Industry 4.0—Position paper

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1 INTRODUCTION

This position paper aims at contributing to the definition of a political and theoretical framework to interpret the processes of production and labour digitalisation—Industry 4.0 and platform-based capitalism—for labour-oriented organisations. Our point of view focuses on the relations between technology and social dynamics. The one taken here is not a deterministic approach: we do not think that technologies are exogenous to the social structure, but rather that technological trajectories are embedded in social relations.

It is worth pointing out that technologies are not neutral, but they are open to certain social options and closed to others; in other words, they are the result of implicit or explicit social choices, i.e. "the ways in which they can embody specific forms of power and authority." (Winner, 1980, p. 121)

David Noble (1986, p. 324), in his elaborations about the third industrial revolution (i.e. the process of automation which took place after World War II) provided an excellent summary of the issue:

> [a]t every point, these technological developments are mediated by social power and domination, by irrational fantasies of omnipotence, by legitimating notions of progress, and by the contradictions rooted in the technological projects themselves and the social relation of production. [...] Technological determinism, the view that machines make history rather than people, is not correct; it is only a cryptic, mystifying, escapist, and pacifying explanation of a reality perhaps too forbidding (and familiar) to confront directly. If the social changes now upon us seem necessary, it is because they follow not from any disembodied technological logic but from a social logic—to which we all conform.

Noble applied this approach to the history of the development of Numerical Control Machines in the US after WWII, which in their final form actually represented an example of digitalisation of a specific productive activity. His method is still relevant:

> The technology of production is thus twice determined by the social relations of production: first, it is designed and deployed according to the ideology and social power of those who make such decisions; and second, its actual use in production is determined by the realities of the shop-floor struggles between classes. (Noble, 1979, p. 101)

We will, therefore, start from social relations of production, in particular from the emergence of a new form of capitalism and a new productive structure. A long lasting Western tradition in the analysis of computing machines criticised both their design and their use, using two competing approaches: the socio-technical one and that based on the collective use of resources.

Following the first approach, the question is: how can we design systems suitable for people? Today here is a revival of this approach of the seventies namely in Germany.

Within the second approach, the question is: how do we make it possible for people to design their systems themselves? This approach is the tradition of participative design, which is still present in particular in Northern Countries. We consider the labour processes and their technological transformations not only from the point of view (Ehn, 1993)

> of the form of the division of labour between the labour process of the design and the utilisation of computer artifacts

but also from the point of view of the aim of design, i.e. the capitalistic goals.

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In the 1980s, computing machines were a tool for the rationalisation of production processes aimed at automating several skills, with consequent de-skilling of workers formerly performing the corresponding tasks. A further aim is to alienate workers from the planning and the control of labour processes: "the genesis and the capitalistic design is fully hidden into the rationality technically objectified of artefacts" which implies "the objectification of social relations that we produce in our daily practice." (Ehn, 1993)

We start from the point of view of the workers. However, we cannot confine ourselves to a strictly analytical approach, but we need to utilize a normative approach to intervening on goals and forms of this process, and not only on its consequences. We must both develop a critique of the "political rationality of the design process" and of the "scientific rationality of the methods for system design and description". We need not only a theoretical critique but also a coherent praxis.

What room for this critique? According to Noble (1979)

> [t]his technology does not develop in a unilinear way, there is always a spectrum of possibilities and alternatives that are limited in time—as some are selected and others denied—by social choices of those who have the power to choose; these choices reflect their intents, social position and relations with other within society.

Now that a spectrum of possibilities does exist, we need to think, design and fight for alternatives about goals and forms of development of Industry 4.0.

The paper, accordingly, will be organised in four parts. The first part concerns a critique of the political rationality of Industry 4.0; the second a critique of its scientific rationality; the third focus on the problem of the skill of the people affected by this technological revolution, and the fourth is the conclusion.

The first part will, firstly, highlight the rise of a new capitalism and its "political demands" of the adaptation of our societies and institutions to its needs. Secondly, the role of Germany in the building of the European Union will be analysed to stress that Industry 4.0 is a competitive strategy of the German "complex of IT sciences – policy makers and firms". This part makes clear the nature of the objective of some key players in pursuing the project of Industry 4.0 and the necessity for the European Trade Unions to design their objectives.

The second part will, first of all, balance the continuity of old technological trajectories, stressed by some scholars, with the so-called revolutionary or disruptive nature of the project. Then, the consequences of this disruption on the industrial structure will be highlighted.

The third part will design an analytical framework to gauge the available room for a positive development of people' skills.

The concluding statements argue the necessity and the possibility of avoiding a choice between prophecies of doom and techno-optimism.

2 A CRITIQUE OF THE POLITICAL RATIONALITY: THE NEW CAPITALISM

2.1 THE CUSTOMISATION OF PRODUCTS

The long transition towards more customised products was born in the core of capitalism:

1) to avoid the trap of "commodification."
2) Because of the need faor reproduction on an extended scale, which in the presence of saturated markets can only be achieved by "deepening" the existing ones. The deepening can be done on the one side by inducing consumers to demand customised variations of traditional products—often concerning their aesthetics only—to speed up products replacement. On the other side, by the commodification of aspects of social and personal life formerly excluded from the process of value creation. An example is given by new services, usually connected to free time and entertainment which, thanks to digitalisation and the internet, can be supplied through physical objects such as smartphones. The supply of such

services also increases the intrinsic value of the physical object itself.(Bryson, 2009)

This higher intrinsic value of hybrid commodities needs the development of integrated production systems. It is a brand-new kind of integration. It is no more restricted to the functional supply chain of the physical "support", but it should scale up to a so-called industrial eco-system, that is a web of different economic, financial and industrial sectors.

This entailed the development of hybrid production systems in which goods and services converge. The clear distinction between different sectors, the separation between goods and services, the forms of oligopolistic market power, are bound to dramatically change on traditional forms of organisation of production under the pressure of these hybrid systems. As a consequence, new forms of articulation of productive activity do emerge, ranging from networks of integrated companies to actual industrial ecosystems, the most apparent example being mobility. (Kelly, 2015, pp. 16-19)

The need for a more and more radical flexibility, therefore, combines with the problems connected to the increasing integration of these production chains. Flexibility does not concern volumes of production only, but also the composition of the final product which is the result of the convergence of several parallel production processes[2]. There also is an increased necessity for a reduction of the time-to-market to speed up products rotation as much as possible.

Customisation does not concern the intrinsic characteristics of products, but also their very fruition. It is, therefore, possible to separate the ownership of a good from the services it can provide; this leads to the creation of new business models such as Uber o Airbnb.

2.2 LABOUR FRAGMENTATION AND THE NEW SOCIO-TECHNICAL OBJECTIVES

Full mobility of capital and increasing global industrial integration have triggered a process of centralisation, in Marxian terms, of industrial governance, coupled with an increasing geographical dispersion of production chains. The dispersion generated a deep fragmentation of labour with workers in competition with each other.

> This new stage of capitalism, which can be labelled as "financialisation", "should be better understood as a real subsumption of labour to finance. The reason is that workers' and lower income households' reliance on stock exchanges and banks, and more generally the fictitious capital bubbles, had quite non-fictitious effects: not only on effective demand but also on firms' corporate governance and real production. [...] This 'subsumption' of labour to finance also transformed the relationship between banks and firms, and endogenously boosted effective demand." (Bellofiore et al., 2015, p. 476)

This is the reason why even in the presence of full employment, as in the 1990s and 2000s, this "was not characterised by 'decent' wages and stable jobs. It was, instead, a 'full under-employment', with unemployment penetrating into the employed labour force through the spreading of part-time and casual/informal occupations." (Bellofiore et al., 2015, p. 476)

Social fragmentation and subsumption of labour to finance turned power relations between capitalists/managers and labour upside down. In the workplaces, this meant a restructuring of labour processes aimed at achieving the maximum development of relative surplus value, the main lever being management and organisational innovation (Lean Production, WCM, etc.). Technology, and especially IT, playing the ancillary role of automating parts of the production process. Managers/capitalists now focus on relational aspects, i.e. relating machines and things on the one side, and these and human beings on the other side. What is at stake now is the process of objectification of the social nature of labour, which Marx mentioned in the *Grundrisse*.

This is the point of view of Castells as well, who points out that

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2 On the distinction between **heterogeneous cycles in parallel** and **organic cycles in line**, first envisaged by Marx, is very relevant the comment by Georgescu – Roegen N., *The Entropy Law and the Economic Process*, 1971: 108 and 237-238. See also Garibaldo, F. The supply chain and the division of labour – Notes for the students of the master degree seminar, 2011, Eichstaat University

> this evolution towards networking forms of management and production does not imply the demise of capitalism (1996, p. 471),

Even if it is a profoundly different capitalism. Castells stresses two fundamental innovations of capitalism: the fact that it is globalised, and that

> It is structured to a large extent, around a network of financial flows. Capital works globally as a unit in real time, and it is realised, invested, and accumulated mainly in the sphere of circulation, that is as finance capitalism.

