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IMPACTS OF REVOLUTIONS IN WORK ON THE TRANSFORMATIONS FROM TRAINING TO WORK IN THE TWENTY-FIRST CENTURY

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Lia Cristiane Lima Hallwass[1] and Mauro Augusto Burkert Del Pino[2]

ABSTRACT

This work analyzes the revolutions in work, which since the twentieth century have been outlining profound social, economic and technological changes, with emphasis on Industry 4.0. In this context of analysis, its objective is to highlight central aspects of these changes to discuss the centrality of work in the capitalist scenario leveraged by IR, the role of the worker throughout these revolutions, and the transformations in training for work in the twenty-first century. Based on qualitative analysis, it is an exploratory bibliographic and documentary research, which allows us to understand characteristics or social trends found in studies on the subject and their bibliographic references. Its findings indicate that Industry 4.0 imputes to the world of work new practices, new methods and new social relations of work, and all subjects must prepare themselves for this increasingly changing and complex world. Based on the assumptions of this phase of IR, everything must revolve around productivity, whether in industry or education. Thus, like any other organizational processes, educational processes must ensure their efficiency in terms of developing individuals at the level of labor market expectations.

Keywords: Industrial Revolutions, Work, World of Work, Industry 4.0, Higher Education.

[1] Dr. in Education
Federal University of Pelotas
Pelotas, RS, Brazil
E-mail: liahallwass@gmail.com
ORCID: https://orcid.org/0000-0000-0000-0000
[2] Dr. in Education
Federal University of Pelotas
Pelotas, RS, Brazil
E-mail: mauro.pino1@gmail.com
ORCID: https://orcid.org/0000-0002-3104-4087

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INTRODUCTION: WHAT WERE AND ARE THE INDUSTRIAL REVOLUTIONS?

In human history, organized production and consumption have ensured the survival of individuals (LANCMAN, 2004; MAXIMIANO, 2017). However, the phases of the Industrial Revolution (IR) marked new production practices (DRUCKER, 1993; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015). Thus, it is preponderant to understand the transformations in work resulting from these revolutions, as well as their social, economic and political consequences for the civilized world. The steam engine, in 1776, gave rise to the First IR, replacing the craftsmanship of small workshops with mechanized production (MAXIMIANO, 2017). The capital-labor relationship was affected by the ideas of factory production, of workers and of the division of labor (STONER and FREEMAN, 1997). At the end of the nineteenth century, new sources of energy advanced to the Second IR (MAXIMIANO, 2017).

Taylorism, or Scientific Management, marked the Second IR, in the search for maximum productive efficiency (TAYLOR, 1990; STONER and FREEMAN, 1997). Through the rational organization of work (ORT), the model proposed savings in time, materials, processes and workers, and automation (TAYLOR, 1990; MAXIMIANO, 2017). Afterwards, Fordism created the assembly line (traction mechanism that moves an object through a linear sequence of workstations, in which specific tasks are performed on that object), enabling mass production (DRUCKER, 1993; OHNO, 1997).

In times of war, this model redesigned industrial production and development (ZENI, 1992), and the modern enterprise. The changes introduced by him were violent for production, work and social relations. Mass production both promoted quality at low cost and generated economic and social problems that were only a preparation for what was to come (STONER and FREEMAN, 1997; ROSA, 2019).

In the mid-twentieth century, the Third IR, also known as the Information or Technoscientific Revolution (ZENI, 1992; DRUCKER, 1993; SANTOS *et al.*, 2018) was based on scientific knowledge and technologies of microelectronics, informatics and robotics. Thus, software, hardware and robots have once again transformed production (STONER and FREEMAN, 1997; DEL PINO, 1997; MAXIMIANO, 2017), and society.

Toyotism allowed for flexible production in the post-war period (OHNO, 1997; PINTO, 2007; MAXIMIANO, 2017). Among similar models, such as the Swedish and Italian (ZENI, 1992; DEL PINO, 1997), this was a worldwide highlight. Thanks to *just in time*, production cells and quality systems (OHNO, 1997), the proposal modernized industries and generated

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a new economic order based on modern capitalism (PINTO, 2007).

Globalization intensified by new communication and information technologies and the internet have shaped globalization (STONER and FREEMAN, 1997; CHIAVENATO, 2021) pointed to financial capitalism based on the opening of markets on a global scale (DRUCKER, 1993; DEL PINO, 1997; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015). Business deals were the basis for the economic development of nations (PINTO, 2007; SCHWAB, 2016). However, the productivity levels of globalized production and trade caused turbulence in the capital-labor relationship and, therefore, in the company-society relationship due to efficiency practices that bordered on the exploitation of human and natural resources (DRUCKER, 1993; STONER and FREEMAN, 1997; PINTO, 2007; ANTUNES, 2008; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015; MAXIMIANO, 2017; SANTOS *et al.*, 2018).

The Fourth Industrial Revolution, dating from the end of the twentieth century, is based on cyber-physical systems and artificial intelligence (SCHWAB, 2016; GARBEE, 2019). Starting from pre-existing technologies now qualified by genetic engineering, nanotechnology, neurotechnology, *big data analytic*, cloud computing, internet of things, 3D printing, *radio-frequency IDentification*, agile methods, augmented reality, drone robots and autonomous devices (GERBERT *et al.*, 2015; SANTOS *et al.*, 2018; ROSA, 2019).

