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Organizational Changes and Work Design in the Context of Industry 4.0 – A Paradigm Change

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Abstract: *Industrial production is currently experiencing a revolutionary transformation through digitization processes and networked technology, so that it necessarily goes through a series of essential changes, which require conceptual design and creation of new terms. In the field of social organization of work, the processes of management and control are experiencing radical changes, and many novelties that bring technological innovations provide the opportunity to analytically observe the interaction relationships of different systems, without losing individuals, organizations and society in the context. Given that digital transformation is not a uniform process, the paper presents the advantages of a holistic approach in the analysis of organizational changes. New ways of organizing work bring various kinds of challenges that must be understood in order to be able to detect the social mechanisms that are at the very basis of change. The paper points out the specific social dimensions of technology that appear during the creation of organizational processes within the framework of the Fourth Industrial Revolution. The very term 'industrial revolution' is understood in the paper in a broader sense, and includes changes in social relations and the status of certain social groups, and not only changes in the production process and factors of production. The paper explains the status changes in power that are connected with the possibility of making business decisions in various forms of organizational practices, showing the increasingly pronounced complexity of interactional relationships between people and technology, which points to the necessity of interdisciplinary observation and finding a holistic approach to understanding the nature of the changes that are taking place.*

Keywords: *organizational logic, work design, organizational changes, flexibility, networking, Industry 4.0*

1. Introduction

Changes related to the transformation of industry through intelligent networking of machines and processes with the help of information and communication technology (ICT), represent global trends that we denote by the term Industry 4.0 or The Fourth Industrial Revolution. The very meaning of the term aims to emphasize the radicality of the changes brought about by the digital transformation of the industry, since the changes are revolutionary in almost all

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spheres of social life. The constant reconfiguration of the relationship between phenomena accompanied by increasingly frequent ‘’industrial revolutions’’emphasizes the need for a new conceptualization of the reality that constantly eludes us in its exponential growth of technological innovation.

The need to find new conceptualizations shows us all the dynamism of changes that technological innovations bring with them. Thus, with the intensification of the use of ‘’smart’’ technologies and algorithmic control guided by artificial intelligence (AI), the forms of interdependence between people and machines are radically changing. The increasing autonomy of different systems on the one hand, as well as the increasing connectivity through networking, on the other hand, mean that the established ways of designing organizational management and control practices are becoming increasingly inadequate. This is especially expressed if we look at the ways of organizing work and the processes of speeding up business decision-making.

In this paper, we want to point out certain social dimensions of technology that arise when designing organizational processes within the framework of the Fourth Industrial Revolution. We interpret the term ‘’industrial revolution’’ in a broader sense than the technical-technological definition, in the sense that it includes changes in social relations and the status of certain social groups, and not only changes in the production process and factors of production. In our case, status changes refer to changes in power that are associated with the possibility of making business decisions in different forms of organizational practices. Starting from this sociological understanding of the concept of industrial revolution, we want to point out the increasingly pronounced complexity of interactional relationships between people and technology, which points us to the necessity of interdisciplinary observation and finding a holistic approach to understanding the nature of changes. [1, 2, 3]

By emphasizing the social dimension of technology, we want to point out that changes in the way work is organized are largely of a probabilistic nature, because,ultimately, they depend on the interests of different groups of people and are connected to certain social mechanisms. In this way, we can interpret specific reconfigurations of the social division of labor in the processes of digital technology integration through all areas of business in the context of the further development of ‘’networked social reality’’ which is a key characteristic of the information society [4]. The basic unit of economic organization of society becomes the ‘’network’’. This network is composed of a multitude of subjects and organizations that are constantly reshaping. The main requirements for reshaping are found in the need to adapt to market structures and the environments that support them. [4]. The changing geometry required by

‘’informationalism’’ is characterized by a social state of ‘’fluidity’’ [5] in which any attempts to crystallize position in the network as a ‘’cultural code’’ are condemned to obsolescence.

We observe the digital transformation from the point of view of the design of organizational, business and work processes that are made possible by digital data, algorithms and computer infrastructure. Our main goal is to point out the aspects of informatization and ‘’smart’’ automation as radically new forms of change that increase the growing share of autonomous activities under the control of algorithms as opposed to the expertise of people. The changes make a more visible difference between traditional processes that relied on social interaction and decisions and digitalized processes that depend on algorithms and data flows [6]. The basic premise from which we start our paper is contained in the opinion that ‘’networking’’ gives us the opportunity to question the conceptual foundations on which the new organizational logic is based.