The great majority of managers/capitalists abandoned the idea, coming from the 1980s, of Computer Integrated Manufacturing (CIM) as an ‘unmanned factory'; it probably condemned, now and then, into the rule of thumb prescribing that to any degree of complexity of the labour process there corresponds a higher degree of complexity of control over it. The new strategy is that of the objectification of cooperation between workers, or at least some aspects, through the cyber-physical system. Whether digitalisation leads to a generalised increase in labour skills or to an impoverishment and simplification of it (Magone and Mazali, 2016) does not depend on technology in itself, but rather on the goals it is designed for.

According to the Authors, the preliminary conclusion can be drawn that at present a generalised transformation of both direct – the operations - and indirect manufacturing activities is ongoing, as well as of design and management. Hierarchies are being redefined in all areas of the production process. Before generalising these conclusions, it is necessary to test these transformations with a dedicated fieldwork. It is however quite clear that if the trend is not reversed—i.e. if we do not start a political and social discussion aimed at developing a concrete action, we are going to see new forms of labour polarisation.

Up to now, we have been talking about issues concerning the quality of labour, but there also are irrefutable consequences on employment to be quantified. These effects will be the object of a dedicated literature review which is currently in progress.

Outside workplaces, the overturning of power relations allowed the emergence of the so-called platform capitalism (Zysman and Kenney, 2014).

According to JPMorgan (2016:20),

> as economic activities involving online intermediaries that are marked by four characteristics[3]:
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> 1. They provide an online platform that connects workers or sellers directly to customers.
> 2. They allow people to work when they want. Participants can choose to pick up a passenger today, or rent their apartment this weekend, or not[4].
> 3. They pay on a “piece-rate” basis for a single task or good at a time[5].
> 4. They intermediate or facilitate payment for the good or service.
>
> We distinguished between labour and capital platforms within our analysis [See Figure 1]. Labor platforms, such as Uber or TaskRabbit, often referred to as the "Gig Economy," connect customers with freelance or contingent workers who perform discrete tasks or projects[6]. Capital platforms, such as eBay or Airbnb, connect customers

[3] *Our definition excludes platforms that might be considered part of the so-called "on-demand" or "sharing" economy but that facilitate the exchange of goods or services for free (e.g., Couch surf ng), do not serve as a financial intermediary of any kind in the transaction (e.g., Craigslist), or do not rely primarily on contingent or independently provided labor or capital (e.g., FreshDirect).*

[4] *Recent industry reports indicate that Online Platform Economy workers vary their hours considerably. In any given week, 65 percent of Uber driver-partners change the number of hours by more than 25 percent (Hall and Krueger, 2015). A 2015 survey of 1,000 on-demand drivers found that 75 percent changed the number of hours they are driving, with 35 percent working more hours and 41 percent working fewer hours (SherpaShare, 2015).*

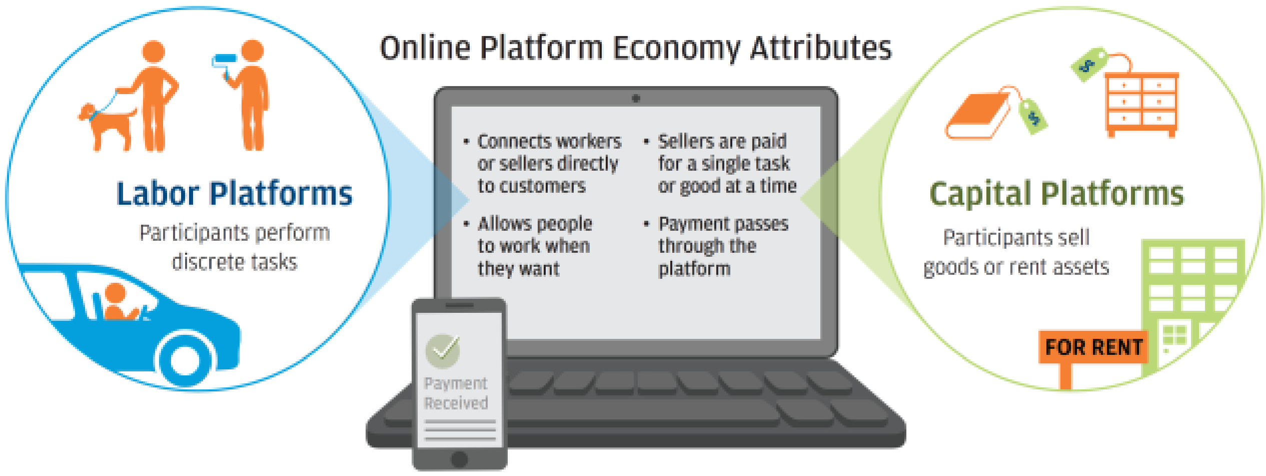
[5] *In fact, not only are sellers paid on a piece-rate basis, but the unit price of a good or service can vary dramatically. For example, many transportation or delivery platforms increase prices when demand peaks.*

[6] *Our definition of labor platforms is consistent with the definition asserted by Harris and Krueger (2015) and McKinsey Global Institute (2015), which describes the “online gig economy” as an online marketplace for contingent work in which online platforms facilitate the sale of “personal tasks” such as driving a passenger from A to B. Examples are listed to illustrate the definition of labor versus capital platforms and do not imply that we*

with individuals who rent assets or sell goods peer-to- peer. We find that labour and capital platforms are quite distinct from each other in who uses them, the prevalence and frequency of use, and the degree of reliance on platform earnings.

This new form of cloud-computing-based capitalism will produce not only competitivity but also an "entirely new category of work organisation, which we term, the "platform economy". Even as advanced country firms find a new competitive advantage, the platform economy they are generating is characterised by interesting new types of work contingency." (Zysman and Kenney, 2014, p. 3)

Figure 1: The Online Platform Economy



Workers involved in platform economy are nowadays, with few exceptions, totally devoid of any right or social protection. D ̈aubler (2016, pp. 16-7) describes the situation of ‘crowdworkers’ in Germany:

> Under German law, the crowdworker is normally no employee. He has to fulfil a pre-defined task and decide himself in which moment and with which instruments he will do it. There will be only a time limit—that is all. There are no instructions given during the working process—he is a self-employed person. Whether the description of the work in the contract itself would be an equivalent to instructions given to an employee and constitute ‘subordination’, may be considered to be an open question in Italy. In Germany, this step has not been taken until now. Some crowdworkers depending economically on one platform are considered to be persons ‘assimilated to employees’. As it was described in the chapter on equality, only some parts of labour law apply to this group of persons.
> Civil law takes place if labour law cannot be applied. The rules of the civil code give a sound protection against unfair clauses put into the contracts by the platforms. But the civil code guarantees no stability, no protection against the dissolution of the contract. As to the clauses, especially American platforms use conditions which are in fundamental contradiction to European conceptions of acceptable rules laid down for instance in the EC-directive 93/13/EEC [(EEC, 1993)]. The platform reserves itself e.g. the right to refuse the work done by the crowdworker and pay nothing without giving any reasons. If corrections are needed, they have to be done within 2 or 3 days; if this delay is not observed, the worker will lose the right to get paid.
> Another point: As crowdwork is the main source of income for two thirds of the workers it does not seem adequate, to get money only if you are the winner; this is the case if one performs a more sophisticated task like the development of a logo. ‘Lottery’ is no form of adequate salary. Additionally, even those who become no ‘winner’ have to transfer all their intellectual property rights to the platform. A German court would never accept such a kind of clauses even if the foreign platform has put a provision that American law applies.

It is worth stressing that these workers are not necessarily separated from the process of labour reorganisation. There are companies, such as IBM, which are building an organisational model in which the internal structure is integrated with external professionals through a specifically dedicated

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have identified income from these specific platforms.

platform called GenO.[7] This trend is spreading in manufacturing companies too, particularly in the field of design. It is necessary to keep this form of employment relationship distinct from the externalisation of production stages characterising, e.g., logistics, where the relationship is between companies.

