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Industry 4.0 and New Forms of Work Organization: An Analysis of the Perspective of Decision-Makers From an Automotive Manufacturer

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ABSTRACT

In the current framework of Industry 4.0 technological transformations, the viewpoint of those who integrate the workplaces being transformed is frequently dismissed. Therefore, this paper explores decision-makers' views concerning such changes and their impacts, considering they also have the power to act on how these processes are employed. The study was developed at an automotive manufacturer in Portugal, through 26 semi-structured interviews. Our findings come to show the decision-makers' perspectives regarding how work is organized, their own operational leeway to manage new work demands stemming from the human-technology interaction, and the perceived impacts of technological change. These results shed light on how technological introduction interacts with the daily conflict to manage productivity and quality demands with health and well-being at work. This will support the next phases of the research, which will include workers from different areas of the company.

Keywords: Technological change, Human-machine relationships, Work activity, Managerial practices, Work psychology

INTRODUCTION

While projections are frequently made about technological change as being a health and well-being potentiator (Cimini et al., 2020), other studies indicate that the real work in interaction with technology makes new risks visible (e.g., Costantino et al., 2021). Yet, the continued perception of technology as neutral regarding those who use it, perpetuated by the predominant techno-centered perspectives, still fails in revealing the risks workers are exposed to (Barcellini, 2019). Adding to this issue, the shortage of studies which consider (i) the importance of how the demands are dealt with by workers daily, and (ii) how the previous professional experience shapes the use of Industry 4.0 (I4.0) technologies at work, further perpetuates the lack of access to the real impacts technology can hold for workers (e.g., Cunha et al., 2022a).

In contexts marked by strong time constraints – partially enforced by machinery – and the so-called "pull-production" models, where the

automotive industry was a pioneer, such as the context where this study was developed, old issues seem reinforced in the context of technological implementation. Though there is a preoccupation with maintaining workers' health and well-being in typically challenging industries such as automotive manufacturing (Spallek et al., 2010) - a central concern for the sustainability of work and the functioning of these work systems -, this often clashes with the high production and quality requirements, and the need to remain competitive (ILO, 2022). For decision-makers in management or middle-management positions, having to deal with these conflicting roles is inherently part of the job (e.g., Parker, 2004). In the case of first-line managers in factory settings, responsible for the performance of the operational lines, such constraints can appear in the confluence between broader organizational strategies (which also frequently include divergent expectations held by superior managers) and specificities of the operational process (e.g., technical demands, the management of members of the work group), often further restricted by their lack of participation in decision-making processes (Hales, 2007). In terms of I4.0-specific studies, divergences in the adoption and implementation of technologies have also been described in interviews with workers in management positions, but the focus mainly resides on practical techno-centered issues (e.g., the pressure to implement technology to maintain the business competitive, but a lack of infrastructural resources to do so, or issues related to the political framework) (Mayer and Oosthuizen, 2022). These examples serve as a basis to point out how certain limitations do not become clear if not understood from a territorial and activity point of view, and highlight the necessity of involving several hierarchical levels in a participatory approach (Bellemare et al. 2001) for the development and implementation of technology, as well as the monitoring of their impacts for workers and the improvement of their working conditions.

Contrary to the literature focused on projections of what the future of work will or can look like, this study focuses on how these changes are lived on a day-to-day basis - a key assumption in work psychology and activity ergonomics (e.g., Lacomblez et al. 2007). The research was developed in the context of a pioneering and emblematic industry in terms of I4.0 technological development (Deloitte, 2020): an automotive manufacturer. Specifically, this article addresses the decision-makers' views concerning technological transformation and its impacts for those whose activity is reconfigured, also regarding their greater involvement and power to act on how these processes are implemented. It places into perspective the difficulties for the management of frequently contradictory work demands, such as production and quality criteria, but also explores how the workers' previous experiences conflict with the new forms of work organization instigated by technological transformations.

METHODOLOGY

Participants and Context

The study herein presented takes place at a large-sized automotive manufacturer in Portugal which is strongly marked by technological transformation.

Our sample consisted of a total of twenty-six participants, of whom one was female: seven managers, three coordinators, 11 supervisors, and five team leaders.