2. New Organizational Logic - Global Trends

On a global level, different types of organizations are experiencing transformations due to the redefinition of business models in the conditions of an increasingly dynamic environment. The business environment characterized by multiple ‘’networking’’ changes the character and nature of business, bringing with it new perspectives. [7, 8] In the organizational context, a series of changes occur that reshape the ways of performing work and affect the design of the work environment. We can observe the new organizational realities through the prism of a ‘’networked logic’’ whose basic characteristic is the intensification of the flexibility process.

The processes of intensification of flexibility can be singled out as one of the key characteristics of organizational changes followed by digital transformation within the framework of the Fourth Industrial Revolution. In this sense, we will refer to the explanation of the ‘’new organizational logic’’ that Johannessen [9] presents through two specific characteristics, defining them as ‘’Lego flexibility’’ and ‘’experience design’’.

In the sphere of production, ‘’Lego flexibility’’, among other things, implies widespread business practices where the production chain extends to a certain number of countries in accordance with costs, quality, innovation and logistics competence. By the same logic, ‘’the administrative system, as well as the various roles of the company’s staff members, can also be considered external. [9: p. 41] The production of each product is broken down into its component parts and is located in places ‘’where the price is low, the quality is high, the

competence is excellent, and the rate of innovation is above average and high''. Depending on these four elements, the production of individual components takes place in different parts of the world in order to combine them to form one final product. [9: p. 42]

The processes of wealth creation through lego flexibility give a new perspective on productivity, changing its character from the logic of production to the logic of global clusters of competences. [9: p. 45] Productivity can be measured with innovation within new network constellations. The unpredictability of global trends brings with it challenges that call into question the concept of productivity that was determined in the traditional way. Thus, according to Johannessen, turbulence and new organizational structures encourage the development of new concepts that represent indicators for measuring productivity, such as: ''innovativeness, flexibility, adaptability, relational and network competence, and resolution of complexity and ambiguity'' [9: pp. 44-45] The organizational form of *lego flexibility* consists of multifunctional teams that make up the smallest units, while global clusters of competences make up the global unit. In the organizational sense, it is very important to dedicate yourself to the development and transfer of knowledge, feedback processes, joint creation and analysis of social sentiment. [9: p. 42] All this in the context of intensifying global competitiveness leads to the development of global networks of competences that highlight the importance of the role of relationship networks in the achievement of success. This is true both for individuals, i.e., on an individual level, and on a corporate level, since network relationships will enable co-creation, both between individuals and between customers and businesses''. Supported by robots, informats[†] and artificial intelligence (AI), the development of ''lego flexibility'' will require new competencies and new forms of cooperation.

One of the main goals of the new organizational logic, according to Johannessen, is contained in assuming responsibility and encouraging the development of creativity in ''the environment and the global network of competences, in order to create innovations''. The basic assumption for the achievement of this goal is the acceptance of an innovative model of management and organization whose focus is processes aimed at supporting people who are on the ''frontline'', that is, ''processes and connecting

[†]By "informats" Johannessen [9] means robots with artificial intelligence (AI) that are interconnected in a global technological network. According to him, ''informats'' appears as emergent robots, and as such ''can sense, analyze and make decisions within one microsecond''[9: p. 101].

customersand workers who do what the organization is designed for'' (known as ''core activities''). Johannessen [9] defines this organizational principle as ''experience design'', which is another characteristic of the new organizational logic in the context of the Fourth Industrial Revolution.
One type of experience-based design is known in the field of service innovation and has previously been used as a model to achieve the required scale of change, and has also been referred to as ''co-design'', ''participative'' or ''interactive'' design. The main characteristic is that the traditional view of the service user as a passive recipient gives way to the view of the user as a co-designer and as an integral part of the process of improvement and innovation. The purpose is to allow designers to focus primarily on the experiences created, rather than the service being delivered. [10: p. 89]