The possible coupling of platform capitalism and the processes of firms' reorganisation towards the "Industria 4.0" model is particularly relevant because it points out that this new form of industrial organisation could spread well beyond traditional companies. The increasing expansion of platform capitalism raises questions about the future organisation of labour:

> There is also the possibility that there will be as much or even more work being performed. However, the relationships, the organisational arrangements through which the work is performed may well be radically altered. If the gig economy expands to become more prevalent, then how will health insurance, worker compensation, and retirement that are based on traditional employment be provided? Indeed, could the provision of these sorts of "benefits" be a set of market apps themselves, or might the provision form the basis of institutionalised forms of worker organisation, the 21st century Union.
> (Zysman and Kenney, 2014, pp. 18-9)

3 EUROPEAN INDUSTRIAL STRUCTURE AND "INDUSTRY 4.0" AS A GERMAN COMPETITIVE STRATEGY

A new industrial structure took shape within Europe—UE and Eastern Europe.

The building of a European industrial structure was based on a process of centralisation, in Marxian terminology, or as Harrison defines it of concentration without centralisation (Harrison, 1994, p. 47). It consists of

> a double move; on one side the strategic functions of a corporation become more and more concentrated (or centralised in the Marxist terminology), on the side of the production operations there is a strong disarticulation via a new concept of the supply chain. I have in turn described this as a process of verticalization and parallelization at the same time. That is, on the one hand, the companies are verticalized while, on the other, they have become parallel: they decentralise. They verticals because all the strategic functions migrate as high up as possible in the network structure, while, on the other hand, there is the parallelisation of the functions of a manufacturing type. In fact, the latter process is technically more complex and has various alternatives. Unlike what it seems to be, decomposition and/or deconstruction, it conceals a very high level of concentration (or centralisation) of capitalistic power which, moreover, by assuming the shape of high finance satisfies a rationale increasingly linked to the value-use of the products and services provided.
> (Garibaldo,2012, pp. 15-6)

This new structure is very different from the supply chains of the past, which had the only objective of making the firm more flexible; it represents a new structural division of labour between firms. The network of suppliers is structured in different levels and poles, within a hierarchical system.

This new European industrial structure, therefore, has an integrated and transnational character; within this productive networks:

> the companies engaged in the upstream activities are no more merely on the buy side of the option
> Make-Or-Buy; they are in some way under the authority of the firms controlling the specific supply chain as a whole—the so-called Original Equipment Manufacturers (OEMs)—or of the other key players in each tier. To be "under the authority" means that the key players decide for the other companies on how to plan the output's quantities in a given period, the pace and the speed to deliver the output's batches, how to arrange in sequences a mix of different items, etc. By and large, they have the classical prerogatives of the managers. Sometimes, namely for the highly specialised companies, such as the modules suppliers, the degree and the nature of the integration in the network is such that the border lines between companies blur and new ways of co-operation start with original corporate governance schemes. These webs of firms sharing a production process of goods or of services are under certain circumstances, from the point of view of the production process, a comprehensively integrated process; thus a kind of factual congruity between the internal organisation and the nature of the

7 For more information on this, see Howard et al. (2010).

relationship between the firms involved should be posited. These new extended or virtual companies are the new key industrial players in Europe and they consider the EU territory as a strategic resource. They can, indeed, organise their networks utilising all kind of diversity of legal, fiscal, social obligations, as well as of skills and competencies availability, as a way to fine-tuning their internal division of labour.

A new regulative power was built in the EU-27 with the possibility of regulating from few head-quarters the economic and social life of the citizens. (ibidem)

Normally it means:

These production systems are distributed in several countries, but in an uneven way; the core is localised in Germany and Austria, countries that represents– with Romania, Czech Republic, Hungary, Slovakia, Lithuania, Slovenia, Poland and Bulgaria – the German manufacturing enlarged area. Italy, the second manufactures country, is important and subordinated part of this German manufacturing enlarged area, but, at the same time, Italy is an autonomous builder of supply chains in the Eastern Europe.

These production systems are strongly integrated; performance concerns less the individual firm and increasingly the entire system. The governance of this systems concerns both the control of good's flows and the overall production efficiency, also the margins of the system as a whole.

(Bellofiore et al., 2015)

From the point of view of the industrial structure, Germany is located at the core of this European industrial system.

The overall effect of the German dominance, according to Simonazzi et al. (2013), was:

the impoverishment of the productive matrix of peripheral countries and the quality composition of trade flows. (Bellofiore, Garibaldo, 2015)

They have clearly explained the importance of the different composition of the productive matrix within the Eurozone. They have also highlighted that the competitive advantage of Germany, in comparison with the other Eurozone countries, is only partially related to the differences in price competition, but on the quality of the products and the coherence of the productive matrix with the external trade demand, namely from China and other countries, with a new emerging middle class. Based on their analysis it is more evident the strategic relevance, for the German model, of the industrial reorganisation, we have described before, namely of a European network of suppliers and of the relocation abroad of parts production, namely in Eastern countries of the EU. It is of paramount importance the impoverishment of the productive matrix they describe because as a consequence

an expansion of the German internal demand, albeit necessary, would not suffice to provide a viable response to the long-term sustainability of the euro area. (ibidem)

As a matter of fact, each increase in demand will be transmitted primarily to the German production trans-national value-chain system.

While eastwards this integration has created a process of productive diversification and specialisation at the same time, it brought about an impoverishment of the productive structures of Southern Europe, and in particular of Central and Southern Italy.

The current industrial vision of the EU is that the only competitive possibility for the EU economy is moving upstream in the value chain. Innovation is considered as the tool to increase the participation of manufacturing to GDP, which should reach at least 20%.

Currently, what is meant by the term 'innovation' is 'technology as a fundamental vector of innovation' (Industry 4.0).

This has remarkable consequences, first of all on industrial structures, confirming the relevance of integration, which is so wide as to being generating genuine 'industrial ecosystems' (Kelly, 2015, pp. 16-19).

Furthermore, we must stress that the final goal of Industry 4.0 is that of reaching a new level of automation based on the optimisation of decentralised and smart parts of the system, able to autonomously react to external stimuli:

> The new automation level is based on a continuous self-optimization of intelligent, decentralised system components and their ability to self-regulate to dynamically changing external conditions, for example, to end-market conditions, production and delivery chains, or to real-time environmental demands. The aim of this conception is to manage by the new automation technologies the increasing flexibility demands of end-markets, an increasing individualization of products, ever-shorter product life-cycles, as well as the increasing complexity of process chains and the products themselves; in other words, the existing technological and economic limits of automation are to be broken and extended precisely in response to the new demands posed by flexibility. (Hartmut Hirsch-Kreinsen, 2014:3)

This level of automation requires high firms' investments in technology and public investments in infrastructures, possibly leading to a further differentiation between strong and weak areas.

Some authors also highlighted that German competitive advantage, in comparison to other Eurozone countries, is only partially related to price competition, depending on the quality of its products and the consistency of its productive matrix with external demand, especially from China and other countries with a newly emerging middle class. These analyses stress the strategic relevance, for the German model, of an industrial reorganisation in the direction described above, with a network of European suppliers and the relocation abroad, especially in Eastern countries, of labour intensive production stages.

A problem of paramount importance is that "an expansion of the German internal demand, albeit necessary, would not suffice to provide a viable response to the long-term sustainability of the euro area." (Bellofiore et al., 2015) As a matter of fact, each increase in demand would be transmitted primarily to German production trans-national value-chains. Therefore, the German project "Industrie 4.0" has been presented at Hannover in 2001 as an urgent and imperative necessity:

> They insist that Germany must be able to assert itself as a production site in a high-wage region and ensure its global competitiveness. On their arguments, manufacturing costs can be reduced despite individualised manufacturing. Networking the companies in the supply chain makes it possible to optimise not only individual production steps but the entire value chain. [...] [P]roduction flexibility and efficiency can be improved and thereby the competitiveness of German industry strengthened.
> (Hirsch-Kreinsen, 2016, p. 5)

This project sees the convergence of several interests, in particular of the complex of IT sciences-policy makers-firms. For policy makers, this is a flagship project, which will deliver an enormous advance in innovation. Moreover, the project has the support of an alliance that brings together IG Metal, BDI and the Federal Economic Minister.

"Industry 4.0" project is, first of all, a German project finalised to keep its competitive supremacy. The development of Industry 4.0 at a European scale, in fact, can lead to confirm current power relations between the different geographic areas.

4. A CRITIQUE OF SCIENTIFIC RATIONALITY

4.1 TECHNOLOGICAL TRAJECTORIES

The digitalisation of manufacturing is the third wave of the propagation of Information and Communication Technologies (ICT). In the previous waves, has been developed a long-lasting strand of literature, which developed some basic interpretative concepts.