Linked to the expression Industry 4.0, this revolution was consolidated in the digital world (GERBERT *et al.*, 2015; SCHWAB, 2016; SANTOS *et al.*, 2018; FIRJAN, 2019; GARBEE, 2019). Its technologies consign advances that enthuse for the connectivity brought to contemporary life (SANTOS *et al.*, 2018; COLLABO, 2019). Through virtualization and the capacity of algorithms, "Industry 4.0 will revolutionize the organization of global value chains" (SCHWAB, 2016. p. 19), connecting individuals to remote devices, machines, companies, governments, creating scales of consumption and, therefore, of production, productivity and work (SANTOS *et al.*, 2018). This new business ecosystem has as its main objective the organic integration between customers, governments, companies and suppliers and the deep customization of relationships, processes and products (SCHWAB, 2016; COLLABO, 2019).

This seems to be the greatest industrial revolution in the world ever experienced, or envisioned (SCHWAB, 2016). As it is in progress, it is not foreseen how far it will go. Its operations efficiently merge complex physical, digital, and biological domains (SANTOS *et al.*, 2018; COLLABO, 2019), establishing its own productive models, mechanisms for the

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use of resources, and dimensions of control. It is unlike anything humans have experienced (SCHWAB, 2016; GARBEE, 2019) and seems to be strong enough to shake up the relations between production, consumption and work like never before.

Based on this text, which introduces important concepts about the phases of IR, in addition to its basic assumptions of operation, this article aims to highlight central aspects of these changes to discuss the centrality of work in the capitalist scenario leveraged by IR, the role of the worker and the transformations in training for work in the contemporary twentieth century. with an emphasis on Industry 4.0.

The exploratory bibliographic and documentary study (SEVERINO, 1984; MORAES, 2003; PÁDUA, 2004; CRESWELL, 2007) was based on the filing of institutional documents, such as: institutional development plans, pedagogical political projects, general regulations, institutional regulations, institutional evaluation reports, pedagogical projects of cusos, among others. These documents belong to the four largest federal universities in the State of Rio Grande do Sul (RS) – Brazil, the Federal University of Rio Grande do Sul (UFRGS), the Federal University of Santa Maria (UFSM), the Federal University of Pelotas (UFPEL) and the University of Rio Grande Foundation (FURG).

It should be noted that the text is part of the doctoral thesis that investigated the relationships between traditional curricular theories, the new public management, and the transformations in higher education (HALLWASS, 2023). The present excerpt privileged information that allows us to understand characteristics and/or social trends found in books, studies and institutional documents highlighted on the impacts of the Industrial Revolutions in question, each of which in its time in the transformations from training to work.

THEORETICAL FRAMEWORK: HUMAN WORK IN INDUSTRIAL REVOLUTIONS

Human work has always been an instrument of human subsistence, and it is the action with the greatest potential to promote changes in the living conditions of individuals (MARX, 1996; DEL PINO, 1997). However, for Lancman (2004) and Antunes (2008), it was in the capitalist mode of production that it gained centrality, becoming the main vector for the generation of value and development of nations (DRUCKER, 1993; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015; SANTOS *et al.*, 2018). Under capitalism, however, says Pinto (2007), contradictions arose about the progress brought about by the integration between science, technology and human labor.

In the era of machinery – the first two phases of IR – the strength of individuals

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competed with the (strength) of machines; and the productive efficiency of small workshops, with that of industries (MAXIMIANO, 2017). The progressive demand for production transformed individuals into workers (MARX, 1996; SCHWAB, 2016). The Taylorist/Fordist industry wanted an efficiency based on accumulated, systematized, rationalized knowledge, aiming at the exponential increase in productivity and business profits (PINTO, 2007).

Taylorism technically divided human labor. Workers applied knowledge, skills and physical efforts mnemonically in predetermined tasks (TAYLOR, 1990; STONER and FREEMAN, 1997), under the command of supervisors who ensured the standardized execution of production operations (PINTO, 2007). For Taylor (1990), productivity at work depended on the mandatory standardization of methods, work instruments, working conditions, and also on strict functional supervision.

Fordism further divided the labor (STONER and FREEMAN, 1997). On the assembly line, each worker had "individual responsibility for a part of the series of services" (FORD, 1967, p. 74). The simplification/division of labor reduced costs and, in addition, allowed the rapid replacement of one worker by another or by a machine, if necessary, motivating him to keep up with his function through competition, wage increases for productivity and the possibility of replacement.

The central ideas of these models were specialization, training, and functional supervision that endorsed human replacement (STONER and FREEMAN, 1997; PINTO, 2007; MAXIMIANO, 2017). Workers were challenged to show themselves relevant within a production process dominated by the efficiency of machinery (HALLWASS, 2023). In the industrial microenvironment, alienation, lack of motivation, work accidents, absenteeism, and very high turnover signaled a negative reaction of workers to this work logic (TEIXEIRA, SALOMÃO and TEIXEIRA, 2015). In the socioeconomic macrostructure, human exploitation and devaluation, the lack of labor regulation and the semi-qualification of workers, added to the inflexibility of the model in the face of market demands, hindered development (ZENI, 1992; DEL PINO, 1997; PINTO, 2007; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015), yielding social criticism to the relations between capital and labor. In the end, says Pinto (2007), the efficiency bases that gave rise to these models made them collapse.

At the time of information technology – Third IR – work in industry demanded the integration of functions, machines and workers (OHNO, 1997). Reiterating studies on human needs and work groups, which began in 1920, it was perceived that intellect and

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human empowerment, as well as good human interactions, could qualify productivity, (DEL PINO, 1997; MAXIMIANO, 2017). It was a new of competencies – a set of knowledge, skills and attitudes (McCLELLAND, 1973) – in which the demands went beyond the physical efforts necessary for the operative activity. In these terms, in addition to muscles, other components of workers in the work process began to be explored: brain, feelings, perception and nerves (DEL PINO, 1997).