According to Johannessen [9], ''experience design'' implies that people on the front line can make decisions in real time, and it is necessary to focus organizational processes on two aspects in particular. First of all, ''competence and maintenance of competence on the front line'' is singled out, which refers to individual and team competence. In addition to these two competencies, the business organization is equally important, which enables the ''frontline'' to have constant support, service and help from all levels of the organization. Secondly, optimal coordination between activities is necessary to harmonize relationships at the system and network level. The focus is on the organization of the process where customers, users and citizens (the public) are located in a center that is organized around the first line. For this reason, Johannessen [9] uses the name ''experience design'' because, in his opinion, the experience that is significant is acquired and happens between customers/users of services and people on the front line. [9: p. 46]
In this way, the key factor for creating wealth and connecting to creative and innovative networks is competence on the front line, according to which it is necessary to develop mechanisms that will use the ''flow of experience'' to ensure the survival of the system. Competence on the front line is reflected in the speed, flexibility and skill of making decisions in real time, which with new technology (robots, AI and informats) enables individualized and customized solutions. The new technology enables a completely individualized relationship with each customer/user regardless of the fact that the customer base, as well as the variety of what they are looking for, is constantly growing. ''The profile of the individual will form the basis for referring the company to the client, and the customer will generate his profile through contact with the company. This experience design will then create wealth for both clients and organizations''. (''The individual's profile will form the basis for a business's referrals to the customer, and the customer will generate their profile through contact with the

business. This experience-design will then co-create wealth for both the customers and the organizations''.) [9: p. 48]
We can find these examples of individualization in various areas such as, for example, media, medicine, music, entertainment, computer software, clothing industry, education, etc. [8, 11] Such adaptation to individual users and customers requires an innovative system that would be focused on constant changes and coordination between different systems. As one of the consequences of individualized adjustment and upgrading of competences in the front line, we can single out the transition from hierarchical management and control systems to more vertical systems of organization and management. An illustrative view of organizational design changes is presented in Figure 1.

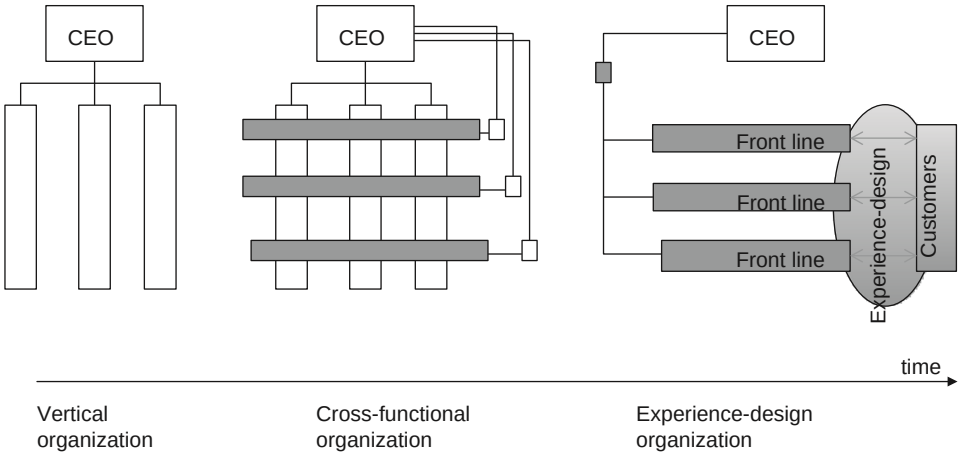


Figure1.Schematic representation of organizational design changes (Source: [9: p. 47]*)*

According to Johannessen [9], the key features of the new organizational logic refer to: process organization, de-bureaucratization, team organization, a large degree of external structural connections, and the continuous development of competencies at all levels. In this sense, we can observe the improvement of worker efficiency, first of all, as a result of new organizational logic, and not primarily of new technology. ''The new robot technology and the systemically linked informats, and even the nano-computers, will be the unifying glue in the organizational spider's web, which holds everything together in a very strong, systemically linked system'' [9: p. 50] The key change is in the way of organizing work and management [12] in the context of new methods of production, distribution and consumption that bring with them new forms of technology in the form of robots, ''informats'' and artificial intelligence. In

thefollowing part of the paper, we will consider certain changes in the ways of organizing work, taking into account the different levels of manifestation of these changes.

