The evolution of the workers role in the transition from Industry 4.0 to Industry 5.0

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Abstract

The literature review conducted in this work made it possible to study the reasons that pushed production systems to implement a new figure: the Operator 5.0; what are the main differences between Operator 4.0 and its evolution and what the future roles will be for the industrial workforce, providing an overview of the main studies.

INTRODUCTION

Geopolitical changes and natural crises, such as the Covid-19 pandemic, have also highlighted the fragilities of current industries, the vulnerability of our sectors and consequently the need to find an intelligent, flexible and robust production system to address these weaknesses. An intelligent production system is described as the combination of "information, technology and human ingenuity". A resilient production system, on the other hand, is defined as “a system with the ability to adjust its operation before, during or after operational changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions” . An intelligent and resilient production system is therefore an agile and flexible system which collects and organizes operational data in real time using intelligent sensors and analysis techniques. Industry 5.0 provides a resilient and intelligent production system that also develops the resilience capabilities of the workforce that will have to manage the system itself. To date, Industry 4.0 has focused less on the well-being and importance of the operator, instead giving more emphasis to digitalization and technologies based on artificial intelligence to increase efficiency, profit and flexibility. However, it has been realized that a purely profit-oriented approach has become increasingly unsustainable and that there is therefore a need for change. And it is therefore Industry 5.0 that shifts the focus from a production system driven mainly by efficiency and cost reduction to a completely human-centred approach, in which technology must be at the service of people and not vice versa. Industrial workers are no longer considered a “cost” or “investment”. Research and innovation therefore lead towards a human-centred, sustainable and resilient industry. Based on the challenges mentioned above, this work aims to explain the path that has led the Industry to a new revolution, in particular to a new type of Operator: more flexible and solid, capable of responding promptly to factors that affect his work. . In this context, we review the literature on production systems. The research was based on an analysis of the literature with the aim of mapping and evaluating the relevant intellectual territory regarding the operator's vision within the industry with particular attention to human-machine interaction. A further objective of the research is to identify if and how operators' tasks and roles have been and/or will be subject to change.

MATERIALS AND MODELS

Data

For this work, a bibliographic search was carried out using the main archives of scientific publications and the most significant works were identified to outline the characteristics that have distinguished the figure of the worker 4.0 in the last 9 years and the characteristics of the workers of the future expected by advent of Industry 5.0 based on the characteristics of the new industrial program. A dataset of characteristics of the two programs and the skills expected for both was constructed. This data set was then analyzed to define the profile of the Industry 5.0 worker and make a comparison with the characteristics of the 4.0 worker.

Model: Bibliography analisis of differences between Industry 4.0 and Industry 5.0

If the fourth industrial revolution was that of the internet of things and data driven companies, the fifth puts man at the centre. Technology must be subservient to the well-being and productivity of the worker, not the other way around. In summary, Industry 5.0 is human-centric and sustainable

The term Industry 5.0 appears for the first time in 2015, in an article by Michael Rada, published on LinkedIn, which advocates a return to the centrality of the environment and people in the industrial process. The concept of "Society 5.0" appears along the same lines, appearing in 2016 by Keidanren, the most important Japanese business federation: a society that seeks to balance economic development with the resolution of socio-environmental problems, in which technologies are used not only for profit, but to improve the quality of life of every citizen. And here we are in 2018, when Esben H. Østergaard, co-inventor of UR cobots, claims that Industry 5.0 is "the return of the human touch to production". Industry 4.0, in fact, risks wasting the creativity, problem solving and critical capacity of humans for robot work, thus missing the opportunity to achieve mass customization. It is no longer the right framework to achieve the objectives that the EU has set for 2030.

We can say that Industry 4.0 is synonymous with the fourth industrial revolution: after the first revolution of steam machinery at the end of the 18th century, the second of electricity and chemistry with mass production at the end of the 19th century, the third of information technology and of electronics with automation since the 1970s, Industry 4.0 is based on the Internet of Things and real-time data communication for a ubiquitous factory, physical and virtual at the same time. Industry 4.0 is therefore a paradigm focused on enabling technologies, efficiency and productivity.