Procedure

The methodology consisted of the development of individual semi-structured interviews, followed by 10 hours of open observations. The 26 semi-structured interviews were conducted using an interview guide, aimed at exploring the work processes which participants consider more or less prone to automation; drivers and obstacles for technological implementation; and the perceived impacts regarding (i) work organization, (ii) operative modes, and (iii) on occupational health and safety. The interviews were recorded, transcribed, and then coded and analyzed using the NVivo 12 software, following a data-driven approach.

RESULTS AND DISCUSSION

From the content analysis which was developed, four main themes emerged. Firstly, "*An infantry of robots*" which emphasizes the principal organizational changes found, stemming from the mass introduction of technology (e.g., new tools, number of workers/team, increased production and quality standards). The second theme, "*New forms of work supervision*", addresses the new mechanisms of supervising work boosted by technology (e.g., quality-controlling robots), and the changes in work content. Thirdly, in contrast to the fast technological introduction, the time constraints leading to fewer training opportunities, as well as how new changes are managed are discussed in the theme "*No time for training*". Lastly, even though technological change is frequently perceived as a source of prestige, this has also led to work intensification and new demands (e.g., the establishment of new work shifts). Thus, the theme "*More propitious to younger minds and bodies*" portrays how such reconfigurations impose other "uses of oneself" (Schwartz, 2020), with consequences for decision-makers' and operators' health.

An Infantry of Robots

The context under analysis is strongly marked by technological introduction, intensified by the recent wave of emerging I4.0 technologies (e.g., digital technologies, cobots, cyber-physical and intelligent systems, 3D printing). The adoption of such technologies (described by one of our interviewees as "*an infantry of robots*", considering the number of robots introduced in some areas) was triggered by the manufacture of a new car model. Such investments are consistent with the expected number of cars produced, and resulted in changes in the whole factory's work organization: "*With the introduction of the* [new model's name] (…) *the production lines come with a degree of automation... it's very high, it's very high*", as mentioned by a supervisor.

These technology-induced changes are not standard, and significant differences were found within the factory in different areas (e.g., a larger or smaller reduction of workplaces, impacting the number of workers per team).

Still, the interviewees highlighted some common benefits. Namely, new state-of-the-art machinery with less downtime, the acceleration of the production processes, increased product quality, the possibility of monitoring productivity and tracking down what was done by each worker in the production lines (e.g., "*Everyone in real time can see what the line is producing, what the operators are delivering*"), the capacity of detecting issues in a faster manner, and the reduction of the physical efforts done by workers (e.g., "*It is time that was gained, of course, for the organization, and for the person too. For the well-being of the person that would take 8 hours to perform the same task and now it only takes 6 or 5 hours.*"), even if this did not mean a reduction of the person's working time. While the reduction of manual workstations in several areas of the factory implied significant changes in their teams, it did not necessarily lead to the overall reduction of the number of workers, due to new supervising activities and new shifts: "*shorter and shorter cycle times or production times force people to also… also increasing the capacity people have for developing this work*", as mentioned by a manager. It did, however, reconfigure how work is organized and done.

New Forms of Work Supervision and Standardization

A team leader mentioned that technological changes have obliged them to "*pay more attention to certain things that were previously uncontrolled*" as "*there are more supervisory tasks, there are more controls to check... because we now have 3 robots ahead of us evaluating our work, right? And in the past, this work was evaluated only at our* [internal] *supplier, later. The supplier was the one who evaluated our work... the way the cars got there. Not now. Now, our work is evaluated at the end of our line*". The increased pressure to produce flawless cars is felt within the whole factory, a challenge to be managed with the intensification of work: more products, no space for flaws, less time per operation, new operative modes imposed by technology, and an in-real-time supervision of everything that is being done. Some operations, however, remained manual - either due to the know-how necessary to do a job well done, or due to the economic investment needed to automate certain repetitive tasks (e.g., "*The fitters' work (...) so, aligning the cars, is all manual, they do not have any equipment, nor robots, to do it in some stations*" as mentioned by a team leader).

The limits of both the machine and the human body become visible during such moments of interaction, but also in the human-machine conflicts which arise from it. So, while technology is praised for making processes faster - a key factor in production chains -, the attempts made by workers to anticipate work and gain some extra time in semi-automatic workstations are negatively perceived: "*We always have to remind people: 'You cannot leave these marks. This is your workstation'. Because of this, sometimes people have a tendency, and we always try to fight that.* (…) *They start anticipating their work. And we try to avoid that, because it's not even good for people, as they're working at a higher pace than what is necessary, and they're failing to comply with the process that has been defined*", a supervisor tells us. The situations mentioned by the supervisor are examples of regulation

strategies, developed by workers to regain control over their work so that a balance between their own well-being and work demands can be achieved (Leplat, 1997; Faverge, 1972). As mentioned by Amalberti (1996), such deviations from the prescribed work happen when workers consider that these 'mistakes' do not pose real threats to the organization nor themselves, and due to the process of 'fixating the thought' (Clot, 2006)- also in line with the idea that work refers to a permanent effort to redefine work-regulating rules (Schwartz, 2021).

While a manager mentioned that "*We are systematically looking for situations where we can replace employees with automatic systems, because they allow us to have more productivity*", and even though the company's policy has been that of reconverting workplaces and upskilling workers, technology also has fragilities. Such fragilities become especially visible in the face of variability and non-predicted situations. In these moments, it is the operators who are called to compensate for such limitations, being able to identify when 'the machine makes mistakes', and make the necessary adjustments. For instance, when the lines experience slight changes in the positioning of certain pieces, this requires changes in the machine's programming, also called "to make a correlation": "*The programs for each piece are made once. Then, sometimes, from production to production, even when one of those parts comes in, there might be some difference.* (…) *It can be just 1mm higher and it can no longer take the part out of the press*", as mentioned by a team leader. A paradox is thus generated: owing to their experience gained prior to the introduction of new technology, human workers are called to supervise and fix machines' flaws; however, the introduction of new technology gradually reduces their opportunities to build the kind of human knowledge that will be needed to oversee future technology (Wurhofer et al., 2018).

No Time for Training

The introduction of new technological machinery, tools, or software entails the adjustments of the operative modes and the development of appropriation processes by those who will work with them. This allows the 'tailoring' of the artefacts to human needs at work on the one hand, as well as the informal adaptation of human activities to what these artefacts allow on the other (Rabardel, 2003). Considering such introductions can threaten the strategies workers develop to preserve their health and well-being at work (see, for instance, Cunha et al. 2022b), the expression of signs of discomfort is perceived as 'resistance to change' by some interviewees, and as a natural reaction to the fear of losing their jobs due to automation by others. Some of the interviewees mentioned the importance of the involvement of workers in the decision-making process as a key factor to overcome such tension moments and manage to create successful technological implementations: "*We started to see with people, the people from* [name of the area], *the technicians who are going to use the software, why they use it, what their needs were to make it easy for everyone. For them not to think 'Oh, it's* [coordinator's name] *who wants a software'. No.* (…) *We started to fill the needs in, we started to change and with that we are now able to have a software that people use*").

However, it was also mentioned how this is not always possible, due to their own resource restraints: "*Sometimes they would like to participate more in the decisions.* (…) *is a planning team responsible for installing the equipment that goes and asks in the production line if there is anything they want to suggest or improve, but of course, we can't involve all the workers there from the line*".

The factory had its operational capacity expanded, especially taking into account that robots do not have psychological limits. Now, production lines work 24/7, in 19 different shifts. Notwithstanding the benefits the interviewees mentioned for workers' health (such as the reduction of musculoskeletal disorders), the changes described throughout this discussion also brought about new challenges for those who have the responsibility of managing teams. Due to work demands, such as the increased pace of work, the long working hours, and the obligation to fulfill production requirements while working at a factory which 'never stops', these participatory moments, including moments for training, become limited and create irregularities within the teams: "[the factory] *works 24 hours a day. It is sometimes difficult to program the training sessions. And we used to have training for a week,* (…) *with time to create problems, to solve them, to learn, to ask questions. And now the training that is provided is someone from the department or someone from outside, from outsourcing, coming to explain that there was this technology that was put in the system, that that's how it works, during 1 or 2 hours* (…) *Then there are some people who learn easily and there are others who take longer or, as they don't use it that often, it's not so easy to learn*". The lack of opportunities for workers' expression (enhanced by the lack of workplace training moments) limits the discussion of technology's possibilities, developed from work activity in the management of everyday demands (Bobillier Chaumon et al. 2019). Considering knowledge of how work systems function has been flagged as a factor which contributes to workers' well-being and performance (Kadir and Broberg, 2020), and that the learning process of managing work variability contributes to the development of health regulation strategies, the reduction of these moments also poses a threat in the exposure of workers to new unpredicted risks for health and well-being (Barcellini, 2019; Cunha et al. 2022a).

