GROUP
Connect-EU
Factories of the future

STRATEGIC AGENDA

for the Manufacturing Sector in Catalonia

With the support of:

ACC1Ó
Competitiveness for Catalonia

AGAUR
Agència de Gestió d'Ajuts Universitaris i de Recerca

Generalitat de Catalunya
Government of Catalonia

Interested in *Factories del Futur***?**

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Printed in Barcelona in 2012

Strategic Agenda for the Manufacturing Sector in Catalonia

Elaborated by the Connect-EU Factories del Futur Group

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The present document has been elaborated by the core group members of the CONNECT-EU working group of Factories del Futur, who wish to thank the supporting entities and the other contribution members for their inputs and collaboration to make the document a representative viewpoint and diagnosis of the Catalan manufacturing sector.

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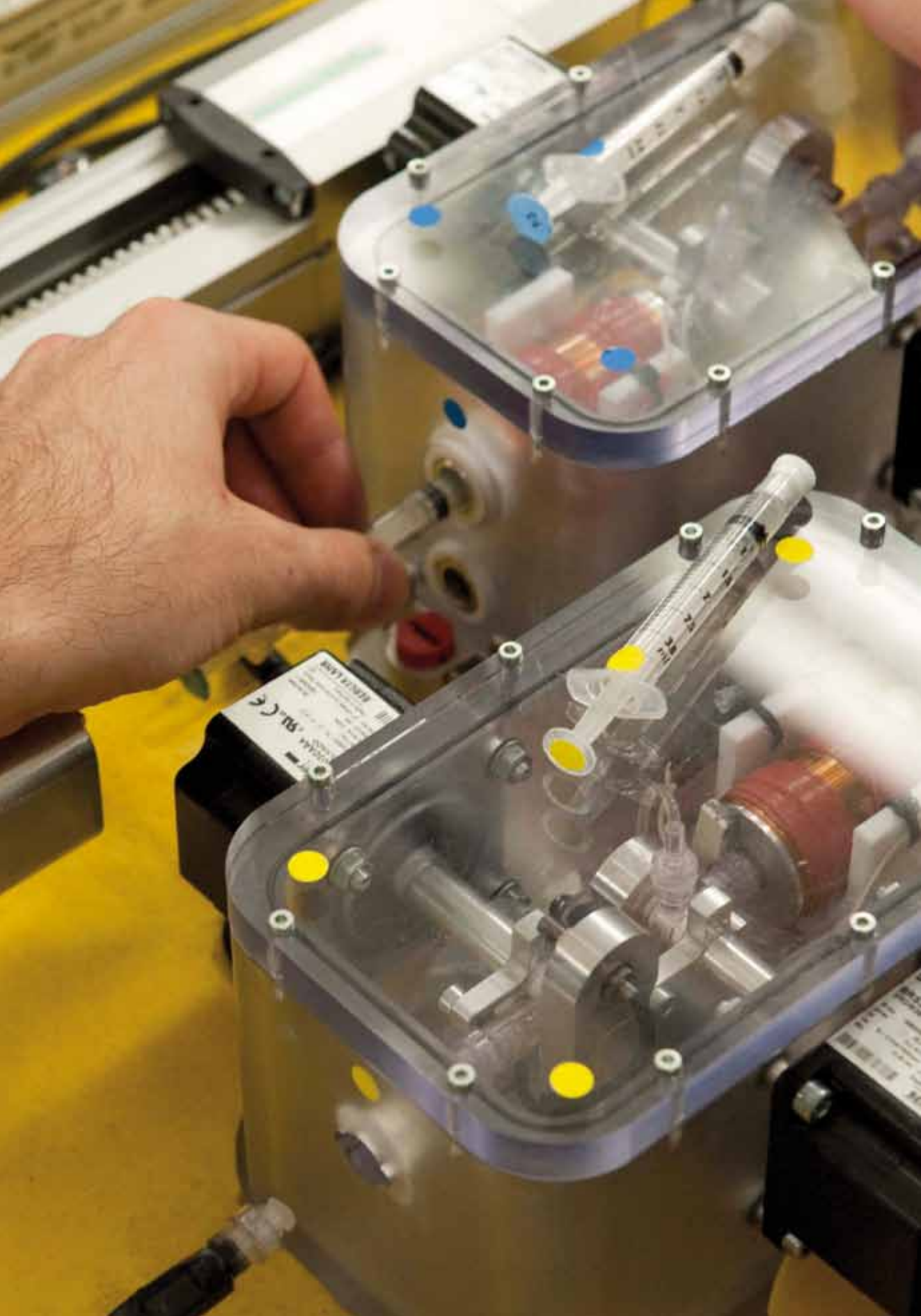
Note: The CONNECT-EU Group was set up by ACC1Ó, the Catalan business competitiveness support agency, to promote the Catalan participation in FP7. CONNECT-EU integrates the main catalan research players in thematic groups to defend the Catalan's interest in European R&D funding Programs (7th Framework Programme, JTI, PPP, IPF, Eurostars, etc.).

The Connect-EU groups have been competitively evaluated by objective criteria of representativeness and impact in FP7. Their main functions are:

- The redaction of common Thematic strategic agendas
- Collaboration with NCP
- Representation at the European Technology Platforms
- Promotional Activitites at the regional level
- Evaluation Experts
- Participation in events at regional and european level



1.0 INTRODUCTION & BACKGROUND

Factories del Futur

The Group "*Factories del Futur*" (Factories of the Future) is composed by Universities, technological centres and companies experts in manufacturing. It is sponsored by ACC1Ó, the Catalan business competitiveness support agency.
Its main objective is to defend the interests of Catalan R&D and manufacturing agents through formal mechanisms (committees) and all other mechanisms (European Technology Platforms, Associations).

During 2011, the group has acquired maximum representation in Catalonia and contributed to the public consultation on the Green Paper: Framework of European Funding for Research and Innovation. It has also participated in work dynamics with National Contact Points, ACC1ó and AGAUR and contributed to public consultation on Competitiveness and Innovation Programe (CIP).

The Strategic Agenda

The Strategic Agenda for the Manufacturing Sector in Catalonia includes the opinion of the Catalan manufacturing sector with two clear objectives: to be technologically representative and technically exhaustive.

To achieve representativeness, the group decided to organize a series of working sessions where all the main manufacturing actors in Catalonia were invited: research centres, technology users and providers (universities), SMEs and large corporations, long-established companies and new spin-offs. In short, all the entities involved in technological development. These sessions performed in 2011 proved to be successful in participation with more than a hundred participants as well as in the contributions collected.

The result is a complete document collecting trends and concerns in the region for the next 5 to 10 years, based on the opinions expressed by the catalan contributors during the open consultations.

This document is organised around four reference areas: Sustainable Manufacturing, Intelligent Manufacturing, New Materials, and High Performance Manufacturing, according to the criteria of the Multi-Annual Strategic Roadmap prepared by the Ad-hoc Industrial Advisory Group ad published by the European Commission.