4.1.1. The conceptual framework

The first is the idea of 'technological practice' by Parcey (1983). Schienstock (2002: 26) summed it up:

The concept of technological practices is used to analyse restructuring processes in companies.
The argument here is that a holistic approach taking into account the interdependent nature of ICT applications, organisation forms, cultural patterns, companies' strategic goals and human resources can maximise synergies to be gained from the emerging information economy. [...] When analysing technological practices, we have to highlight a cluster of complementary variables which go together with the technology-in-use. Besides the applications of modern ICT, as we have argued above, technological practices also include organisation forms, companies' strategic goals and specific cultural patterns. As the elements of technological practices.

Another relevant concept is that of 'social shaping of technologies', by Wyatt (1998). Schienstock (2002: 27, note 10) summed it up:

This approach rejects any kind of technological determinism. It focuses its attention on social relationships and interactions between individuals but also among collective actors involved in innovation processes to improve technical artefacts. The concept of 'technology frames' developed to analyse these processes mentions goals, key problems, problem-solving strategies, theories, tacit knowledge, testing procedures, design methods, users' practices, and the perceived substitution function of the new artefact as intervening factors […]. This approach still provides a limited perspective, as it only analyses how relevant social actors involved in the process of technological innovation perceive users' practices. It does not pay attention to the actual use of technological artefacts.

Finally, we can mention the general concept, developed by Zuboff (1988), of the distinction between 'automate and informate in the use of ICT'.

These concepts allow building a model of the different uses of ICT, which can lead to a 'cognitive map' for social actors (in particular Trade Unions) to distinguish between positive and negative paths.

In the field of political economy of the telematics network, the main contribution is:

1) The pioneer work of Garcia (1994) about regulatory politics of Electronic Enterprises in the US.
2) The defence of the public role in the field of regulation of the processes by Mumford (1934):

the problem of integrating the machine into society is not merely a matter of making social institutions keep step with the machine. The problem is also one of altering the nature and rhythm of a machine to fit the actual needs o the community". (Mumford, 1934, p. 367)

3) The analysis of the US legal framework on TLC and property rights by Garcia (2000).
4) The economic analysis of information networks by Antonelli (1992)

Zuboff (1988, pp. 9-10) highlighted the fundamental duality of IT, which can automate operations and/or informate the processes it is applied to:

On the one hand, the technology can be applied to automating operation according to a logic that hardly differs from that of the nineteenth—century machine system—replace the human body with a technology that enables the same processes to be performed with more continuity and control. On the other hand, the same technology simultaneously generates information about the underlying productive and administrative processes trough which an organisation accomplishes its work. It provides a deeper level of transparency to activities that had been either partially or completely opaque. In this way information technology supersedes the traditional logic of automation.

A report published in 2001 by a European, Finnish coordinated, research group highlighted what can be considered the first wave of the process:

Modern ICTs, Zuboff (1988) argues, are qualitatively different from traditional machine technologies. Contrary to traditional technologies, modern ICTs can not only automate activities and work processes, but also informate. They accomplish tasks as traditional technologies do, but they also translate them into information. ICT works

on and changes its object but, at the same time, it generates information about the underlying production and administration processes. While contributing to the development of the product, it also reflects back on its activities and on the system of activities to which it is related (Zuboff 1988). This means that modern ICT is reflexive in the sense that it generates additional information, and by this, it supersedes the logic of automation. The masses of accumulated data can systematically be exploited to make previously inaccessible activities and work processes more transparent.
(Schienstock, 2002: 47)

4.1.2. The nineties

Research published by the same author in 2002, titled *Information Society, Work and the Generation of New Forms of Social Exclusion* (Schienstock, 2002) focuses on the social dimension of the phenomena; he also states (: 55-56) that, in the nineties:

> [m]odern ICT, characterised by the merger of computer and information technology, has developed dramatically during the last decade. There is evidence of a shift over the past five years from data processing and management information systems (MIS) to individual and office support on PCs and office systems, and then to electronic data interchange (EDI) and inter-organisational systems, organisational 'platforms', and network computing. Systems within companies have been developed in such a way that they increasingly relate to and interact with each other.
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> Our empirical findings demonstrate that the majority of companies have developed the technological basis for installing organisational network structures. But there are different types of technically connected systems supporting intra-organisational and inter-organisational networks.
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> While telematic systems automate both the processing of information as well as information transfer, telecommunication systems only automate the transfer processes, leaving the process of information processing to the employees. The first technology represents the technisation of company-to-company relationships, while the latter represents the technisation of person-to-person relationships. In our company survey less than half of all companies have fully automated their information exchange with other companies. And there are still a significant number of companies which have hardly applied modern ICT and miss the technical basis for network forms of organising production processes. Particularly small manufacturing companies are often making less use of modern ICTs. Indeed, there are many examples of employers for whom the use of these technologies is restricted to a PC for word-processing, spreadsheets and databases, with the possible additional use of e-mail.
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> Here we have argued that it is the functions ICT is chosen to perform that determine both the nature and extent of benefits gained from modern ICT. Companies associate ICT primarily with the tool function to improve quality, but they also use modern ICT as a mechanism to control production processes and quite often as a communication device, the latter indicating that the new Leitbild of a network organisation is influencing companies' restructuring practices.
>
> The case studies, however, give little support to the argument that the character of ICT usage is clearly shifting from automation and control technology towards communication and network technology. Instead, the case studies demonstrate the multi-functionality of modern ICTs; they can serve several functions at the same time. Companies often combine the communication function with the surveillance and control function. On the one hand, they allow intensive information and knowledge exchange between organisational sub-units, while top management can monitor production processes and even single machines.

The change towards networking computing has started but is still far from having exploited its full potential, which shows the unrealistic character of the CIM project.

The Computer Integrated Manufacturing (CIM) project had something in common with Industry 4.0, i.e. the idea of integration–led by informational processes—of production over the entire value chain:

> With the concept Industry 4.0 as discussed in Germany is referred to on the one hand existing production concepts, which in recent decades has been developed under the name "Computer Integrated Manufacturing" (CIM) and in the 1980s and 90s was realised at least in part (e.g. Harrington, 1973). One the other hand, however, the concept Industry 4.0 aims for a new dimension of industrial on the base of the highly flexible integration of the virtual world of data processing with real manufacturing processes. The thereby attempted leap in automation [power] can, to follow the innovation debate, be termed categorically as disruptive process innovation. (Hartmut Hirsch-Kreinsen, 2014:2-3)

Some of the so-called promising technologies of today such as the 3-D printing, also called additive manufacturing, have a long story behind. The additive manufacturing can be considered the evolution of the stereolithographic process by Charles Hull in the eighties.
Network computing has been already in use, and is now following an evolutive path, characterised not only by radical, or disruptive, innovations. The same thing is true for CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) that are in use since the 1980s. The CAD/CAM technology is the first example of a combination of a physical (CAM) and a virtual process CAD). For this reason, there are people wondering whether this is the case of "much ado about nothing".
But notwithstanding these elements of continuity, we can also talk about elements of radical innovations. The first is the combination of Big Data with Cloud Computing. These technologies make the birth of new business models and new market forms possible (Valenduc & Vendramin, 2016: 11-12) – the *prosumer* – or rather of new market forms – *two-sided markets* [8].
Zuboff (2016:8), utilising the concept of accumulation by dispossession, by Harvey[9], describes a new form of capitalism:

> *a wholly new genus of capitalism, a systemic coherent new logic of accumulation that I call surveillance capitalism (..)in which profits derive from the unilateral surveillance and modification of human behaviour.*

The objective of this new capitalism, according to one of the people interviewed by Zuboff, (ibidem:2) is brand-new:

> *The goal of everything we do is to change people's actual behavior at scale. When people use our app, we can capture their behaviors, identify good and bad behaviors, and develop ways to reward the good and punish the bad. We can test how actionable our cues are for them and how profitable for us (..) The game is no longer about sending you a mail order catalogue or even about targeting online advertising. The game is selling access to the real-time flow of your daily life –your reality—to directly influence and modify your behaviour for profit. This is the gateway to a new universe of monetization opportunities: restaurants who want to be your destination. Service vendors who want to fix your brake pads. Shops who will lure you like the fabled Sirens.*

These are deeply antidemocratic practices, and therefore a new set of regulatory schemes is needed.
The use of Big Data and Cloud Computing can also transform workplaces within traditional manufacturing. The usage of CAD/CAM, although connecting the physical and virtual world, was limited to designers and machine tools operators only. On the contrary, internet of things (IoT) is making it possible to transform labour in manufacturing in its entirety. According to a report by