Toyotism restructured industry with the organization of work cells (OHNO, 1997; STONER and FREEMAN, 1997; DEL PINO, 1997; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015). Within them, groups of workers were autonomous to plan, organize, execute and control their functions and results, and were then workers, managers and supervisors of themselves (MAXIMIANO, 2017). The central ideas of this work philosophy were autonomy (combination of human autonomy and automation) and the enrichment of functions (ZENI, 1992; DEL PINO, 1997; OHNO, 1997; MAXIMIANO, 2017). Toyotism challenged the worker to show new virtues within a productive process based on the intellectualized relationship between men and computerized technologies (HALLWASS, 2023).

Against Toyotism weighed the demand for versatility, that is, for workers with multiple aptitudes: physical, technical, mental and behavioral (STONER and FREEMAN, 1997; TEIXEIRA, SALOMÃO and TEIXEIRA, 2015) to generate productivity. In society, (weighs) the fact that it aimed at the exploration of human intelligence, as much as the previous models (PINTO, 2007); if not more. Its ideological empowerment led the worker to self-exploitation without the need for corporate control (MAXIMIANO, 2017).

From the 1970s onwards, the proposal began to face resistance from workers and unions (DEL PINO, 1997; PINTO, 2007), alleging an increase in the level of extraction of surplus value (MARX, 1996) and the precariousness of working conditions and relations (PINTO, 2007; ANTUNES, 2008). The intensification of work, and changes in developmental policies, resized the capitalist economy (DRUCKER; 1993; STONER and FREEMAN, 1997), which according to Del Pino (1997) continued to be strong and changing the profile of workers due to the technical, economic and political transformations of society.

In the fourth phase of IR, digital connectivity and the on-demand economy of Industry 4.0 impose on the worker the challenge of resignifying themselves in a production process whose strategic values are the extraction of surplus value from the worker and the liberalization of labor relations. With more leisure, repetitive and precision operations have already been automated (SCHWAB, 2016). Intelligent machines can even simulate

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operations (ANTUNES, 2008; SANTOS *et al.*, 2018), whether financial, actuarial, legal, journalistic, medical, academic, among many others (SCHWAB, 2016; ROSA, 2019).

In this way, work based on digital connection, then, wants to deepen the extraction of human intellect and emotions (STONER and FREEMAN, 1997; PINTO, 2007). Tropia, Silva and Dias (2018) point out that Industry 4.0 requires interaction of individuals for complex and interdisciplinary operations, requiring abstraction, problem-solving skills and a global view of processes, demanding more creative and cognitive work from humans. In effect, this raises the competencies focused on the practice and social organization of work, for the survival of individuals in the changing world of work (BODEN, 2004; GRUGULIS and VINCENT, 2009; CARLUCHI and SCHIUMA, 2018; SANTOS *et al.*, 2018).

However, the revolution brought about by this industry is in the flexibility of work and social relations (GERBERT *et al.*, 2015; TROPIA, SILVA and DIAS, 2018). Industry 4.0 wants the strength and intellect of individuals, but not necessarily social relations (GERBERT *et al.*, 2015). The accumulation of capital takes place in a network of "autonomous service providers managing business demands launched in the digital cloud, working with whomever they want, from where they want, when they want and how they want" (SCHWAB, 2016, p. 57). Digital technologies create a work ecosystem that, thanks to connectivity, changes the nature of work. The organic fusion between physical, digital, and biological technologies directs humans to a context in which their integration with these technologies is vital for the execution of services, that is, they work in collaboration with machines (COLLABO, 2019; GARBEE, 2019).

The fact is that "the on-demand economy is changing the relationship with work" (SCHWAB, 2016, p. 56): demand, production, products, services, processes, functions, labor relations, contracts, wages, social benefits (TROPIA, SILVA and DIAS, 2018; SANTOS *et al.*, 2018; COLLABO, 2019). And it can lead to the extinction of jobs (GERBERT *et al.*, 2015), as it has already done with salespeople, receptionists and cash tips in large retailers.

However, the real threat of the Fourth IR is not in the replacement of the individual. Machines are good at repetitive tasks, but they can't compete with humans at humanized roles. And the capitalist mode of production needs human labor as a source of value creation (PINTO, 2007; ANTUNES, 2008). Furthermore, the most obvious, unlike machines, human workers are necessary to maintain the cycle of production and consumption. That said, Industry 4.0 does not entail the end of work as human action (PINTO, 2007;

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ANTUNES, 2008; SCHWAB, 2016; ROSA, 2019).

On the other hand, this IR transforms the *modus* and *locus* of work, either by empowering the individual in flexible digital work; or by transforming the world into a jumble of deregulated virtual factories (SCHWAB, 2016). So, it can mean the restructuring of human work as it is known, related to employment (PINTO, 2007; ANTUNES, 2008; TROPIA, SILVA and DIAS, 2018). Outsourcing, subcontracting, informality, overwork, temporary, part-time or on-demand jobs arise (DEL PINO, 1997; PINTO, 2007; COLLABO, 2019). Although the concept of worker is still the individual deprived of the means of production who sells his labor power (MARX, 1996), this situation exposes workers to new types of exploitation of their labor power (DEL PINO, 1997; ANTUNES, 2008). The consequences of this restructuring will depend on political decisions, which must consider "the time and scope that the capitalizing effect can supplant the destructive effect and the speed of this destruction" (SCHWAB, 2016).

Human history – it is worth remembering! – has already suffered from the effects of technologies on production and work (DEL PINO, 1997). Each phase of IR created problems, inequalities and concerns (ANTUNES, 2018) regarding the exploitation of workers and the extinction of jobs (GARBEE, 2019). From them emerged new demands and occupations (SCHWAB, 2016). Therefore, except for normal and occasional recessions, everyone can find work, and it remains to be seen what conditions are offered (ANTUNES, 2008; SCHWAB, 2016; COLLABO, 2019). This story has also seen renewed the strength of human adaptation and ingenuity, which are vital skills in the broad context of Industry 4.0.