Industry 5.0, on the other hand, is not so much a technological revolution as a cultural one: a paradigm focused on people and the environment, therefore on quality of life and sustainability at the center of the production process, with the support of Industry 4.0 technologies.

Table 1: Adapted from: "Industry 5.0: A Transformative Vision for Europe"

Industry 4.0	Industry 5.0
• Focused on greater efficiency through digital connectivity and artificial intelligence • Technology focused on the emergence of cyber-physical targets • Aligned with the optimization of business models within capital market dynamics and existing economic models, i.e. ultimately aimed at minimizing costs and maximizing profit for shareholders • No attention to the design and performance dimensions essential for systemic	• Ensures a framework for the industry that combines competitiveness and sustainability, enabling the industry to realize its potential as one of the pillars of transformation • Empower workers through the use of digital devices, endorsing a human-centered approach to technology • Builds transition paths towards eco-sustainable uses of technology • Expands companies' responsibility mandate to all their value chains

transformation and the decoupling of the use of resources and materials from negative environmental, climate and social impacts for sustainability and resilience.	• Introduces indicators that show, for each industrial ecosystem, the progress made on the path towards well-being, resilience and overall sustainability • Highlights the impact of alternative modes of (technological) governance

RESULTS AND DISCUSSION

The founding characteristics of Industry 5.0

Industry 5.0, as presented in the European Commission report, is characterized by **humancentricity, sustainability and resilience**. Let's see what these terms imply.

- **Humancentricity**: Means: people first. Industry 5.0 puts humans at the center of production processes; technology is used to serve the quality of life of citizens and workers, and not vice versa. The result is a more attentive approach to fundamental rights such as privacy, autonomy and human dignity. Another consequence leads the company to guide and train the worker, thanks to technology, regarding his needs, rather than making him adapt to the needs of the technology. The Industry 5.0 question then becomes: what can technology do for us?

- **Sustainability:** Industry 5.0 is by its nature sustainable. It guarantees the needs of current generations without compromising those of future generations. Reuse and recycle natural resources, or in any case avoid their exhaustion; optimizes energy consumption and emissions, develops circular processes that reduce the environmental impact of its activities. A reduction that can occur thanks to the use of specific technologies for each phase of the product/service life cycle, from simulation to supply chain optimization.

- **Resilience:** Industry 5.0 is resilient: that is, it is capable of reacting to sudden changes, even traumatic ones, without causing permanent consequences. It is an industry that has developed a high degree of robustness in production, which guarantees high levels of operational continuity and disaster recovery, which has an adaptable production capacity and flexible commercial processes, capable of guaranteeing products and services even in the event of extraordinary events , such as pandemics, natural disasters, geopolitical changes.

Figure 1. Industry 5.0 Cycle (Source: European Commission)

Effects on companies

Industry 5.0 relocates companies to the contemporary context in which they operate, making them co-responsible for the well-being of society and the planet, therefore at the same time more attractive for both investors and consumers. The characteristics of Industry 5.0 change business models, favoring circular models, increasing servitization, stimulating personalized mass production, improving the adaptability of production processes. In industry 5.0, the worker is considered an investment, which allows the company to grow. He is therefore trained, made responsible and involved in the design and execution of new industrial technologies. Thanks to technology, he is relieved of the most repetitive and dangerous tasks carried out by robots and encouraged to make use of his skills.

Industry 5.0 uses new technologies to make working environments safer and more inclusive, to help workers better control and manage the burnout risks of digitalized work, to reduce environmental impact. It ensures that the use of artificial intelligence does not undermine the dignity of the worker and guarantees the possibility of always receiving an explanation of an algorithmic decision in the event of a violation.

Consistent with this concept, last June 14, the European Union Parliament approved the AI Act ("Artificial Intelligence Act" or, translated, "artificial intelligence law") and in the next few months it will become effective as soon as the trilogue. This is the first form of all-encompassing regulation of innovative systems and applications of Artificial Intelligence. The AI Act was developed with the dual objective of making the most of the innovative potential of AI systems, while ensuring the protection of the fundamental rights of citizens of the Union.