[8] (Valenduc & Vendramin, 2016: 11-12): *One side of the market is made up of consumers who benefit from access to low-cost or free services and positive network externalities, since the services become more attractive as user numbers grow; by accessing these services, however, and whether they realise it or not, they are supplying the platform with sets of data on their personal profile, location and consumer habits. The other side of the market comprises economic players who are involved in the provision of platform-based services and which also benefit from positive network externalities in proportion to the size of the consumer base. The value of a service for the actors on one side of the market correlates to the number and quality of the actors on the other; economists refer to such phenomena as 'cross-network externalities' and regard them as a typical feature of two-sided markets (..) Examples of platforms which correspond to this description include Google, Booking, Uber, Amazon and many others, and the fact that some of their services are superficially 'free' (Google when used by individuals, for example) is in reality merely a manifestation of the optimum pricing model for one side of the market.This business model has introduced the concept of 'prosumers', or in other words individuals who both produce and consume digitised information. Although rarely paid, prosumers carry out work by supplying data and services for which salaried employees were previously at least partly responsible, such as amateur reviews of services or products, user generated content and data entry.*

[9] Harvey: *The new imperialism*: "*What accumulation by dispossession does*," he writes, "*is to release a set of assets…at very low (and in some instances zero) cost. Overaccumulated capital can seize hold of such assets and immediately turn them to profitable use…It can also reflect attempts by determined entrepreneurs…to 'join the system' and seek the benefits of capital accumulation.*"

Datameter:

> Data-driven companies are already using machine-generated data from the IoT to enhance customer service, generate more revenue from new products and services, optimise operations, and feed more data into existing analytics efforts. They are also using it to:
> • Move from selling products to selling end-to-end services
> • Build new and innovative products
> • Reduce system downtime and identify and resolve network bottlenecks
> • Improve customer experience
> • Increase the productivity of existing operations and infrastructure
> • Make smarter decisions regarding future infrastructure investments
> • Predict and improve mean-time-to-failure for machinery and other capital-intensive assets

The huge amount of data collected through the IoT is unmanageable without the "Big Data analytics":

> This means moving beyond the limitations of traditional enterprise data warehouses (EDWs) and business intelligence (BI) software. EDWs can't handle unstructured data, so IT has to try to force structure upon unstructured data before business users can analyse it. The problem is, this takes too much time – and any attempt to structure unstructured data in tables limits its potential value as a source of insight.
> This is where big data analytics comes into play. It allows you to:
> • Combine, integrate, and analyse all of your data at once – structured, semi-structured, and unstructured – regardless of source, type, size, or format
> • Quickly and affordably scale to huge volumes of data and analyse them for insights.

If, on one side, IoT and Big Data analytics make possible to develop a data-driven company, on the other side, the recent development of Artificial Intelligence (AI) represents a leap forward. As for other technologies, AI is available for at least fifteen years, but it was a totally different kind of AI. As a recent report by the Stanford University states:

> Until the turn of the millennium, AI's appeal lay largely in its promise to deliver, but in the last fifteen years, much of that promise has been redeemed. (Stanford 2016: 14)

And a sort of revolution is under way in the AI world fuelled by several factors:

> The maturing of machine learning supported in part by cloud computing resources and wide-spread, web-based data gathering. Machine learning has been propelled dramatically forward by "deep learning," a form of adaptive artificial neural networks trained using a method called backpropagation. This leap in the performance of information processing algorithms has been accompanied by significant progress in hardware technology for basic operations such as sensing, perception, and object recognition. New platforms and markets for data-driven products, and the economic incentives to find new products and markets have also contributed to the advent of AI-driven technology. (ibidem: 14)

The combination of the *reinforcement learning* with the deep learning makes possible a real leap forward:

> Whereas traditional machine learning has mostly focused on pattern mining, reinforcement learning shifts the focus to decision making and is a technology that will help AI to advance more deeply into the realm of learning about and executing actions in the real world. It has existed for several decades as a framework for experience-driven sequential decision-making, but the methods have not found great success in practice, mainly owing to issues of representation and scaling. However, the advent of deep learning has provided reinforcement learning with a "shot in the arm." The recent success of AlphaGo, a computer program developed by Google Deepmind that beat the human Go champion in a five-game match, was due in large part to reinforcement learning. AlphaGo was trained by initializing an automated agent with a human expert database but was subsequently refined by playing a large number of games against itself and applying reinforcement learning. (ibidem: 15)

On this technological progress is built the possibility of a new "breed" of robots able to interact with the environment "*in a generalizable and predictive ways*".

Digital manufacturing, i.e. the possibility of simulating an entire production process, makes it possible to save time and resources. Furthermore, industrial logistics, new advanced robotics, intelligent products, and tools such as augmented reality, will contribute to a global transformation of manufacturing and labour.

4.2. ORGANISATIONAL CHANGE

The issue of organisational restructuring and the new ICT is dealt with by Schienstock in the already quoted report on the nineties (2002):

> Schimank takes up the aspect of ‘structural reflexivity' by stressing the increasing subjectivity of work [...]. Contradicting Braverman's traditional thesis, according to which the introduction of a technical system leads to an increase in control of the production process and to marginalisation of subjectivity, he argues that "subjectivity is just as necessary in the production facilities at present and in the future as it ever was in the past—possibly even more so" (ibid.: 72). The reason for this basic need for subjectivity is formulated as follows: "The—in principle insurmountable—inability of mechanised systems to insure the environmental conditions of its operability is the source of the need for subjectivity in mechanised production facilities. Mechanical systems have to be linked with personnel systems. The vision of the fully automated factory is a technocratic illusion. Only subjectivity can reintegrate, when necessary, the horizons of reference which had been banned by techniques, to determine which environmental conditions were not anticipated by the assessment of mechanical operations and to convert them into conditions which can be mastered by the machinery." (ibid.: 82).

Something alike is happening today according to Magone & Mazali (2016: 85-105).

4.3. THE GOVERNANCE OF THE VALUE CHAIN

Vertical integration of value chain concerns the physical control of production flows—quality, timing, flexibility, products mix (services or hybrid); efficiency—productivity, lead time, time-to-market; and profit margins. It requires managing the flows of materials, components, semi-finished products and so on.

The management of this flows problems of coordination, fine-tuning, proportions, and demand-side management. The stock management system is uneconomic because a strong customisation is also needed within large production volumes. Getting the final product requires the interaction of multiple actors in the value chain. In a process consisting of several interdependent segments, overall efficiency crucially depends on the that of each single segment.

Modern management is nowadays assisted by ICT, which allows managing this complexity; suffices to think of how cyber-physical systems might enable huge gains in flexibility and speed up production, improving time-to-market and optimising the use of financial resources.

The digitalization of value chain complies to a logic of integration and operative control by the original equipment manufacturers (OEMs). However, a linear logic between OEMs and suppliers does not exist, because:

1) On the one hand, OEM wants to reduce suppliers' operative autonomy and margins, to improve the performance of globally integrated supply chains.
2) On the other hand, OEM needs partnership and collaborative relations with its suppliers to manage the complexity.
3) Finally, the creation of an integrated chain entails significant investments; furthermore, many firms are suppliers of several different OEM. Who covers the costs? There is also a problem concerning standards.

4.4. FLEXIBILITY AND BATCH ONE

The modern concept of flexibility entails a dynamic relationship between the *work done* and the *work to be done*; each industry or each firm has to adjust the work to be done, i.e. its capacity, to the *effectual demand*. As a matter of fact, a production cycle can be connoted as rigid as long as there is only one possible combination of work to be done and a work done; vice-versa, it can be connoted as flexible when it is possible to accommodate work to be done with different outputs. The original problem has now shifted to the industrial side: the ability to accommodate technical division of labour—the internal organisation of production processes—to *effectual demand*.

Customization brought about the reduction of the batches of production and the necessity of new technical design and manufacturing based on modular and scalable equipment.

All manufacturing processes need of flexibility and costs reduction, which is harder within integrated systems which are characterised by synchronisation problems. In the past, these problems were faced within each single assembly line. Industry 4.0 has to deal with these problems.

Unlike the past, markets are going to demand not only different volumes of output but also different products (customisation).

The most radical perspective is the realisation of cyber-physical systems (CPSs). This will lead towards the reduction of batch's dimension and the associated production costs. Flexibility will be removed from social regulation and control (e.g. by trade unions) and placed in the 'neutrality' of CPSs.

