

## AdvManuNet: Support for a European Metrology Network for Advanced Manufacturing

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### Abstract

Advanced manufacturing has been identified as one of the key enabling technologies (KET) with applications in multiple industries. Advanced manufacturing requires new and enhanced metrology methods to assure the quality of manufacturing processes and resulting products. However, a high-level coordination of the metrology community in Europe is currently absent in this domain and limits the impact of metrology developments on advanced manufacturing. This gap aims to be closed through the establishment of a European Metrology Network (EMN) for advanced manufacturing. Here we report on the approach, first activities and the latest progress to establish a EMN on advanced manufacturing within EURAMET, the European Association of National Metrology Institutes (NMI). The objectives of this EMN are to set up a permanent stakeholder dialogue, to develop a Strategic Research Agenda (SRA) for metrology input needed for advanced manufacturing technologies, to create and maintain a knowledge sharing programme and to implement a web-based service desk for stakeholders involved in advanced manufacturing.

advanced manufacturing, metrology, European metrology networks (EMN), Strategic Research Agenda (SRA), stakeholder, Industry 4.0

### 1. AdvManuNet: Project concept and aims

Advanced manufacturing has been identified as one of the key enabling technologies (KET) with applications in multiple industries. The joint networking project (JNP) 19NET01 AdvManuNet started in June 2020 and has been detailed in [1]. The JNP aims to accelerate the process of establishing an European Metrology Network (EMN) to strengthen Europe's position in advanced manufacturing. The specific aims are the following:

1. Creation of a single hub for stakeholder engagement across the landscape of various industrial sectors and including relevant societies and standardization bodies.
2. Development of a Strategic Research Agenda (SRA) and roadmaps for advanced manufacturing metrology based on the stakeholder engagement activities, considering current gaps in metrological capabilities existing networks and roadmaps.
3. Establish a knowledge-sharing program for advanced manufacturing stakeholders, promoting the dissemination and exploitation of the results of the project, including those from previous EU funded research projects.
4. Development of a sustainable web-based platform and service desk for advanced manufacturing stakeholders to allow

for easy access to European metrology capabilities and support the wider advanced manufacturing community with metrology-based requirements.

5. Develop a plan for a coordinated and sustainable European metrology infrastructure for advanced manufacturing via a European Metrology Network.

This extended abstract details some of the recent activities of the JNP with the goal of establishing a sustainable EMN for advanced manufacturing

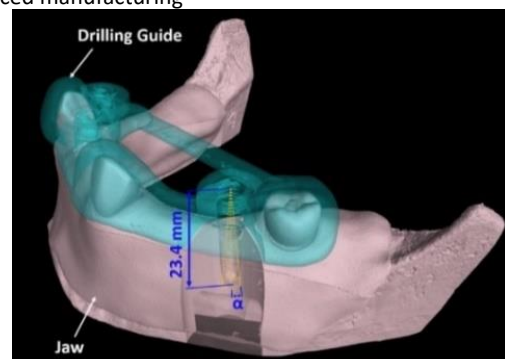


Figure 1. Trial of a dental drilling guide produced by additive manufacturing and features measured by means of computed tomography. (Source: [2])

## 2. Definition of Advanced Manufacturing

For the purpose of the planned EMN on advanced manufacturing, a definition of advanced manufacturing was required due to a lack of a formal definition by ISO or CIRPedia. Therefore one of the first activities was a proposal for the following definition, based on the CIRPedia definition of manufacturing and taking into account information from other references:

“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.”

This proposed definition is backed up by explanations given as additional notes. The complete definition is given in [3]. An example of an application of metrology for advanced manufacturing is given in Figure 1.

### 2.1. Key industrial sectors

Another task was the identification of Key Industrial Sectors (KIS) covered by advanced manufacturing. AdvManuNet has identified 13 KIS to be considered where metrology infrastructure is seen as an indispensable enabling technology:

- 1) Metrology equipment & service
- 2) Machine tools & robotic
- 3) Digitalized and integrated manufacturing systems
- 4) Energy generation, transmission & storage
- 5) Advanced materials & processing
- 6) Nano- & microelectronics
- 7) Nano- & microtechnology
- 8) Optics and photonics
- 9) Land and sea-based mobility
- 10) Aerospace
- 11) Complex infrastructure & civil engineering
- 12) Life science technology
- 13) Defense & security

The stakeholder engagement will be focussed on these identified KIS in order to discuss the future metrology requirements within advanced manufacturing.