3. A Holistic approach to organizational changes and working environment design

The landscape of digital transformation of industrial production is illustrated by the current trends of automation and data exchange in production technologies, such as: cyber-physical systems (CPS) which include machines, devices and robots connected via the Internet where management is performed through computer algorithms; the Internet of Things (IoT), which refers to the connection of all physical places and things to the Internet; cloud computing and cognitive computing, and the creation of a smart factory[13]. As a new business paradigm, the application of Industry 4.0 is represented in many industry sectors [11].
What we especially want to highlight is that in the context of digital transformation, the processes of information, communication and networking, both within and between companies and business systems, bring special challenges related to the possibilities of designing work. By work design we mean the way in which people are arranged in a certain organization or institution, and the way in which jobs are performed and the different types of tasks and interactions that these jobs include [14].

In this sense, together with Hirsch-Kreinsen & Ittermann [14], Industry 4.0 can be seen as a design project that, among other things, includes different alternative views on the relationship between work and technology. Various alternative views are represented in the tradition of sociological research whose findings show us that there is no linear relationship between the phenomenon of work and technology. In addition, instead of a one-sided deterministic relationship, whether it is technological or social, complex and reciprocal relationships are presented that are shaped by the influence of multiple social, economic, political, labor-legal factors. These multiple factors ultimately determine how new technology will be adopted and how it will shape the future of work. [14]
The conceptual basis for the analysis of [14] finds a socio-technical approach which, according to them, can serve us in the most convenient way when formulating a suitable framework for work design in digital conditions of industrial production. The authors find the advantage of this approach in determining the socio-technical system, which, despite the inconsistency in definitions, can be understood as ‘’a production unit consisting of interdependent technological, personnel and organizational subsystems’’ [Trist &

Bamforth,1951; Rice, 1963; cited by: 14: p. 279]. Despite the fact that the technological subsystem can limit the design possibilities of the personnel and organizational subsystem, these two subsystems have independent characteristics that influence the functioning of the technological system. In this sense, the relationship between the subsystems is reciprocal and probabilistic, and in this way the socio-technical approach emphasizes the interactions and mutual dependence of technology, people and the organization as a whole.

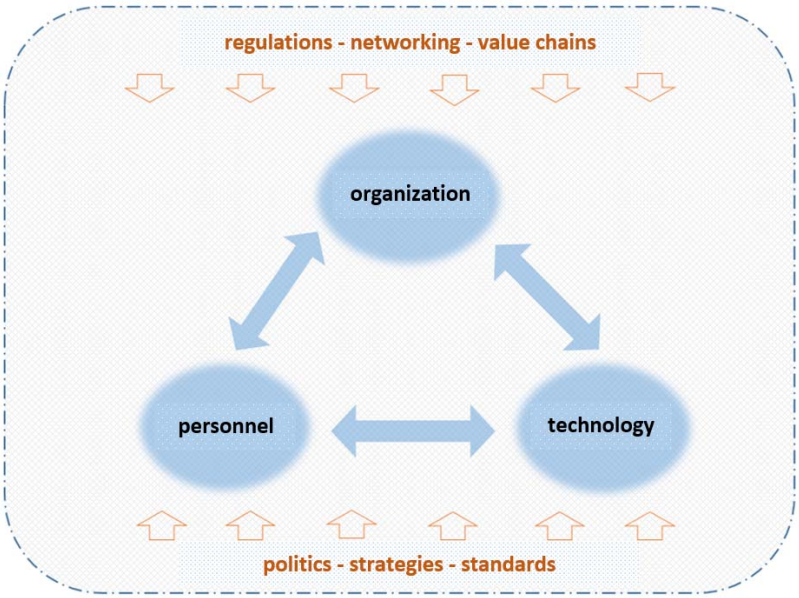


Figure 2.A holistic presentation of the socio-technical concept of work design (Source: authors according to [14: p. 279])

If we look at the socio-technical system in the context of digitization and Industry 4.0different subsystems, according to [14], we can determine that technology includes ‘’innovative transport technologies’’ and ‘’smart objects’’ that manage themselves through production processes. Personnel as a subsystem includes skill requirements, employment structures and employee participation modalities. Organization as a subsystem would refer to changed workplace structures, new management functions and innovative business models. Additionally, the work design in its entirety should take into account the economic requirements of various application fields and knowledge domains of Industry 4.0. Around that, ‘’the socio-technical system is embedded in the strategic and institutional framework and factors of the socioeconomic context’’ [14: p. 279]. In this way, we can adapt the traditional view of organizations as

socio-technical open systems [15] because interaction with the environment forms an integral part of work design.
Another conceptual advantage of the socio-technical approach is reflected in the possibility of harmonizing correlative social and technical subsystems through ''joint optimization'' [16], which emphasizes the principle of the reciprocal relationship between work, organization and technology. This once again underlines the inadequacy of the deterministic view. In the following, we will consider a conceptual framework of basic guidelines for human-centered work design based on the key findings presented in the work of Hirsch-Kreinsen & Ittermann [14].

