

Educational Programs in Between Design and Supply Chain

Significant Examples of Academia-SMEs Joint Labs in Italy

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Locate: Furniture manufacturing in Italy is based on interconnected small and medium-sized enterprises based on craftsmanship know-how. Focus: These companies have undertaken profound transformations within the production chain in a logic of *advanced craftsmanship*, integrating enabling technologies into high-quality craftsmanship processes. This transformation is aiming at shaping *intelligent enterprises* and it requires new design professionals able to work with systemic view, connecting design competencies to an overview on the supply chain issues. Report: In this context, academia-industry joint programs could train design managers able to understand, acquire and integrate the tangible and intangible values of manufacturing culture and technological innovations. The research reports on joint labs cases studies in between Academia and SMEs that aimed at defining innovative design paths based on digitalization of production and production management. Argue: The presented experiences highlight on how the overall training systems provided by the university could represent a significant booster within the entire digitization process and innovation management. In fact, the laboratories have been involved within specific production steps of the companies.

Keywords: advanced craftsmanship; supply chain; design education; joint lab programs; digitalization

Italian Manufacturing Districts of Furniture and Home Details. Socio-Economic Transformations Underway

The organization of furniture manufacturing districts in Italy is based on an articulated differentiation of productions that involves highly specialized independent small and medium-sized enterprises. Each of them focuses on a single activity or on a series of small and consequential tasks that define a specific phase of the process. This *collaborative* structure is known as *Industrial District*, a cluster of manufacturers that allows to cover the entire manufacturing process of the artifact thanks to the territorial proximity between the companies.

Proximity among these players facilitates a direct interaction in between them, setting a production model able to transfer the cultural aspects of the territory and “*Made in Italy*” intangible values into a product with strong and significant aesthetics (Morace & Lanzone, 2010). This relational attitude in between companies is widespread in many Italian regions, in particular in production areas characterized by manufacturing contracting and sub-contracting models. This “relational” link among SMEs is also allowing to virtuously manage the financial aspects to start the production and acquisition of raw materials, as well as time and operational phases.

The complex management of districts issues and the effects of the COVID-19 health crisis have partly affected this organizational model which, although still valid for its relational aspects, today can only be effective by widening the boundaries of innovation as much as possible. By involving new experts and technological aspects apparently far from the specific production process (Di Lucchio, 2005) it is possible to boost a regeneration of this company cluster and to develop new competitive advantages.

In fact, advanced digital equipment could help SMEs that present management skills in facing emerging market



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challenges. Moreover, through a design-driven digital innovation it is possible to strengthen the link in between product and territory. In fact, digitalization allows to design “*the traceability of products within trans-territorial supply chains, making the manufacturing framework transparent about the different production steps and processes up to the final marketing stage*” (Rullani, 2016).

This new scenario forces Design Research to rethink a brand-new system that preserves the positive relational aspects of the district - emphasizing them through the digitization of the supply chain and optimizing times and phases - and that develops a g-local approach, on one hand promoting the intrinsic social, cultural and territorial aspects of the product system and on the other hand opening up localized manufacturing clusters to new global opportunities and connections.

Advanced Craftmanship: Ongoing Trends in Made in Italy Supply Chain Bridging Manufacturing Traditions and Innovation Processes

This industrial district models often refer to values and production techniques proper of traditional craftmanship. The strategic communication in between visionary designers and open-minded craftsmen stands as a *pillar* within history of Italian Design, in fact many Italian design masterpieces have been developed within this strategic synergy (De Fusco, 2009).