Thus, it is unequivocal that the purposes of each phase of IR encompassed attempts to meet the globalized demands of production and consumption, in which both capital holders and workers in one way or another resignified themselves and still seek to resignify themselves (COLLABO, 2019). This did not happen only through the introduction of technologies in the productive field, but also through the maturation of management techniques (DRUCKER, 1993). The efficiency idealized by management scholars evolved, feeding back the designs of capitalist thought and straining the relations between those who sell their labor power and those who buy it in order to increase the circulation of goods and services. Just like production, work, the business community and the worker have become flexible, adapting to the contradictions of capital (MARX, 1996). This last revolution, in particular, intimately altered the structure of work, affecting the set of sociocultural and

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economic relations, as Pinto (2007) would say, making it (work) an oracle of society.

RESULTS AND DISCUSSIONS: IMPACTS OF REVOLUTIONS AT WORK ON TRANSFORMATIONS FROM TRAINING TO WORK IN THE TWENTY-FIRST CENTURY

The scientific, technological and economic transformations promoted by the phases of IR, most evidently in the twentieth century, marked the structure and processes of work and employment (DEL PINO, 1997; PINTO, 2007). Its consequent demands for workers involved the educational system initially in professional training for work (SILVA, 1997), a purpose for which education proved to be relevant. In particular, at the technical and higher levels, which are simultaneously responsible for professional training and the social well-being of individuals (ZENI, 1992; DEL PINO, 1997; PINTO, 2007; SANTOS *et al.*, 2018).

The interests of capital challenged education to provide training in quantity and proportion of the market (DEL PINO, 1997; PINTO, 2007; SCHWAB, 2016; SANTOS *et al.*, 2018; COLLABO, 2019). The market, in turn, requires flexibility, interdisciplinarity, technological processes and a globalizing vision of training for work. This complex pointed to the need to reflect on the relationship between work and education.

The First and Second phases of IR – or rather, ORT – required efforts for the mnemonic execution of tasks (TAYLOR, 1990; STONER and FREEMAN, 1997). Due to human undervaluation, the lack of formal education did not matter; the specialization established through internal training was more important (PINTO, 2007; MAXIMIANO, 2017).

However, at the turn of the twentieth century, in the face of Taylorist scientificity, Bobbitt theorized about educational efficiency (KLIEBARD, 2011; HALLWASS, 2023). Showing his perception of how education should be/remain aligned with economic development based on production, industry or the labor market, the efficiency scientist researched and, based on his results, created more than 800 objectives consonant with the work occupations of the time. He said that the social function of educational institutions should be the promotion of the necessary training for work, and their social efficiency should be measured by their ability to produce workers based on the quality technical specifications required by the labor market, that is, professional, social and general skills (BOBBITT, 2004).

Other efficienists, a few years later, deepened this perspective in the 1940s, Tyler (1979) deepened this perspective, rationalizing the curriculum for the production of workers.

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For him, after investigating the labor demands of the labor market, it is up to education professionals to define objectives, didactic experiences, and instruments for evaluating curricular results, aiming to meet and demonstrate compliance with such market demands (HALLWASS, 2023). And Bloom *et al.* (1973) who proposed a model of instructional teaching psychologically based on a taxonomy of educational objectives dedicated to the professional training of individuals.

These ideas made up a new educational order. Bobbitt mechanically referring to the development of all competencies related to work in the industry, including good conduct, individual and collective performance, and commitment to the organization and the employer (HALLWASS, 2023). Tyler and Bloom softened their coolness, but intuitively pursued Bobbitt's goals. Together, and despite criticism, they impregnated the educational ideals of much of the twentieth century (KLIEBARD, 2011), signaling that educational institutions, through curriculum and instruction, should be seen and charged as spaces for the internalization of broad competencies – according to the concept of (McClelland (1973) – for performance and professional qualification aimed at the labor market.

The Third IR, later, centered human autonomy on the efficiency of the productive cells (PINTO, 2007). Here, work required versatility, abstract aptitudes (McCLELLAND, 1973; DEL PINO, 1997; GRUGULIS and VINCENT, 2009; SANTOS *et al.*, 2018), scientific and technological knowledge, group work, graph analysis, creativity (ZENI, 1992; BODEN, 2004; CARLUCCI and SCHIUMA, 2018). Training prepared individuals for this enrichment/accumulation of functions, promoting technical knowledge and cultural values and disciplining (MAXIMIANO, 2017). Formal education was valued to the extent that it reinforced behaviors that were fundamental to the success of Toyotist philosophy (DEL PINO, 1997; PINTO, 2007).

In the turn of knowing, thinking and self-managing, and at "the risk of not only machines becoming obsolete, but also people" (DEL PINO, 1997, p. 117), "education appeared as a decisive component in the generic training of the working student" (*idem*, p. 195). In the meantime, the business community, inspired by the experiences of economically developed countries, emphasized the link between education and production (STONER and FREEMAN, 1997; KLIEBARD, 2011), fostering investments in both areas.

Under a dominant view that "if the economy requires a new type of skill, capacity or worker, it is unquestionably up to the school to develop it" (SILVA, 1997, p. 13), it was concluded that professional education would raise the levels of business competitiveness

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(ZENI, 1992). Thus, the educational system turned to it (DEL PINO, 1997), internalizing the industrial demands for specialized labor, opening space for the understanding that education should contribute to the promises of employment and income (PINTO, 2007) and narrowing the relationship between the productive and educational processes.

