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Chapter 10
The Design of "Future Work" in Industrial Contexts

Lessons Learned from Worker–Technology Cooperation and Work Transformation Management

Flore Barcellini

Abstract This chapter proposes to discuss work transformation management as a key issue to designing working conditions to ensure safe, healthy and performant work in a context of technological transitions. Here, we view the design of future work as a transition process and as a set of projects—social, organisational, technological—that will together shape a "future of work". We consider lessons from the past regarding: (1) cooperation between workers and technology and (2) project management of work transformations, as resources to manage this transition. These lessons will be discussed with reference to ongoing research dealing with introduction of artificial intelligence (AI) or collaborative robotics at work in the French industrial context, as an illustration of the transformation of industry at a global level.

Keywords Worker–technologies cooperation · Transformation of work management · Activity-centred design · Ergonomics · Industry 4.0

10.1 Introduction

Work situations in industry are facing a profound transformation in relation to the introduction of technology due to both an evolution of this technology (evolutions of AI algorithms and massive data analysis, collaborative robotics…) and a political invitation at an international level [11] to promote the "modernisation" of industry. Indeed, a closer look at issues raised by technological transformations reveals that some "old" ones seem to be ignored by promotors of those transformations.[1] In this context, the objective of this chapter is to recall lessons learned concerning both workers-technology cooperation and work transformation management. We discuss

[1] See for instance [22] for an argumentation.

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the relevance of these lessons learned on the basis of several ongoing collaborative research projects dealing with introduction of collaborative robotics in industry line [5, 12, 30, 37] or artificial intelligence in various work situations (radiology, online counselling, legal activities, design and engineering) [5, 22, 23].[2]

In this chapter, we propose to discuss work transformation management as a key issue to designing "a future work" to ensure safe, healthy and performant work in a context of technological transitions. Here, we view the design of future work as a transition process and as a set of projects—social, organisational, technological—that will together shape a "future work" in a given situation. We focus here on lessons learned from the past regarding two key issues for managing this transition: (1) cooperation between workers and technology and (2) project management of work transformation, i.e. design project management.

10.2 Lessons Learned for Worker–Technology Cooperation Research and Project Design Management

10.2.1 Is Worker–Technology Cooperation a Myth or a Possible Reality?

Worker–technology cooperation has been studied at least since massive introduction of automation at work, as well as the first surge of artificial intelligence or expert systems in the late 80s, and in particular in relation to safety. Previous works on automation, AI and cooperation between human and machine sought to qualify the feasibility of human–machine cooperation and the risks implied for human health and organisational safety [26, 27, 35, 42]. These earlier works outlined limits such as impossibilities for an "intelligent or cooperative machine" to access and interpret context of action or to build a shared understanding of a worker situation, a poor relation between workers and technology that may be unidirectional and non-adaptative, i.e. the "machine" is not able to display dynamic behaviour in the course of the joint action with workers. These limits implied that the "machine" was not actually cooperative in a strong sense, as cooperation is anchored in the capacity of sharing common goals and of regulation of interdependent situations on the basis of understanding of a given situation of action [27, 39]. Technologies and workers were, thus, mainly in interdependence more than in cooperation [18, 26, 39, 42]. Regarding safety issues, these limits in the worker–technology relationship may imply [26]: loss of human expertise and lack of mutual control over a given situation, limited situation awareness construction and thus reliability of the worker–technology systems; complacency of workers regarding technology proposals and lack of self-confidence;

[2] ANR project HECTTOR ANR-17-CE10-0011; ANR project ICARO ANR-10-CORD-0025 on collaborative robotics. Collaboration with Orange Labs or car manufacturer on introduction of AI in various work situations (radiology, online counselling, legal activities, design and engineering).

and finally a lack of adaptivity of the worker–technology system due to a lack of anticipation and feedback [36]. Moreover, these limits are reviewed as being one cause of accidents [21, 38]. They can be explained by: (1) the limitations of the technology, the lack of in-depth modelling of human socio-cognitive activities [2, 16, 35]; but also (2) by the way, the introduction of technology is managed in particular with relation to socio-organisational consequences of technological changes, as outlined by the participatory approach and activity-centred ergonomics approach since the 70s [24, 40].

