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The study of manufacturing workplace organizations from a technology perspective*

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Abstract

This working paper summarizes mainstream theoretical approaches through which workplace researchers have approached the technological sphere to understand systems of production organization. The increasing absorption of technologies in manufacturing workplaces opens an opportunity to explore new implications and review old ones regarding workplace relations. Therefore, a fresh review of how different technology perspectives are applied to understand systems of production organization, how their concepts are related, and how they observe the meaning of technology is relevant for 21st-century researchers interested in reviewing the intertwined relationship of technological change and manufacturing organization.

Keywords: manufacturing workplace; systems of production organization; technological change; technology perspective; workplace relations

* This working paper is based on my doctoral dissertation: *Technology, participatory management practices (PMP), and dignity at work: Negotiating the use of technology in a plastics packaging firm.*

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Introduction

Workplace organization is directly correlated with technological developments (Noble, 1986). Doolin and McLeod (2007) noticed that technology goes hand in hand with workplace organization and they reinforce each other: "[T]here is no technology without organization and no organization without technology" (Bloomfield, 1994 as cited in Doolin & McLeod, 2007, p. 154). Since the first industrial revolution, the introduction of machinery has resulted in a division of labor and gains in productivity, both of which reveal the importance of technological innovations in workplaces (Smith, 1955). According to Adam Smith (1776), the division of labor led the average shop floor worker to become creative and invent machinery and processes to save their work. As soon as the market grew, the innovative enterprise became absorbed by new individuals who, under the market incentive, created a new way to profit through the scientific method. This enterprise was directly involved in the production of machinery and development of new ways to use this machinery and was managed by two distinctive groups: the inventors (engineers) and the philosophers (entrepreneurs or scientists), who were the ones that took the lead.

Market expansion created a symbiosis between technological development and workplace organization. However, market expansion has not addressed the problem of a growing number of unskilled workers and routine tasks, while new technological developments have created sub-divisions of skilled and specialized labor (Marshall, 1920). New machinery or technological innovation[1] is still expected to replace the tedious and routine tasks undertaken by workers (Einzig, 1957). As a result, technology has continuously been interpreted as an exogenous and fixed determinant force of a market, independent of workplace social interactions.

Most workplace organizations in the 21st century are organized as a lean production system. A lean production system, which varies among industries, is characterized by intensive technological driven production methods, constant efforts to develop and advance Taylor's scientific management practices, and the spread of participatory management practices. In this context, managers have to deal with the realities or actual state of the organization's technology, and their decisions focus on two things: (1) the design, acquisition, redesign, implementation, definitions, and use of technology, which must be adequate at all levels of the organization; and (2) managing labor processes, which includes the selection and assignment of tasks and activities to workers, matching workers' skills, knowledge, and experience to the required job, or designing work in accordance with the abilities and capabilities of the actual technologies. If required, managers shape the labor process by giving workers opportunities to acquire the skills needed by the organization. The increasing development, production, and use of technologies have been fruitful to capitalists, with the efficiency of lean production systems.

This working paper is divided into three sections. The first section offers a simple typology of manufacturing systems of production. For each system of production, a clear relationship in the use of technology and manufacturing organization is summarized. A second section focuses on technology perspectives applied to understand systems of production, in which a

[1] "Technological innovation is the first commercially successful application of a new technical idea" (Ashford & Hall, 2018, p. 405).

clear appreciation of what technology means is emphasized. The third and last section makes the point that exploring the Socio-technical Systems Theory (SST) as an approachable perspective to reviewing the intertwined relationship of technological change and manufacturing organization in the actual mainstream and massive Lean production system offers an interesting opportunity to reveal clues to the new manufacturing organization use and connotation for technology development.

Manufacturing systems of production

A manager's ability to increase pressure to adopt a new technology, in accordance with market principles, empowers administrators, e.g., owners and managers, to manage the means of production and shape the evolution of the systems of production. Workplaces are comprised of a complex array of processes that have a broad range of functions. What follows is a brief description of the characteristics of the different developmental arrangements of production processes (Top-Down) or systems of production (Figure 1).

Professional and craft production

According to Womack et al. (1990), craft production is based on highly skilled workers and flexible tools that shape a product in a way that consumers want. Since production costs are high, craft products are not affordable to all. Professional and craft production workers are considered as perceiving their work as meaningful and fulfilling (Hodson, 2001; Zuboff, 1988). If technology reflects the use of flexible tools, the manufacturing organization would be based on creativity and workers' skills. Technological development is appreciated by helping to shape the final product, enhancing workers' pride in the result but also consciousness about personal growth in their dexterity.

