical, it is not clear how ideas generated by the "back office" are implemented into more mature research products. Probably because of the young history, it is also not clear if basic research work is derived from application-oriented projects with industry. There is also a concern that the research is not monitored using formal KPIs although such indicators are used by the Leadership team informally.

Scientific ambition and quality:
The overall strategy of the Centre is ambitious and adventurous with the goal to create methods and models for next generation of digital processes and human-machine systems. In delivering this, the Centre and the Steering Board have recognised the multidisciplinary nature of the scientific and industrial challenges and have brought critical mass from a number of disciplines at both TUT and VTT. Bringing together the two organisations has also helped in creating an unique innovation chain with basic research (TRL0-3) conducted by the University academics and researchers and both organisations working together in maturing the technologies and delivering technology demonstrators (TRL4-6) leading to downstream industrial applications.

The Centre has been operational for more than 2 years so far and some of the initial projects that have been either legacy or new projects that are still ongoing. In that context, it is difficult to comment on the scientific rigour of the research conducted by the Centre. The Centre has started

as a collection of research projects defined jointly with industrial partners or driven by thematic calls of national and EU funding agencies. It is expected that as it develops the Centre will adopt more strategic agenda-driven approach in developing new projects.

The SAB members were presented with an overview of the current research portfolio in a poster session. The core thematic areas are as follows:

- Advanced digital and hybrid manufacturing including direct energy deposition with online control, bringing the additive manufacturing process early in the design cycle, material development for AM and embedded intelligence in 3D printing
- Engineering design n digital twins including model-based design process, co-design with virtual prototypes and digital twins
- Data-base service innovations including complex systems, transformation to service-based models, equipment-based data, data sharing and new business models using constructive approaches to data collection
- Digital LCM including process data, statistical data, advanced data analytics with scalable solutions for SMEs
- Smart connected mechatronic machines including self-awareness, data fusion, robotics in the field and autonomous devices
- Robotics and automation with focus on human-robot communication, capability matching, robotic logistics in the factory
- Systems engineering with a focus on requirements engineering, with automatic extraction of requirements from text files as well as large systems engineering methods
- Engineering materials science with a focus on powder piloting service in terms of design and pilot of powder-based materials, thermal spray methods and modelling assisted material design and performance evaluation, tribology and wear.

Whilst the current project portfolio appears quite broad thematically, the actual quality of the research and its international standing was not clearly communicated. The SAB would expect a clearer focus on identifying and communicating research excellence both in terms of individual projects and overall ambition of the research strategy of SMACC. The SAB would have preferred to see a more focused presentation on outstanding results.

The quality processes appear to be driven by the requirements of the funding bodies and review frameworks. As the Centre develops, we would expect to see in future a more centre-specific quality assurance process including a rigorous internal project review procedure.

Impact:

The Centre has the potential to deliver significant impact to both the local industry and key industrial sectors in Finland. There are some impressive examples of impact which were referenced in conversations with the leadership of the Centre. However, these do not appear to be properly collected, described and evaluated and as a result it is difficult to judge how significant the academic as well as economic and social impact of the Centre has been. This needs to be put in context of the short period of existence of the Centre and therefore clear recommendation need to be made for the next period to create a clear methodology and process for collecting, analysing and presenting impact data and its use for promoting the capabilities of the Centre.

The PhD students associated with the Centre have pointed to some very positive impact of the Centre on their development including: help with developing industry connections, opportunity to work closely with VTT, help in preparing new projects, setting clear targets driven by industrial requirements, assistance in applying for funding.

Recommendations:

- Clarify the research strategy and develop a set of technology roadmaps to guide the research activities of the Centre.
- Develop clear mechanism for translating research from the "back office" to the "front office" and vice versa in a systematic and robust way.
- Define formal KPIs to guide the delivery of the research.
- Introduce quality assurance and internal project review processes to improve research quality and maintain research excellence.
- Develop and implement a methodology and process for impact analysis and promotion.

2. Societal impact

Rating: 3.5

Written statement:
The discussions with the Industrial Advisory Board (IAB) showed that SMACC's Strategic Research Agenda is highly relevant to the needs of the user manufacturing community in Finland as it aims to enhance the interactions between the industrial and research communities, strengthen the export capability of the Finnish manufacturers and empower the SMEs. SMACC activities so far are mainly directed towards serving the local community in Finland. SMACC ecosystem contains more than 300 partners from key industrial sectors for the Finnish economy. The members of the IAB are engaged and represent different sectors and types of companies; they are highly motivated and interested in smart manufacturing and digital transformation. Some of SMACC's successes so far have a more global dimension. Examples include training the next generation of researchers and forming a strategic alliance between TUT and VTT, with a clear focus on creating a critical mass. There are opportunities to engage with a broader user community along major societal challenges facing the Finnish society such as jobs, sustainable development and health care for an ageing population.