10.2.2 A Lack of a Participative and Work-Centred Project Management Approach in Introducing Cooperative Technology at Work

Indeed, several studies reveal that a majority of projects to introduce new technologies "fail" (60–80% according to studies [15]) with regards to delays in actual usage of new systems, budget overrun, goal achievement, safety and health issues [41]. Different models may be considered to explain these failures. There is extensive literature about a so-called resistance to change in organisations or an organisational inertia [20], the necessity of a cultural change or the role of leaders and managers [3]. However, there are several strong empirical and theoretical limitations to these models addressed by alternative research in ergonomics, sociology, organisation and management sciences (see [1, 7, 10, 24, 31, 33] for critics of previous models) revealing alternative causes of project failure: (1) the lack of political management and of actual cooperation in project management (weakness in the political management of the project and in the definition of project goals; poor collaboration of leaders; technically driven projects; absence of true participatory design approaches) and (2) the work that takes place in the organisations is approached only as a set of theoretical tasks in project management. The social and organisational dimensions of work are overlooked at the beginning of the projects and addressed only at a later stage, as consequences of technological choices. The constraints and leeway related to work activity, the consequences on health and on the quality of production or safety are poorly addressed. These may lead to some hazardous consequences for performance and health of workers, including safety and reliability. In order to overcome these pitfalls, some participative and work-centred project management approaches have been proposed for more than 40 years by participatory design or activity-centred ergonomics [24, 40]—sometimes supported by legislation successfully framing industrial relations as in Scandinavia [29], or not as the failed "Auroux" laws in France in the early 80s [28], and with more or rather less actual adoption in organisations.

10.3 So, Are Ongoing Transformations of Work in Relation to Technology Neglecting Lessons Learned from the Past?

As said in the introduction, industrial work situations are experiencing ongoing transformations in relation to introduction of technology (big data, RFID, virtual reality, AI, collaborative robotics…), these transformations are being encouraged by various national political programmes [11], such as "Industry 4.0" in Germany, "Industrie du futur" in France, "National Network for Manufacturing Innovation" in USA, "Manufacturing Industry Innovation 3.0 Strategy" in the UK, Made in China 2025. Here, the statement is that the globalisation of the financial market, coupled with the ageing of the working population and industrial facilities and ecological issues, may make it necessary to improve production plant and competitiveness. Moreover, the COVID-19 crisis may increase the wish to preserve and to develop a strong and innovative national industrial activity. So, what can be said about this "new era" of workers-technologies cooperation and the way introduction of these technologies is managed with regards to lessons learned from past research? To address these questions, we focus on two flagship "modernisation" technologies: AI and collaborative robotics, and we analyse proposals made by the French programme "Industrie du futur" to organise transformations, as it is claimed that this is one of the only national programmes which puts "Humans at the heart" of transformation.

10.3.1 A Strong Techno-Determinism, a Lack of Explainability and an Under-Estimation of the Socio-organisational Impacts of Technologies

Ongoing studies [5, 12, 22, 23] and analysis of the French "Industrie du Futur" programme using concepts and framework developed by activity-centred ergonomics and sociology [5, 30, 37] reveal a strong techno-determinism in the way technologies are still being conceived/thought of. Technologies are still seen as "remedies" to "problems" (e.g. competitiveness; safety…) with a lack of systematic analysis of those "problems". In addition, the possible consequences on company performance and worker health of the introduction of heterogeneous technologies "there and everywhere", without imagining their joint integration and the contradictions in everyday work that they may generate for workers, are not always considered. It is, however, necessary to assume there is a duality of "cooperation between workers and technology vs. subordination of workers to technology" and evaluate its risks for health, performance and safety, considering organisational and collective issues associated with the introduction of technologies. One can argue that some "old issues" are re-emerging nowadays even if they may be renewed by the enhanced performance of a "machine" [22, 37].

Concerning AI, Gamkrelidze et al. [22] pointed out that issues are tackled from an economical and technical angle, mainly to promote new AI systems. The same is observed for collaborative robotics[3] [34, 37]. Promotors of those technologies advocate for an *augmented* or *collaborative* approach between workers and technologies and not a *substitutive* approach. Beyond those promises, we observed in three studies [4, 12, 23] that collaborative robotics or AI still raise the question of actual cooperation between workers and technologies as well as questions about transformations of professional gestures, division of labour between workers and technologies, autonomy and responsibility of workers dependent of a machine behaviours, organisational issues or more societal job issues.