More Propitious to Younger Minds and Bodies

In spite of the attempt to reduce the physical workload experienced by workers in the production lines, many assembly stations still involve repetitive and straining movements. This is a central concern for decision-makers, who mention some attempts done to minimize workers' health risks, without jeopardizing production (e.g., "*In terms of well-being, we organizationally increased the breaks we have during shifts from seven to ten minutes (…) without prejudice to the operation. That's a good point that's been made*", as mentioned by a manager). However, an ageing workforce, largely made up of male workers who were exposed to hazardous working conditions from this point of view, gradually turned into a risk to the functioning of these working systems as they are more likely to be reported with less work ability, due

to work. The interviewees mentioned the need to, on the one hand, comply with the production objectives their jobs require (which implies reformulating their teams in order to have enough available personnel to get the job done), but also, on the other hand, manage the suffering of those who become less able to work in these systems: "*But a person who has worked a lifetime as a* [name of the workers function] *is at a level of... here we call him an expert technician, you know? He's an expert in what he does. At this moment, he practically can't move... There are colleagues of ours who can't even hold 2 kg. (…) It's hard to reconvert someone who has been a* [name of the workers function] *his whole life into another profession, isn't it?*", as mentioned by a coordinator. From this issue, a second one emerges. To find appropriate workstations to place these workers with medical restrictions, they face the struggle of those who will see their workplaces taken over when replaced by these workers: "*Sometimes it's difficult to explain to people that 'you have been working here for 7 or 8 years, but now a person who has never worked here, but cannot lift weights anymore, weights over 5 kg, is going to take your place, and you have to go do some tough work'. Sometimes this happens. It hasn't been easy*", as mentioned by a supervisor. For them, the reconfiguration of teams - when members are reallocated to other parts of the factory - with whom they have strong interpersonal relationships is a '*cost*' of technology, and a constraint of the activity they carry out. One supervisor mentions: "*The difficulty at the moment is that we create bonds with people* (…) *with the optimizations that are being done, the main group, which has been there for better and for worse, will have to lose members*".

The management of both their own and others' suffering intensified with the implementation of the 19 production shifts. As these are rotating shifts, known to be hazardous for health (e.g., Bara and Arber, 2009; Kecklund and Axelsson, 2016), some of them imply working for 5 nights in a row: "*The 5 nights are very complicated. It's very complicated, especially the first few nights. There are other more favorable shift regimes here in the company, but they do not apply to the production teams*". However, both nighttime and daytime timetables make the balance of work with life outside of it fragile, and the impacts of not being present at home are intensely felt: "*Some shifts, we are working during the whole weekend and our families are at home and we, when we have our own weekend, in this case, this week it was Monday and Tuesday (…) our families aren't there. Our kids are at school. It's not easy. But then we have, on the other hand, the night shift, which is not easy either. People either have difficulty sleeping or wake up in the middle of the night*", as mentioned by a team leader; "*All of this has had a huge impact on all of us, on our families, on the entire factory.* (…) *25 years ago, it would have been very easy, and I didn't care. Now, at 50 years old, it costs me a lot, especially the nights. And the weekends. We go practically whole weekends without seeing our family*", as mentioned by a supervisor.

Young and recently trained workers are frequently perceived as more able to work with new technological equipment (e.g., "*Some new, some people 28/30 years old... People who have another... able to see the problems more in terms of computers, mobile phones, bits and bytes, PLCs*"). On the one hand, one manager told us that the areas which became mixed in terms of age are

an opportunity for the exchange of experiences and to complement different competences, as older workers have expertise which was built through the use of more traditional equipment (e.g., "*We have an older portion* [of workers], *who are more used to using a screwdriver and a hammer*"). Specifically, he tells us: "*In fact, workers, both old and new, are, shall we say, on average, really good, but with clearly demarked skills. We had a lot of people here, concerning heavy mechanics, let's say, people here with a lot of experience* (…) *This type of expertise, this type of knowledge is fundamental with the introduction of these robots of ours (…) what we find is that, I don't know… picking up a robot console, programming a robot, for a robot to move the way we want, the older people walk around almost with their tongues hanging out, you know? And the new ones grab it as if it were a spontaneous thing.*". On the other hand, the replacement of manual workstations can be read as a fragility for older, more experienced workers, as their long professional history at the factory suddenly becomes maladjusted to the new working conditions. The physical restrictions this older population already faces and the new uses of oneself these workplace reconfigurations demand (Schwartz, 2021) also add to this conflict: "*the younger ones compensate a little bit for that... breakage or weakness, let's say, of the older ones, in order to create a homogeneous force*", as mentioned by one manager.