2.0 VISION AND STRATEGIC OBJECTIVES

The Catalan Manufacturing sector

Catalan industry has been known for its high level of adaptation to new technologies and customer demands. According to the OECD 2010 report, the manufacturing sector in Catalonia represents over 20% of the total Gross Value Added (GVA) in this region. The relative weight of sectors of medium and high technology in Catalonia significantly exceeds the Spanish average. While in Catalonia the GVA of the medium and high technology sectors accounted for 7,7% of GVA Catalonia, for Spain, this sector represented 4,5%. The difference between Catalonia and Spain in the relative weight of knowledge-intensive sectors increases if we consider only the high technology sectors, which represents 1,8% in Catalonia and 0,8% in Spain.

In 2009, the negative behaviour of the manufacturing sector, which showed a reduction of 13,4% between 2008 and 2009, led to a fall of the GDP per capita in Catalonia of 4,2%. In fact, the manufacturing sector's share of the total GVA has fallen steadily since 1995, moving from a 26% in 1995 to 19,2% in 2008.

Although Catalan industries are mostly part of a chain of fragmented development and few produce final products for consumption, the region has achieved a successful combination of manufacturing capabilities and service, with a strategy based on technological research and innovation promoting industrial transformation and ensuring a certain level of job creation.

Nonetheless, the necessity for the manufacturing sector to innovate is now more present than ever to face the competition from other countries and to avoid knowledge delocalisation.

Areas of action

The 7th Framework Programme currently offers multiple opportunities for participation by companies. The work of the Factories of the Future Group will be to increase the representation of the Catalan companies' interests.

Factories of the Future focuses on the field of new manufacturing technologies which represent an opportunity for the industrial sector to be more competitive.

Nonetheless, the centre of interest is not only the manufacturing industry but all the entities intervening in the process of creating, designing and manufacturing, from the raw material to the final product.


1
EUR

3.0 MAIN INDUSTRIAL NEEDS AND RELATED R&D CHALLENGES

3.1 SUSTAINABLE MANUFACTURING

a Emissions

The reduction or elimination of emissions is necessary to improve the economical, social and environmental welfare. To attain this objective, not only there is a need for new technologies, processes and materials but also for a stable and consistent legal environment. The following topics intend to improve the image of the region and give value to the products produced.

THE CATALAN CASE

- The measure and control of emissions is complicated and does not receive many incentives, the legislative requirements are strict, inflexible, rarely homogeneous and bureaucratically slow.

- There is an instability related to changes in legislation and government administrations. Environmental policies are highly variable depending on the region which prevents the sector's competitiveness in a global market and encourages the relocation of contaminating companies to regions with more permissive policies.

- The cost of implementing new technologies is high and the initial investment to adapt the facilities and to purchase equipment takes time to pay back. Therefore, the risk associated with the introduction of new technologies when the current is already generating profit often fuels the inertia to continue with what has been tested.

The main Catalan research objectives regarding the reduction of emissions are the following:

(a1) Zero - Emissions Factories
Adapt the factory through the design of convenient prevention processes and equipment to monitor emissions, such as intelligent systems for re-use emissions as an energy source and automated systems to reduce human involvement in hazardous work.

(a2) Green Products Manufacturing
Integrated preventive environmental strategy to processes and products in order to increase the overall efficiency by the conservation of resources and energy.

(a3) Strategies at market level
Promotion of recycling, social responsibility and environmental policies through more active promotion of industrial ecology (networking reuse of scrap between companies). Encourage control measures (e.g. making public enterprises in the control samples).

b Energy

Energy is the basis of every part of the manufacturing process, thus sustainable manufacturing should be centred on an efficient use of clean energy. It is important to promote the use of cleaner alternative energy sources to reduce environmental impact, costs and related geopolitical dependence on fossil fuels. Through a more efficient use of energy companies can beneficiate both on a social and economic level.

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- Industries waste a considerable amount of energy during the production process and the handling of raw materials. The infrastructure of the systems are often inefficient and unreliable with poor energy distribution facilities not optimized regarding energy saving.

- The change of energy supplier is difficult with few companies operating the market and setting switching costs.

- The costs for using clean energy are higher than those related to conventional energy and are not sufficiently incentivised. Thus companies continue relying on fossil fuels.

- Companies often do not take into account the costs related to energy when designing the production process or do not consider energy consumption in investment decisions.

The main Catalan research objectives regarding energy are the following:

(b1) Energy-Saving Factories
More flexible machinery, adapted to the production, that is, with the ability to self-manage energy consumption according to production. Machinery capable of re-using emissions as an energy source. Integrated machinery (concurrent engineering - automation applied to the industry) able to optimize manufacturing processes to consume less energy.

(b2) Regulations
Study of the benefits associated with the use of alternative energies. Holistic sustainability analysis of the manufacturing equipment from idea to decommissioning. Sustainability effects on energy consumption of tax-reduction and reducing building permits to make energy improvements, etc.

(b3) Low energy-consuming materials
Greener energy through greener materials and an optimization of their performance. Incorporation as raw materials formulations and solutions that require less energy expenditure in order to be processed

(b4) Energy Infrastructure
Efficient systems of accumulation and storage of energy. Optimization of existing power grids to reduce losses. Collectivize the transport of energy and promote waste exchange between industries or companies for re-use of energy (energy clusters in the industrial states).

(b5) Energy Management
Planning and design of integrated sustainable global supply chain.

c Waste

Our society produces large amounts of waste. To prevent the waste of natural resources and the growth of landfills, waste needs to be reduced, reused and recycled. Several solutions are currently available

THE CATALAN CASE

The Government of Catalonia has set up a "waste to energy" management network to manage waste in the same area or business more efficiently (http://www.subproductes.com/eBSPWEB)
Nonetheless, the problems generated by industrial waste in Catalonia are still numerous:

- In general, all waste pollutes in one way or another. Within factories, the waste accumulated often causes problems and insecurity for workers or neighbours. Moreover, many Catalan industries have a heavy dependence on hazardous materials and products which undervalue the environmental impacts.

- The costs related to waste are high: costs of storage, processing and waste treatment or the outsourcing of its management, legal costs, costs related to recycling and costs related to cleaning and maintenance of the factories that produce corrosive waste and end up deteriorating machinery.

- Regulations concerning the handling and waste management are quite restrictive and involve high costs, in most cases companies need special credentials to manage the waste, or due to legal problems it is difficult to comply with the regulations. All these complications hinder the growth of the SMEs, due to large investments to manage waste produced.

The main Catalan research objectives regarding waste are the following:

(c1) Products Eco-Design
Design from recycled materials. New substitute materials more efficient and producing less waste. Identification and characterization of the waste or by-products that can be re-used.

(c2) New technologies for waste management
New systems for more efficient waste management, especially concerning the separation, characterization, handling and transportation of waste.

(c3) Use and re-use clusters
Intense collaboration between companies and universities or technology centres with the creation of waste management clusters of companies, business groups and knowledge centres to encourage the purchase / sale of waste. Dissemination of information, training and networking in waste management.

d Materials

Many companies try to use traditional materials more efficiently to achieve higher performance. There are tools for selecting materials; such as databases of materials, knowledge centres of materials or design methodologies which take into account recycling in the selection criteria. However, most of the times the best solution continues being to utilise unused and not recycled materials.