Key characteristics of Operator 4.0 in literature

Romero et al. (2020) Identifies and characterizes the first anthropocentric models of human-machine interaction in advanced production systems and the first manifestations of Operator 4.0 understood as: "an intelligent and qualified operator who not only carries out cooperative work with robots but also machine-assisted work as and if necessary by means of cyber-physical human systems, advanced human-machine interaction technologies and adaptive automation to achieve human-automation symbiosis work systems". New intelligent working environments such as "cyber-physical factories" and "Digital Twin environments" will directly influence the operator and the nature of his work, creating new interactions not only between humans and machines, but also between the digital world and the physicist. A socio-technical transformation towards the Smart Factory of the Future will require a new design and engineering philosophy for 'human-centric' and 'cyber-physical' production systems. Cimini et al. (2022) highlight the importance of interconnection and communication between humans, machines and products within new intelligent production systems. This implies the need for perfect integration and cooperation between the capabilities of human beings and those of the cyber-physical systems (CPS) that constitute smart factories. For the traditional Operator 4.0, the amount of information available in intelligent production systems will not be easily manipulated due to the enormous variety and quantity of data. For this reason, new methods will be needed to allow the operator to manage such information parameters and consequently make the right decision, as it can be assumed that Artificial Intelligence techniques cannot solve every data problem.

Rauch et al. (2020) confirms that in the period following the introduction of Operator 4.0, a transformation of the physical and above all cognitive help systems was evident. The development of so-called sensory aid systems has been identified. While data played a minor role in the past, increasingly intelligent sensors are now being integrated into machines and products to capture as much data as possible (or necessary) and to be able to evaluate and use it for optimization purposes. Furthermore, Weichhart et al. (2018) highlights that for human-robot collaboration, in which activities must be synchronized, an adequate approach is not yet available that allows complex and effective processes to be represented in a useful form and to support reasoning in an automated way. Such forms of representation and reasoning should be usable by both agents, both human and robot, this is the requirement that allows collaborative robots to dynamically share tasks. Workers today are slowly starting to rely on modern smart and collaborative technologies, often wearing virtual assistants, sensors, smartwatches, augmented reality headsets, powered exoskeletons, and more. While people still remain an essential part of smart manufacturing processes, their capabilities will also change. Increasingly sophisticated and cutting-edge technologies will be implemented to enhance the Operator 4.0. Sun et al. (2020), for example, formally defines and extends the concept of Healthy Operator 4.0 (HO4.0) as a system focused on the health and well-being of operators, aimed at facilitating worker empowerment by enabling the creation of relevant knowledge and modeling their behaviors. The concept of Healthy Operator 4.0 is expanded thanks to the use of the HO4.0 Digital Twin, which collects all health-related information from operators and potentially allows the learning of rules from different behaviors.

It not only enables real-time information on possible health threats, such as risk alerts, but also allows operators to simulate how they will act in the future. It also allows us to deduce and predict the evolution of their behavior in the medium to long term, with the aim of reducing the cognitive and physical workload to which employees are subjected and increasing the operator's well-being in terms of safety and health at work (OSH), satisfaction with the activities performed, work-related affect and improving productivity in the context of Industry 4.0.

An emerging technology that the literature has rarely been related to production activities has been that of the voice assistant. This can be explained by the fact that this field is still little explored for these activities. However, such emerging technology can offer numerous benefits to workers in production systems and can be applied in different activities. A study by Longo et al. (2020)14 explains how the Operator 4.0 could interact via auditory responses with the Voice Assistant of a networked manufacturing resource, a work order, the environment, a particular product or the workers themselves. Both industry experts and authors agree on the need to design a voice persona that evokes a distinct tone and personality in order to build trust and improve the acceptance rate among different user groups.