4. Basic Guidelines for Work Design

In accordance with the concept of a socio-technical system, we can observe changes in the way subsystems interact under the conditions of application of digital technology. As an example of the key characteristics of the Fourth Industrial Revolution Hirsch-Kreinsen & Ittermann [14] present a work design that would include correlations between technology and personnel, personnel and organization, and technology and organization.

The first correlation ''technology and personnel'', starts from the essential question that refers to new forms of ''distribution of functions and interaction between machine and man''. The necessity of a holistic and collaborative view of human-machine interaction that ''identifies specific strengths and weaknesses of human work and technological automation'' is stated as a basic requirement. Due to the expansion of the scope of automation (through smart technology), according to Hirsch-Kreinsen & Ittermann [14], the central goal that human work should achieve and preserve is transparency, as well as control possibilities over production processes. At the same time, it is important to develop much-needed practical knowledge that should be supported by intelligent assistance systems. Hirsch-Kreinsen & Ittermann [14], state two basic criteria for designing new forms which they formulate as: ''sensitivity to context and adaptability'' and ''complementarity''.

Sensitivity to context and adaptability - should include changes in the spectrum of employee tasks due to ergonomically oriented adaptation of digital systems to specific working conditions. ''An intelligent ability to adapt information systems and help individual, partially different skill levels of workers is necessary, in order to ensure opportunities for continuous learning and qualification processes on the staff side'' [14: p. 284.]. ''Necessary is an intelligent capability to adjust the information and assistance systems to individual, partly differing worker

skill levels, in order to thereby ensure on the personnel side, the possibilities for continual learning and qualification processes'' [14: p. 284.].In other words, it is necessary to alleviate the consequences of diminishing the importance of the practical knowledge of employees and to ensure the processes of continuous learning and qualifications.

Complementarity - refers to the flexible division of functions in human-machine interaction in order to ensure sufficiently transparent and controlled ''smart'' systems given to employees. This principle would allow digitally supported real-time decision-making and employee behavior options to be secure and changeable. ''The relevant design aspects are here: to provide human-machine interaction through intuitive serviceable hardware that can quickly be learnt, as well as targeted access to real-time digital information for specific situations, thereby enabling digitally supported decision-making and employee behavior options as safe and changeable''. [14: p. 284.] ''Relevant design aspects are here: assure human-machine interaction through intuitively serviceable and rapidly learnable hardware as well as targeted and situation-specific access to digital information in real time, in order to make thereby the employees' digitally supported decision-making and behavioral options secure and modifiable''. [14: p. 284.]

In the context of the mentioned criteria, we are shown that in digital transformation, technology is not a passive object that is manipulated, but an active subject that behaves in a way that requires constant specific establishment of decision-making competencies. ''The interaction between smart systems and worker behavior can generally be characterized as hybrid'' [14: p. 284.]. According to the author, this brings us to a controversial issue related to the interaction between man and machine, and it concerns responsibility. Namely, the question is: to what extent, in human-machine interactions, can we talk about 'machine responsibility' as equal to 'human responsibility'. [14: p. 285.]There is no doubt that this remains an open question that leads us to consider a number of ethical and other social aspects of modern life and work. Together with the authors, we can agree that it will gain more and more importance due to the increasingly dynamic intensification of the autonomous systems of Industry 4.0.

The second correlation, ''personnel and organization'' is presented in relation to changes in the ''scope of action and model of working hours, and new requirements in terms of training standards and skills''. The key issue here is the way in which the organizational design of work in I4.0 will enable the use of competencies and empirical knowledge of employees in the context of developing the range of activities and continuous learning through the acquisition of various qualifications. The design of the work would include the multivalent disposition of workers and the processes of acquiring relevant skills and knowledge during the actual performance of the tasks.

The central characteristic of tasks is that they are less and less individual, i.e., addressed to one worker, and more and more team-based, i.e., addressed to working teams. This team character of the task influences the working teams to ''act self-organizing, highly flexible and situationally determined according to the problems that need to be solved in the technological system''. 14: p. 285.]. Likewise, the absence of strictly defined tasks requires organizational forms that can coordinate loose networks of qualified and differently specialized workers. In this way, the flexible integration of work could be subsumed under two key characteristics: ''holism'' and ''dynamism''.