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- The properties of a considerable amount of raw material used in manufacturing processes are unknown and therefore those materials are not used at the best of their efficiency. Many materials are not intended to hold the entire lifecycle of products and the recycling or reuse is still limited and often rejected by customers. In general, the materials are not ready to be recycled and the many manufacturing processes go through make it even more complicated.
- There is a shortage of new materials and the costs associated with them are considerable. Moreover, the industries are rarely involved in the development of new materials and the economic properties they bring are often not sufficient to justify a change from a more traditional and economic option.

The main Catalan research objectives regarding Sustainable Materials are the following:

(d1) New processing strategies
Production strategies based on the "reduce, reuse and recycle" with new processes to encourage recycling, taking into account the entire production chain from manufacturing to destruction.

(d2) Less pollutant materials
Development of new multifunctional materials of high quality that do not involve a great environmental impact. Introduction of materials from products of other industries with no loss in quality.

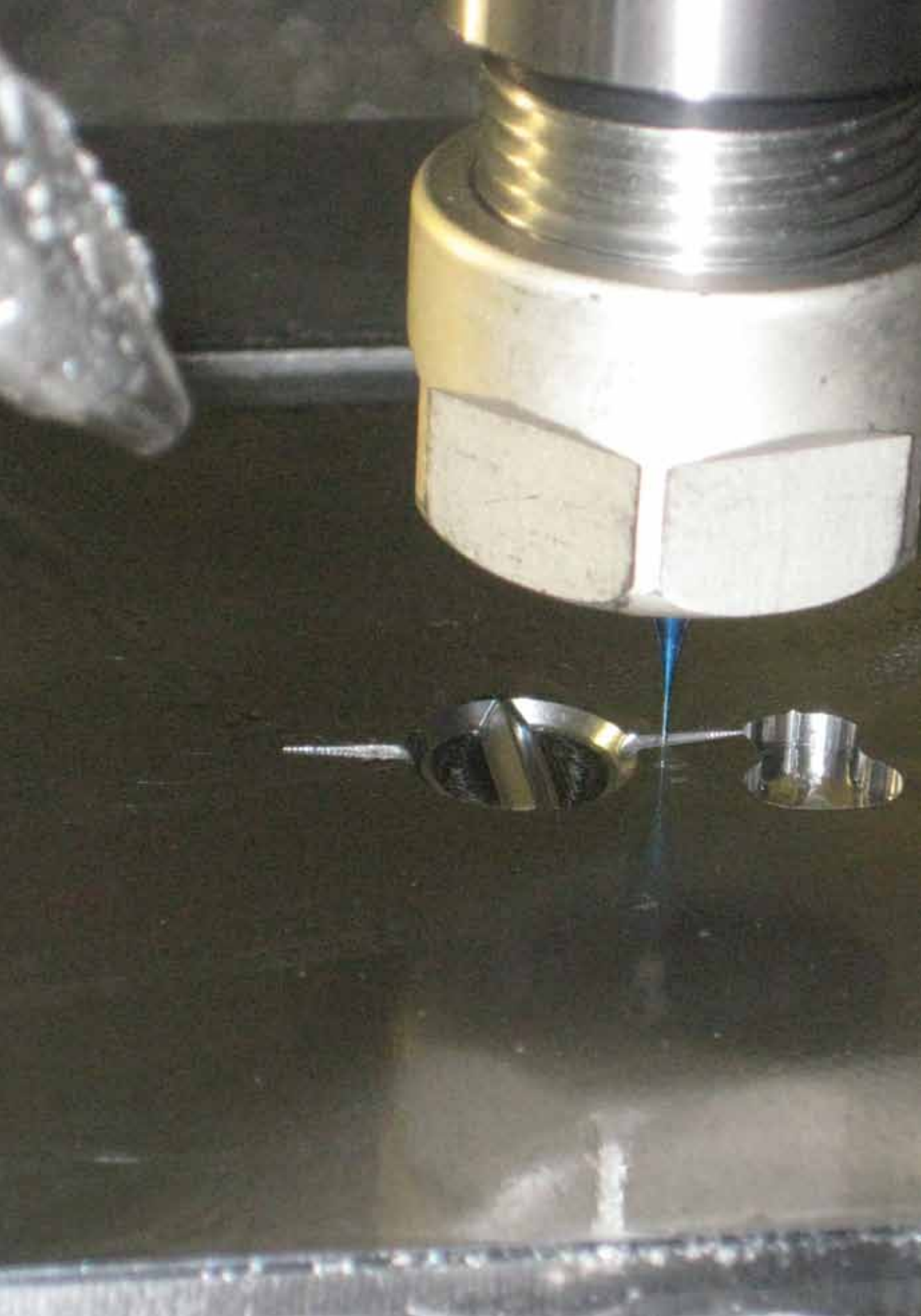
(d3) Consumer awareness
Initiatives to raise awareness of consumers about purchasing products not harmful to the environment. Promotion of the concept of eco-innovation, without compromising the competitiveness of enterprises.

CONCLUSIONS

To achieve the implementation of Sustainable Manufacturing in Catalonia, it is necessary to implement a good business strategy in order to reduce hazardous emissions in the environment, non-recyclable waste and consumption of polluting energies, and this can only be possible using more efficient materials and more flexible technologies.

A network linking universities and industry to enhance the optimization of materials and technologies suitable for each factory while avoiding compromising the profitability of the industry is also essential.

Finally, further innovation within companies to "Reduce, Reuse and Recycle" should be promoted to encourage the concept of sustainability at all stages of the manufacturing process.



3.2 ICT-ENABLED INTELLIGENT MANUFACTURING

a Digital factories

Digital Factories are characterized by digital processing of all or part of the information necessary for manufacturing. Computer modelling of prototypes with the use of computational simulations reduce the need to build physical prototypes, allowing the use of new information technologies and communication as a basic support for manufacturing. Tools for computer aided design and manufacturing type CAD/CAE, virtual and augmented reality applied to manufacturing and fluid simulation tools, such as structural and mechanical modelling of processes are key to the digital factory.

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- Strong need for interoperable solutions. Technologically advanced solutions can fail miserably when integrated to existing tools. This problem is a key point in the setting of digital factories and is often the source of a considerable waste of time and money.
- Although companies are aware of the many existing protocols, to conform to all requirements, they all ask for standard data structures for information exchange to facilitate this level of interoperability in information systems (IS).

The main Catalan research objectives regarding Digital Factories are the following:

(a1) Product and process modelling based on the manufacturing, distribution and recycling
Incorporation of the cost factor in the conceptualization and design of products. Tayloring of the manufacturing for the different phases of the product lifecycle:

- Logistics: The transportation can be incorporated into the products modelling tools, as transportation costs are often higher in the long term. The products could be designed to optimize future transportation costs.
- Packaging and handling: In the same way, product design can be optimized to reduce handling costs, which tend to be quite high in large-scale production, which is closely related to transport costs.
- Design for specific manufacturing processes i.e.: Additive Manufacturing or Casting.

(a2) Mechanical simulation tools, structure and processes
System software capable of simulating the behaviour of engineered products: a complete digitization of the product to avoid the construction of physical prototypes, therefore, requires simulation software to validate designs. This point emphasizes the need to incorporate simulation-based features that must be met by products that ensure current regulations, such as in ergonomics. To make this possible it stresses the need to establish processes and databases on which to establish standards and generate the simulations.