Another example of emerging technology are Visible Light Communication (VLC) and Visible Light Positioning (VLP) which will implement a type of worker strongly enhanced by a solid communication system, precise localization and fast down link/up link transmissions with low latency (Danys et al., 2022). New innovations in production systems have the opportunity to allow effective dissemination of information to better support the work of the Operator 4.0 by including competitive, as well as cognitive, advantages within the Industry 4.0 paradigm. The development of enabling technologies has facilitated the communication of data, information and knowledge by avoiding the traditional face-to-face interaction which must take place at the same time and in the same space, contributing to the flexibility of communication when it comes to time and space for the actors who participate in the dissemination. What emerges from the investigation by Longo et al. (2020)16 is the importance of extending the worker's cognitive abilities to bridge the gap with technology. Human-robot collaboration would increase production efficiency, while better problem solving is enabled by faster and more intuitive access to data information, skills and knowledge available in the workplace. In industry, enhancing workstations with augmented reality technology, for example, can reshape the human presence in the process value chain and support the development of self-awareness and new skills, especially where manual work is unavoidable. eXtended Reality (XR) technology is pioneering new forms of interaction that disrupt traditional desktop interaction, where users' degree of freedom and mobility is limited.

It is proposed by Serras et al. (2020), for example, the dialogue-based Interactive Extended Reality architecture to alleviate cognitive load by increasing the multimodal information available to support operators. This architecture was subsequently tested in two use case scenarios: the maintenance of a robotic gripper and as a workshop assistant for the assembly of electrical panels. In both cases, a high rate of acceptance was found by users who confirmed efficient communication and distribution of knowledge, thus demonstrating the suitability of the solution to assist workers in industrial production processes. However, they were identified by a study by Di Pasquale et al. (2022) of the limitations linked in many cases to the inexperience of operators in the use of AR devices but also to problems relating to the devices that were found to be invasive, unsuitable, limiting and uncomfortable. It was therefore highlighted how the role of the operator is still overshadowed by the technology that characterizes it and this represents an important social challenge. Much effort still needs to be made to improve its usability by operators and eliminate negative effects on health and performance. Additionally, it would be helpful to establish a set of human factors design guidelines that can help match device capabilities with the tasks and environmental requirements of the workplace. Continuous technological innovations in the domains of information technology (IT), Internet of Things (IoT), and artificial intelligence (AI), among others, have significantly changed manufacturing systems. Recent advances in these technologies have enabled a systematic implementation of cyber-physical systems (CPS) in manufacturing, improving the efficiency of production systems and making them more resilient and collaborative.

Palasciano et al. (2021) presents a proposal and successful testing of a knowledge engineering user interface-based simulation and predictive optimization architecture to support an Operator 4.0. The FASTEN project exposed by the paper adopted an Industrial IoT (IIoT) architecture by integrating a system Digital Twin and a discrete event simulator to support human-machine cooperation. The platform deals with the tactical level, through the Prediction Layer and the Optimization-Simulation Layer; and the operational level, with the Data Sources level. De Miranda et al. (2020) proposes, instead, a new framework called Design for the Human Factor in Industry 4.0 (DfHFinI4.0), which allows us to place the human factor at the center of Industry 4.0. It is based on the conceptual frameworks of the connectivist paradigm, the law of the required variety and on the theory of activity. Zolotová et al. (2020) highlights the need to use a combination of multiple types of Operator 4.0 to achieve better results in the future. Their research is based on four case studies. The first case study, Legacy of screens design for HMI applications, presents how modern technologies and principles for HMI applications can improve operator reaction times. The second case study, cognitive healthcare, in this case study, are three types of Operator 4.0 discussed: Smarter Operator, Healthy Operator finally Social Operator. The third case study, Maintenance and Prediction, explained how the production system based on a service-oriented system is supported by two types of operators: Smarter Operator and Analytic Operator. Finally, the M2P interaction based on the operator position case study covers two types of operators: Smarter Operator and Augmented Operator.

Key features of Operator 5.0 in the literature

At the turn of the Fourth Industrial Revolution, Operator 5.0 seems like a distant and progressive theme. In the literature only two articles discuss the figure of the Operator 5.0 within manufacturing systems.