Craftmanship implies *knowing how to do things* and includes the arts of making, the ability to produce, the knowledge of materials and transformation processes. When the craftsman know-how meets rising contemporary innovation, incorporating brand new technics and processes into tangible and intangible values of artisanship, in this case we talk about *advanced craftmanship*. This new perspective on craft bridges the concept of *quality driven know-how* to contemporary innovation, making technologies facilitating the processes and supporting the values of a good productions. Then, digital equipment could strengthen the production intrinsic values without reducing or *damaging* the exquisite craft mastery (Goretti, 2017). This scenario presents rising trends and case studies underway. Within these transformations, it is possible to highlight significant implementations and new supply chain practices (Fry et al., 2016) that could be categorised as follows:

- Technological transfers and cross fertilization:

The transfer of technology from a manufacturing area to other one, by saving the previously experienced expertise and reinterpreting this innovation know-how within the new production sector. Technology transfers have represented a strategic factor in market repositioning for many production chains in recent decades - an emblematic case is the transfer of laser cutting from the automotive system to fashion (Fry et al., 2016). In addition, some exchanges and transfers of knowledge between different production areas could establishing totally new supply chain networks that go beyond the traditional manufacturing categories.

- New technologies and supply chain logistics:

Consistent advancements in innovation of supply chain logistics aims at improving production planning, time-to-market. In addition, research on logistics could develop new strategies in raw materials procurements and suppliers' management, artefact certification systems and traceability methods. Furthermore, Industry 4.0 program -as part of Horizon EU framework- offers innovation paths that represent a strategic tool to furtherly systematize the ongoing updating processes.

Developments of Advanced Product Design and Design Management Competencies for SMEs Supply Chain

Digitalization process of production companies doesn't stand as a new subject and some significant transformations became more than fifteen years ago. Anyway, limitations and measures today imposed to deal with COVID-19 prompted the companies to introduce new technological supports and improving the digital transitions already started in the past years.

The transition from the Third to the Fourth Industrial Revolution was in fact characterized by an even greater interaction in between man and machine within the SMEs production and in between the different players involved in the design process connected to the companies.

During the second half of twentieth century, the state-of-the-art of technologies highlighted on the emerging need to create and manage production processes able to generate knowledge (Di Lucchio, 2005); however, recent emerging issues within the SMEs supply chain in different market areas require new business models aiming at redesign the traditional systems of production, consumption, transport and shipment (Schwab, 2016).

Then, the new scenario of Italian manufacturing districts requires the creation of a widespread management

system that makes emerging enabling technologies -part of *Industry 4.0* model, promoted and supported by national Government and European Commission- as a tool for enhancing and evolve the best practices and values of "*Made in Italy*" supply chains. These strategic implementations generate updated business model based on optimization of resources, integrated management and communication of tangible and intangible values of advanced craftsmanship to the final customer. In practice, the new achievements of SMEs clusters aim at accomplishing the *intelligent enterprise* as defined by Acts: "*Integrated Digital management of technical processes, as production and management of the traditional company through the implementation of enabling technologies of Industry 4.0*" (Atti, 2018).

Therefore, the new districts of "*Made in Italy*" don't focus only on good design, artefact quality and control of traditional processes, but also on the integrated logistics management of different manufacturing paths of the cluster. Then, the traditional role of the design and product manager is not enough anymore. We highlight on an emerging request of new design managers able to face the Industry 4.0 technologies and to become the centric point of reference of the *intelligent enterprise*.

Anyway, considering the national Italian overview, only few districts and production processes have completely developed a digital integrate transition and Italian scenario looks quite fragmented. Even if these limited case studies could represent a significant strength, the weight of these companies is not suck as to lead a real transformation at national level.

The main reason why of this structural weakness is due to the lack of access for SMEs to the up-to-date research outcomes on advanced implementation of enabling technologies and supply-chain management – as product lifecycle management (PLM)- or lack of competencies in setting feasible planning for the implementation. This gap occurs despite the fact that we can detect an already existing knowledge in the companies about some digital technologies, although they are used in a limited way to specific processes and not in an interconnected framework. Examples are the use of cloud systems, CNC machines, laser cutting and 3D printing for the development of specific production and finishing techniques (Italian Ministry of Economic Development, 2018).

