European Commission

This fiche is part of the wider roadmap for cross-cutting KETs activities

'Cross-cutting KETs' activities bring together and integrate different KETs and reflect the interdisciplinary nature of technological development. They have the potential to lead to unforeseen advances and new markets, and are important contributors to new technological components or products.

The complete roadmap for cross-cutting KETs activities can be downloaded from:

http://ec.europa.eu/growth/industry/key-enabling-technologies/eu-actions/ro-ckets

Potential areas of industrial interest relevant for cross-cutting KETs in the Manufacturing and Automation domain

This innovation field is part of the wider roadmap for cross-cutting KETs activities developed within the framework of the RO-cKETs study. The roadmap for cross-cutting KETs activities identifies the potential innovation fields of industrial interest relevant for cross-cutting KETs in a broad range of industrial sectors relevant for the European economy.

The roadmap has been developed starting from actual market needs and industrial challenges in a broad range of industrial sectors relevant for the European economy. The roadmapping activity has focused on exploring potential innovation areas in terms of products, processes or services with respect to which the cross-fertilization between KETs can provide an added value, taking into account the main market drivers for each of those innovation areas as well as the societal and economic context in which they locate.

Taking the demand side as a starting point, cross-cutting KETs activities will in general include activities closer to market and applications. The study focused on identifying potential innovation areas of industrial interest implying Technology Readiness Levels of between 4 and 8.

MA 3.1: Monitoring, perception & awareness in manufacturing

Scope:

Monitor the actual state of components and machines in a continuous manner to allow diagnosis and context-awareness in the associated systems. Ubiquitous sensing approaches will monitor variables affecting the performance, energy-use and reliability of the manufacturing systems and the production.

Demand-side requirements (stemming from Societal Challenges) addressed:

- Tackle the “secure, clean and efficient energy” as well as the “climate action, resource efficiency and raw materials” societal challenge

Demand-side requirements (stemming from market needs) addressed:

- Provide for cost optimization including through predictive maintenance
- Provide for rapid and flexible production capabilities to match supply with volatile demand of today’s rapidly changing markets

Specific technical/industrial challenges (mainly resulting from gaps in technological capacities):

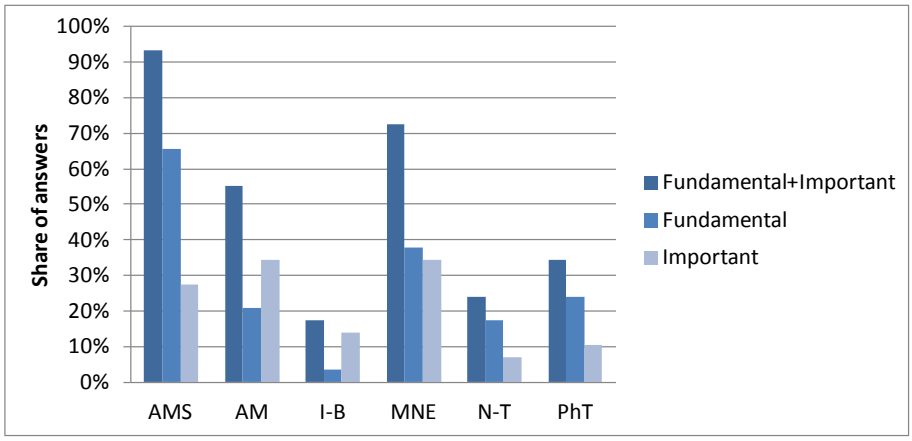
- Development of novel large-scale control-intensive applications for high yield performance and energy efficiency, in order to validate and benchmark the effectiveness and usability of the integrated automation and control systems, e.g. by means of fully integrated interfaces from Manufacturing Execution Systems (MES) to shop floor level or knowledge management of process data with shop floor relevance
- Software assisted diagnostics: software that identifies the reasons of break-downs after they take place
- Preventive maintenance: software that makes a forecast of machine break-downs before they take place
- Development of ubiquitous sensing approaches to actively support engineers in their aim of detecting, measuring and monitoring the variables, events and situations which affect the performance, energy-use and reliability of high value-adding manufacturing systems and the production at factory level

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of advanced approaches for monitoring, perception and awareness of the actual state of manufacturing components and machines in a continuous manner to allow diagnosis and context-awareness in the associated systems. The integration of KETs could contribute to the development of large-scale control-intensive applications for high yield performance and energy efficiency, building on solutions such as Manufacturing Execution Systems (MES) and innovative diagnostics and preventive maintenance approaches.