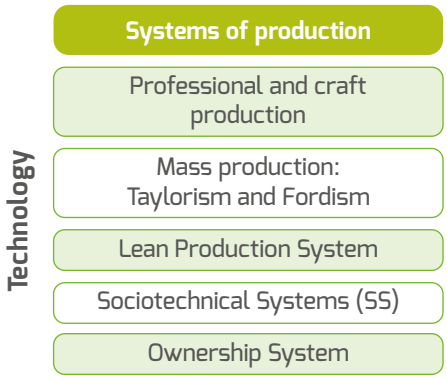

Figure 1. Systems of production.
Source: own preparation.

Mass production: Taylorism and Fordism

Mass production is the ability to produce goods with parts that are interchangeable and easily attach to each other, transforming the process of production. According to Taylor (2016), the production efficiency starts by selecting the adequate workman capable of following orders and keeping the pace of the job. Mass production systems have replaced many skilled workers with single-purpose machines, adding suppliers, less-skilled workers, and opening space in the production system. Skilled workers are typically utilized only for product design, while less-skilled workers perform assembly work. As a result, production costs can be cut because of the reduction in the costs of employing skilled workers.

On a mass production line, workers move to stations to perform a single task. However, the process can be slowed or jammed by workers at a specific station. For example, more agile workers can get ahead

of slower workers, which can increase the time to finish a product. Given these types of challenges, Ford invented the moving assembly line in which parts of a vehicle were brought to a stationary stand where workers performed their tasks and reduced the cycle time. Technology development is clearly at the core of and an instrumental asset to manufacturing organization.

One of the problems of Ford's assembly line was its inability to modify the product to satisfy customers' demands. Sloan's approach in General Motors solved this problem by standardizing the mechanical items he produced and locating them around the plant, allowing versatility and flexibility in the production while altering the appearance of the vehicles, thus increasing the consumer interest in his product. As a result, Ford and Sloan's approaches gave birth to the mature form of mass production in which a combination of marketing and management techniques were focused on customer relations and workplace organization based on controlling jobs and task assignments.

Lean production system

Lean production came into existence when Taiichi Ohno, the developer of the Toyota production system, eliminated the need for die-change specialists and refined the technique by producing small batches of product, which reduced the carrying cost of large inventories and led to cost reductions (Dennis, 2016; Womack et al., 1990). Ohno focused on quality and eliminated defective parts. In order for the system to work, he needed skilled and motivated workers to anticipate problems and take the initiative to find solutions. In order to get rid of waste, he assumed that assembly workers could perform many functions as specialists and add value to the car's production because of the right conditions on the line. He created groups with team leaders, instead of traditional foremen or supervisors of the mass production lines. Team leaders coordinated the teams and engaged in all assembly line tasks. The leaders would also fill in for any absent worker. When the team was running smoothly, team members were allowed time to suggest ideas to improve the production process. As teams became more experienced, errors decreased, and the line practically never stopped due to the decline in defective products. Lastly, parts are only produced when they are demanded to further reduce the inventory. Participatory and employee involvement in the production process was critical to the success of the system. Technology characteristics for reducing costs are at the core of the lean production system meanwhile enhancing quality and trying to extract workers' pride by satisfying workers' creativity and ability from the technological advantages of the production process rather than the effort invested in the final product (as a professional and craft production system).

Lean production systems prioritize face-to-face communication among workers by using as little space as possible. This communication helps workers quickly identify and address problems, which is why the process has been widely adopted in most industries. To maximize the benefits of a production system, a company must adopt high-tech automation processes. Therefore, a lean organization must focus on transferring tasks and responsibilities to workers that add value to the production line. The dynamic of the work team is essential to a lean production system.

The operational methods of lean production are referred to as "lean thinking," which is strategically implemented through "lean principles" to assess the organization's "state"

of transformation (Stone, 2012). With regards to technology, lean production systems are characterized by detailed procedures and focus on the selection and location of machines. The Machine that Changed the World, written by Womack et al. in 1990, was one of the primary references that promoted the Japanese automobile industry's method of production. Since then, the concepts of waste and value have been at the core of lean thinking. Waste refers to any human activity that absorbs resources but creates no value, while value is a capability provided to a customer at the right time and price, as defined by the custome (Womack et al., 1990, p. 331).