For instance, actual cooperative AI or systems should be able to understand the goals and actions of workers, and workers must be able to understand the functioning and decisions of AI or cooperative systems. This goal has not been reached yet as AI is still not really "explainable" [23]. In the same direction, collaborative robotics exemplified the promises—and pitfalls—of articulation between so-called cooperative technologies and evolution of work situations. On the "promises" side, this technology is presented as "easy to implement and to maintain"; "favouring productivity gains"; virtuous by making certain workstations more attractive for young workers or by contributing to the prevention of musculoskeletal disorders (MSD)—cobots taking over repetitive or strenuous tasks. This illustrates well the "technologies seen as remedies" perspective referred to above. On a previous project,[4] we tried to articulate technical and work-related issues in the design of a collaborative robot demonstrator intended to equip automobile assembly lines in order to prevent musculoskeletal disorders [5]. Although the demonstrator was not industrialised,[5] its design helped to understand technological locks related to dynamic regulation of interdependence between workers and cobots (e.g. dynamic re-planification of robot trajectories related to its analysis of the worker's position in space, gestures or direct communication). However, it was impossible to evaluate its potential role in MSD prevention. Indeed, the demonstrator was designed to reduce some of the biomechanical constraints incurred by workers, but it was only a necessary condition to prevent MSD and not a sufficient one. Indeed, design of the technology alone will not solve prevention and health issues; psychosocial dimensions of work, work organisation, interdependence between introduction of technology projects and other organisational projects related to the work situation [30] are as just as necessary—or even more so—than design of technological artefacts. Yet, in the former project, neither the evolution of the professional gestures nor collective or organisational issues related to the future work organisation were addressed. This advocates for strong proposals of work transformation project management approaches, in order to jointly design technologies and future work situations, including social and organisational issues.

[3] There is no consensus on the definition of cobot [32]. We will consider that cobots are robots assisting workers but remaining dependent on worker objectives and gestures. Cobots are thus seen as partners of workers with a direct physical interaction between them.

[4] ANR funded project ICARO ANR-10-CORD-0025.

[5] Because the demonstrator was too slow to cope with the pace of the industrial line.

10.3.2 A Claim for More Participative and Collaborative Project Management with a Lack of Operational Proposals

As said previously, there is a claim for the centrality of humans and a "vital" need to renew design and change management, but we outlined that those discourses are still dominated by technical rationality and political communication with a poor representation of human and labour sciences (ergonomics, occupational psychology, sociology of work, management and organisational sciences, adult education). Indeed, there is a lack of understanding and proposals regarding transformation of work situations and introduction of collaborative organisations. This is obvious, for example, in the "Industrie du Futur" programme and in the operational means that are proposed to companies to achieve their transformation. On the contrary, we observe a promotion of the Lean Management model as "the" model for so-called operational excellence [19] even though the limits of this model have been outlined in the French context [9]. Moreover, despite the wish for more "collaborative innovation" processes in industries, only technical or financial tools are proposed to help industries in coping with transformations and not really alternative project management approaches supporting actual collaboration of workers in designing their future work and developing the potentially relevant uses and usefulness of technologies as one of the resources of work [13]. Finally, the place left to "Humans" is reduced to training, with training programmes that mainly ignore the importance of "past" experience and the presumed outdated competences of workers to ensure performance and safety at work while assuming that training may compensate for a lack of anticipation of organisational evolutions of work situation questions regarding organisational issues. If humans and work are taken into account, it is often with an individual perspective and situated only at the workstation level, thus neglecting the collective dimension of work and its role in—once again—preserving performance, safety and health.

10.4 What Recommendations to Foster the Success of Projects in Terms of Health, Safety and Performance?

Here, we advocate for widespread promotion and experience of participatory or activity-centred ergonomics project design management approaches [6, 8, 17, 24] as good candidates for one of the "collaborative innovation" approaches. These approaches are designed to address political, social, organisational and technical issues related to work transformation. Indeed, the finality in work transformation related to introduction of technologies has less to do with the characteristics of the technologies themselves (products, tools, working spaces, workstations, organisation, technologies, etc.) as with the *work situations*—articulating individual, social, organisational and technological dimensions—in which these technologies

are present. It assumes that work transformation projects are decision-making and design processes [14], socially determining work situations (i.e. structured by a set of decisions made by CEO, designers or prescribers of work in general) and defining a set of prescriptions (tasks to be carried out, technologies to work with organisational structure staff allocation, contracts, timetables, rules, etc.) that workers will have to cope with [25]. In order to be successful, these approaches argue that: (1) an effective political management of work transformation articulating and organising debates and negotiation within the different logics at stake in the project (technology, safety, health, production, human resources, etc.) in a systemic way is needed; (2) and that the decision-making process must be grounded in an understanding and a modelling of actual and future work situations based on an in situ activities analysis.

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