Romero et al.(2021) develops this concept as Resilient Operator 5.0, which is described as an intelligent and skilled operator who uses human creativity, ingenuity and innovation enhanced by information and technology as a way to overcome the obstacles on the path to creating new and frugal solutions to ensure the sustainable continuity of production activities and the well-being of the workforce in light of difficult and/or unexpected conditions. The vision of the Resilient Operator 5.0 is twofold, on the one hand we have the creation of "self-resilience" and on the other the creation of "system resilience".

- **System resilience**: in a production system in which operators and machines must work closely together, alternative systems must be considered to allow man-machine systems to continue to collaborate in a positive way. The resilience of human-machine systems refers to the ability of cyber-physical systems to demonstrate adjustable autonomy and control, in order to keep the system cooperative, practical, comfortable and continuous.

- **Self-resilience**: due to natural human frailty, self-resilience is linked to biological, physical, cognitive and psychological health and safety, as well as productivity at work. Biological resilience refers to an operator's ability to maintain industrial hygiene in terms of health and safety at work. This type of resilience can be supported by smart healthcare wearables and smart personal protective equipment.
- **Physical resilience** refers to an operator's ability to maintain strength in the face of demands. This type of resilience can be supported by exoskeletons that provide muscle power, protection and endurance. Cognitive resilience refers to an operator's ability to maintain concentration and avoid human error even in the presence of considerable stress. This type of resilience can be aided by augmented reality acting as a digital assistance system.
- **Psychological resilience** refers to a worker's ability to deal with emotional crises. This type of resilience can be supported by Virtual Reality which offers a safe environment for risk and crisis management. Designing system resilience with operator 5.0 in CPS involves designing work cells related to adaptive automation and autonomous and adjustable human-machine agents. If the goal is to avoid disruptions to human-machine systems, both agents should aim to avoid unwanted events to protect the system.

In this scenario, the Analytical Operator 4.0 will have to combine advanced data analysis and human intuition with a Smart Machine Tool with prognostic and management capabilities. The system thus formed will create a "joint cognitive system" focused on increasing predictive capabilities. The two subsystems will be able to alert each other to potential disruptions to support overall resilience. If the objective is, however, to resist interruptions in human-machine systems, sharing and trading control strategies play a fundamental role. The adjustable autonomy of the system agents and the adaptive automation of the system itself allows both agents to change the assignment of tasks by shifting control of specific functions whenever predefined conditions are met. In this context, the different types of Operator 4.0 can temporarily carry out tasks originally assigned to the Smart Machine Tool thanks to their cognitive and physical enhancements. In case the objective is to adapt to an unexpected change, human operators will provide the maximum contribution to system resilience thanks to their agility and flexibility. Operators are able to contribute to creative responsiveness through human ingenuity and creativity. For example, Social Worker 4.0 can perform creative and collaborative problem solving with all types of resources.

On the other hand, intelligent machines will be able to reconfigure or optimize themselves thanks to different production modules available quickly. Finally, if the objective is to recover from situations that have never occurred before, it is important to look at the "self-healing" progress made by machine tools and the development of "mutual learning" between man and machine. The latter allows human operators and intelligent machines to learn from each other in order to better solve problems in the next generation of machine tools when the self-healing functionality is not bootable.

In Mourtzis et al. (2022) key skills are attributed to the 5.0 Operator

1. Creative problem solving
2. Digital Literacy: An individual's ability to find, evaluate, and communicate information through typing and other media on various digital platforms.
3. Ability to use AI and Data Analytics
4. Critical interpretation of the results
5. Strong entrepreneurial mentality
6. Ability to work safely both psychologically and physically and efficiently with new technologies
7. Intercultural and disciplinary mentality, inclusive and oriented towards diversity
8. Cybersecurity, Privacy and Data/information Mindfulness
9. Ability to manage the increased complexity of many simultaneous requirements and tasks

10. Ability to communicate with human operators, artificial intelligence systems through different interfaces and platforms
11. Open minded towards continuous changes.
12. Characteristics of Operator 4.0