(a3) Management of multidisciplinary knowledge
The modelling features based on required processing and data processing of different levels: physical, legal information, process information, financial data, information on recycling etc... Thus, the multidisciplinary treatment of information is a key area of the research in this trend and is extrapolated to other scenarios. Set up standard data structures for information exchange to facilitate this level of interoperability in information systems (IS).

b Virtual factories

The concept of Virtual Factories refers to the use of new information and communication technologies for the efficient management of business networks and supply chains. Tools for real-time monitoring of production processes in the chain, and its dynamic management and virtualization throughout the production process, shaping the virtual factory. This section includes tools that allow management to cross all the actors and companies involved in the life cycle of products manufactured from its conceptualization and design, through manufacturing and ending with recycling, dismantelling or reuse.

MAIN INDUSTRIAL NEEDS AND RELATED R&D CHALLENGES

THE CATALAN CASE

- There is still a lack of communication between clients and providers
- The current portals developed by multinationals for small suppliers to manage their orders often limit or force their use.
- Current client-provider systems are time consuming and often fail because they require continous manual information updates.

The main Catalan research objectives regarding Virtual Factory are the following:

(b1) Customer -Supplier Information Systems
New information systems allowing a more transparent, flexible and interoperable communication between clients and suppliers. Systems capable of acquiring the information automatically. Standardization in data structures and communication protocols.

(b2) Distributed Management
New systems of supply chain management as a distributed management of stocks and access to ICT through mobile platforms, monitoring suppliers from different centres of the same company or different companies, as well as managing and moving stock from suppliers. Thus capable of forecasting of the time and cost of manufacturing and distribution more accurately. Confidentiality of information, considering that customers could access sensitive information from different companies. Standardization of protocols for exchanging information between companies. RFID technology to monitor the entire supply chain.

(b3) Management of volatile manufacturing assets
Planning and optimization of the offer and demand, taking advantage of the large volume of data that can be analyzed using data mining techniques. Simulation of supply chains allowing the analysis of the behaviour of all actors. Standards to be established among others:

- Routes of internal stock and staff
- Routes suppliers
- Productive Capacity
- Capacity, demand and purchasing
- Critical Chain (bottlenecks)
- Policy and legal regulations
- Versatility of resources, people and materials.

c Smart Factories

Smart Factories represent the next generation of manufacturing companies that make intelligent use of digitization and virtualization. The manufacture of complex products require factories ready to be flexible, fast and mostly reactive to ensure efficient and sustainable management of resources. The automatic monitoring and automation of independent production processes, robust and efficient implementation of algorithms for intelligent use of industrial robotic systems, the use of smart sensors to control distributed RFID identification manufacture and application of laser systems for manufacturing or processing of materials are some of the scenarios that are addressed within the area of smart factories.

THE CATALAN CASE

- The automation of manufacturing processes is a reality but it misses tools to detect the quality of production. The human factor is still determining the proper functioning of supply chains to ensure the quality of the partial or final products.

- A complete control over the entire manufacturing process is necessary through sensors which would enable the proper handling robots and their ability to communicate and share information.

- Current automatic quality control systems produce a significant share of rejection, and therefore, require extra validation by operators because they are not adapted to the product and process using their own data based information.

- The manufacturing processes generate a large amount of data that are usually stored in databases or spreadsheets and that is seldom converted into information through a proper statistical analysis. Tools such as Analytics, Datamining or data-based management applied systematically.

- Interoperability is one of the most common problems to be solved.

- Need to increase the safety of workers involved in manufacturing processes.

The main Catalan research objectives regarding Smart Factories are the following:

(c1) Automation for intelligence on manufacturing processes
Use of robotics and embedded systems for intelligent manufacturing automation. It can be related to ambient intelligence. However, the automation must provide added value on the "simple" integration of robots in production lines. That is, robotic systems with machine learning systems able to react to failures, which collect information and have the ability to communicate. Such systems would enable to detect waste or surplus of energy and enable a rethinking of the production line and thus a more sustainable manufacturing.

(c2) Information management and access
Access to information in a flexible, agile and closer to natural language. Ubiquity, interoperability and adaptability. New techniques for automatic indexing of documents, access to semantic and natural language processing, as well as new ways to view and navigate through the results.

(c3) Production equipment with intelligent operation and control systems
Future manufacturing equipment must incorporate Artificial Intelligence decision tools capable of assessing the quality of the production performance so as to improve the manufacturing strategies. Methods involve the integration of automatic data collection, control parameters, quality control, efficient management of information, decision-making and general process self improvement.

(c4) Human-Machine Interaction
Appropriate interfaces for each role, easy to use, self explanatory and adaptive to key manufacturing processes.
Smart applications for mobile access from remote devices.

(c5) Smart metrology
New tools and methodologies to enable in-process automatic or semiautomatic quality assurance and reaction of the supply chains in case the product quality is not adequate.

d Ambient intelligence

The previous trends are much more popular for small and medium companies of the Catalan manufacturing sector, the concepts related to environmental intelligence are much more tangential. Ambient intelligence seeks to incorporate environmental items, ability to communicate with each other and the user's sensitivity to context (adapting to the location, user preferences, devices that are around them, etc.) and reactive (reacting to certain events). The technologies implemented include fibre optics, wireless networks, cameras and microphones, accompanied by very small size and pattern recognition techniques for voice recognition, fingerprint sensors, location sensors (RFID).

THE CATALAN CASE

- There is a strong interest in machines that would be able to send information such as if it stops or runs poorly to the mobile operators to reduce the reaction time.
- The companies also seek machines that could detect the user's level of expertise to guide them according to their needs and / or abilities.

The main Catalan research objectives regarding Ambient Intelligence are the following:

(d1) Sensor Networks
New sensors such as interconnection for new applications and new systems. Sensors allowing applications to facilitate logistics and management through comprehensive product traceability and stock throughout the supply chain. Personnel management, monitoring of the physical position for possible retrospective study of time management, and physical needs in order to improve ergonomics in the workplace.

(d2) Embedded systems
Materialisation of intelligent products and systems embedding elements in their structure (electronic, sensors, etc.).

(d3) Internet of Things
More autonomous machines and objects through embedded systems able to communicate among themselves and with humans in a smart, flexible and above all adaptable environment. Creation of new expert systems that could lead to virtual (using virtual reality or augmented reality) repairs to the machines, and security issues. Embedded intelligence of the machines to detect the user's level of expertise and act accordingly. Secured communication systems between machines (wireless connections are often unreliable and the use of cables greatly undermines the flexibility of these solutions).

