METROLOGY AND STANDARDS IN A DIGITAL FUTURE

European Metrology Network for Advanced Manufacturing
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The overall objective is to **create sustainable structures in areas of strategic importance for the future of European metrology.**

EMNs will …

- cover an area of major strategic importance, with European dimension;
- consist of a core network of NMIs/DIs with a clear commitment to contribute to the network;
- establish close links to a wider stakeholder community;
- strive for scientific excellence;
- plan the activities based on a strategic agenda;
- establish a knowledge, technology transfer and promotion plan;
- plan for sustainable structures;
- develop and coordinate common infrastructure if needed
Currently there are nine EMNs:
(1) Advanced Manufacturing
   approved by EURAMET in June 2021
(2) Climate and Ocean Observation
(3) Energy Gases
(4) Mathematics and Statistics
(5) Quantum Technologies
(6) Radiation Protection
   approved by EURAMET in June 2021
(7) Smart Electricity Grids
(8) Smart Specialisation in Northern Europe
(9) Traceability in Laboratory Medicine
Advanced Manufacturing

**Advanced manufacturing (EC):** one of six Key Enabling Technologies (KETs)

- Applications in multiple industries
  - full exploitation of KETs: creating advanced & sustainable economies
- European Technology Platform **MANUFuture**:
  - Vision 2030 strategy document (HLG, 12/2018):
- **Manufacturing:** backbone of European economy
- 2014: 2.1 million enterprises, 30 million people, 1 710 B€. However: European manufacturing has been losing ground
- In 2030, European manufacturing will be competitive at global level due to its high-performance and technological level, targeting zero-defect, zero-delay, zero-surprise and zero-waste production processes
Metrology demands

Aim for production processes:

- **zero-defect**
- **zero-delay**
- **zero-surprise**
- **zero-waste**

**Example:**
Additive Manufacturing:
- in-process metrology
- fast & holistic metrol.

**Example:**
Machine tools:
- improved control by 5G sensor technology
- sensor integration: metrology data interface

**Example:**
Lithography tools:
- full simulation of relevant processes
- metrology tools using AI data algorithms

**Example:**
Machine tools & Additive Manufacturing:
- less scrap via hybrid manufacturing chains (MT & AM)
- reduced energy consumption by advanced machining processes

**EMN sections:**
- Advanced Materials
- Smart Manufacturing Systems
- Manufactured components and products
Major activities of the EMN

Current supporting activities*: Provide and prepare input for the main tasks of the EMN
(1) Preparation of Definitions
(2) Analysis of stakeholder capabilities and needs
(3) Analysis to prepare the development of a strategic research agenda (SRA)
(4) Create impact – disseminate results to relevant community

*Slide developed according to EMN Climate and Ocean Observation
Who is leading what?*

*Slide developed according to EMN Climate and Ocean Observation
Definition of Advanced Manufacturing

- Our route to the EMN, require definitions to define the scope
- No current agreed definition of Advanced Manufacturing (ISO or CIRP)
- As a first step to define what **advanced manufacturing** is, a bibliographic search was carried out to look for existing definitions and statements.
- Definition extended from agreed definition for Manufacturing.

“**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**”
Overlap of gap analysis is crucial to identify the future topics to be addressed by the SRA for metrology for advanced manufacturing

Need a broad input from range of stakeholders:

- questionnaire of metrology experts of TC-L contacts in EURAMET member states
  Q2: metrology demands and national strategies in dimensional metrology
- literature review of academic articles in peer reviewed journals

The next stages …

- existing roadmaps for advanced manufacturing
- direct stakeholder feedback
Identified Metrology challenges per KIS from questionnaire of NMIs

- Traceability for XCT of internal defects and structures
- In-situ deflection measurements of large structures
- In-process measurement and detection in additive manufacturing
- Digital Twins
- Machine Tools & Robotics
- Digitised & Integrated Manufacturing Systems
- Defence & Security
- Life Science Technology
- Advanced Materials & Processing
- Energy Generation, Transmission & Storage
- Aerospace
- Complex Infrastructure & Civil Engineering
- Nano & Microelectronics
- Nano & Microtechnology
- Reference nanoparticles
- 3D Metrology for composites, new (nano)materials and surfaces
- 3D scanning of large structures
- Dimensional metrology in micro and nano scale
- Complex asphere and freeform component
- Traceability for XCT of internal defects and structures
- Wind turbine gear metrology
- Land & Sea Based Mobility
- Optics & Photonics
- Injection systems
Literature analysis of identified gaps

Next key step: Identify current and future gaps of stakeholders in advanced manufacturing

topics identified in questionnaires:

- uncertainty, inspection, verification
- 4.0, digitalisation, digital twins
- in-situ monitoring, system integration
- process optimisation and performance
- process control
- sensor development
- evaluation strategies
- transfer into industrial applications

[A. Przyklenk et al., 2021]
Major activities of the EMN

Future EMN: Cyclical process*

Needs input from:
- stakeholder engagement
- metrology capability analysis
- analysis of roadmaps
- stakeholder feedback

- to a sustainable EMN, engaged & well embedded in their communities, making impacts

*Slide developed according to EMN Climate and Ocean Observation
Relevant EU projects, programmes and networks
Outlook

- EMN for Advanced Manufacturing approved 07.06.2021
- EMN to be organised into three sections:
  - Design for manufacture and recyclability
  - Advanced Materials acting vice-chair LNE, F
  - Smart Manufacturing Systems acting vice-chair NPL, UK
  - Manufactured Components and Products acting vice-chair INRIM, IT
  - Formal kick-off meeting planned for 11-12th Oct 2021
  - Stakeholder engagement and preparation of SRA for Metrology for Advanced Manufacturing
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