Table 2: Skills necessary for Operator 5.0 divided by thematic area

• Creative Problem Solving • Critical interpretation of the results • Operator Capability 4.0 • Management skills • Communication skills • Ability to work safely	• Digital Literacy • Ability to use AI and data analytics • Cybersecurity and Privacy	• Strong entrepreneurial mentality • Inclusive mentality • Open minded
COGNITIVE SKILLS	**TECHNOLOGICAL SKILLS**	**ETHICAL AND SOCIAL SKILLS**

The main changes and similarities between Operator 4.0 and Operator 5.0 found in the literature

The Operator 4.0 has appeared in the literature as the operator of the future, who creates relationships of trust between man and machines, an ideal participatory and proactive operator. New technologies had to broaden job prospects also for people with physical or cognitive disabilities. Despite good intentions, the adaptation of technology to people has not been satisfactory. New technologies have taken over and "choked" the operator. While some workers felt freed from boring and repetitive tasks, another part felt overwhelmed and replaced by technology. Industry 4.0 bases its foundations on flexibility, profit and product customization, the human centrality which should have been one of its pillars has instead been neglected. Industry 5.0, on the contrary, aims to bring the concept of anthropocentrism back to the surface within production systems, placing greater emphasis on the topic and including all operators and not just those who have possible deficits at work. The 5.0 Operator is a collaborative operator, who lives in perfect harmony with new technologies using his physical, sensorial and cognitive abilities in a safe and inclusive working environment while technological systems provide him with real-time information. If on the one hand Operator 4.0 cooperates with machines, on the other hand Operator 5.0 co-evolves with them. The new entrant aims for a complete symbiotic relationship with the machine by enabling truly intelligent resilient manufacturing systems to benefit not only from the machines but also from itself. Operator 5.0, unlike its previous version, seeks to create a stable, robust and resilient balance within the production system. We conclude by saying that in reality the expression "Operator 5.0" does not introduce a new industrial paradigm and its enabling technologies do not, at the moment, have an innovative character. What distinguishes the new paradigm from the previous one is the social point of view which puts man and not machines at the center of production processes, guaranteeing the right balance between work and private life, privacy, safety and well-being.

The fundamental characteristics identified in Operator 5.0

The concept of Operator 5.0 is still in its infancy and is under both conceptual and methodological development by researchers and professionals. In the literature this paradigm is still new and consequently there are not yet many documents on it. Despite the lack of contributions in this field, the three pillars of Operator 5.0 can be drawn from the literature: resilience, man-machine relationship and ethics. In the case of resilience, a Resilient Operator 5.0 was defined by Romero et al. in 2021. While in the case of the man-machine relationship a Collaborative Operator has been defined. But, when it comes to ethics, much work remains to be done. Researchers are oriented towards a “human-centered” approach rather than a “tech-centered” approach, focusing on ethical and social considerations. The fundamental rights of workers cannot be put at risk at any stage of the new industrial revolution. Wellbeing, not only physical but also psychological, must be guaranteed within the new industries. Operators must feel part of a system that supports them and helps them in all phases of the production process. In this context he could be defined as an “Ethical and Social” Operator 5.0. The next generation workforce will have to rely on technologies aimed at extending the operator's capabilities without risking their autonomy, their privacy or their physical and mental health. These new technologies must be implemented in such a way as not to harm the dignity of the worker, regardless of their race, gender, possible deficits or age. Another task assigned to new generation machines will be to avoid risks associated with working methods, such as excessive stress loads, lack of control, sense of exclusion from the system, tensions between colleagues or the risk of an always available work culture that leads operators to become excessively tired. With the help of new technologies, production systems will have to promote mental health as an indispensable part of corporate culture. This new type of Operator could be implemented thanks to wearable sensors, corporate social networks and above all protection barriers on technological security and privacy.