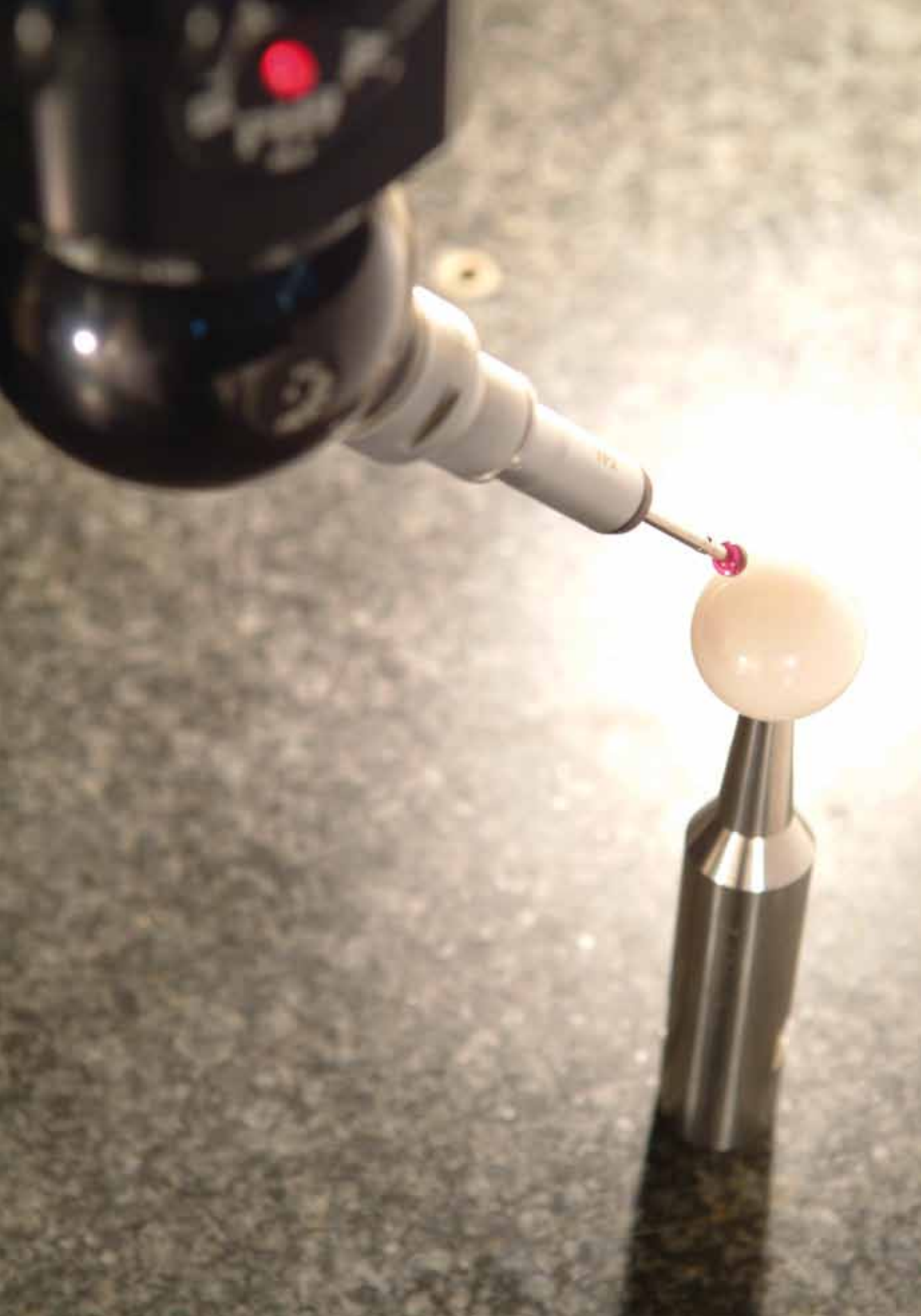
CONCLUSIONS

To achieve the implementation of Intelligent Manufacturing in the Catalan industrial sector, it is vital to develop interoperable solutions, i.e. solutions capable of being integrated to existing technologies.

In general, there is a big opportunity for improving the design environment in Catalan companies. For example, Kansei Engineering (KE) is a technique used to incorporate emotions in the product design process. It is a quantitative method and it has been successfully applied to many different products - especially in Japan, by the contribution of its founder Mitsuo Nagamachi.

The companies highlighted the need to optimize the in-process automatic quality assurance of products and to optimize energy consumption. It is necessary to forge a new company point of view, where the Ambient Intelligence is not seen as luxury or secondary.

The companies prefer short-term solutions that improve productivity and reduce costs. That is why the focus is on conceptualization and design to optimize the product in order to reduce costs, especially in logistics, packaging and handling.



3.3 HIGH PERFORMANCE MANUFACTURING

a Adaptation of flexible production equipment, systems and facilities reconfigurable and optimized energy

Currently the industry has the need to adapt to a growing demand for personalized and smaller batches. This new situation forces the industry to design flexible machines and production systems allowing the process to adapt to the product, thereby reducing time and costs of setting up a new production process.

THE CATALAN CASE

- Fast changes in production, with even smaller batches.
- The launch of a new product represents high reconfiguration time and cost, since the reconfiguration and programming of machines is still manual. Nowadays it is very difficult to reuse a manufacturing or assembly line as machines are designed for large productions. The systems do not adapt to changes in the process.
- Lack of programming machines to control and optimize energy costs (prognosis).
- Communication problems between machines. Lack of standardization between brands needed to make the plug & produce.
- Difficulties in the integration between design and production flexibility. High investment required. Complexity of the system setup.
- Some systems are not yet automated. In mixed production lines there is still a big barrier to overcome in human-robot interaction.

The main Catalan research objectives related to Flexible Production are the following:

(a1) New high performance manufacturing technologies
Adaptive machine-tools with automatic reconfigurations and prepared for rapid changes in production. Systems to monitor all machines for fast reconfiguration. Machines adaptable to changes in the process and control systems for closed loop (feedback) and sensor systems and actuators to close the loop. Smaller systems, modular, transportable and self-adjusting with standardized protocols to install new machinery from different brands. Design of the production process focused on the flexibility of the lines. Parallel robotics applications to machine-tools.

(a2) Plug and produce components
Based on intelligent materials or combinations

of passive and active materials (engineered materials) to allow Automatic Reconfiguration of new elements to the production process. Auto setup: "Plug & Produce" and "Turn on & Produce"

(a3) Adaptive machines and production systems
Systems to optimize and achieve more efficient energy consumption (e.g.: incorporation into the machine metaphor "start & stop" in cars), with energy Recovery. Feed forward. Low cost highly adaptive smart production systems.

b Micro-machining systems and high precision manufacturing

The benefits of micro-manufacturing are considerable. Nonetheless, very few Catalan industries have the capacity to get into this sector and often need to outsource to China. To counter this trend, there is a special need for R&D in this domain.

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- Currently machines occupy large areas. Factories are very rigid, with very little ability to change location.
- There is no national culture of miniaturization (problem of how to make small parts with large machines). There is no investment in developing these technologies, thus the Catalan state of the art in this domain is limited.
- Difficulty in the dimensional and surface quality in miniaturization.
- High costs of verification measures of micro products. It is very difficult to achieve the precision the micro product industry requires.
- Currently, machines and micro-manufacturing systems are not functional for production (usually used only for prototypes). Machines and micro-manufacturing systems are not cost effective for large batches.

The main Catalan research objectives regarding micro-machine systems are the following:

(b1) Rapid micro-manufacturing technologies
Implement machine tool control systems. Dimensional analysis focused on micro-manufacturing.

(b2) 3D micro-parts production
3D micro-components using a wide range of materials (metallic alloys, composites, polymers, ceramic) on large volumes. Varnish with micro-capsules (furniture industry). Sputtering (cathodic spraying) for glass and mirrors in car industry.

