Application of digital-metrological twins for emerging measurement technology in advanced manufacturing (ADAM)

Excellence

Need
Advanced manufacturing methods demand for new technology, assembly concepts and product designs. To adequately measure the products, **methods for the measurement uncertainty evaluation of freeform geometries and using non-contact optical sensors** are of increasing importance.

To enable the **efficient and reliable** use of emerging measurement technologies in industry, **machine-interpretable results** need to be created using **validated digital-metrological twins (D-MTs)**. Operators have to be trained and guided to **determine the influencing parameters by traceable means.**

Example: Femoral implant

Objectives
1. To determine the measurement uncertainty sources attributed to **freeform geometries**, and to develop accurate mathematical models for use in D-MTs.
2. To develop D-MT models for different types of **optical sensors** integrated into CMMs and/or MTs.
3. To develop methods and measurement standards for the **traceable parametrisation of models** used for measurement uncertainty evaluation in D-MTs
4. To use the D-MTs in **case studies and optimise their performances** for economically efficient application in advanced manufacturing.
5. To **facilitate the take up of the technology and measurement infrastructure** by the EMN Advanced Manufacturing, the measurement supply chain, standards developing organisations, and end users.

Implementation

Management (Lead: PTB)
WP6: Management and coordination
20.8 PM

Freeform Geometries (Lead: VSL)   52.2 PM
WP1: Digital-Metrological Twins for representing freeform geometries in advanced manufacturing
- Design/manufacturing of freeform standard
- Virtual reference artefacts (softgauges)
- D-MT development by considering the main uncertainty influences
- Glossary

Optical Sensors (Lead: VTT)   40.3 PM
WP2: Digital-Metrological Twins for optical sensors and metrology tools
- Sensor characterisation for selected commonly used optical sensors
- D-MT development by considering the main uncertainty influences
- Integration into D-MTs for CMMs and MTs

Parametrisation Strategies (Lead: TEKNIKER)   56.4 PM
WP3: Parametrisation of D-MTs for CMMs and MTs for traceable measurements of freeform geometries
- Measurement standards and strategies for prismatic and freeform geometries
- Parameter determination for CMMs and multi-axis MTs
- Testing of D-MT models on industrial freeform specimens

Validation and Optimisation (Lead: PTB)   60.9 PM
WP4: Evaluation of Digital-Metrological Twins (D-MTs) and implications for practical use
- Performance evaluation and optimisation
- Case studies
- Uncertainty evaluation
- Good practice guidelines

Example: Performance evaluation

Exploitation (Lead: RWTH)   31.1 PM
WP5: Creating impact
The consortium comprises active members in:
- ISO/TC 213/WG 10 and AG 12
- ISO/TC 39/SC 2
- ISO/IEC JTC 1/SC 41
- and several national committees

The methods and strategies for reliable use of D-MTs will enable the establishment of a long-lasting **working group** in the **EMN Advanced Manufacturing** and will be disseminated e.g. by **Good Practice Guidelines** to the **supply chain, accredited laboratories** and **standardisation organisations**

The project website will serve to distribute information.

Impact

Economic
The following industries will directly benefit from the results:
- Advanced manufacturing industries (e.g. healthcare, aerospace/aeronautics, electric mobility)
- CMM and MT producers
- Calibration service providers/laboratories

The project outputs will help to
- improve quality control for **novel production processes**
- enable **innovative product designs** for new functional requirements
- foster **cost-efficient manufacturing processes** through use of digital-metrological twins
- provide new calibration services

→ Manufacturers and industrial users are involved in this project.

Environmental
Key environmental impacts of the project results are:
- Supporting the **twin transition** of digital transformation and **mitigating climate change**
- Enhanced manufacturing processes will
  → **reduce re-working** times and processes
  → enable **novel energy efficient designs** in aerodynamics, electric mobility and power generation
  → **reduce waste** and scrap material ("*right-first-time*")
  → increase **product life time** through life-cycle management

Social
- The project will increase capabilities of more than **2 million enterprises employing over 30 million people** in manufacturing,
- Strengthen European **advanced manufacturing infrastructure**,
- Improve **quality of life** through e.g. customised implants, ergonomic work place designs and high machine operability.
- The project will create a **self-sustaining metrology infrastructure** between NMIs, universities and EMNs improving collaboration.

The consortium brings together **scientific excellence** in 8 NMIs, 8 universities and research centres and is complemented by 4 **industrial users and manufacturers** of metrological instruments. The **industrial stakeholder committee** will advise and guide the consortium to maximise the impact of the project results for the benefit of metrology in advanced manufacturing.