CONCLUSION

If, on the one hand, technological change is associated with the automation of workstations and perceived as a sign of optimization and operational excellence, supported by the increase in production and revenue enhancement; on the other hand, this transformation also led to the increase in working times to maintain the factory running for 19 out of 21 possible shifts per week and the need to deal with new challenges for the management of teams, including expert workers with health restrictions and whose workstations seized to exist. Even though the sector's main health impacts (e.g., musculoskeletal disorders) are, in some cases, minimized with the automation of previously straining workstations, those impacts do not disappear as the new forms of interaction with the machines impose intense working rhythms, redefine the workers' leeway, and are at the origin of less visible psychosocial risks.

These findings show how the decision-makers' viewpoints are not limited to human-technology relationships in the strict sense, but rather are inscribed in a given workplace, with specific resources and constraints. Thus, they go beyond what workers actually do and include all non-realized possibilities (e.g., what technology prevents workers from doing, or what they have tried without succeeding) (Clot, 2006); work organization options assumed and their perceived impacts; and the conflict between productivity/quality demands, and health preservation. This conflict is at the core of these actors' activity, but also that of the operators working in this context.

Technological change must not be perceived as a mere resource for work without being supported by a real reflection on the impacts these bring for

those in the work situations. This issue is vital for workers to be able to perform quality work, supporting the construction of healthy professional paths, performance, and skill development (Barcellini, 2019). Notwithstanding, in light of the work psychology and ergonomic scientific tradition, there is incommensurability when it comes to work activity perspectives – they are dependent on the place occupied in the company, the employment status, and the history of their professional path in the company. It means that managers and operators "belong to two different worlds and if they are different that is, first of all, because the solutions (...) that they propose to the problems posed are a function of the different place that each one occupies both in the company and in society" (Oddone et al. 1981, p. 200). Thus, the next stage of the project will be dedicated to the analysis of the workers' points of view, in view of developing a shared representation of technical artifacts, work organization options and the impacts of work on health.

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REFERENCES

Amalberti, René. (1996). La Conduite des systèmes à risques. Paris: Le Travail Humain/Presses Universitaires de France.

Bara, Ana Claudia and Arber, Sara. (2009). Working shifts and mental health–findings from the British Household Panel Survey (1995-2005). SCANDINAVIAN JOURNAL OF WORK, ENVIRONMENT & HEALTH Volume 35 No. 5.

Barcellini, Flore. (2019). "Industrie du futur: quelle place pour le travail et ses transformations", in: Le Travail en mouvement, Bourdu, Emilie. Lallement, Michel. Veltz, Pierre and Weil, Thierry. (Eds.). pp. 136–147

Bellemare, Marie. Montreuil, Sylvie. Marier, Micheline. Prévost, Johane. and Allard, Denis. (2001). L'amélioration des situations de travail par l'ergonomie participative et la formation. INDUSTRIAL RELATIONS Volume 56 No. 3. pp. 470–490

Bobillier Chaumon, Marc-Eric. Barville, Nadia. & Crouzat, Pauline. (2019). Innovations technologiques de rupture: quels champs de réflexion et d'intervention pour le psychologue du travail et des organisations?. LE JOURNAL DES PSYCHOLOGUES Volume 367.

Cimini, Chiara., Lagorio, Alexandra. Pirola, Fabiola. and Pinto, Roberto. (2021). How Human Factors Affect Operators' Task Evolution in Logistics 4.0. HUMAN FACTORS AND ERGONOMICS IN MANUFACTURING Volume 31 No. 1. pp. 98–117

Clot, Yves. (2006). La fonction psychologique du travail. Paris: PUF.

Costantino, Francesco. Falegnami, Andrea. Fedele, Lorenzo. Bernabei, Margherita. Stabile, Sara. and Bentivenga, Rosina. (2021). New and Emerging Hazards for Health and Safety within Digitalized Manufacturing Systems. SUSTAINABILITY Volume 13 No. 19.

Cunha, Liliana. Silva, Daniel. and Maggioli, Sarah. (2022a). Exploring the status of the human operator in Industry 4.0: A systematic review. FRONTIERS IN PSYCHOLOGY Volume 13 No. 889129.