(b3) Micro-factory and micro-manufacturing systems
Processes with different micro-operations. Ultrasonic machining. Manufacturing environments ideal for micro-manufacturing. Ensure flexibility in the micro-manufacturing. Micro-fabrication additive techniques to meet the batch size demands. Systems of measurement for micro-manufacturing to achieve an acceptable cost in check and ensure high accuracy.

(b4) **High precision clamping**
High precisión fastening and subjection systems and methodologies for high speed and multiaxis machining. Solutions for exotic materials such as Technical Advanced Ceramics.

c Tools for production planning and in-situ simulation for open reconfigurable and adaptive manufacturing systems

The industrial sector sees the current planning and simulation tools too complex, too expensive and of little use to deal with real problems that are commonly found. In addition, these tools are often useful only for very specific production processes mainly of large industries. The SMEs lack useful tools to plan their production processes.

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- The solutions offered by current tools for planning (ERP) do not adapt to real problems, they do not give the evolution of the process.
- The cost of these tools is higher than having one person fully dedicated to the production planning. Currently these tools are a supplement, never a substitute since they still require an expert in planning.
- The current simulation tools are very flexible, highly complex and expensive. They are designed for production processes of large industries and do not adapt to the SMEs.
- Currently a production process can be simulated, but it cannot simulate the impact the process will have on the rest of the factory.
- Currently there are no tools to adapt to unforeseen changes in production processes.
- Lack of implementation and need for further development of Computer Aided Programmes for Simultaneous Engineering.

The main Catalan research objectives regarding Simulation Tools are the following:

(c1) Methodologies and tools for reconfigurable manufacturing systems design
Methodologies that define the set of resources and the control system architecture having characteristics and performance that optimally match the demand and the process plan over time. Developed production system solutions should also address internal uncertainty, such as unforeseen events, by continuously tuning process parameters and production flows. Define a standard language parameterisation.

(c2) Knowledge based tools for process planning
Tools that can replace the planner: flexible with capacity or self-learning & intuitive data. RPS planning process for Identification of defects in design processes and provides solutions. Send data to improve production processes. Join ERPs with actual production.

(c3) Integrated shop-floor simulation
Simulation of the entire production process, a tool that covers all existing simulation tools with all these tools capable of communicating together.

(c4) Advanced interactive graphical user interfaces
Tools allowing workers to deal with the increased complexity of simulation and decision systems embedded in machines and production lines. Tools able to integrate all the different manufacturing phases: from design to shop-floor operation.

d Zero-defect manufacturing

Producing deficient products is a costly problem common to all manufacturing companies. R&D in zero-defects manufacturing is necessary for companies to cut down on the cost of their products and stay competitive.

THE CATALAN CASE

- Difficulty in identifying the origin of failures when there are many different processes involved in the manufacture of a piece. Variability of material, environmental and human factors. Variability in dosage of materials.
- Lack of analytical sensors. Lack of efficient management of software defects
- Quality issues usually come from the most important stage: design
- Lack of evaluation of the cost of non quality. The impact on the end user

is very difficult to assess but it is very important.

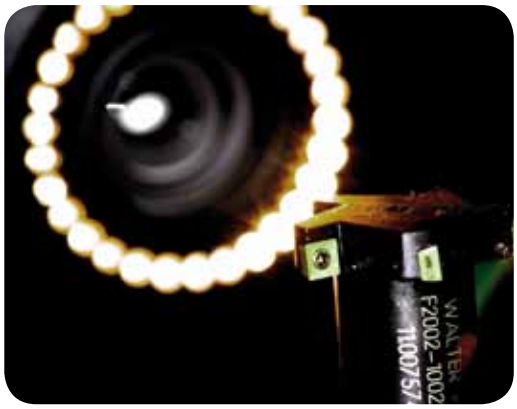
- Distance between large amount of information and knowledge. Still far from the artificial intelligence of machines and manufacturing systems capable of providing self-learning solutions.
- RFID (radio frequency identification) does not support high TBMP (Trademark Trial and Appeal Board Manual of Procedure).
- The production increasingly personalized (not serial) hinders the traditional quality control. We do need new tools for self-control. Currently, the market marks a very short time between products that do not have time to use MAFE (Modal Analysis of Failures and Effects).

The main Catalan research objectives regarding zero-defect manufacturing are the following:

(d1) New generation of measuring tools
System analysis for chemical components. Analysis of subjective factors such as smell. Development of thermal sensors. Affordable Computer Vision. Smart parts, smart raw materials. The part as an active element of the production process.

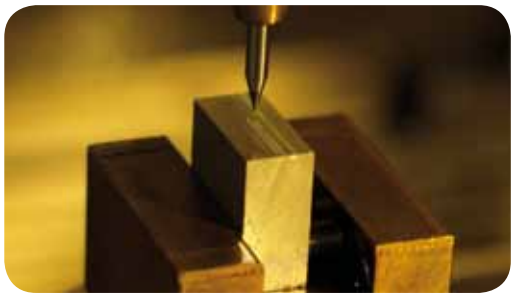
(d2) Advanced decision-making tools for zero defect manufacturing
Intervene at the early stages of product design, involving both client and supplier. Knowledge management system that allowing the designer to have all the information needed about the production process. Create working methods accessible to logistics, production, etc.

(d3) In-process quality monitoring and proactive process improvement for geometric shape data and material quality
Create a system of quality associated with each phase of product that controls and retro-feeds the information. Simplify the setting up for the detection of defects. In-process quality assurance.



(d4) Development of a new generation of knowledge based self-learning systems
Process control through monitoring and sensor systems. The machines must make decisions about the process so that it can adapt to different production strategies to avoid defects. In-process quality correction.

(d5) Intelligent measuring systems for zero-defect manufacturing
Development of fast and reconfigurable low/medium and high resolution measuring systems for accurate and time efficient measurements. Distributed Intelligent Measuring Systems reconfigurable both in space and time.



CONCLUSIONS

The manufacturing sector has adapted rapidly to the changes in the economy and the consumers' needs. Nonetheless there remains a need for standardization of the different production systems in order to make a reality the "plug and produce". With the increasing awareness of energy optimization, so that should move towards better management of energy resources through self-learning and Auto adjustment of the machines.

Technologies allowing machines and systems to create micro-manufacturing of high precision are not yet developed at the national level, there is a strong need for Catalonia to develop R&D in this domain to bring the region to the level of other countries. The aim is to reach flexible and portable micro manufacturing processes to create production lines easily adaptable to any location.

R&D in planning and simulation tools mainly aim to develop intelligent software, able to adapt to existing production processes so as to be 'tailored' for each company. In addition, it must allow its use by a person not necessarily expert and have the ability to store the knowledge of experts.

The aim of zero-defects manufacturing is to develop new tools capable of monitoring the quality as would an expert, identify potential quality problems at any stage of the process through continuous monitoring and sensor systems, able to intervene more actively in making decisions about the process and correcting deviations that lead to errors in manufacturing.