In fact, if in the previous phases of IR the worker should not think, give an opinion; in that phase it was in the interest of capital to do so. This strategic ideological shift created another level of reality, in which the evolution of labor capital began to involve the social needs of the worker. Therefore, education should work on them. Even without consolidated theories, and with questionable purposes, "the educational forms conceived by the theorizations and justifications developed by the educators of power" (SILVA, 1997, p. 12) forced education to assume responsibility for the development of a general education that would better respond to the insertion of workers in the productive sphere (DEL PINO, 1997).

This perspective, although referring to the Third Phase of IR, makes sense for the Fourth. From this point on, all educational changes were related to the maintenance of a transcendental education related to revolutions at work (DEL PINO, 1997; PINTO, 2007; ANTUNES, 2008; SCHWAB, 2016; HALLWASS, 2023) As a result, society is far from developing forces and forms of work without the support of education. And education, to develop forces and forms of work that are not related to these revolutions.

The Fourth Industrial Revolution has multidynamic purposes (SCHWAB, 2016), which takes advantage of the intellect and profiles of the most qualified individuals for creative functions and those without qualifications. The only requirement is that they adapt to flexible digital work (GERBERT *et al.*, 2015; COLLABO, 2019; GARBEE, 2019). In this sense, it is up to formal education to align the expectations of individuals with this new work format, prepare for the prevailing global competitiveness, provide qualification for functions that can be created, remodeled or even extinguished by Industry 4.0.

This revolution is so imposing that it coined the term Education 4.0, based on the same digital, physical, and biological technologies characteristic of its phase: artificial intelligence, robotics, cloud computing, virtual and augmented reality technologies, among others (FIRJAN, 2019). On the other hand, the socio-emotional issues necessary to work in Industry 4.0 support movements such as Education 5.0 (VILELA Jr. *et al.*¸2020), which has had repercussions as a major educational trend. It enables the healthy integration of individuals into the information society. Its conception of education includes the preparation

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of individuals for productivity, dynamism and social transformations resulting from the digital world, therefore, digital work. In the end, the two proposals are also preparatory for work in Industry 4.0 or in the following industries. They reinforce the revolutionary force of Industry 4.0 and expose the impact of work revolutions on job training.

In this story, education is a means of systematically developing training for work. The school provides general education; the technical school and the university, the professional one (DEL PINO, 1997; FIRJAN, 2019). All important for the working class. Further, it is up to the university to provide integral education, as the apex of the development of intellectual skills that reorganize productive activities and those of life. The previous model started this trend, which extends to Industry 4.0 despite its controversies.

Thus, the overcoming of the traditional business model (face-to-face) gives rise to flexibility and decentralization of control (DRUCKER, 1993; STONER and FREEMAN, 1997; MAXIMIANO, 2017; SANTOS *et al.*, 2018; ROSA, 2019), which allows the execution of the work in different countries and continents. Preparing individuals to work in this reality presupposes identifying "where people will be situated within the production process in the future, and how the interaction between people and machines will occur" (SANTOS *et al.*, 2018, p. 112). This makes professional training for Industry 4.0 as paradigmatic as the revolution itself, which requires multiple fronts of action, but has doubts about the totality of responsibilities and skills necessary for these workers (COLLABO, 2019).

In these terms, education must map competencies expected by this industry to propose training at the level of work, even without work being organized (BODEN, 2004; GRUGULIS and VINCENT, 2009; SCHWAB, 2016), and in the face of great expectations about what humans can project in the direction of technological innovations. For Schwab (2016, p. 52), "talent, more than capital, will represent the crucial factor of production". But without a definition of talent, it is not possible to quantify the shortage of skilled labor, or how to train it. The adjectives of order are: flexible, adaptable, multidisciplinary, multifunctional, innovative (BODEN, 2004; CARLUCCI and SCHIUMA, 2018; SANTOS *et al.*, 2018).

From this, it can be summarized that, in the current phase of IR – different from the first ones – training for work must provide the knowledge capable of making the individual transition to work and its multiple possibilities, which will determine their survival, growth and/or competitiveness in the world of work (HALLWASS, 2023). Pinto (2007) states that the companies of this phase want an intellectually multicompetent worker, therefore, a

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generalist education. For Collabo (2019), the education that is now called integral should prepare individuals for the profession, for work, but also develop the versatility necessary for them to face the many changes they will face throughout their lives. Schwab (2016) adds that current education should imprint on the individual the idea of continuous qualification, through which he sees the obsolescence of machines, knowledge, innovation and himself as normal.

Santos *et al.* (2018) warns that a critical challenge of Industry 4.0 is the integration of workers into different cultures and skills. To this end, companies should invest in continuing education for the use of technologies and for the systematic renewal of their knowledge and practices, so that workers feel effective in this industry. Becoming effective within a model of this order will demand a lot from individuals and education for work. It involves multiple skills, not always converging, in an on-demand universe, just like working in a group in a virtual group. Del Pino (1997) mentions that the proposal contributes to the human obsolescence of the worker who does not qualify.

However, without clearly defined competencies, it is difficult to both qualify and be effective in this industry (BODEN, 2004; GRUGULIS and VINCENT, 2009; CARLUCCI and SCHIUMA, 2018; SANTOS *et al.*, 2018). But it is part of the business strategy to organize good professionals within its operations. This justifies the search for good professionals in educational institutions and, before that, the struggle of educational institutions to successfully train such professionals for this complex scenario, in which knowledge itself (intellectual effort) has been overtaken by the competence to undertake and innovate. The Fourth IR made workers competing with each other and entrepreneurs of themselves. The individual no longer belongs to a company; it is connected to a cloud where demands are launched and is therefore allusive to the place where work happens where demands are launched (SCHWAB, 2016).

