

Advanced production systems: new challenges, new opportunities

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The current economic context has proven the weaknesses of the Catalan growth model followed in the last years, while international reports show the lack of competitiveness of the production fabric and its unsatisfactory evolution.



The Catalan industrial fabric has traditionally stood out in a highly competitive global setting and has evolved, experiencing a set of relevant changes to adapt to global economic change in an excellent way. This has often not been acknowledged and many still think that the manufacturing industry has no future, not only in Catalonia but in all Europe.

Yet this is not true. Although there are companies that are part of a fragmented development chain, most have reached a successful combination of manufacturing and service capacities by means of a strategy based on technological research and innovation fostering industrial transformation, while ensuring the creation of qualified jobs.

We thus find that many companies in branches like aerospace, automotive, pharmacy, food, defence, telecommunications, energy and many more take up manufacturing activities or encourage internationalisation of the most critical and valuable part in the chain for reasons of traceability, security, strategy, product and service customisation and transport and logistic cost.

Advanced production is on the borderline of new technologies, products and working patterns, and our future will be based on a balanced model in which the industry and services strengthen each other.

Nobody doubts that a change of model is needed, but associating this necessary change to technology only is oversimplified as the different social, cultural, educational, territorial, etc. factors are also important. Nevertheless, the technological and industrial capacities and the ability to create adequate strategies in this field create the indispensable framework to guide the future of the Catalan industry and place it on the European map of advanced production as it deserves.

In this respect, the concept of advanced production has to be perceived in a wide sense, including all activities done in relation with integration of solutions to develop and update products, processes and services allowing to satisfy in an efficient and sustainable manner economic, social and environmental needs of an increasingly globalised society that however stresses its local identity.

Advanced production is on the borderline of new technologies, products and working patterns, and our future will be based on a balanced model in which the industry and services strengthen each other. So far, technology has been the main driver of progress in the industry, and it will remain so. Yet to fully understand the current setting, science, technology, new business models and especially talent need to be taken into account.

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To summarise, the main production trends can be pinpointed as follows:

- ▶ Global trends characterised by the «think global, act local and think personal» principle. Concepts like customisation – product design and manufacturing catering for the needs of each individual customer – thus take shape and are to be applied in both technologies and business models.
- ▶ Immediate conversion of information into knowledge. This becomes crucial in decision-taking and sets the development towards an innovative manufacturing sector based on knowledge and intelligence.
- ▶ Creation of added value in products to cater for changing customer and user needs. Apart

from providing new features, products need to be increasingly efficient, safe, ergonomic, clean, valuable, cheap and user-friendly.

- ▶ Flexible companies with organisational and technological capacity to provide quick response to changing market opportunities and needs.
- ▶ Safety, privacy, connectivity and ubiquity are trends affecting directly the development of information and communication technologies and their adoption by all industrial sectors.
- ▶ Environmental sustainability and compatibility, which involves reduced waste production, energy diversification and environmental impact close to zero.
- ▶ Technological convergence guiding companies towards collaborative, interdisciplinary and transversal innovation.
- ▶ Shift in labour profiles based on the global change and new technologies, by which knowledge-based labour tends to play a relevant role.

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So although the manufacturing industry is clearly affected by global economic deceleration in the medium term, challenges and opportunities are identified that can turn Catalonia into an advanced production cluster in Europe as is occurring in other European regions.

These global trends open a wide range of opportunities for the Catalan economy, and future challenges are identified to cater for these opportunities.

Challenge no. 1: Products and processes with high added value

This challenge provides for the generation of sustainable products with high added value and related technologies and processes, with the ultimate goal of satisfying increasing user demand.

The creation of new technology-based industries and companies needs to be fostered. Clusters have to be created to reorient and modernise the activity of Catalan companies so they become able to migrate to new strategic or emergent sectors in which they can take advantage of their technological capacity and know-how acquired to develop more valuable products and services. The most competitive products are those featuring more knowledge, more services, more individualisation, more user-friendliness and more customer participation in the final design. This evolution shall allow companies to detect potential, more attractive markets and generate innovative products catering for new needs in order to get away from their traditional activity, seriously compromised by the international competitive setting.

In this respect, a new, highly competitive entrepreneurial fabric is being created based on the development of products, processes and services with high added value associated to the needs of strategic and emerging industries like renewable energies, biotechnology and health. Also, it is becoming increasingly clear that companies do not create groups based on their branch but rather cooperate along the value chain to develop new products together and increase their competencies and knowledge thanks to open, collaborative and multi-disciplinary innovation.