3.4 NEW MATERIALS FOR MANUFACTURING

The emergence and development of new materials with new functionalities, enhanced intrinsic properties, with less environmental impact, etc. should generate opportunities to increase business competitiveness. At the same time processes also produce new challenges to adapt existing technologies or build new ones to manipulate and transform them. Moreover, the symbiotic relationship between new materials and new manufacturing technologies leads to new processes of transformation and / or combination of materials, new technologies also require specific handling of this matter on scales increasingly precise and refined.
Therefore we can generate new materials and apply them to new smart products, complex internal structure, more efficient or completely innovative, with lower production costs and logistics. This aligns with the momentum at the European level of efficiency and sustainability policies that promote a more rational use of raw materials, waste recovery and use of more efficient processes with lower resource consumption.

a Net-shape manufacturing for advanced structural and functional materials

THE CATALAN CASE

- Problems of anisotropy of mechanical properties and repeatability of the products.
- Additive Manufacturing still does not meet the expectations of some part characteristics such as surfaces roughnesses, material properties or cost levels.

The main Catalan research objectives regarding net-shape manufacturing are the following:

(a1) New processes and new trends in the transformation of metallic alloys and light alloys
Research in powder metallurgical alloy susceptible to magnetism. This is useful for electromagnetic heating of the mould.

(a2) Micro / Nano-technologies, materials, micro / nano-structured micro / nano-surfaces
Development of new bio plastic materials and natural reinforcements that can be reused to reduce the burden of plastic and reduce dependence on oil. Generation of organic materials, light and durable without major investments in the production process and can be manufactured in situ. Development of alternative materials on the market (fibreglass or carbon loading), with affordable and tailored. Development of new thermostable materials, insulation and autoreparable. For the case of the health sector stated the need for biocompatible materials with mechanical damping capacity and osteointegration.

(a3) New Materials for Additive Manufacturing Processes
Metals, Plastics and Ceramics. Recyclability and production from recycled materials.

(a4) New Additive Manufacturing systems for mass production
Improvement of parts surface finish. Extension of material range. Increase on the processes sustainability. Cheap self replicant AM production systems**.**

b New equipment manufacturing functionalities through processing

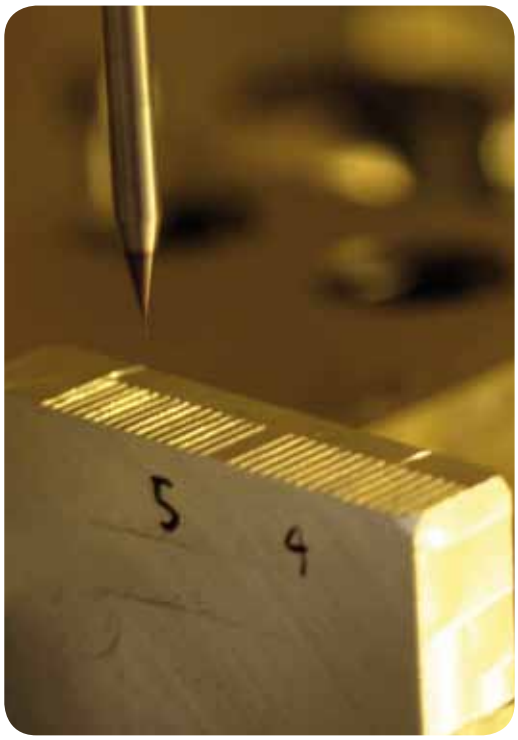
THE CATALAN CASE

- Problems of scalability for the industry.
- The production of nanomaterials suffers from the variability between different batches, which hinders the application in markets that require a large reproduction of the materials with which they work.
- In the process of powder metallurgy, the dimensional stability of products is a problem.

The main Catalan research objectives regarding new equipment are the following:

(b1) Micro / Nano-technologies, materials, micro / nano-structured micro / nano-surfaces

Standardization of quality control of nano materials. Development of test methods for nanoscale characterization and the incorporation of nanomaterials in the production process. Methodologies are needed to evaluate the properties and physical, chemical and mechanical nanoscale. Development of new production technologies that allow highly accurate work at a nanometer scale. Development of specific software that allows modelling and simulation of nanocomposites in the production process; development of different models depending on different materials (metals, polymers and inorganic).



(b2) Process Transformation and production of composites

Optimization and process innovation in forming light alloy matrix composite materials and metal. Automation of the generation of materials, looking for improvement with respect to material costs, repetition, and adaptation of the process of the polymers. Development of methodologies, processes, equipment for the detection of discontinuities. Reduce the production processes of new materials (currently required many steps in the generation / process, which increases equipment costs). Implementation of cellulose for application of composites reinforced with natural fibres. Study of the influence on micro-geometry and new materials research and its adaptability to different processes (anisotropy). Greater integration of the simulation of structural materials (possible customization of the compounds). Continuous production processes and scalability of production of new material (especially Bio).

(b3) New processes and new trends in the transformation of metallic alloys and light alloys

Machining of very abrasive materials, (e.g.: ceramics), since the level of tools and process have not yet obtained the desired results. Processes to obtain the combination of substrate materials/layers allowing features such as materials superconductivity.
Improvement of the polishing technologies for complex shapes (still too manual). The PVD coatings are limited by materials developed by powder metallurgy and can evaporate. It would be interesting to develop new materials for sintering that can then evaporate.

c Sustainable product design using material processing technologies

THE CATALAN CASE

- Problems between different suppliers of materials such as Cr / Co, Ti or ceramic materials to ensure equivalence. From a supplier or other material differences exist.
- Lack of specific measuring equipment to measure exposure to nanoparticles.
- Materials are provided, not tailored to the applications.

The main Catalan research objectives regarding sustainable product design are the following:

(c1) New processes and new trends in the transformation of metallic alloys and light alloys
Research into new lighter materials such as magnesium, steel or high strength metal foams is a strategic field for the automotive sector (especially the new generation of hybrid vehicles and electric).

(c2) Traditional non-metallic materials
Exploration of the uses of non-metallic materials in new innovative applications.