The skills that the Operator of the future must have

Research has highlighted that one of the biggest fears associated with increasing automation is the lack of human capabilities to manage new technologies. The learning of new skills will have to move hand in hand with automation and digitalisation. For the Fifth Industrial Revolution, the tasks required are expected to change further, making the problem of the "skills gap" even more glaring. The workforce in the future may not be or feel up to automation and may feel somewhat overwhelmed by it. The European Commission itself34 has highlighted how its industries lack qualified and competent personnel for the new jobs and the lack of training institutes to fill these gaps. It is therefore of fundamental importance to guarantee a certain basic level of knowledge and understanding for everyone, in particular for the key technologies of the Industry. A possible way out of this skills mismatch would be a new approach to technological development. The technology could be made more intuitive and easy to use, so that workers do not require specific skills to use it. Furthermore, training should be developed simultaneously with this technology, thus ensuring that the available capabilities best match the skill requirements in the industry. Digital skills, however, are not the only ones that are relevant for the “workers of the future”. Research related to Operator 4.0 has highlighted the need for industries to implement an anthropocentric system for production and to give greater emphasis to the human side. In the field of human resources management, therefore, companies will have to ensure that employees have not only the technical skills but also the right human and social characteristics to carry out their jobs. Researchers and experts predict that digital evolution will in fact significantly influence communication between employees.

While cooperating with robots and enabling technologies they must continue to be able to operate effectively with other operators inside and/or outside the production system. Many studies have highlighted the demand from operators to be included not only in production functions but also at the design and development level. It will therefore be essential to increase the level of responsibility, participation and involvement of operators in achieving company objectives so that they can best adapt to evolution. It was highlighted several times throughout the research how increased automation creates the potential for employees to add more value by tackling complex problems and thinking critically.

While robots will be busy carrying out a series of repetitive, simple and dangerous tasks, human operators will be able to concentrate on more creative and complex tasks. Employees are therefore expected to use their “creative” problem solving skills both in the process of creating customized production for customers and in the process of human-robot cooperation. Experts have highlighted the importance of possessing technological skills in the era of Industry 5.0, data analyst, digital marketing, Big Data, automation, artificial intelligence and machine learning have already started to require advanced technological skills. In fact, operators will have to know how to use and make the most of new technologies.

CONCLUSION

The literature review conducted in this work made it possible to study the reasons that pushed production systems to implement a new figure: the Operator 5.0; what are the main differences between Operator 4.0 and its evolution and what the future roles will be for the industrial workforce, providing an overview of the main studies. Twenty-three total documents were selected and analyzed to identify research trends in recent years. These identified trends have highlighted four main research fields in which experts have concentrated their efforts in recent years: Operator 4.0 characteristics; problems of competence and qualification of personnel; new jobs; problems due to the implementation of new technologies and possible solutions or innovations. The role of the Operator 5.0 is not yet addressed in the literature considering in depth its technical and social characteristics. results obtained from the SLR have allowed us to develop a conceptual framework that investigates the current state of the art on the topic and highlights gaps in current research. The contributions to the first question, which aimed to highlight the differences between the Operator 4.0 and its evolution, highlight how what we are about to face will not be an industrial revolution but a social evolution, it has been realized that the beating heart of the industry is the operator, who has unique capabilities that machines will never be able to match. For the first time during an industrial evolution the human operator is not asked to adapt to change, but rather the change is asked to adapt to man. The second question listed the characteristics of Operator 5.0, bringing out its true definition, unfortunately due to the limited bibliography, many points have not yet been studied in depth. The complete implementation of the new type of operator will be a challenge that will need to be addressed as best as possible in the future. Finally, the third and final question focused on the capabilities that will be required in the near future within production systems. The research highlighted a growing concern about the current lack of qualified staff. Starting from training institutes, which are not yet up to speed with innovation and digitalisation, up to training systems within workplaces which are still not satisfactory. Training, qualification and retraining are the basis of new operators. The job landscape is evolving rapidly, traditional jobs are already at risk while innovative jobs are still vacant. The job market is currently not balanced. Evolution has now become a constant of our times, every day new technologies are implemented, new skills are required, new problems arise and new solutions are found. In a digitalized era like ours, managing all these changes as best as possible has become a demanding discipline. The only certainty is that the way operators embrace change will determine the future of production systems.

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