According to Stone (2012), after four decades of promoting the "ideology of lean," several aspects of the manufacturing process are intertwined in the idea of "doing more with less." Traditional characteristics of a lean production organization include, but are not limited to, six sigma, localization of workers, cost/waste reduction, quality in each step of the production process, respect for humanity, and flexible production with quantity controls. Lean production characteristics were developed from best practices relating to Just in Time (JIT), Total Quality Management (TQM), standardization, functional layouts, inventory reduction, and continuous flow strategies. Lean production sets specific arrangements and implementation processes to reduce "waste" and remove inefficient activities that reduce the ability of the production process to increase profits. All of these approaches are connected with the adoption of technology. Therefore, reaching the maximum performance of a lean system implies a philosophy in which technology is used to save resources in the production process, and the workplace must be organized through participatory management practices. Lean practices can be configured in several forms and ways to achieve the desired goals. For instance, Brown and O'Rourke (2007, p. 250) describe how teams are organized to increase "the role of workers, who are 'empowered' to make critical decisions – including stopping production – to adjust malfunctioning machines, removed damaged parts and materials, and modify product flows and sequences based on actual production experience."

According to Womack et al. (1990), lean principles are universal and should be used by any industry. Industries with a "homogeneous production input" (Van Bijsterveld & Huijgen, 1995, p. 38), such as the automobile, chemical, and aircraft industries, can transfer and adapt lean manufacturing principles (along with important nuances) so they align with different institutional and cultural settings. "High standards of lean production mean the harmony and consistency of manufacturing techniques, and personnel practices are the backbone of the Lean production organization" (Alder, 1993, as cited in Van Bijsterveld & Huijgen, 1995, p. 38). However, different types of industries have encountered many difficulties in transferring lean principles due to technological challenges and the organization of the workplace. The packaging industry falls into this second group and can be classified by its use of hybrid lean practices.

Sociotechnical Systems (SS)

According to Niepce and Molleman (1996), the difference between systems of production derives from principles concerning human issues. For that reason, Taylorism and Fordism, lean production systems, and Sociotechnical Systems (SS) differ radically due to their work design. Human resource management in lean production seeks to eliminate buffers to increase the flow of information, reducing "waste" and increasing productivity and efficiency. On the other hand,

sociotechnical systems are characterized by balancing efficiency goals and workers' needs while promoting maximum autonomy to increase workers' satisfaction and productivity. Whenever "socio" and "technical" are written in the literature, it means the "interaction of social and technical factors creates the conditions for successful (or unsuccessful) system performance" (Walker, 2015, p. 171). However, in this research, "Socio-technical System Theory" (SST) refers to workplace organizations from a technology perspective. In contrast, "Sociotechnical Systems" (SS) refers to a particular system of production in which the "work system should balance the needs of the organization for efficiency and the psychosocial needs of the worker" (Niepce & Molleman, 1996, p. 77).

The SS system of production assumes that there is a new philosophy that leads the organization of the workplace through success and failure while navigating the system. The SS perspective assumes that there are specific characteristics of workplaces in the 20th and 21st centuries that make participatory practices quickly embedded in the more technological and complex organization of the workplace that go beyond the control behavior explanation. For instance, according to Niepce and Molleman (1996), participatory management practices are by design different from scientific management and mainstream approaches to the organization of the workplace. This points to a fundamental change (e.g., flexibility) in the organization of the labor force in which participatory practices are transformed.

Ownership system of production

On the side of the system of production, the worker's ownership system promotes a system of participatory principles in the decision-making structure. In this case, the organization of the workplace tends to increase the likelihood of worker dignity because of their role as owners of the assets of the company and democratized forms of decision making (Rothschild & Whitt, 1986). The system's impact on dignity is more significant because of its focus on the well-being of the workers as the main principle of functioning (Hodson, 2001). A democratization mechanism for technology is developed here, which adds complexity to the manufacturing organizing protocols and procedures.

Technology perspectives applied to understand systems of production

Technological innovations have increasingly been naturally integrated into workplaces, shaping systems of production to accomplish the mission and vision of a business and succeed in competitive markets. As a result, technologies have become immersed in workplaces, optimizing the performance of their production processes. Technology plays a critical role in the organization of the workplace. Orlikowski (2000) identified a typology of organizational theories that have evolved to understand workplace organizations in terms of technology, including strategic choice models, symbolic interactionist approaches, transaction-cost economics, network analyses, practice theories, Marxist studies, and structuration models. However, Grint (2005) and Grint and Woolgar (1997) claim that any organizational study focused on technology will struggle to define it as an objective form that can explain work transformation or change. The following text discusses four perspective frameworks that have evolved to understand workplace organizations in terms of technology (Figure 2).