Thus, the same administrative techniques of production lead to a compulsory educational revolution. Now, the main idea of adapting education to managerialist assumptions goes beyond preparation for work. It requires curricula to strengthen entrepreneurial approaches to increase skills aimed at entrepreneurship and constant innovation (GERBERT *et al.*, 2015). If the world revolves around strategies that feed entrepreneurship and innovation, then professionals who understand them will be better able to take advantage of the good opportunities of this revolution (COLLABO, 2019).

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These are "high competencies" that are highly prescribed for work in Industry 4.0 (SCHWAB, 2016, p. 54). Increasing the concept of competence (McCLELLAND, 1973) – high competences are knowledge, skills and attitudes circumscribed to a domain of specialization (GRUGULIS and VINCENT, 2009); not to a profession. They enable the individual to move in the world of work. In addition to these, for this industry, technological aptitude and various increasingly subjective skills (*soft skills*) are underlined (BODEN, 2004; GRUGULIS and VINCENT, 2009; SCHWAB, 2016; MAXIMIANO, 2017; (CARLUCCI and SCHIUMA, 2018; ROSA, 2019), such as human adaptation, continuing education, vitality, initiative, creativity, multifunctionality, intuition, teamwork, individual and collective responsibilities, and synergy. Accepting their importance presupposes designing curricula, contents, and experiences connected to this industry, even recognizing the human character of these skills, therefore, the difficulties of teachability and immeasurability.

Industry 4.0 still provides an additional dilemma to individuals. Even in times of digital connectivity and on-demand economy, the desires for purpose and belonging to work are maintained. According to Schwab (2016), they have even been expanded.

Earlier, Marx (1996) had already expressed that individuals seek in work, in addition to their subsistence, a harmonious professional integration. To do so, they seek to belong. In education, they seek training to achieve such work, qualifying for it. However, the future is worrisome since even with the great reach that education has achieved, "only a minority of individuals can achieve such satisfaction" (SCHWAB, 2016, p. 54). Industry 4.0 demands a tough vision about undertaking, adapting, meeting demands, qualifying, and remaining employable, demanding that "from basic education, elementary and high school, where the basis of thought and instrumentation that will shape the professional future begins" (FIRJAN, 2019, n.p.). That said, educational institutions are recurrently charged with the efficient development of workforces.

Situations like this demand from education a performativity that is not its own, governing its objectives, relationships, values and experiences, and justifying the adequacy of education and training to revolutions in work. In this regard, Schwab (2016) states that:

> Despite the positive impact of technology on economic growth, it is essential to address its potential impact on education. [...] They need to develop models of academic training that require social and creative skills; in particular, decision-making in situations of uncertainty, as well as the development of new ideas. [...] [The Report *Future of Jobs* shows that the demand will fall much more on complex problem-solving skills, social and systems competencies and less on physical skills or specific technical competencies. [...] The next few years will be a crucial period of transition: global employment prospects are flattened, there is a significant turnover between

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> jobs in industries and in most professions, which could generate social inequalities. [...] In this rapidly evolving work environment, anticipating future work trends and needs in terms of knowledge and skills indispensable to adapt and becomes even more critical for all *stakeholders*. This would be a negative result of the Fourth Industrial Revolution (SCHWAB, 2016, p. 50).

If it is difficult to draw conclusions about the world of work (ANTUNES, 2008; SCHWAB, 2016; TROPIA, SILVA and DIAS, 2018; ROSA, 2019), consequently, on education as well. "From the alteration of the technical basis of the works derive changes in the relationship between work and life, and within life is education" (DEL PINO, 1997, p. 171). These changes start to demand new practices, new work methods, as well as new worker participation and education at work (SANTOS, 2011). The technological revolution in society becomes a fundamental issue in education in the face of the world of work, as well as in the real conditions of man's existence. The answer will come from society itself as changes take place (BODEN, 2004; COLLABO, 2019; GARBEE, 2019). Once the types of professions and the necessary skills are discovered, the type of education compatible with Industry 4.0 and its business models will be understood.

Therefore, the global impact of Industry 4.0 on education is still difficult (SANTOS *et al.*, 2018; ROSA, 2019). However, even so, says Firjan (2019), it can be said that countries that still want to join this revolution need to invest in a broad restructuring of their educational systems, envisioning partnerships with the business community and representatives of emerging markets, in order to survive the risks of global instability in relation to work. It is essential, therefore, to have a balance between supply and demand, as well as the skills required must invariably coincide with the operations performed at work (BODEN, 2004; GRUGULIS and VINCENT, 2009). This means abandoning skills that are no longer useful for work and investing in those that are.

This thought (convergence between the demands of the world of work and training for work) has already marked a large part of the twentieth century in a forceful way. The idea that the efficiency of educational establishments was comparable to that of factories exposed at that time the coldness with which education was seen by the eficients during the Second IR (TYLER, 1979; BOBBITT, 2004). However, for Hallwass (2023), it is in the twenty-first century, thanks to the spread of the neoliberal perspective of how the world works, that these perspectives seem to have reached fertile soil to transform education into what it has always wanted: a rational process of producing workers to work in industry, whatever it may be.

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Considering the practices found in higher education, based on the analysis carried out by Hallwass (2023) with federal universities in RS, it can be said that these issues are strengthened in the institutional discourses of these educational institutions.

Universities manifest in their official documents social functions linked to the purpose of serving the labor market. They declare visions of education, business, and educational services that aim to meet "social demands that are also professional" (HALLWASS, 2023, p. 197). As examples, professional training with a view to the advances of globalization and the challenges of the labor market and with training appropriate to the professional reality (UFPEL, 2003), the generation of jobs and products that promote social growth (UFSM, 2016), comprehensive training for social and professional exercise (UFRGS, 2016; FURG, 2019a), professionalization for the world of work (UFPEL, 2003; 2022; FURG, 2019a), the training of qualified professionals for the market (UFPEL, 2022), and the formation of citizens useful to society and the nation (UFRGS, 1996; 2016).

The intention to serve the market is directly related to the technical quality desired for these professionals, and which is expected to be notably recognized by the market (UFRGS, 2016; 2017; UFSM, 2016). From this, universities recognize that they organize their institutional structure in order to achieve this quality, whether through their teaching, research and extension activities, as well as their administrative operations (UFSM, 1987; UFRGS, 1996; 2016; UFSM, 2016) that are updated, expanded, or innovated to the extent of the demands found in this market (UFRGS, 2016; FURG, 2019a; UFPEL, 2003; 2022).

Certainly these statements are summarized here. However, such functions seemed to be summarized in the training of labor. And this training was officially expanded in the documents at the pace that the market demanded, in accordance with the fundamentals of business management (DRUCKER, 1993; STONER and FREEMAN, 1997; KLIEBARD, 2011; MAXIMIANO, 2017; CHIAVENATO, 2021; HALLWASS, 2023) that boosted educational efficiency in the educational institution (BOBBITT, 2004), in the curriculum (TYLER, 1979) or in the instructional teaching conveyed by Bloom *et al.* (1973).

Thus, the strategic objectives of these institutions are established, with a view to the contemporary demands of work, with a focus on professional training, that is, the development of competencies converging with the ways of working from IR. Still from the Third Phase of IR, but incorporating those of Industry 4.0: "innovating, undertaking, focusing on results, adapting, having a strategic vision, having interdisciplinary capacity, updating, among others, give the idea that [...] the individual needs to be the protagonist of

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his or her story and contribute to social progress through his or her profession" (HALLWASS, 2023, p. 230-231). This shows that education, in its social obligations, must go beyond technical issues.

Thus, education is required to establish social relations with the market. All the universities investigated share this requirement. For them, the insertion of the university in society constitutes an institutional responsibility (UFRGS, 2016), since it allows them to seek relevant information for their academic work and for delivering value to society (FURG, 2019a), ensuring both the convergence between their objectives and educational performance with the real objectives of society that depends on human work to develop (UFSM, 2016; UFPEL, 2022). Furthermore, because it is in this field that job opportunities are, and it is the role of the university to train individuals for their insertion in the professional field (UFSM, 2016; FURG, 2019b; UFPEL, 2022).

It is a fact that universities in their documents perceive themselves as organizations and agents of social transformation, as well as the knowledge and individuals developed by them. And that this transformation occurs through its exchanges with the market. The market indicates what it needs in terms of knowledge and training, and universities adjust their performance to achieve these results. Furthermore, (it is a fact) that this perspective has gone through several phases of IR over the centuries, invaded the educational field in the twentieth century, and is now part of the ideals, discourses and university practice, according to the documents analyzed.

To this end, universities assume in their documents that they need to pay attention in parallel to legal prescriptions, to their particular vocations – each institution has a different mission in terms of its contribution to the world –, to the opinions of specialists, to the particular interests and capacities of students, but, above all, to the global demands of the labor market. reacting and possibly anticipating them (UFPEL, 2003; 2022; UFRGS, 2016; UFSM, 2016; FURG, 2019a). In other words, the consequences of labor revolutions have great weight in the educational organization.

Likewise, they accept that their educational quality is based on the market evaluation of their performance in numbers of courses, vacancies, students, approved students, graduating students, employed students, professors with professional experience, public articles, projects, partnerships with agents of society, among many related (UFRGS, 2016; 2017; UFSM, 2016; FURG, 2019a; UFPEl, 2022). The failure to achieve certain indices may suggest inefficiency of university management, the insufficiency of educational services

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(FURG, 2019a; UFRGS, 2016; UFPEL, 2022) and, with fear, spill over into its institutional reputation in the market, as can happen with any organization in its segment. This is what is meant by professionalization of university management: the orientation towards results that brings with it several other efficient concepts (TYLER, 1979; BOBBITT, 2004; SANTOS *et al.*, 2018; HALLWASS, 2023).

Unsurprisingly, this load of responsibilities is reflected in the construction and updating of the pedagogical projects of courses (UFPEL, 2014; UFRGS, 2017; FURG, 2019b; UFSM, 2019), which also aim at the administrative molds in terms of producing results, focusing on the set of skills required by the market. Considering the five most important professional competencies for professional training, according to universities, they are in order of relevance: **(1)** Creativity associated with innovation (UFRGS, 2016; 2017; UFSM, 2016; 2019; FURG, 2019a; 2019b; UFPEL, 2003; 2014; 2022); **(2)** Adaptability or flexibility (UFRGS, 2016; 2017; UFSM, 2016; 2019; FURG, 2019a; 2019b; UFPEL, 2022); **(3)** Effectiveness as a synonym for focus on results (UFPEL, 2014; UFSM, 2016; 2019; UFRGS, 2017; FURG, 2019a; 2019b); **(4)** Entrepreneurship (UFRGS, 2016; 2017; UFSM, 2016; 2019; UFPEL, 2022); and **(5)** Strategic vision (UFPEL, 2014; UFRGS, 2017; FURG, 2019b; UFSM, 2019).

It should be noted that despite the importance of technological aptitude, only UFRGS (2016) and UFSM (2016) listed it as a competence to be developed in their students. In addition, in all these competencies one can see both the efficient assumptions of following market trends for the development of individuals with a focus on work as an unquestionable direction, as well as the demands of today's society – which faces Industry 4.0 – for education (BLOOM *et al.*, 1973; TYLER, 1979; SILVA, 1997; BOBBITT, 2004; KLIEBARD, 2011; FIRJAN, 2019). In the context of the courses, this is equivalent to commitments signed by the courses with the university, and between the university and society.