It has to be said that new materials are an infinite source of inspiration to add value to products, reach new performances and open new markets. Yet the development of new materials

with new properties requires advanced technologies to transform them or optimise existing resources as ignorance of their behaviour and features can pose an additional difficulty on the design and transformation process.

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Among high added-value processes we could single out those process technologies aimed at obtaining microproducts and industrialisation of **nanotechnology** progress to obtain products with enhanced properties and their manufacturing technologies.

Challenge no. 2: Reconfigurable companies and concurrent manufacturing

The competitive climate, strengthened by communication and shared knowledge, requires a quick response to changing needs of customers and market opportunities. Companies need to be flexible and manufacturing processes reconfigurable to adapt to customer specifications by providing tailor-made solutions to produce in mass but also to be used for small amounts of customised products.

In this respect, there is a clear trend towards implementing all technologies allowing to accelerate the product development process as what really matters is that the time between an idea springing up till it becomes a commercialised product is as short as possible, yet keeping a relation with other economic or logistic matters. Besides, the consumer is increasingly intervening in the design and

development of products, originating new business models and the need of optimising existing production means in order to reach flexible and innovative manufacturing, in which knowledge and intelligence become another production factor. Under these conditions, flexibility and reactivity are two key points to sell solutions rather than products.

This concept includes the development and validation of new technologies and industrial strategies allowing to considerably improve processes in terms of swiftness, productivity, adaptability and anticipation to reach flexible production oriented to customised production. These technologies need to consider all aspects of the process and the product life cycle in the design and production stages, continuous feedback during their life and especially user needs.

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To support these concepts, new technologies and information systems need to be implemented to connect all tasks within and outside the company. They shall allow to combine all operations with standardised methods and protocols with the aim of exchanging information to optimise logistic and manufacturing processes in order to reach out to the customer or user in a swifter and more customised way. In this respect, we talk of network production systems that have to be dynamic and include technologies facilitating collaborative and virtual design; identification and verification of manufacturing patterns of all parts involved in the product development process; monitoring, maintenance and remote control systems; systems of perception, artificial vision, image treatment and shape recognition to achieve

total quality control; and technologies applied to distribution networks and e-commerce.

However, increasing production process efficiency also requires reconfigurable manufacturing systems allowing not only to increase productivity but also to have the capacity to do so-called local customisation. In this respect, productive companies have decidedly gone for robotisation and HMI (human machine interface) applications. A significant progress in hardware for intelligent collaboration systems has to occur as production sectors approach self-supervision and correction systems in closed cycles in which process patterns are controlled and fed back on an ongoing basis. Unconventional manufacturing processes like **rapid manufacturing** technologies oriented towards obtaining short series need to be taken into account.

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Challenge no. 3: Smart production, information management and knowledge

With a strong link to the previous challenge, competitiveness of industries, especially the most mature ones, depends on their ability to turn information into useful knowledge for immediate decision-taking. Thus there is capacity to adapt continuously to changing requirements of the market and do cooperative operations at global level.

Networking and the inclusion of intelligence as a further factor to consider in product

development becomes increasingly relevant for structure production. The opportunities for the Catalan industry arise from the capacity to develop and assimilate systems encouraging cooperation and sharing knowledge outside the companies. The necessary time reduction in developing new products requires real-time information transfer between stakeholders involved in the manufacturing process.

Hence the development of communication systems and the implementation in a web setting of tools and methods allowing to do cooperative operations at a global level becomes essential: collaborative design, identification and verification of manufacturing patterns of all parts involved, process identification and specification, integration of the logistics chain and improved supply chain management.

Also, information and communication systems need to be developed to increase the connectivity and ubiquity of all operations and stakeholders involved in the value chain.

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The development of applications oriented to partial or full automation of industrial processes, including product design, numeric simulation of processes and products and the inclusion of smart decision agents, neuronal networks, expert systems (KBE and KBS) and programmable algorithms and automatons is also crucial.

Finally, the evolution towards a manufacturing industry based on knowledge and the adoption of intelligence in products and processes to permanently have immediate information on the real situation of the setting leads us straight to acquire and develop

knowledge in mechatronics and sensorics. Its great applicability in strongly differing industries will definitely revolutionise production, causing a great impact in terms of security, traceability, user-friendliness and customisation.

Challenge no. 4: Sustainability

Environment and energy efficiency of production processes and their respective regulations have become some of the main concerns of the industry for the future. The interest for environmental impact goes beyond recycling components and both material and design are affected by recyclability concepts. From an environmental point of view, the use of recycled material stands out in the development of new products, automation of manufacturing processes, minimisation of waste and emissions and internalisation of environmental costs in order to have a sustainable industry.