The system would thus have the characteristics of an integrated production flow, not necessarily contained in a single company, which is simultaneously "tense" and flexible. On flexible meaning, we have already said. A production process is to be considered "tense", that is a way of thinking of a production process as a flow of interconnected and interdependent activities, when the different activities are interlinked in the shortest and compact way, according to the lean production criteria. Besides, it should be a direct feedback from the market demand to the production process, according to lean production criteria, so that you can reach both the levelling and the continuous synchronisation of the different parts of the system. We have seen that, unlike in the past, this policy has to deal not only with the quantities required by the market but with the demand for different products in different quantities. The point for the capitalists / managers is that this must be done "efficiently". In a single company, this means that you cannot sacrifice to the altar of the need for maximum flexibility the parallel need of the working time saturation. As the engineers of Fiat stated in an internal document, it means that the worker must be "subservient to the needs of" levelled and synchronised system. In the model of industry 4.0 it is assumed that the tight flow is achievable through the digital connection of the different parts of the production line, not only the one internal to the company but of the entire supply chain; the connection would not only between machines but between machines and men. It would reproduce, in new forms, to be researched, the enslavement of the worker to the needs of the system; needs that would arise less and less as demand from the hierarchy who presides over the production process and more and more like an "objective" request of a self-regulating system.

The first researches available[10] stress that this goal is still very far from being reached, also by the most advanced firms. First of all, there is a problem of costs: IOT and electronic governance systems are more expensive than using workers. Furthermore, the idea of a factory without humans is considered unrealistic, but in very specific activities[11].

The managers of the packaging District in Bologna are accustomed, since the beginning of this district, to produce customised products by orders and in small batches. They are involved in the industry 4.0 national project, but they don't believe that it will be desirable and useful for them a full substitution of their employees through digital solutions. The reason why is the customised orders require a final fine tuning of the products to very strict specifications by the customer, and this can be achieved only through the skills of their workers. They are planning, until now, to utilise the new technologies as a support and a facilitator for their workers, as well as a possibility of

10 Magone, A.; Mazali, T. – Industria 4.0. Uomini e Macchine nella Fabbrica Digitale – Guerini e Associati - 2016

11 Magone & Mazali classify the Avio Aero company's machine-shop as an unmanned factory. The factory utilises 60 3D printers to produce parts for Boeing 787. The workers are very few – 15 – but 10 out of 15 are involved in the operations, so it seems not a full unmanned factory.

shifting to machines and robots "dirty and dangerous" activities.

4.5. BIG DATA AND ALGORITHMS

These excerpts from O'Neil's book make clear what creating a model implies:

> *To create a model, then, we make choices about what's important enough to include, simplifying the world into a toy version that can be easily understood and from which we can infer important facts and action. We expect it to handle only one job and accept that it will occasionally act like a clueless machine, one with enormous blind spots. (...) A model blind spots reflect the judgment and priorities of its creator. (…) Models are opinion embedded in mathematics. (2016:2 0-21)*
>
> *It is obvious, besides, that the definition of its success and utility depends on "what that person or company is trying to accomplish".*

Algorithm is a clueless machine which produces important effects on personal or collective issues; therefore, in the age of a widespread utilisation of algorithms to substitute people's choices it is of the utmost relevance to discriminate a "good" one from a "bad one". The increasing popularity of algorithms also depends on the possibility of utilising the Big Data analytics to make "well-informed" decisions and to "*eliminate human bias*". As O'Neil states:

> *The question, however, is whether we've eliminated human bias or simply camouflaged it with technology (:25)*

The camouflage is not the position of Anderson, the editor in chief of Wired, (2008):

> *This is a world where massive amounts of data and applied mathematics replace every other tool that might be brought to bear. Out with every theory of human behavior, from linguistics to sociology. Forget taxonomy, ontology, and psychology. Who knows why people do what they do? The point is they do it, and we can track and measure it with unprecedented fidelity. With enough data, the numbers speak for themselves. The big target here isn't advertising, though. It's science.*

But the information utilised are selected through the criteria defined at the beginning; if those criteria were biased the decision-making process will be "well informed" in the meaning of being coherent in producing biased outcomes. The numbers don't speak for themselves and in the case of machine learning there is the concept of the *inductive bias*, that is (Yudkowsky**)**:

> *Suppose that you see a swan for the first time, and it is white. It does not follow logically that the next swan you see must be white, but white seems like a better guess than any other color. A machine learning algorithm of the more rigid sort, if it sees a single white swan, may thereafter predict that any swan seen will be white. But this, of course, does not follow logically - though AIs of this sort are often misnamed "logical". For a purely logical reasoner to label the next swan white as a deductive conclusion, it would need an additional assumption: "All swans are the same color." This is a wonderful assumption to make if all swans are, in reality, the same color; otherwise, not so good. Tom Mitchell's Machine Learning defines the inductive bias of a machine learning algorithm as the assumptions that must be added to the observed data to transform the algorithm's outputs into logical deductions.*

Algorithms, besides, can become, as in the title of O'Neil's book,
weapons of math destruction (WMDs), because they can scale up their effects, for instance:

> *If a bank's model of a high-risk borrower is applied to you, the world will treat you as just that, a deadbeat – even if you are horribly misunderstood. And when that model scales, as the credit model has, it affects your whole life – whether you can get an apartment or a job or a car to get from one to the other. (…) And here's one more thing about algorithms: they can leap from one field to the next, and they often do. (: 30 - 31)*

And again:

> *Spam filters are being retooled to identify the AIDS virus.*
>
> *The scalarity can produce collateral damage turning a local nuisance into tsunami forces*. (:31)

So, how, according to O'Neil, we can discriminate good and bad algorithms? There are three

criteria or questions to be addressed:
First, *is the model opaque, or even invisible* to the people affected by its functioning? Even utilising the justification of being it an intellectual propriety?
Second, *does the model work against the subject's interests? In short, it is unfair? Does it damage or destroy lives?*
Third, *can it scale?*
An important feature is the possibility of feedback to correct the collateral damage or the unintentional effects.
So, summing up, a "good" algorithm should be open and transparent with its selection of criteria and goals; should be open to correction trough feedback assessed in an open and public discussion, it should be fair to the interests of the people affected and it should do no harm to them. Its domain of application should be exactly and openly delimitated.
The possibility of utilising Big Data analytics can represent a very positive improvement for society and people because *of the possibility to find patterns that invisible to human eyes* (:216). The issue to cope with is that a pattern can identify a problem but not automatically a constructive solution. A constructive solution requires not only static but also a dynamic analysis of different possible future states of the system objective of the analysis, and eventually a qualitative and open assessment of alternative sets of solutions for the identified problem. For instance:

> *A simple workflow data analysis might highlight five workers who appear to be superfluous. But if the data team brings in an expert, they might help discover a more constructive version of the model. It might suggest jobs those people could fill in an optimized system and might identify the training they'd need to fill those positions. Sometimes the job of a data scientist is to know when you don't know enough. (: 215)*

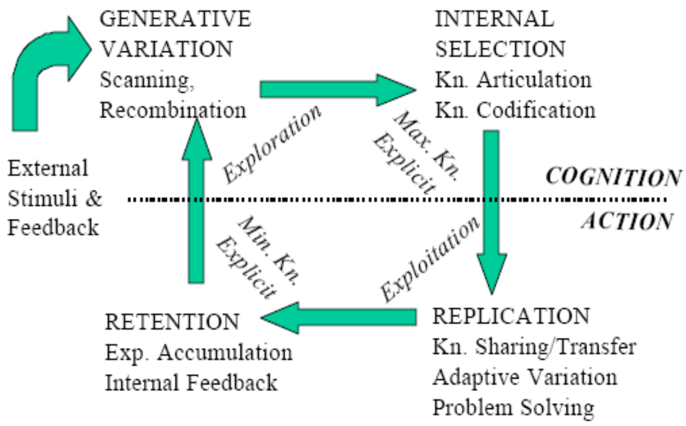
It can be added that possibly a trade union can be brought in to discuss alternative solutions together with the employees involved.

5 Skills and routines

One of the most debated topics, for its obvious social consequences, is that of the degree of substitution, by "smart" devices, of different professions and/or activities. Quantitative forecasts, critically assessed in the forthcoming literature review, start from some hypothetical assumptions. The first regards the greater or lesser ability to codify the occupational activity. The more, in fact, the knowledge required for that specific activity is tacit (Polanyi) the more difficult, if not impossible, to turn it into a routine and then into codes that can be automated in the sense of Zuboff.
The second assumption is that the progress in artificial intelligence and robotics open scenarios of substitution of human labour even in non-routine activities, ranging from the world of production to that of high finance.
The weak point of these forecasts - like those by Frey & Osborne - is their static nature. It assumes that there is a predefined stock of routine and non-routine activities; the latter too are partially replaceable, as in the case of interactive robots.
In fact, in the case of innovations, including those arising from scientific and technological progress, companies have the opportunity to develop new skills in ways that have been described, in cognitive terms, by Zollo and Winter (1999) as dynamic capabilities.[12]
Here a figure describing the mechanism:

[12] As part of a European project -VIVA – the Institute for Labour (IPL) - drafted a position paper, written by me, included in the final reports entitled: *IPL Position paper on the definition of innovation excellence in Europe*. I am therefore utilising parts of this work , without reporting a formal quote of it.