Cunha, Liliana. Silva, Daniel. Maggioli, Sarah. Correia De Barros, Ana. Correia, Catarina. Ricaldoni, Fernando. Amorim Brito, Susana. (2022b). Pleasure and suffering at work in the technical act: a case study from a garment factory in a context of technological transformation, in: Intelligent Human Systems Integration: Integrating People and Intelligent Systems, Ahram, Tarek (Ed.)

Deloitte Insights. (2020). Industry 4.0 in automotive Digitizing the end-to-end automotive value chain. Deloitte Development.

Faverge, Jean Marie. (1972). L'analyse du travail. in: Traité de Psychologie Appliqué, Reuchlin, Maurice (Ed.). pp. 7–60

Hales, Colin. (2007). Structural Contradiction and Sense-Making in the First-Line Manager Role. IRISH JOURNAL OF MANAGEMENT Volume 28 No. 1.

ILO - International Labour Organization (2022). Charging ahead. The future of work in the Portuguese automotive sector. Geneva: International Labour Office

Kadir, Bzhwen, and Broberg, Ole. (2020). Human Well-Being and System Performance in the Transition to Industry 4.0. INTERNATIONAL JOURNAL OF INDUSTRIAL ERGONOMICS Volume 76.

Kecklund, Göran and Axelsson, John. (2016). Health consequences of shift work and insufficient sleep. BMJ Volume 355.

Lacomblez, Marianne. Bellemare, Marie. Chatigny, Céline. Delgoulet, Catherine. Re, Alessandra. Trudel, Louis. and Vasconcelos, Ricardo. (2007). Ergonomic Analysis of Work Activity and Training: Basic Paradigm, Evolutions and Challenges. in: Meeting Diversity in Ergonomics, Pikaar, Ruud. Koningsveld, Ernst. and Settels, Paul. (Eds.). pp. 129–142.

Leplat, Jacques. (1997). *Regards sur l'activité en situation de travail*. Paris, PUF.

Mark, Benedikt. Hofmayer, Sarah. Rauch, Erwin. and Matt, Dominik. (2019). Inclusion of Workers with Disabilities in Production 4.0: Legal Foundations in Europe and Potentials through Worker Assistance Systems. SUSTAINABILITY Volume 11 No. 21

Mayer, Claude Hélène., and Oosthuizen, Rudolf. (2022). Unconscious system-psychodynamics within a German 4IR engineering company in South Africa. FRONTIERS IN PSYCHOLOGY Volume 13 No. 926245.

Oddone, Ivar., Re, Alessandra., & Briante, Gianni. (1981). Redécouvrir l'expérience ouvrière. Vers une autre psychologie du travail?. Paris: Editions sociales.

Parker, Martin. (2004). Becoming Manager: Or, the Werewolf Looks Anxiously in the Mirror, Checking for Unusual Facial Hair. MANAGEMENT LEARNING Volume 35 No. 1. pp. 45–59

Quéinnec, Yvon. (2007). Horário. LABOREAL Volume 3 No. 2.

Saabye, Henrik. Kristensen, Thomas Borup. and Wæhrens, Brian Veirum. (2020). Real-Time Data Utilization Barriers to Improving Production Performance: An in-Depth Case Study Linking Lean Management and Industry 4.0 from a Learning Organization Perspective. SUSTAINABILITY Volume 12 No. 21. pp. 1–21

Schwartz, Yves. (2020). Activité(s) et usages de soi: quel (s) 'milieux' pour l'humain? LES ÉTUDES PHILOSOPHIQUES Volume 1 No. 132. pp. 93–123

Schwartz, Yves. (2021). Travail, ergologie et politique. Paris: La Dispute.

Spallek, Michael. Kuhn, Walter. Uibel, Stefanie. van Mark, Anke. and Quarcoo, David. (2010). Work-related musculoskeletal disorders in the automotive industry due to repetitive work-implications for rehabilitation. JOURNAL OF OCCUPATIONAL MEDICINE AND TOXICOLOGY Volume 5 No. 1. pp. 1–6.

Wurhofer, Daniela, Meneweger, Thomas, Fuchsberger, Verena and Tscheligi, Manfred. (2018) "Reflections on Operators' and Maintenance Engineers' Experiences of Smart Factories", proceedings of the 2018 ACM Conference on Supporting Groupwork, Sanibel Island, FL.