However, this commitment does not depend on the prescription how to develop them. At no time was there talk about pedagogical theories or initiatives such as Education 4.0 (FIRJAN, 2019) or Education 5.0 (VILELA Jr. *et al.*¸2020). Each university, each course, as well as each professor in his classroom, must establish the relevant practices and provide the means for this to happen, as well as face the challenges of developing valuable skills like these, but subjective, therefore, less teachable, comparable and evaluable. Several literatures referenced here have manifested these challenges. However, among the universities studied, only UFSM (2019) indicated guiding pedagogical guidelines for its

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professors to take care of them (challenges). No structure was identified for them. Not even the legal guidelines are able to keep up with these changes, as "the market really is more agile in generating demands" (HALLWASS, 2023, p. 290), but higher education institutions, their courses, and education professionals must do so, for the sake of their survival and/or their growth in the educational market.

To this end, education must be as innovative, entrepreneurial, adaptable as the students it undertakes to train for the job market (BODEN, 2004; CARLUCCI and SCHIUMA, 2018; SANTOS *et al.*, 2018; HALLWASS, 2023). This gradation of objectives and challenges of training for work seems to update education in multicompetences, which in the twenty-first century is required of everyone. As a response, universities have been trying to develop the same skills in themselves and their students, even if many remain in documentary theory, not being reflected in didactic practices.

Finally, as in an administrative process, universities are also subject to evaluative action. Not only within the pedagogical issues, but also within the numbers mentioned above that will expose its efficiency or inefficiency in meeting market demands. From the perspective of the social utility of education, "educational results aimed at the professionalization of individuals and educational adjustments predominantly aimed at employability are constantly under judgment" (HALLWASS, 2023, p. 296).

In this regard, the Brazilian educational legislation has been increasingly demanding such results, which indicate the evaluation not only of the training and performance of students, but also of the educational processes, the organization and institutional activities, whether pedagogical, academic and administrative, and what can be called the quality of its professionals. And, also, the ability to internalize the demands of the world of work to these processes and activities (BRASIL, 1988; 2004; 2014; 2017). To which universities have been trying to respond, achieving and maintaining good scores in evaluations by higher education regulatory bodies (UFRGS, 2016; 2017; UFSM, 2016; 2019).

In terms of these assumptions, the work, production and development of individuals are important for this, even at the expense of the destructuring of the social processes we know, such as education. In this, it is preponderant that education is attentive to what the capitalist economy postulates, as it is the reality we have come from, but also to the historical needs of individuals (HALLWASS, 2023), in order to maintain or achieve the prominent place it deserves on the world stage, regardless of the era, revolution, or future of society.

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FINAL CONSIDERATIONS

The first phases of the industrial revolution marked the beginning of capitalist forms of production, generating impacts on human labor. However, they were only a rehearsal for the true transformations in work in this economy. While the movements of the Third IR appropriated the machinery and accumulated scientific knowledge, the Fourth IR appropriated, qualified, and physically, digitally and biologically integrated the pre-existing technologies to human intelligence with a view to a potential for economic development that was still unknown. In this context, revolution after revolution, workers found themselves in the midst of unprecedented labor relations. Industry 4.0 reconfigured the structure of society, resignifying human action within the physical, technological, and social aspects of work.

During the IR phases, it was seen that training for work is as adverse to the worker as it is to education. In the first IRs, the list of academically respectable knowledge was small. The following phases replaced them with the requirement of a series of skills which show difficulty in inserting them in the curricula. Both the problems and the solutions arising from these statements permeate the fields of educational, social, economic, and technological policies whose changes give rise to technically incompatible interests: the economy, labor and education.

Industry 4.0, in turn, imputes to the world of work new practices, new methods and new labor relations, which makes it difficult to make conclusions about the world of work, as well as about the real conditions of human existence in this world. The only truth so far is that individuals, both educated and formed, must prepare themselves for an increasingly changing and complex world in terms of social labor relations.

This truth is valid for the worker and for education and its professionals. The central ideas of this revolution – on-demand economy and digital connectivity – not only shake up the modes of work, but also the settings of training for work. Just as in Industry 4.0 calculations are necessary, data that are transformed into useful information for decision-making and for the efficient achievement of results, in the field of education, a series of analyses must be made, in order to develop the endless skills – technical and human – that are required of individuals for contemporary work. All of this revolves around productivity, whether in industry or education.

These mutations resulting from the revolutions in work instilled transformations in the way of life of the worker and in the functioning of education. The questions permeate

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educational, social, economic, and technological policies, and their solutions will involve clashes between incompatible interests. The answers may come from society itself, as changes take place, but they invariably involve the action of the market, the social function of education and its results. In view of the patterns of production, education absorbs social values that are essential to the economy, praising technologies and management techniques that aim to increase productivity in any sector, even education.

Through this reasoning, it is possible to report evidence that the current phase of IR seems to rescue theoretical movements typical of its first phases, such as educational efficiency. They continue to have the same potential to regulate higher education, redefining agendas around the training of individuals for the – now, global – job market. This phenomenon occurs from the internalization of new theories, such as Education 4.0 or 5.0.

In conclusion, the revolutions in the world of work did not occur only in the labor sphere with an economic nature, they transformed social, cultural, political, and also educational dynamics. The work within the globalizing process was restructured in the search for results, as well as the role of workers and the function of education in the formation of individuals. Business efficiency seems to be an educational trend, so educational institutions privilege in their processes actions justified in their relationship with training for the labor market, resignifying them in the midst of the molds of economic capital.

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