GMEE RESEARCH AREAS

FOREWORD

Measurement is currently applied in all domains of human activities and represents a crucial factor in the evolution of a fair, efficient, technological and knowledge-based society. Measurement is therefore a key enabler for the advancement of a vast diversity of sectors (not only technical) of vital importance for the society, including energy, environmental protection and climate changes, medicine, justice, quality of life, information and communication technology, transportations and automotive, aerospace, food industries, agriculture, bio-technology, chemical industries, nanotechnology, materials, pharmaceutics, space, security, safety, sustainable development, organizational management, resources management, quality management, innovation management.

Being aware that:

- valuable improvements are expected in measurement key-enabling technologies such as sensors, computing and communications systems technologies that will yield interactive, embedded, distributed and ubiquitous measurement systems capable of continuously monitoring large-scale complex systems;
- technological evolution will be driven and constrained by the societal priority requirements and needs;
- measurement brings objective information and is, hence, a key enabler of every scientific, technological and organizational solution for all major challenges engaging the global society in the near future;

the members of the GMEE contribute to the advancement of the state-of-the-art in measurement science and technology with emphasis on problem-led research and according to the following main, partially overlapped, research areas:

RA#1: *Fundamentals of measurement and metrology*

Keywords: metrology; measurability; unified measurement fundamentals; International System of Units (SI); measurement uncertainty; measurement standards; measurement traceability; measurement based decision making; weakly defined measurement; legal metrology; forensic metrology; measurements and ethics; measurements and scientific method.

Scope: this area covers: fundamental principles and definitions about measurability, e.g. for weakly defined properties; fundamental metrology, e.g. innovations in the SI, values of fundamental constants, measurements and methods validation via inter-laboratory comparisons; issues in scientific, legal, industrial and forensic metrology; definition and evaluation of measurement uncertainty according to different approaches, e.g. frequentist, Bayesian, fuzzy, random-fuzzy; relationships between measurements and scientific method, ethics, responsibility.

Challenges:

- ***Scientific***: supporting the establishment of a unified measurement body-of-knowledge.
- ***Industrial***: conceptual frameworks and advancements in measurement principles exploitable for technological development, including support for standardization in metrology.
- ***Societal***: exploring ethical, economical, legal, psychological, and sociological issues related to measurements.

RA#2: *Measurement signals and data*

Keywords: data acquisition; signal acquisition; sampling and quantization; A/D and D/A conversion; waveform generation; analogue and digital processing of measurement signals; measurement data analysis and information extraction.

Scope: development of methods, algorithms or techniques for the generation, acquisition, analysis or communication of measurement signals and data. Distinctive features of this research area are the metrological characterization of hardware and software methods, the identification and analysis of uncertainty contributed by signal and data management steps, the study of accurate signal and data models for measurement.

Challenges:

- ***Scientific***: propose and characterize novel strategies, methods, algorithms and techniques for satisfying measurement needs deriving from the pervasive development of science and technology, and at the same time promoting it.
- ***Industrial***: provide the technological ground for enhancing innovation capabilities and competitiveness of manufacturing companies.
- ***Societal***: provide reliable and trustworthy information to enable effective solutions to major societal challenges.

RA#3: *Measurement for reliability, quality and innovation management*

Keywords: technical diagnostics and prognostics; maintainability; fault detection diagnosis and location; risk assessment; safety and security; innovation models and assessment; technology audit; quality models and assessment; quality indices; accreditation; certification; calibration; standardization; conformity.

Scope: development and characterization of models, methods, instruments and tools for measurement, assessment and management of reliability, quality and innovation. This area covers: measurement activities for ensuring required levels of RAMS (Reliability, Availability, Maintainability and Safety), activities to manage quality and innovation processes, application of statistical process control techniques, reliability and dependability analysis and management, technical diagnostics and prognostics, condition monitoring and maintenance, laboratory testing and quality auditing and assessment.

Challenges:

- ***Scientific***: advancement of the state-of-the-art in measurement techniques, methods and tools for technical diagnostics and prognostics, and for quality and innovation management.
- ***Industrial***: development of new measurement methods, techniques and instruments aimed to guarantee RAMS requirements and to support quality improvement.
- ***Societal***: improving satisfaction and wellbeing of people, mainly through safety, product quality and innovation.

RA#4: *Measurements for characterization of components and systems*

Keywords: system characterization; compliance testing; performance assessment; conformity assessment; metrological characterization; testing; electromagnetic compatibility; assessment of human exposure to electromagnetic radiation.

Scope: development of innovative and competitive metrological methods, procedures, and systems for the characterization of the behavior of components, devices, and systems implemented by electrical, electronics, and information technologies. Specific interest is devoted to compliance testing, performance assessment, conformity assessment in analog, digital, or mixed components, devices, and systems; experimental characterization for fault diagnostics; Non-Destructive Testing (NDT); measurement for electromagnetic compatibility; measurement and instrumentation for particle accelerators.

Challenges:

- ***Scientific***: metrological characterization of the new measurement methods and systems proposed for the characterization of components and systems.
- ***Industrial***: provide methodological and operative support to the development of cutting-edge measurement technology for increasing innovation capabilities of manufacturing companies with specific focus on compliance testing, performance assessment and conformity assessment.
- ***Societal***: reliable and trustworthy information to effectively support critical decisions of everyday life.

RA#5: *Measuring systems and instrumentation*

Keywords: measurement systems; instrumentation; automatic measurement systems; instrument characterization; instrument specifications; instrument calibration; instrument interface; distributed measurement systems; smart metering.

Scope: this area deals with the development of new instrumentation and measurement systems and their metrological characterization. In particular the area covers: instrument architecture, physical design, metrological characterization and performance improvement; distributed architectures; interface protocols and buses; embedded measurement systems; Instrument Fault Detection and Isolation (IFDI). The metrological characterization of both hardware and software components of the proposed architectures is a distinctive feature of activities in this research area.

Challenges:

- *Scientific*: development of novel measurement instruments or systems and characterization of their performance.
- *Industrial*: development of innovative instrumentation aimed at improving competitiveness of manufacturing companies.
- *Societal*: development of metering employed in daily life; main fields of interest are: metering for the smart grid, households, smartphone and automotive.

RA#6: *Sensors and transducers for measurement*

Keywords: sensing, transduction methodologies, sensor modeling and characterization, microsensors, nanosensors, Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS), Labs on chip (LOC), print sensors, smart sensors, autonomous sensors, soft sensors, virtual sensors, distributed sensors, wireless sensors networks, energy harvesting.

Scope: this highly cross-disciplinary area addresses the general concepts of sensing and transduction with emphasis on both methodologies and new high-performances devices. Analysis of transduction uncertainty sources and metrological characterization of novel devices are distinguished features of research activities in this area. Topics in this area cover: sensing and transduction methodologies, modeling and characterization of sensors and transducers, micro- and nano-technologies for sensors fabrication, sensors based on plastic and non-conventional materials, rapid prototyping of sensors, sensors for IoT (Internet of Things), sensors for Assistive Technology and Smart Living, wearable sensors, integrated self-supplied sensors.

Challenges:

- *Scientific*: advancement of the state-of-the-art related to sensing and transduction methodologies and technologies by developing and characterizing new and high-performance sensing devices.
- *Industrial*: provide methodologies, technologies and devices addressing industrial challenges, thus enhancing companies market penetration.
- *Societal*: provide solutions to societal challenges mainly by means of non-invasive, distributed and interconnected sensor nodes able to provide accurate, real-time and reliable measurement.