Holism - this criterion means the organization of work activities in a holistic sense in a way that includes types of tasks that, in addition to executive tasks, also include dispositive tasks such as organization, planning and control. Similarly, it includes a combination of tasks according to their demands in order to enable the reduction of workload and the achievement of greater freedom of action and self-organization of work in the context of new forms of cooperation between robots and humans.[14]

Dynamism - on the basis of this criterion, within the design of work organization, they could influence the realization and encouragement of learning at the workplace. In addition, it is necessary to take into account the new functions of social media that ''promote interdisciplinary communication and cooperation between differently specialized employees'' and thus ''increase the innovative capacity of work''. Considering the speed of technological changes, it is important to be able to ''try it in the shop'', and at the same time respond to the demands of loosely structured forms of work in such a way as to achieve the engagement of employees of different abilities and capacities. In dealing with various contingencies, loosely structured and dynamic work processes should be a good basis for making effective decisions and interventions.

The third correlation of ''**organization and technology**'' implies new design options that would include comprehensive structural changes in the work organization of the entire company. The changes concern ''the direct value chain in terms of functions and hierarchy, and the structuring and connection between key production processes and management and support processes''. Here, the main focus is on the decentralization of the organization's segments in the form of exploiting the potential of decentralized digital technology and autonomous production and logistics systems. The organization of the company acquires ''permanent flexibility'' through new technological systems of highly individualized production. Related to this are changes in management functions that are a consequence of changes in decision-making competencies and a focus on employee participation.

The realization of the possibilities of new forms of value chain structures and business models due to the networked system of planning and control, and the application of data mining methods, leads to the creation of industrial values that

are not limited to what happens within traditional organizational boundaries. Reciprocal connections between technology and organization in the ‘’smart networked company’’ create new types of work design challenges that should respond to the organizational requirements of overcoming company barriers in digital transformation processes [14].
Here we could single out, as an example of new challenges, the application of complex systems in production such as Cyber-physical Systems - CPS. They make industrial systems capable of communication and networking, which can then be added to new production capabilities. Communication capabilities are reflected in the fact that they contain intelligent control systems and built-in software, and thus can be connected to a network of cybernetic systems[13].It is basically a computer system where mechanisms are controlled and monitored by algorithms. In addition to industrial control systems, some examples of applications are smart grids, autonomous car systems, medical monitoring and robotic systems. [17: p. 4; 7]
Therefore, we can see that the relationship between the organization and technology is the main emphasis on the processes of system decentralization, which emerge as key guides in designing work. In this way, the extracted correlation relations of the subsystems with certain work design guidelines givenby Hirsch-Kreinsen & Ittermann [14] provide us with a series of further insights into the types of changes brought about by digital transformation.
What we could single out as key to understanding the new realities of the work environment are the presented work design possibilities that would holistically treat a number of issues of different interaction relationships in new forms of industrial production.

5. Conclusion

If we look at the digitalization of industrial production in the way of the revolutionary transformation brought about by networked technology, we can see a series of changes that require conceptual design and the creation of new terms. Many novelties that bring technological innovation provide us with the opportunity to analytically observe the interaction relationships of various systems and subsystems, taking into account individuals, organizations and society as a whole. In the field of social organization of work, management and control processes are experiencing radical changes.
In the context of general global trends of change, we can single out the need for a new organizational logic that would correspond to the networked reality with stated requirements for support processes for qualitatively different relations between workers and machines (robots). In the organizational sense, on the one hand, it is necessary to enable conditions for the continuous improvement of workers’ knowledge and the acquisition of skills (digital data management

competencies, symbolic knowledge) and, on the other hand, to enable decision-making processes in ‘’real time’’ with the support of ‘’machine learning’’ andartificial intelligence. Designing organizational processes would imply that we have in mind a special type of flexibility that, based on networked communication, can harmonize the interactional relations between man and machine. We have to bear in mind that human expertise and algorithmically controlled processes are inherently different.

Respecting all the diversity of digital transformation, the paper tried to present the advantages of a holistic approach in the analysis of organizational changes. New ways of organizing work bring us various kinds of challenges that must be understood in order to be able to recognize specific social mechanisms that are the basis of changes.

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