Recommendations:

- Define a clear strategy towards delivering societal impact, both in terms of short-term and long-term challenges.
- Introduce KPIs and means to capture research outputs relevant to societal impact.
- Consider innovative models (e.g. introducing a subscription model) for working with companies.

3. Research environment

Rating: 4

Written statement:

The SMACC Centre is supported by an impressive set of labs and state of the art equipment provided by TUT and VTT. Young and experienced researchers have the opportunity to work together and cooperate in joint multidisciplinary projects to ensure the long-term success of SMACC. In that context, the Centre provides an excellent environment for flexible and agile research work. Because of the history the project teams are not physically co-located and work in different labs at both VTT and TUT. Looking forward, there might be a case of physical co-location of researchers at least for project durations. The industry cooperation gives the great chance for applied research work close to needs, especially of SMEs. Concrete results or success stories are limited because SMACC is a quite young research unit.

VTT does not seem to be sufficiently involved in PhD supervision. The Centre will benefit from a better collaboration between the two institutions in join formulation and supervision of MSc and PhD research projects.

The international composition of the researchers group is used for a well working and outstanding global network and exchange.

The number of published papers can be evaluated as good and on international level. Due to the different experiences of the researchers and spent time in research the results are different. The targets for number of publication seems to be different and not documented. The success of industry cooperation project is not measured or estimated.

The cooperation of VTT and TUT has created an excellent research infrastructure based on a number of well-equipped state of the art laboratories. This provides excellent possibilities for students to work with automated equipment in the robot laboratory. Single robot investigations can be carried out under very good conditions. Room for system set-ups is limited, e.g. for production lines which could be entirely digitised. There appears to be a need for remote robot test fields with specific focus on mobile applications. The machine tool laboratory is state of the art and provides good opportunity for both machining focused research as well as manufacturing informatics in terms of data analytics and system integration and communication. The human-robot collaboration research lab is of good standard and provides opportunities for both MSc students and researchers to work closely together.

The materials science research presented looks like an extract of conducted research work outside the scope of SMACC, and in that sense somehow only as an addition to the AM. The laboratory capabilities in Tampere are very specialised and perhaps need a better communication strategy on how they can be better integrated and strategically aligned to the research vision of SMACC.

Recommendations:

- The scope of SMACC spans from basic research via applied research to innovation community which needs to be narrowed driven by strategic targets.
- Consider physical co-location of project teams working together at least temporarily at one location, for instance, installing a “project house” would be a way to achieve efficient cooperation.
- Introduce a visible system for assessing the quality of basic and applied research results.
- Describe success stories of successful industry cooperation and applied research work.
- Consider practical validation of digitised and automated manufacturing, and mobile systems.

- The Centre will benefit from a better collaboration between the two institutions in joint formulation and supervision of MSC and PhD research projects.
- Develop a coherent strategy on how to focus the research activities within the scope of SMACC on its vision; the activities especially in the area of materials science need to be integrated and strategically aligned to the research vision of SMACC.

4. Potential of SMACC

Written statement

The SMACC is becoming an established Centre with growing reputation in industry as a provider of quality research in smart machines and digital manufacturing. As it now enters the next stage of development, it requires a number of changes to strengthen its potential and deliver real academic and industrial impact.

Research governance
The Centre was created as a lean unit which combined research capacity and expertise from two leading institutions: TUT and VTT. As it grows, it will require a more robust governance structure and professional management. As a minimum, it is recommended that TUT and VTT make a joint appointment of a Centre Manager and Administrator to support the Centre Director and ensure robust Centre processes are introduced and maintained.

Science quality and unique skills
The Centre has a fairly large scope of activities which in long term cannot be sustained at internationally leading standard. It is therefore recommended that a review is carried out to clarify the future focus of the Centre and deliver its potential to be internationally leading. Where appropriate, the skills and capabilities of the Centre need to be strengthened by bringing in additional expertise from other disciplines from the newly formed UT and VTT.

Gender equality
It is recommended that the Centre considers measures to improve the gender balance of the leadership team and its Industrial Advisory Board.

Policy influence
The Centre has the potential to influence positively national policy and funding landscape. Members of the Centre from TUT/UT, VTT and the SMACC industrial community should be encouraged to engage widely as members of national and EU bodies that influence future research strategy and industrial policy.