Fig. 2 - Knowledge Evolution Mechanisms



The basic chart is a cycle that from a stage of generative variation, which is born from a combination of an impulse external to the company and some ideas, even in a tacit and/or embryonic form, with its consolidated routines, moves from a stage of internal selection that explicitly evaluates their potential. These first two phases are exploration and explicit phases of the external stimuli and involve some cognitive processes in an important way. There follow two phases, the replication and the retention, in which action typically prevails. The first action is the utilisation of what has previously been selected and leads to the reproduction of the routines, in the light of the context modifications – an adaptive variation, therefore, and the second, of explicit, is an action of experience accumulation, in the new context, something that determines the new set of procedures, an action of recombination, therefore. Cognitively speaking, the cycle moves, from right to left, in the direction of explicit forms of knowledge, well-articulated and codified, while from left to right, the knowledge tends towards tacit forms

> as it becomes highly embedded in the behaviour of the individuals involved in the multiple executions of the task. (Zollo et al., 1999: 7)

That having been said, what then is a dynamic capability? It is

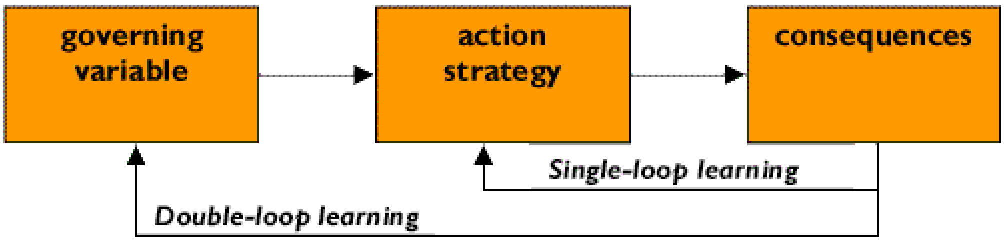
> *a learned pattern of collective activity through which the organisation systematically generates and modifies its operational routines in pursuit of improved effectiveness*. (ibidem:10)

Thus, for a company, to have that dynamic capability or not to have it is not a "*target hit or missed*" with an isolated and singular act of creativity, but the availability, or non-availability, of stable structures and/or operational patterns. It is not even an individual mechanism in a strict sense even if it has been set off and conveyed by the people involved.
Zollo and Winter rigorously define the three mechanisms involved in this dynamic process: the organisational routines, the articulation and the codification of knowledge. Let's look at these in detail:

A. The organisational routines are distinguished into operational, and learning or search; for our discussion, the latter are decisive.
B. Knowledge articulation.

Knowledge articulation is for us essential because it consists in the implementation of a collective learning mechanism that spins off from the chance for the individuals to express their opinions and beliefs using a constructive dialectic discussion with others, even by contesting their points of views. These forms of learning enrich the capacity to elaborate learning or search organisational routines. This involves a specific organisational pattern which, in the first place, allows one to express oneself freely and, in the second place, to have time and place

resources to allow this dialectical interchange: the possibility, in other words, to organise discussion groups, seminars, etc.
The cognitive mechanism described, therefore, requires to operate the specific organisational forms that can be described by use of the Argyris & Schön's theory on the learning process double-loop (double loop) - this is the causation rings and feedback - it can be argued intuitively by the following scheme:



For Argyiris and Schön (1978)[13] there are two opposing theories of action; those that are implicit in what we do without specifying what he calls theories-in-use (theories-in-use), corresponding to the routine; They are tacit knowledge structures. In contrast, there are the theories explicitly adopted (espoused theories). The two theories must be consistent, which you can see the consequences that must be those expectations.

Knowledge in use in an organization is always socialized knowledge that arises from the interaction between the continuous and dynamic people involved (ibid: 16-17):

> Hence, our inquiry into organisational learning must concern itself not with static entities called organisations, but with an active process of organising which is, at root, a cognitive enterprise. Individual members are continually engaged in attempting to know the organisation, and to know themselves in the context of the organisation. At the same time, their continuing efforts to know and to test their knowledge represent the object of their inquiry. Organizing is reflexive inquiry….
> [Members] require external references. There must be public representations of organisational theory-in-use to which individuals can refer. This is the function of organisational maps. These are the shared descriptions of the organisation which individuals jointly construct and use to guide their inquiry….
> Organisational theory-in-use, continually constructed through individual inquiry, is encoded in private images and public maps. These are the media of organisational learning. (Argyiris and Schön,1978: 16-17)

What happens when an organisation appears a mismatch between what is expected and the result? Their response distinguishes a learning process single-loop from the double loop:

> When the error detected and corrected permits the organisation to carry on its present policies or achieve its presents objectives, then that error-and-correction process is single-loop learning. Single-loop learning is like a thermostat that learns when it is too hot or too cold and turns the heat on or off. The thermostat can perform this task because it can receive information (the temperature of the room) and take corrective action. Double-loop learning occurs when an error is detected and corrected in ways that involve the modification of an organisation's underlying norms, policies and objectives". (ibidem:2-3)

But to be able to access reflective processes, such as those of the critical assessment of the variables, people must, therefore, get out of a defensive scheme, which is as very efficient as it can be deadly dangerous. This specific learning process, which they call the model I, prevents a deeper

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13 For a critical assessment of Argyiris and Schön's theories see:
Smith, M. K. (2001, 2013). 'Chris Argyris: theories of action, double-loop learning and organizational learning', *the encyclopedia of informal education*. [http://infed.org/mobi/chris-argyris-theories-of-action-double-loop-learning-and-organizational-learning/. Retrieved: 16 december 2016

learning skills to restructure or redefine the rules. It is so moving to the Model II that enables the extension of the capacity of the individual and the organisation in dealing with new situations.
These theories can be very questionable - see the note 12 - bat allow us to connect skills development to the educational and training processes. The problem is not qualifying the skills only as a fixed stock or to think that the adjustment is just a learning process school-type. There is a dynamic that begins from the re-elaborating of personal and professional expertise in the light of a process of change; the very process of change also must be explained and critically examined. In conclusion Zollo and Winter state:

> Dynamic capabilities emerge from the co-evolution of tacit experience accumulation processes with explicit knowledge articulation and codification activities (Zollo & Winter: 17)

This requires organisations to be open to these dynamics, a situation today provided quite exceptional. It, in fact, does not depend on a situation institutionally defined, as in the case of Mitbestimmung, but from daily working practices.

If you choose a digitising perspective that instead of pointing to automation and replacement of human labour using the:

> enhanced opportunities to support workers and to strengthen their capacity for autonomous action and decentralised self-regulation (Krzywdzinski, Jürgens & Pfeiffer, 2016: 22),

The results can also be positive. This depends on how the possibilities inherent in the manufacturing business transformation process are selected, for example

> whether companies will introduce the new technologies in a gradual or disruptive manner.

And it will depend on:

> on what the relevant actors will do and which of the chosen approaches will prove most successful in the market. (ibidem:23)

In a not fully dystopian perspective, in fact, the windows of opportunity that we talked about at the beginning should be declined in concrete proposals and objectives to struggle for. From our first field research results, in fact, these possibilities exist when the union is particularly strong. A strong union is unfortunately tied to very specific business situations and are often linked to inequalities between the central enterprises and those of production networks associated with them, that is, corporate labour practices. There is also the historical experience that, even in the opinion of some managers, suggests a cautious attitude on all emphases of full and widespread automation / digitalisation of work, particularly on the assumption of complex, self-regulating cyber-physical systems. This does not mean that cyber-physical systems cannot be realised, as the industrial reality shows us, but as Krzywdzinski et al. state:

> based on past experiences with automation processes, the degree of process stability produced under laboratory conditions is hardly achieved in practice. (2016: 23)

in so doing these processes produce:

> a very high need for improvisation and creative problem-solving – in a complex as well as simple production processes. (ibidem:23-24)

Unfortunately, past experience shows us that, even when there are not the consequences envisaged by advocates of a dystopian future, a polarisation processes will occur producing winners and losers. Krzywdzinski et al., after having recalled examples of de-skilling in the previous transformation of the work - the third industrial revolution -, highlight the risks faced by workers with tasks of feeding the machines, those jobs in Germany are classified as "residual work", but also workers with high skills:

> At the same time, higher-skilled tasks, and increasingly also the indirect tasks performed by skilled workers and engineers, can be made easier, for instance with the help of assistance systems guiding workers by sending them instructions via smart watches or data eyeglasses. Thus, the use of digital assistance systems involves the danger of devaluating experiential knowledge even among workers previously considered highly skilled. (ibid: 23-24)