Thus, we can highlight on a rising need of new training programs of design managers that would focus on proposing a supply chain model that is able to integrate different methods of technological development. Some new interests of the *intelligent SME* could be the digitization of the *historical* products' archive, the optimization of manufacturing and integration to suppliers' management, the introduction of 3D modelling software in different steps of internal and outsourcing phases and the digital dialogue between design, production, distribution and sales logistics.

Design Education Programs with Joint Labs Academia-Industry

In 2012, the DIDA Department of University of Florence (Italy) developed a program of Joint Laboratories for the training of bachelor students and master students in design about advanced craftsmanship, through study and research paths that combine knowledge of the artisan tradition and innovation processes in manufacturing. Connections were therefore developed between artisanal SMEs in Tuscany and teams of students interact directly with the artisans and working on digital innovation issues of SMEs supply chain. Through these programs, companies have been able to develop, with the help of academic tutors and *digital native* students (Ferri, 2011), significant improvements in digitization and R&D. On the other hand, university had the chance to provide a higher education program in direct contact with "*Made in Italy*" production sectors.

Joint Labs Academia-Industry: Planning and Program Development

Following the Italian Ministry of Education framework, the Joint Labs programs have been developed according to following phases:

a) *Setting the Partnership*

University of Florence DIDA Design Department is used to organize vocational students' visits guided by faculties to international Design Events as Salone del Mobile of Milan, Pitti Uomo fashion fair in Florence or Maison Objet Paris. Within these happenings, the students have the chance to face directly significant design products and services, understanding the market trends and meeting significant companies. This kind of experiences become particularly relevant in case of meeting with enterprises including both design departments and manufacturing processes. In this case the students can directly investigate on how the entire supply chain can implement a design concept. This kind of visits could represent also significant chances to connect companies needs and research expectations to education and research programs.

Then, after these immersive experiences and after setting common interest on design exploration fields, University of Florence and SMEs company set a proper Joint Lab agreement, involving a team of faculties and

the enterprise referents. Joint Labs framework presents a win-win solution: University can be introduced into the company by setting specific workstations and spaces for the faculties and the students, the company can share technologies and research equipment together with the academic staff.

b) Selection of Students and Placement Programs in the Company Through Curricular and Post-Graduate Internships - duration: one month

The *pilot* research team of the DIDA Department selected a group of six students within bachelor program in Design and Master program in Design of University of Florence. For each laboratory path, students received theoretical training on traditional production techniques and digital systems *as is* or being tested in the partner company. Subsequently, the students team started the internship experience in the company. Each laboratory involved more than one internship cycle, thus involving several groups of students. The company, in agreement with the *pilot* team, prepared the necessary computer hardware and software equipment for each student: all costs were shared between the partner company and the University, with the support of regional public funding as part of European Commission's Horizon Program.

c) Training in the Company of the Students' Team and University Tutors - duration: two weeks

Following a theoretical preparation at DIDA Department, the selected students and the designated tutors started a training course in the partner company, under the supervision of the technical departments. This phase represents a strategic step to introduce and involve the students into the company as a new resource. Different Joint Lab experiences presented many *frictions* in this phase. SMEs companies are often characterized by a traditional mindset, typical of workers part of the company *family* and not open to new *fresh* collaborators. It is the duty of the faculties, as tutors, to supervise the students' introduction process and to allow them to set an appropriated work relation with the company staff.

d) Joint Lab Kick-off. Activities Developed in Semestral Cycles

Following the training phases, the technical departments of the company assigned specific tasks to the work team of the students supported by the tutors who developed a calendar of activities and reviews of the work done. The tutors follow the work of the students, setting monthly a tutorial including the proper procedures and the best practices developed by the team in this timespan. In addition, according to the company needs, the tutors set a delivery calendar about the works and commitments that have to be provided by the academic team. The students are involved in the Joint Lab through curricular or post-degree internship programs supported by Tuscany Region as part of Horizon Research Framework of the European Commission.