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Also, the use of limited material and energy resources are increasingly relevant problems fostering the use of renewable energies and the reduction of energy consumption. For the industry, opportunities concentrate not only on taking advantage of progress in alternative and renewable sources for energy diversification like solar energy and photovoltaics. There are also great opportunities in massive industrialisation of components provided by this new energy map based on diversification, which is creating a new industry based on the development of new products and solutions

that shall allow to adopt clean technologies in facilities, engine vehicles and means of transport.

Challenge no. 5: Human and social capital

Introducing new technologies in production processes is necessary as a strategy to adapt to change; yet the degree of technological progress and the impact of information technologies on the production systems has been a success and growth in the sector depends largely on the capacity of companies to assimilate and implement this progress. Together with new products and the exploration of new markets, this requires more resources to consolidate new knowledge and improve human resource qualification required at industrial companies.

There is an increasing demand for skilled workers able to adapt to changing market needs, technically much more skilled and with multidisciplinary capacities and knowledge.

This needs to come with higher investment in training and retraining of people as there is an increasing demand for skilled workers with an appropriate level of training and able to adapt to changing market needs. It is proven that having skilled labour is a basic requirement for development, and in this respect, human resources, their motivation and educational level require long-term social investment of the different social instances (educational, production and governmental system). In this respect, the educational offer needs to be adapted, both at universities and in vocational training, to the real needs of the industry that requires technically much more skilled individuals with multidisciplinary capacities and knowledge.

Finally, as human and social capital are the most important assets of companies, special attention needs to be paid to fostering the protection of intellectual capital from an institutional perspective, while encouraging export, exchange of staff and an expatriate culture so Catalonia becomes a logistic knowledge hub.

Conclusions

The key to consolidate a cluster of advanced production in Catalonia lies in taking on these challenges successfully. There are three key factors to do so: technology, know-how and swiftness. These three factors are part of the Catalan industrial culture, which creates a scenario of endless opportunities. New trends and emerging markets are a great source of opportunities the industry, with all its know-how, must not let pass by to settle as the technological hub of advanced production in Southern Europe.

To reach this goal, appropriate conditions for ongoing innovation and development of overall production means need to be created, which includes technologies, organisation, manufacturing means and human resources. Health, security, environmental and other aspects need further to be taken into account.

In Catalonia, we have a set of strategic factors that, if well combined, can place us as one of the world's advanced production regions:

- ▶ Macroeconomic stability allowing the industry to plan for the long term.
- ▶ Investment in R&D and new technologies as well as development of related professional capacities and careers.
- ▶ Science and innovation: a scientific and technological base able to help the industry develop new products and processes.
- ▶ Productivity-based industrial tradition able to help companies in their strategic reorientation.
- ▶ Consolidated educational system to train, retain and attract talent.
- ▶ First-class scientific and technological infrastructure.
- ▶ Logistic infrastructure and communication networks allowing effective transport.
- ▶ Appropriate market setting and critical mass providing support for business and an entrepreneurial culture.

Nevertheless, a joint effort is needed to turn the manufacturing sector into an innovating industry based on knowledge and intelligence. The industry needs to focus its competencies on developing the end product and valuable components in the value chain, while areas like advanced production processes are consolidated in which we have a clear competitive advantage.

Open innovation, increasingly focused on the consumer, involves the creation of partnerships with universities and research centres, customers, suppliers and strategic partners with the aim of ensuring success.

In this respect, a strategy based on technological research and innovation needs to be developed and implemented so as to ensure quality job creation and the maximum possible share in global manufacturing. Hence the results of flat technological research need to be effectively adopted, which means to implement knowledge and the development of new applications by crossing different technologies and disciplines to maximise the added value of the industrial fabric. Open innovation, increasingly focused on the consumer, involves the creation of partnerships with universities and research centres, customers, suppliers and strategic partners with the aim of ensuring success.

Also, the next generation of companies has to place a big effort in the human factor and the industry needs to become an attractive career option with the goal of securing flexible, innovative labour force with multidisciplinary skills.

Advanced production is and will remain a critical element for the success of the Catalan economy. We firmly believe that the foundations

and the industrial capacity are already out there. What is needed is to articulate them appropriately, put some self-esteem into it and learn to work in a cooperative way along the lines of so-called open innovation. Considering this, Catalonia can become one of the industrial clusters of advanced production in Europe, as is already the case of other European regions with an economy heavily based on industrial activity.

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