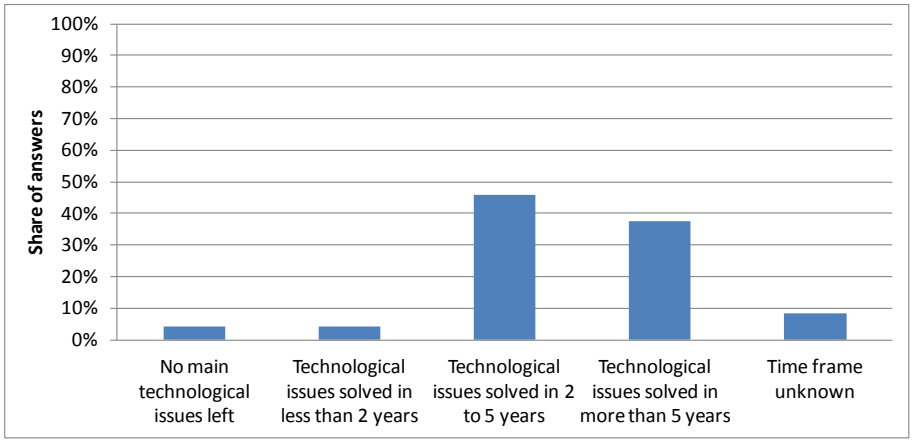
To this aim, the combination of KETs experts’ opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong interaction of KETs with respect to this Innovation Field, with either fundamental or important contribution mainly by the following KETs:

- Advanced Manufacturing Systems (AMS)
- Advanced Materials (AM)
- Micro- and Nano-Electronics (MNE)



Timing for implementation:

According to the majority of KETs experts' opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field could be solved in a time frame of 2 to 5 years, yet significant consensus by experts indicates also greater periods being necessary:



Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

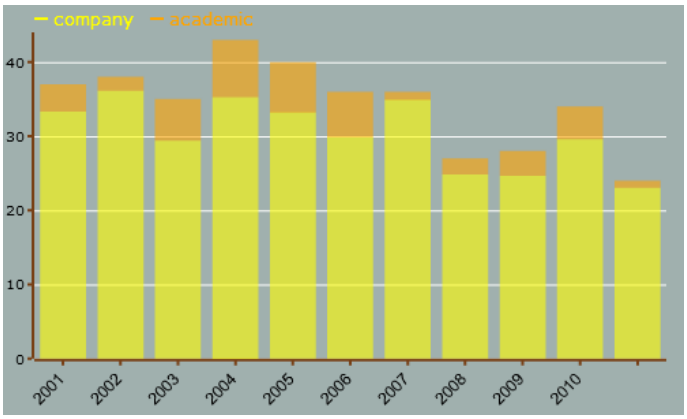
- ***Impact assessment:***
  - The involvement of information technology in manufacturing processes has increased over the last years. Information technology is used to provide for improved management of energy as well as resources in manufacturing as well as processing operations, but also to monitor data and support in decision taking (thanks to decision support systems) or to plan maintenance thanks to condition monitoring. All these performances are possible today thanks to in-line monitoring of process parameters and other monitored data.
  - In-line condition monitoring, which is an advanced major component of predictive maintenance, is capable to identify deviations from the standard operating conditions which are indicative of a developing fault. Condition monitoring allows maintenance to be scheduled, or other actions to be taken in order to prevent failures, thus avoiding consequences in terms of downturns or even accidents, which inevitably translate in costs. Condition monitoring can therefore have significant benefits in terms of costs savings.
  - Condition monitoring techniques, such as vibration condition monitoring and diagnostics, lubricant analysis, acoustic emission monitoring, IR thermography, ultrasounds emission monitoring, motor

condition monitoring and motor current signature analysis, are normally used especially on rotating equipment and other machinery (such as pumps, electric motors, internal combustion engines, presses), while periodic inspection using non-destructive testing techniques and fit for service evaluation are used for stationary plant equipment such as steam boilers, piping and heat exchangers.