Joint Lab Programs Bridging Furniture and Home Details Production Processes and Academic Education: RED Design Lab and "From Design To Product" Project

RED Design Lab (Reverse Engineering Design) -active from 2012 to 2016- has been established through the agreement in between DIDA Department and the company Baldi srl, an artisan company specialized in high-end home details and furniture, crystal and bronze products (Cianfanelli et al., 2015).

The laboratory, together with the company staff, planned and started developing a digital archive of "historical productions" of the company. The work, organized in different steps and developed by different students' teams and tutors, created digital models aiming at supporting the innovation in product shapes and the optimization the production chain.

The archive has been developed through digital scanning rotating workstations, that have been used to digitalize very complex artworks and technical elements of the products. Each component has been properly transformed through advanced parametric design software as a digital form that could be transformed and redesigned to optimize the product shapes and to create new product variants. Then, digital archive doesn't stand just as a memory of company history but furthermore as a creative platform for new design challenges and new market strategies.



Figure 1. RED Joint Lab 3D Scanning

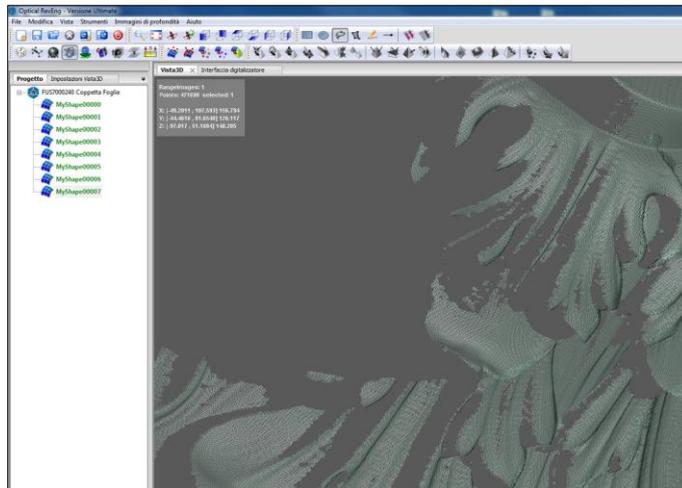


Figure 2. RED Joint Lab Parametric Design 3D Modelling

In addition, the students were involved in seminars held in the SME in collaboration with start-ups consulting companies about supply-chain management area. The program of meetings aimed at developing a PLM Product Lifecycle Management platform (Balocco et al., 2006) for the management of the manufacture and external suppliers. The operational model defined within the seminars provided a strategic methodology to include 2D and 3D digital models of the digital archive in a PLM platform, specifically customized for the company.

Therefore, we can define the RED Joint Lab goals as follows:

- Development of a digital archive of the artisanal knowledge. Kick-off of the use of the implementation of parametric modelling software (Feng & al., 2002) including technical and formal aspects of the product, the supply chain logistics and artefact storytelling, about the relation in between tangible and intangible values of the item;
- Training students about design strategies in optimization of time-to-market, providing effective response to the market by combining technical and formal strengths of the product and effective customization systems;
- Training of students about research paths on shapes and design-driven innovation in furniture product, through parametric modelling processes integrating traditional craft practices and up-to-date enabling equipment.

The rise of these new kinds of academic experiences allows some local institutions to support the agreements in between university training processes and furniture production chains. Local Institutions aimed at involving bachelor and master students into the advanced craftsmanship, boosting design research guidelines within the supply chain and setting new systemic innovation clusters within the manufacturing districts.

Economic Development Department of the Tuscany Region in 2017 presented a strategic design project for the furniture production district of Quarrata (Pistoia, Italy); linking companies and to different design education programs of the Tuscany area. The project organized a series of visits to the company for selected students. After these introductory vocational experiences each team of students has been connected to specific

production chains guided by a leading company. For each combination, the program aimed at designing a collection of products that would develop new shapes and collections for reference international markets, and that would highlight the tangible and intangible values of the supply chain.

The project "From Design to Product - Strategic Product Development Project for the Home Furnishing System" aimed at enhancing the high craftsmanship value integrated with the innovation processes related to "Time Compression Technologies" and new management organization of the supply chain. In this perspective, supply chain management systems can develop new services or new product systems, such as personalization or storytelling processes, to develop new qualities and artefact performances for the customer engagement. The research aimed at enhancing the synergy between the contractor – or the brand that commissions the work - and sub-contractors of the supply chain already including in their work some enabling Industry 4.0 (Morace, 2010) to build an archive and a reorganization of production. The project results have differentiated *primary* management systems develop synergically in between the leading company and to suppliers - properly structured and based on advanced modelling and assembling systems - from *secondary* management systems that focus just on innovative technologies of the contractor and then manage on timing and manufacturing phases of sub-contractors of the same supply chain as a top-down flow depending on the leading company.

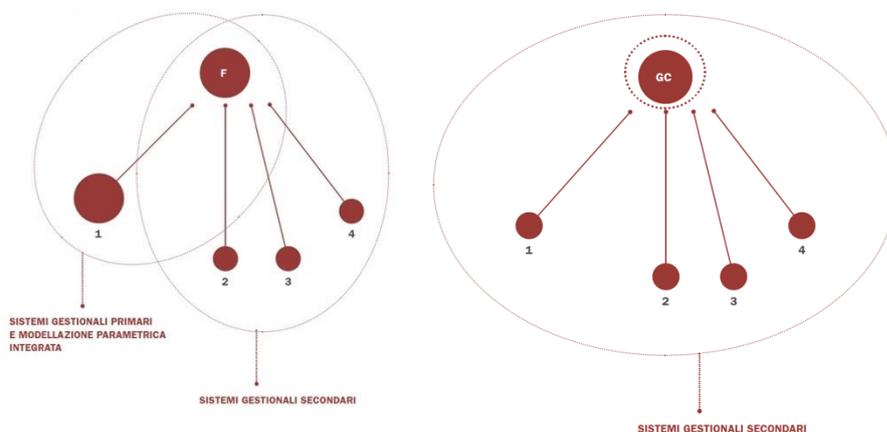


Figure 3. Digital innovation in Quarrata's Furniture District (Pistoia, Italy). The relation in between "primary" and "secondary" management systems within the SMEs supply chain.

Ecraft Joint Lab: Focus on Supply Chain Management, Product Storytelling and Up-To-Date Logistics for Ecommerce Services

Ecraft Joint Lab has been established from 2014 to 2016 in between the DIDA Department and Luisaviaroma.com, leading ecommerce company specialized in fashion and developing a new online portal about furniture design products. The training and research path aimed at defining an innovative sales and communication channel able to highlight on high craftsmanship values on luisaviaroma.com: ecommerce website leader within the European online fashion market in terms of number of online viewers per month (Cianfanelli et al., 2015).

Ecraft Lab was structured by teams of students and research fellows with interdisciplinary skills. The Laboratory staff selected products proposed by independent brands in Central-Northern Italy, as best practices in advanced craftsmanship in furniture design and manufacturing. The lab supported the company work through digital modelling and design research that could support the SMEs production. Product placements were therefore studied and performed on the website, as well as multi-channel and trans-disciplinary models of interaction design and narrative strategies (Bettioli, 2015). In particular, the lab team worked on establishing an effective link in between fashion styling and furniture design values. In addition, Ecraft project aimed at developing a new dialogue in between the global market and the intrinsic values of the local supply chains – following a "G-Local" perspective- through the pervasive power of internet and the emotional strategies that can be designed through the research on user interface design.

The Laboratory dedicated a special attention on logistics of product procurement processes coming from the participating SMEs to Luisaviaroma.com storage. This focus of the research aimed at developing a feasible time-to-market in order to make an effective response to the orders placed on Luisaviaroma.com, as well as an efficient storage management and related shipments.

Then, we could summarize on Ecraft objectives as follows:

- Product scouting area, support to the production chain, procurement and shipment logistics;
- Photography and video production for editorials development and product storytelling;
- Web graphics and strategic design.

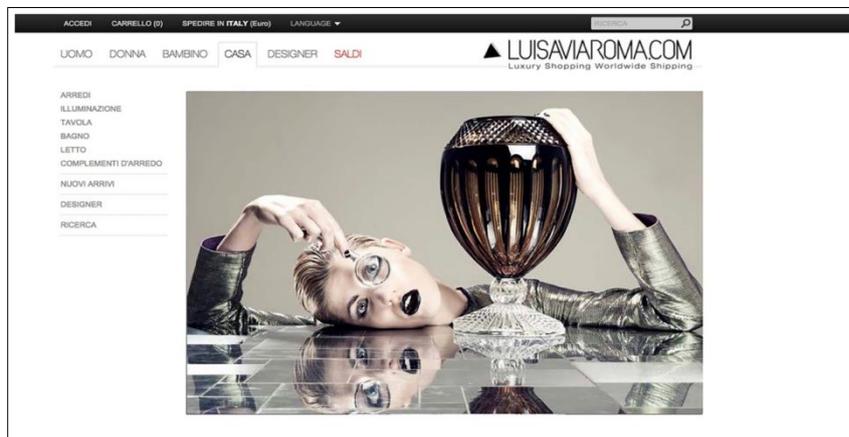


Figure 4. Ecraft editorial including home details and fashion items

Evolution of the Joint-Lab Model. From Kick-off Joint Programs to Structured Design Departments

RED Design Lab and Ecraft lab represented a first example of Joint Lab experiences in Tuscany. Since the presentation of the achievements of these research paths within *Abitare il tempo* Exhibiton in Verona (Italy) in 2014 and Milan Design Week in 2015, University of Florence have been able to develop other similar experiences among Tuscany territory. In addition, several students that participated RED Design lab have been hired by the company and developed high-profile career in design and design engineering (Cianfanelli et al., 2015).

Other significant examples from Tuscany area followed in recent years similar research processes. Savio Firmino srl, company specialized in high-end furniture characterized by craftsmanship decorations, followed the Baldi methodology in developing joint research experiences in partnership with academia from 2013 to 2017. In this case either, the research REM (Reverse Engineering for Manufacturing) focused on manufacturing digitalization through digital archive and 3D modelling technologies. Savio Firmino represented an additional success in introducing digital processes into artisanal processes. The company has reorganized since 2015 the whole production and design processes. This significant innovation program made the company able to expand its market influence by improving the time-to-market and its flexibility in responding to the emerging market trends. The joint lab best pictures and design achievements are still implemented and tested in the company design and production processes. The REM joint lab DIDA-Savio Firmino trained several junior professional profiles that created the new design Innovation department of the company. Thanks to the advancements achieved by the REM research the company was able to develop its design references and skills, developing new shapes and involving new suppliers. The collection “*Welcome to The Jungle*” presented at Milan Design Week 2018 and 2019, aimed at highlighting on this new creative path of the company. Manufacturing digitalization and training new professionals able to manage the innovation within the supply chain represent a strategic asset to structure and strengthen the companies’ competitiveness in the global markets. Moreover, these strategic investments of the SMEs could represent a significant booster the improve their resilience within unexpected events, as Covid-19 pandemic has shown off. Craftsmanship-based SMEs companies that present digitalization process, innovation knowledge and awareness about the potentials of technologies could face tricky times and changes with a stronger structure. Then, Joint lab models could represent a strategic research input to structure an innovation mindset, overpassing short-term production strategies and setting new perspective for medium and long-time plan for the company.



Figure 5. Savio Firmino – Welcome to The Jungle Collection 2018



Figure 6. Savio Firmino – Digital Archive

Conclusions

The research background and experiences described the general contemporary trend of SMEs production systems that require a complex and many-sided approach on digital innovation and enabling technology issues.

In this sense, some ongoing and future design educational programs could be established in partnership to strategic companies. This synergic agreement could provide students a big-picture overview on design and production flow and complexity of the supply chain, not just through partial focuses on specific manufacturing steps. In addition, small companies represent a strategic chance for the students to be in touch with the workers, technical departments and real production chain, a significant experience for their education that could be rarely developed within big corporations.

The skills acquired from the students can be directly applied to the real company context, supporting the entire digitization management process to implement innovation programs on three different levels:

- *the process*: the application of digital enabling technologies both in the phases with low added value and in the most characteristic phases of manufacturing process -as a tool for the enhancement of craftsmanship quality and values (Micelli, 2011);

- *logistics*: the management of transport that implements the traceability of the product, promoting knowledge about “where” and “how” the products is made. Thus, highlighting the qualities related to the territory and socio-cultural aspects that strongly characterize “*Made in Italy*” productions;

- *the story*: using digital platforms virtuously to tell and make the peculiarities of Italian production highly recognizable not just for the local customer but also for the global market audience (Bettiol, 2015).

Regarding the process, the reconstitution of craftsmanship qualities and its values can be achieved through the use of new technologies. In fact, their use can guarantee a reconstruction of those aspects connected to skills and traditional techniques (Micelli 2011). Their support is realizing a process based on the interconnection between different production components and an approach oriented towards process and product innovation (Bettarini & Targliatore, 2018). This is a general way a flexible business model is configuring for SMEs that implement Industry 4.0 as a technological and organizational approach to re-evaluate existing production resources in a more *intelligent* way (Magone & Mazali, 2016).

Logistics is also rethought in this sense, configuring three levels of application: Smart Lifecycle, Smart Supply Chain and Smart Factory, which can be defined as follows:

- Smart Lifecycle, which includes the development process of a new product, the management of its life cycle and the management of the suppliers involved in these phases;
- Smart Supply Chain, which includes the planning of physical and financial flows in the expanded logistic-production system;
- Smart Factory as the process that represents the heart of manufacturing: production, internal and external logistics, maintenance, quality, safety and compliance with regulations.

According to these three levels, Industrial IoT, Analytics and Cloud stand as relevant factors.

According to Marco Taisch, scientific director of the Osservatorio Industria 4.0, in 2019 these technologies favored a growth of 22%, almost tripled in four years for a total of 3.9 billion euros (Fiertler, 2020). It is possible to frame the development of these operative systems between 2019 and 2020 by looking at the three areas of application in the entire production process. In the lifecycle, Cloud Manufacturing has increased up to 45%, Additive Manufacturing has an application rate of 23%; at the supply chain level, Industrial Analytics grew by 30%, against a growth of 85% for Cloud Manufacturing; the level of the smart factory is the one that mostly highlights on a development through the application of three different technologies. In fact, The IoT has undergone an increase of 20%, Cloud manufacturing by 35% and Advanced Human-Machine Interaction by 30% (Osservatorio Industria 4.0, 2020).

Finally, companies will have to learn to communicate all these characteristic aspects of their identity through new media, because these factories are the hallmarks of Italian manufacturing production that has been able to constantly reinterpret the know-how of tradition, ensuring that manufacturing production became a “cultural manufacturing”, able to produce artifacts with a great technical quality that have ended up feeding and elaborating cultural contents (Bettiol, 2015). Furthermore, Bettiol declares that advanced craftsmanship, design innovation, personalization and authenticity are the elements that characterize this cultural manufacturing values and that contribute to increasing its attractiveness towards the national and international consumer (op. 2015), as demonstrated by Savio Firmino srl case history.

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