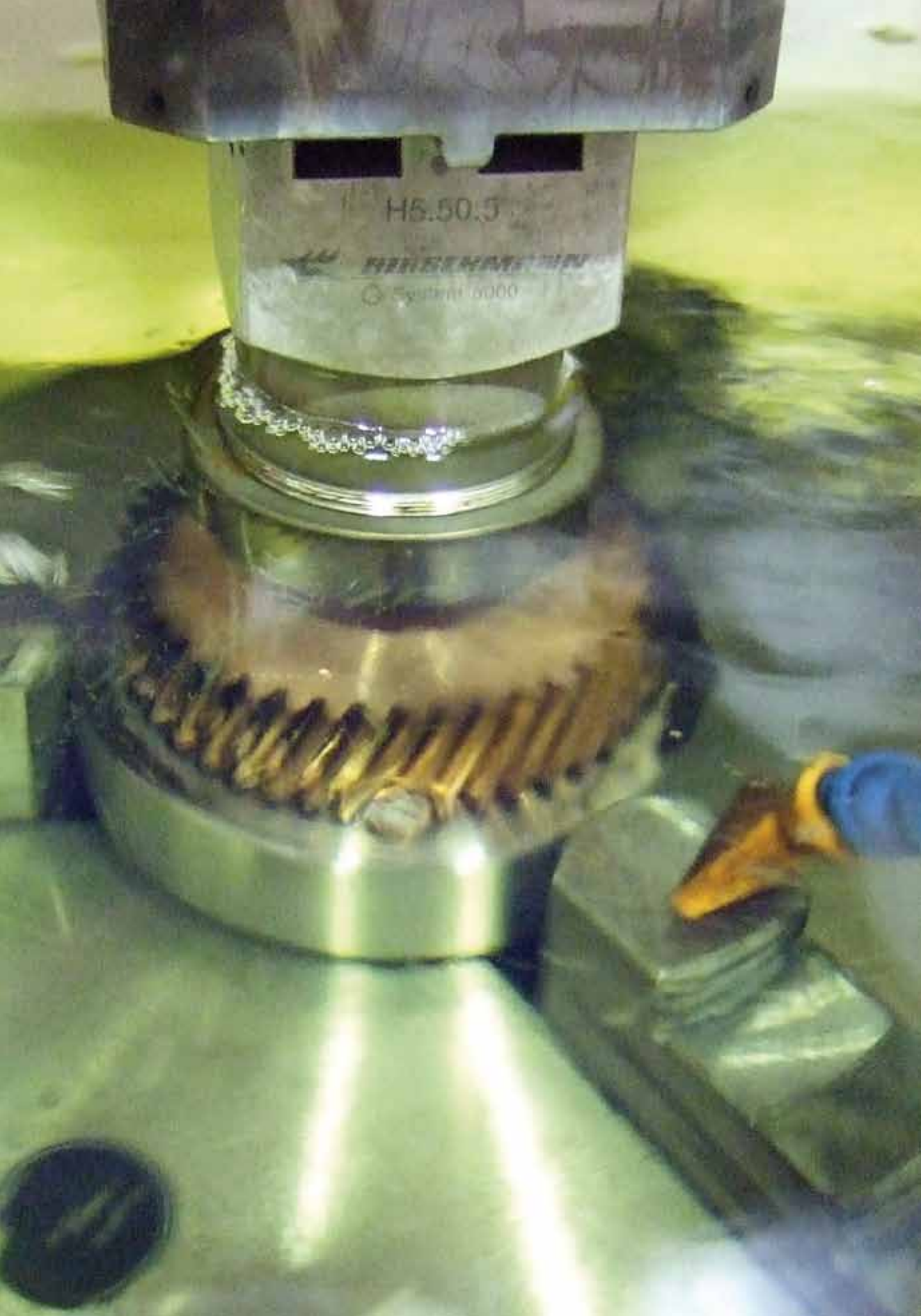
(c3) Development of recycling technologies in nanocomposites, nanomaterials, and derivatives.

(c4) Development of energy efficient materials
Materialisation of materials that require less energy to be processed. Special graded materials.

(c5) Study of the effects of nanoparticles on human health
The size of these nanoparticles is the same as some biological molecules and can interact with them. Study possible consequences such as heart diseases and lung inflammations.

CONCLUSIONS

The development of new materials is as important as the development of technologies to process them efficiently. In this regard, it is considered that the recycling, recovery and reuse of materials is a determining factor for its implementation.
Companies tend to invest in materials that meet different attributes. The same material can be used for a maximum number of applications and most extreme conditions.
Developing technologies that allow the incorporation of new materials in the production chain is vital. These technologies highlight the lack of high-precision instruments for nano / micro manufacturing.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4.0 EXPECTED IMPACT OF THE FACTORIES OF THE FUTURE GROUP

The CONNECT-EU Factories del Futur Group has been launched in order to have a direct economic impact on innovation and research in manufacturing. This public-private partnership will promote research focused on the needs of Catalan manufacturing companies, especially SMEs. The main goal is wealth creation through a competitive market position and adding value.

The research and development results will be applicable across many industrial sectors and the new production methods, processes and technologies are expected to reach industries across all of Catalonia and beyond.

An additional expected benefit is linked to the cooperation, in line with the Factories of the Future PPP objectives, between the academia/research institutes and the European industry. The export share of the European manufacturing and process equipment industry will be reinforced as a result of the achievement of the Strategic Agenda objectives because technological improvements combined with better environmental performance will lead to competitive advantage. Moreover, the supply of this equipment to third countries will also lead to a reduced worldwide environmental impact.

Typically, contribution and participation of Catalan industries in European Framework Programme has been below the involvement of the related RTD stakeholders. Being one of the most industrialised regions of Europe and producing thousands of scientific publications per year, our region can contribute to the achievements and objectives of the European 2020 Agenda.

Finally, the active participation of the related actors will help to align the regional interest with the coming objectives of the Horizon 2020 programme. As a first milestone, this Group pronounced its position for the public consultation raised by the European Commission to elaborate this new joint research and innovation programme.

5.0 STAKEHOLDERS INVOLVEMENT

This Strategic Agenda for the Manufacturing Sector in Catalonia should not be seen as representing the perspective of only one group of stakeholders, nor as having been realised through narrow, highly specialised approaches. The knowledge of the wider community of stakeholders, embracing all the relevant manufacturing sectors (users, customers, researchers, environmentalists, etc.) is expected to be integrated together for this initiative, including:

- The Catalan manufacturing industry: large companies, SMEs (including knowledge-intensive SMEs), as well as the Trade Associations. This includes both supplier companies for production technologies and customer companies.
- The Catalan research and education sectors: universities and Highschools, basic research centres, applied research organisations, technology centres and technology brokers.
- Regional Technology Platforms, and related Sub-Platforms.
- The Catalan Administration

Moreover, the research areas identified in this Strategic Agenda for the Manufacturing Sector in Catalonia can deserve action on a European scale. In that context, it is worth exploring joint activities where involving partners from Europe would lead to win-win situations. Where appropriate, international bi- or multi-lateral collaborations might be envisaged to maximise the benefit for European industry and society. In this sense, the Intelligent Manufacturing Systems initiative (IMS) and, in particular, the IMS2020 coordination action, should be taken into account.

Grup CONNECT-EU Factories del Futur
Strategic Agenda for the Manufacturing Sector in Catalonia

Acknowledgements

Special thanks are expressed for their contributions to all industry-related members of the "Factories of the Future" Public-Private Partnership, to all those who participated in the public consultation to the wider community of stakeholders and to all the entities and people who individually took part in the discussion sessions during the elaboration of this document.
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STRATEGIC AGENDA

The Strategic agenda for the Manufacturing sector in Catalunya collects trends and concerns of the manufacturing sector for the next five to ten years.

This agenda, sponsored by ACC1Ó (the Catalan business competitiveness support agency), was redacted by the Group "Factories del Futur" (Factories of the Future), integrating Universities, technological centres, and companies experts in manufacturing. Its main objective is to promote the interests of Catalan R&D and manufacturing agents through formal mechanisms (working committee) and all other mechanisms (ETPs, Associations).

To achieve representativeness, a series of work sessions were organized where all the main manufacturing actors in Catalonia were invited: research centres, technology users and providers, SMEs and large corporations, companies and spin-offs. In short, all the entities involved in technological development. The result aims to be a complete and technically exhaustive document to be taken into account for Technological Policy-making.

With the support of:

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