### 3. Analysis of current metrology capabilities in Europe

In order to assess the current capabilities of National Metrology Institutes (NMIs) and the corresponding industry demands for advanced manufacturing, a questionnaire was sent to the dimensional metrology experts in EURAMET TC-L. This questionnaire addressed the calibration capabilities and national requirements using the length service classifications DimVIM [4] defined by the Consultative Committee for Length and reference artefacts for advanced manufacturing [5] as structuring elements.

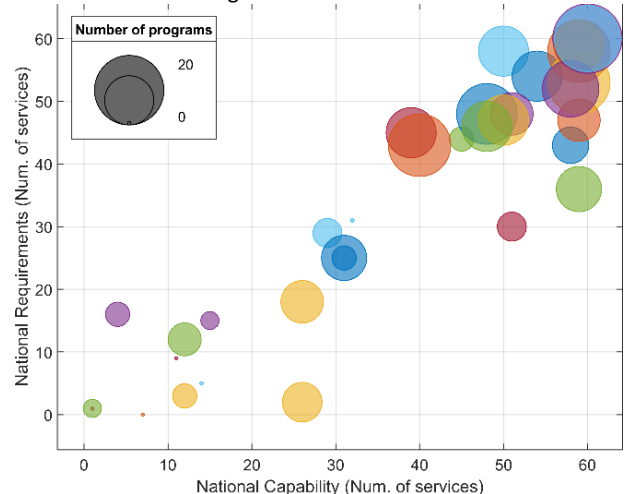
The feedback of the questionnaire is summarised in Figure 2 anonymously and is combined with additional information on participation in metrology coordination activities. There is a general linear trend of matching capability to requirements and participation in coordination and smart specialisation programmes.

There are 3 groups of countries captured in the analysis:

- countries with high number of requirements / capability and programme participation;
- countries which have established a lower number of capabilities (mostly new EURAMET member states).
- countries in between which are increasing their capabilities, national requirements and programme participation.

A small number of countries were found to have a lower number of existing calibration capabilities compared to the number of national requirements. It is one aim of the planned EMN to help those countries firstly attain the matching capability to requirement relationship and secondly to increase

the participation and activity of these NMIs in metrology for advanced manufacturing.



**Figure 2.** Analysis of national calibration demands and capabilities in length categories in Europe on both axes in combination with the number of programmes in coordination and smart specialisation of participant EU and Non-EU countries represented in as the size of circles.

### 4. Strategic Research Agenda (SRA)

Current work is in progress on tasks related to the development of an SRA for advanced manufacturing metrology. The SRA will identify gaps in current metrological capabilities and consider existing networks and roadmaps.

The second aspect is to develop a plan for a sustainable European metrology infrastructure for advanced manufacturing via an EMN. This plan has to be completed within 12 months and will address - amongst other topics - options for further coordination and smart specialisation of metrology capabilities related to advanced manufacturing in the European NMIs.

### 5. Outlook

Activities are now focused on developing the proposal for the planned EMN on advanced manufacturing and on the stakeholder engagement, including the establishment of a Stakeholder Advisory Committee (SAC) and development of the Strategic Research Agenda (SRA). To facilitate the stakeholder discussion, a workshop will be organized at euspen's 21st International Conference & Exhibition in June 2021.

### Acknowledgements

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### References

- [1] Bosse H et al 2020 *Proceedings of the 20th International Conference of the European Society for Precision Engineering and Nanotechnology, EUSPEN 2020* 357–358
- [2] Borges de Oliveira F 2019 *Quality control of additively manufactured medical products using computed tomography* [PTB press release](#), 03.06.2019
- [3] Przyklenk A et al 2021 *Support for a European Metrology Network on advanced manufacturing*, submitted to *Meas. Sci. Technol.*
- [4] DimVIM, <https://www.bipm.org/en/committees/cc/ccl/dimvim.html>
- [5] Carmignato S, De Chiffre L, Bosse H, Leach R K, Balsamo A and Estler W T 2020 *Dimensional artefacts to achieve metrological traceability in advanced manufacturing Manufacturing of multiscale structured surfaces*, *CIRP Ann.–Manuf. Techn.*, 69, 693-716, <https://doi.org/10.1016/j.cirp.2020.05.009>