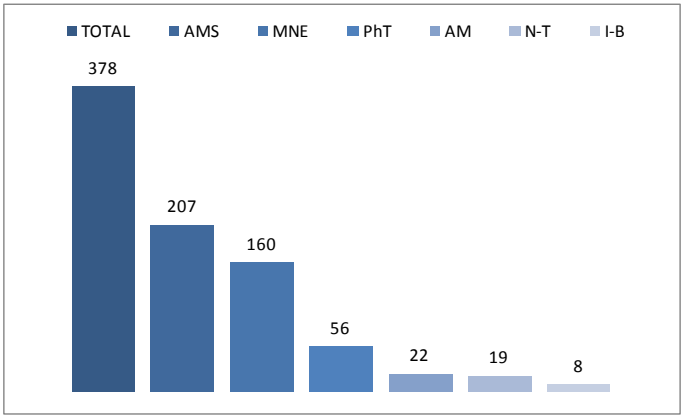
- Furthermore, Manufacturing Execution Systems (MES) have helped many industries to improve their processes, leading to sustainable improvements. MES has changed the manual operations into paperless operations for faster data transfer and better decision making. Connected networks of various MES systems can particularly help senior managers to take decisions based on real time data from remotely. As a result, the MES market was estimated to be 4.8 billion Euro in 2014 and to be worth 10 billion Euro by 2020 at an estimated compound annual growth rate (CAGR) of 12.61%. Discrete and process industries are the two major categories of manufacturing that MES serves. MES has been used in process industries for a long time; however, discrete industries are very large in nature and have the potential to grow for MES to be implemented.
- Automobile, healthcare, aerospace and defence, and FMCG (Fast Moving Consumer Goods) are the major discrete industries that will highly profit from MES in the future.
- Source: Markets and Markets, Manufacturing Execution System Market by Applications (Process Industries- Chemicals, F&B, Oil & Gas, Pulp & Paper, Life Sciences Power, Water & Wastewater Management; Discrete Industries- Automotive, Medical Devices, Aerospace & Defense, FMCG) and Geography (Americas, EMEA, & APAC) - Global Trends & Forecasts to 2014 – 2020, 2013.

➢ ***Results of patents scenario analysis:***

- 378 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
- Decreasing trend curve (number of patents per year)
- Highest share of industrial applicants:



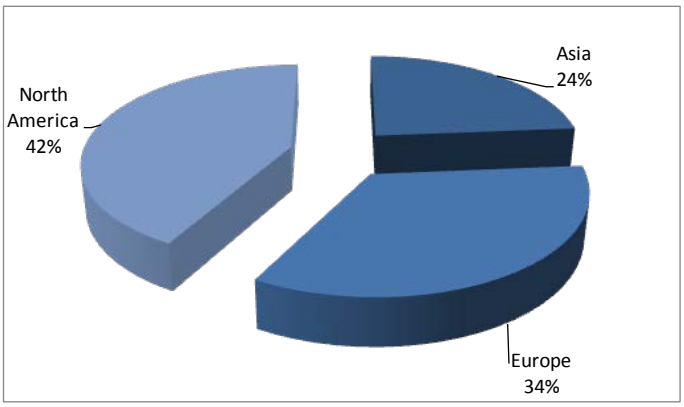
- Patents by KET(s):



- Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	22
AM / IBT	1
AM / IBT / MNE	1
AM / IBT / MNE / N-T	1
AM / IBT / N-T	1
AM / MNE	4
AM / MNE / N-T	3
AM / MNE / PhT	1
AM / N-T	6
AM / PhT	4
AMS	207
AMS / AM	5
AMS / AM / IBT	1
AMS / AM / IBT / MNE	1
AMS / AM / IBT / MNE / N-T	1
AMS / AM / IBT / N-T	1
AMS / AM / MNE	2
AMS / AM / MNE / N-T	1
AMS / AM / MNE / PhT	1
AMS / AM / N-T	2
AMS / AM / PhT	1
AMS / IBT	1
AMS / IBT / MNE	1
AMS / IBT / MNE / N-T	1
AMS / IBT / N-T	1
AMS / MNE	41
AMS / MNE / N-T	1
AMS / MNE / PhT	5
AMS / N-T	4
AMS / PhT	9
IBT	8
IBT / MNE	2
IBT / MNE / N-T	1
IBT / N-T	1
MNE	160
MNE / N-T	7
MNE / N-T / PhT	2
MNE / PhT	25
N-T	19
N-T / PhT	2
PhT	56

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: