Metrology For Advanced Manufacturing – The Networking Project AdvManuNet

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DEC 2020_ISSUE EIGHTEEN

PRECISION

METROLOGY FOR ADVANCED MANUFACTURING – THE NETWORKING PROJECT ADVMANUNET

Introduction and summary

Advanced Manufacturing is a branch of manufacturing that is considered to be an important driver for future economic and societal progress. The European Commission (EC) has identified Advanced Manufacturing as one of six Key Enabling Technologies (KETs) with applications across multiple industrial sectors. In particular, it can be thought of as a connecting hub for the other EC identified KETs of Micro- and Nanoelectronics, Nanotechnology, Advanced Materials, Industrial Biotechnology and Photonics, since it often acts as the enabler for these technologies. However, Advanced Manufacturing can be considered to extend beyond these identified KETs to a wider spectrum of industrial sectors.

The progress of Advanced Manufacturing, which uses emerging knowledge and innovations is strongly reliant on the development of metrology capabilities. EURAMET, the association of metrology institutes in Europe, has established metrology research programs to address the metrology needs in different thematic areas, including metrology for industry. However, in order to leverage the benefits of and increase the impact of these developments on the wider industrial landscape, a high-level coordination of the metrology community supporting the Advanced Manufacturing landscape is required. This current gap in coordination aims to be fulfilled by the establishment of European Metrology Networks (EMNs), which are intended by EURAMET to provide a sustainable structure for ongoing stakeholder interaction in different thematic areas. The networking project JNP19Net01 AdvManuNet funded by EURAMET for four years starting in June 2020 aims to accelerate the process of establishing a European Metrology Network (EMN) to strengthen Europe's position in Advanced Manufacturing. The consortium to deliver this project comprises National Metrological Institutes (PTB, NPL, INRIM, RISE, CMI, METAS, TUBITAK, GUM), Designated Institutes (BAM), University partners (Politechnico di Torino) and the European Society for Precision Engineering and Nanotechnology (euspen) from across Europe.

The AdvManuNet project will address the need for a sustainable EMN on Advanced Manufacturing through the following specific aims;

1. To establish a single hub for regular, constructive dialogue and liaison with stakeholders across the Advanced Manufacturing landscape, as well as overlapping areas in Advanced Materials and Nanotechnology. This engagement extends to relevant societies and standardisation bodies.

2. To develop a Strategic Research Agenda (SRA) and roadmaps for Advanced Manufacturing metrology based on the stakeholder engagement activities. In particular, the SRA will identify the current gaps in metrological capabilities and consider existing networks and roadmaps.

3. To establish a knowledge-sharing program for Advanced Manufacturing stakeholders, which will promote the dissemination and exploitation of the results of the project, including those from previous EU funded research projects. This activity will build on existing training programs and include a range of regularly hosted activities, such as exchange of researchers, industry focused events and training courses.

4. To develop a web-based platform for Advanced Manufacturing stakeholders to allow for easy access to European metrology capabilities and connections to other relevant European and international networks. In addition, a service desk will be established to support the stakeholders and the wider advanced manufacturing community with metrology-based needs. A particular requirement to support the sustainability of the network is to assure that this infrastructure and capability can be maintained by a future EMN over the long term.

5. To develop a plan for a joint and sustainable European metrology infrastructure for Advanced Manufacturing via a European Metrology Network. The plan should be completed within 12 months of the start of the project and should use coordination and smart specialisation of capabilities, align with other running initiatives and projects, promote the development of emerging member states, and consider how to extend collaboration to third countries.

In order to realise these goals, the project is subdivided into five work packages lead by four institutes. Broadly the first three work packages address the five aims of the projects, while the other two relate to dissemination of the results and management and coordination of the project. They are as follows;

- Dialogue with stakeholders
- Strategic road mapping and plan for EMN
- Technical infrastructure for EMN operation
- Creating impact
- Management and coordination

The success of the project will be measured by the following key deliverables over the course of the project and will be overseen by the Scientific Advisory Committee (SAC). The SAC will be comprised of established figures representing the diverse range of industries within the Advanced Manufacturing domain. The key deliverables for the AdvManuNet project are;

a. Plan for a joint and sustainable European metrology infrastructure for Advanced Manufacturing via an EMN to be presented to the EURAMET General Assembly 2021.

b. Report on the knowledge sharing program for Advanced Manufacturing stakeholders. The program includes promotion of the dissemination and uptake of research results on advanced manufacturing and a range of regularly hosted activities.

c. Produce a final list of the metrology needs for Advanced Manufacturing, which includes input from stakeholders, relevant societies and standardisation bodies.

d. Report on the final testing of the functionality of the web-based platform for Advanced Manufacturing stakeholders. This platform includes access to European metrology capabilities, links to other relevant European and international networks, as well as a service desk to answer stakeholders' questions.

e. Develop a Strategic Research Agenda (SRA) for metrology for Advanced Manufacturing.

f. Provide examples of early implementation of the project deliverables by end users and examples of contributions to new or improved international standards.

The project has started the early activities which are necessary to establish the scope of the project. In particular, Advanced Manufacturing still does not have a universal and accepted definition, which is needed to establish the boundaries to conventional Manufacturing. The definition which will be used within the project is: Branch of manufacturing that exploits evolving or emerging knowledge, technologies, methods and capabilities to make and/or provide new or substantially enhanced goods or services, or improve production efficiency or productivity, while ensuring environmental and societal sustainability. However, to assist with the scope definition, a list of keywords and key industrial sectors is also being created.

Advanced Manufacturing represents a broad landscape of technologies and industries with both unique and overlapping metrological requirements. Understanding these requirements and identifying the capability gaps is a key early task in the establishment of the Strategic Research Agenda for Metrology for Advanced Manufacturing.

An example of the diverse requirements for metrology in Advanced Manufacturing are illustrated for the key technology of Additive Manufacturing. These requirements range from the dimensional characterisation of the feedstock powder through to the temperature measurement of the melt pool via in-situ thermography and the final part dimensional and NDT inspection, including surface roughness with re-entrant features. Figure 1 shows an application of Additive Manufacturing techniques in the area of medical implants using computed tomography as an advanced metrology method, developed within the EMPIR project MetAMMI.

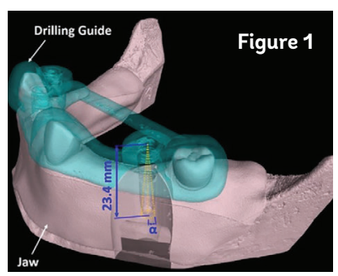

Figure. 1: Trial of a dental drilling guide produced by additive manufacturing for the drilling of holes to fit dental implants into artificial jaw models with only few abutment teeth. The drilling angle α and the drilling depth were measured by means of computed tomography. Source: PTB

Another example of where Advanced Manufacturing and metrology connect is shown in Figure 2 which is a thermally stable multi-feature standard for checking the performance of machine tools with integrated measuring capabilities. The standard had stringent requirements on the manufacturing specifications (form error ≤ 1 µm, roughness ≤ 0.2 µm) and therefore had to be realised using advanced manufacturing techniques, such as jig grinding.

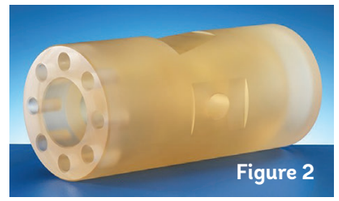

Figure 2: Multi-feature check standard, made from Zerodur using advanced manufacturing technologies. Source: PTB

https://www.euramet.org/research-innovation/search-research-projects/details/project/support-for-a-european-metrology-network-on-advanced-manufacturing

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