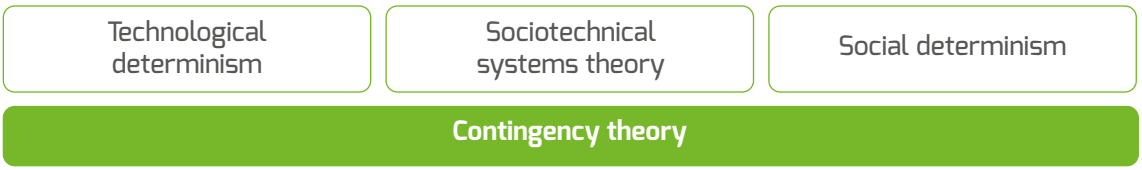

Figure 2. The study of technology in workplace organizations.
Source: own preparation.

Technological determinism theory

According to Grint (2005), technology was long considered fully independent of an organization's labor process. The theory of technological determinism posits that technology emerges as an exogenous and autonomous development that determines social structures and shapes an organization's relationships. This theory regards technology as the primary resource that shapes workplace relations, neglecting any substantial transformation in workplace organization that may arise from social interactions around technology (Blauner, 1964). To a certain extent, this approach assumes workplace machinery and its development as the main transformational force of the workplace organization. However, uneven technological advancement across organizations suggests that social or power relations also influence an organization's technology structure.

Socio-technical systems theory (SST)

As a middle-ground theory, the Socio-technical System Theory (SST) states that organizations result from a social and technical process, with technology influenced by complex social relations that shape organizational life (Grint, 2005). Empirical studies have shown the complex and contradictory social relations that arise in defining adequate technologies and implementing organizational change (Thomas, 1994). SST refers to a theoretical approach which seeks to understand the appropriation, use, specification, adaptation, scope, scale, and interpretation of technology by workplace actors embedded in the dynamics of workplace organizations. Hence, technology is not only determined by the organization but also defined and appropriated by the social relations and interactions of the labor force that shape the dynamics of workplace organization.

Through the technological change process, technology is learned, appropriated, and apprehended by the workforce. Computerization promotes not only production but also social networking and work-related interaction. Technological change creates flexibility and open access to communication and participation in workplace decision-making (Nicolosi & Ruivenkamp, 2013). Skilled workers become more reliant on technology as computerized systems become more sophisticated (Burris, 1998), and organizational needs become intertwined with technological developments.

Although the SST perspective has been around for more than 40 years since the Tasvitack studies of Tristen (Fox, 1990), it presents a unique way to study how technological infusion in workplaces, combined with participatory management practices, shapes the organization of the workplace.

Social determinism theory

Technological development is not neutral and is always bound and shaped by

socio-historical events. The recognition of uneven technological advancement across organizations was used as evidence by social determinism theories to claim that technology by itself cannot be the only factor influencing social organization. Instead, organizations must acquire specific technology structures. Technology is not only designed to be acquired by an organization but also undergoes a process of implementation that may include phases of redesign and rediscovering new technology uses to increase profits. Focusing exclusively on technological outcomes rather than on how decisions are made oversimplifies the complex and contradictory processes that shape, accomplish, or stop technological change (Thomas, 1994). However, focusing exclusively on power relations obscures the fact that technological change influences social outcomes, shaping power and powerless structures within the labor process, and neglects the reality that the technology embedded in the workplace is an essential factor in a learning environment (Billett, 2004).

Contingency theories

Contingency theories assume that the workplace environment must be contextualized and develop its dynamics in response to differences among the industry's production process, levels of power relations, and internal policies and cultural organization (Grint, 2005; Thomas, 1994). Contingency theories disallow the possibility of developing a general theory of organization because a workplace's response is too unique for the formulation of a general theory, contingent on its peculiar circumstances and environment (Form et al., 1988). Therefore, this theory may be close to the deterministic extremes as well as the middle ground of sociotechnical systems.

Final annotation: A socio-technical systems theory (SST) proposal

A general definition of technology is the "application of science for the achievement of practical purposes" (Dorf, 2001, as cited in Ashford & Hall, 2018, p. 178). However, Devinatz (1999) and Orlikowski (2000) note that there may be differences between the "apparatus" and the "technology". By distinguishing between technologies as artifacts and technologies-in-practice, researchers can not only reduce technology and the workplace to the capabilities embedded and known by a technology user but also observe how technology users can promote structures to use technology in a different way than intended by its designers (Orlikowski, 2000). This approach does a better job of understanding changes in work through a technological lens.

In this sense, the SST approach opens opportunities to understand old inquiries attached to all different systems of production. For instance, this approach may shed light on how power relations can shape the production process in any production system in ways that make it more efficient and productive.

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