There are risks, indeed, as well as opportunities. The most obvious opportunities are the possibility of more ergonomic and safer work places. Robots can, in fact, solve many problems, even in the collaborative version, for example by loading the machines with heavy and uncomfortable parts, leaving the worker with any adjustment tasks and guide of the machines. Examples of this type have emerged in our first field research' upshots. But just where the risks are greater, there are also opportunities. Krzywdzinski and others, for example, point out the possibility that the manufacturing work can be re-evaluated:

> Process support provided by mobile robots and assistance systems can be used to strengthen the team's operational autonomy, to facilitate training processes, and to make improvements. Especially for assembly line workers, use of the new technologies could mean a liberation from repetitive and monotonous work for tasks involving process monitoring and improvement. (ibid: 24)

While in our fieldwork research we found this kind of case in the assembly work offline and in companies working in small batches, at the time we did not find cases for assembly line workers, in productions based on high volumes and short cycle times. Also, because, as the authors claim:

> Such a development, however, would require a shift away from today's predominant philosophy of lean production—a philosophy whose global triumph was celebrated as another industrial revolution not so long ago, and which has resulted in a return to design principles of standardised and short-cycle work. (ibid: 24)

The emergence of lean production thanks to the reversal of the balance of power between the capitalists and the workers, described above, is in fact also reflected in the design criteria, as stated by Winner as well by Noble. A point to be emphasised, in fact, is that among the stakes of the class struggle there is also the design principles; what we have previously called the critique of scientific rationality of the methods for the design and description of the systems. The principles and design methods are therefore part of the political and social struggle to take advantage of the windows of the aforementioned opportunities.

The two Dreyfus (1986) differentiate five stages in the acquisition of skills: novice, beginner, advanced, competent, skilled and expert. The distinction relates to the degree of adaptability of abstract rules to the context; the adaptation starts already in the beginner stage and then mature progressively up to the degrees of skilled and expert. These last two degrees of adaptability are characterised by involvement, rapidity, fluidity, intuition whatever the degree of complexity of the context. In the specific case of the designers, some experts, according to Schön quoted by Ehn, are capable of maintaining, in a distinct manner from their performance involved and fluid,

> A supplementary reflective conversation with the situation which develops theories on the spot. Schon calls this reflection-in-action. (Ehn, 1990: 75)

This progressive widening of capabilities in concentric circles depicts the capacity development in any career. When there is a discontinuity in his/her professional experience - such as the intervention of the **automate processes** - as Zuboff defined it -, then there is the risk that the higher levels of professional capacity can become obsolete through the degradation of the skills to pure

routine. The routine can be formalised and morphed in an algorithm, regardless of the context, and then, finally, replaceable by the algorithm and therefore automatable. The **informate process**, the one Zuboff defined, is much more complex. It requires, in fact, that the context does not disappear. The computerised system must be able to adapt its performance to the context, as in the case of collaborative robots that use probabilistic models of interaction with the context. In this second case, therefore, the replacement of human labour occurs, when it occurs, in the proper sense of the expression, without having to "degrade" the competence to a routine.
The processes of **automate** and **informate** are designed according to a social and/or economic purpose and do not automatically descend on the availability of technology. How can designers of computer artefacts to open, instead of closing, opportunities to human labour, by maintaining and improving personal skills, as well as by developing socialised and cooperative dimension of the work?
The Ehn reflections are still useful. By the way, it should be remembered that these are theorising ex-post and critical reflection of Scandinavian design and labour practices of the mid-70s that led to the creation of Demos and Utopia programs. As I recalled in the introduction, the approach Ehn develops downstream of those experiences is the **use of collective resources**. In this approach, in fact, there is a clear stress on the difference in **designing for the capabilities**, that is, for the design of computer artifacts that avoid the deskilling of work, and **designing for democracy at the work place**, that is, the change of power relations in the workplace in favour of the employees. It means acquiring a collective control over the processes of technological change.
Not only the two design processes have to be distinguished, but they are in constant tension between them. The risk, in fact, is, on the one hand, that the orientation to the capabilities will result in corporate union practices that feed forms of polarisation / segmentation of workers.
On the other side, an approach focused on the conquest of all forms of control of power by the workers and their trade unions on employment and work organization process - a sort of a direct causal link between the production control by workers and the company's profitability – is risky in the process of change in which there are at the same time:

I. The transition of the form of the firm from a stand-alone company to a network of firms,
II. The real subsumption of labour to finance
III. A radical technological change.

The risk is that the power of control will be emptied out from within.

It happens, in fact, that the overall conditions of the employees of a specific company are determined by choices and governance mechanisms of the production network entirely external to that enterprise; indeed, the very existence of that specific firm may be at risk for purely financial reasons, beyond the effectiveness and efficiency of the production results. All this is the outcome of the financialisation of the companies. As part of the transition from managerial capitalism, which has characterised the whole phase until the crisis of the mid-seventies, the one based on today's financial managers, the so-called money managers.
Segmentation and fragmentation affects the companies' social structure, with the construction of different segments and poles of working positions, ranging from permanent working position to on-call working positions, as well as the relations between companies, depending on their position in the value chain, and, eventually, the labour market as a whole, with the introduction of the "work on demand" that is, forms of on-call work without the legal status of an employee, however precarious, and the creation of a large *industrial reserve army of labour* (Marx) which, according to some experts, could become a structural fact. Fragmentation went up to the explosion in individual and isolated forms of work without any protection and law and faked as free-lance positions.
Here, then, that the sort of a direct causal link model - between the production control by workers and the company's profitability - no longer works, with the exception of the handful of companies that control the main industrial sectors and the layer, of minority and highly specialized companies

that need stable and highly skilled workers, in a very significative proportions, relative to their total work force.

The process of setting up an alternative project, then, has to join the conquest of new forms of power of control, adjusted to the new unit of analysis and action, with a capacity of intervention on the criteria themselves of technological and organizational design, which requires an idea of society and the role of work; this we meant when we used the double formula:

"*A critique of the political rationality of the design process*" and implementation of these technologies, and "*a critique of scientific rationality of the methods for the design and description of the systems*".

6. Conclusions

From the point of view of the employees and their trade union, the first problem is to avoid a choice between prophecies of doom, which serve only to paralyse their collective action, and techno-optimism, which accept the technocratic rule by which the social consequences are the natural and unavoidable effect of the technologies. The cultural and political position more suitable for a strategic defence of workers ‘rights, of developing high levels of employment as well as the right to have a say on all societal processes of change, is that of a full understanding of the political, cultural, social, economic, industrial and technological objectives at stake. Secondly, a field research and a thoroughly monitoring the process of change should be organised, with the help of the people affected by that process.

It is very simple for a research group to draft the above statements on what should be done, but what happens to ordinary people coping with a radical change or, to utilise the trendy wording of this period, a disruption?

This was the situation at the beginning of the 1980s in Italy; it was the period of the first wave of the ICT revolution, namely the widespread adoption from industrial firms – mostly the medium and big ones - of the personal computer to automatize – in the meaning of Zuboff – parts of the work process. It was a disruption of the traditional way of working in the office, because of the PCs, as well as on the shop floor, because of the adoption of the Numerical Control machines also in small and medium enterprises and the diffusion of the CAD/CAM technologies in the medium and big companies. The Trade Union were caught off guard; quoting a leaflet of the Metalworkers Trade Unions – at that time FLM – Trade Union (Mancini & Sbordone, 2004: 177)

> *Is having some difficulty in wholly grasping the nature and the consequences of these transformations and in particular their effects about the working conditions. The routine Trade Union instruments, such as meetings and assemblies, do not always allow for a deeper analysis of these issues from all the points of view, particularly the ones most tied to the direct experience of work. Hence, the need for the Trade Union to start up different processes of knowledge that are not merely those of mundane administration.*

So, how to afford this new situation? In the same leaflet:

> *Along with the research addressed to understanding the technical, economic and organisational aspects, we are aware of the need to dispose of instruments that allow us to get to know the phenomenon also from the standpoint of the people who are directly involved in such processes. It is a matter of attempting to provide a location and some scientifically established instruments to express workers' subjectivity.*

The solution was to start a research project on workers’ subjectivity in different Italian situations: from the SMEs in Bologna and Reggio Emilia to the Comau Factory of Turin and the Olivetti factories of Ivrea and Crema. Later, at the end of the 1990s, the same methodology was utilised to analyse the subjectivity of the people working in the ICT sector in many different Italian software factories as this kind of companies are known.

What the research group found?

> *the existence of strong feelings of loss (of health, employment, one's own professionalism, one's own identity as a worker, one's own capacity to think, the sense of one's own job, the Trade Union, etc.) accompanied by fear (of the war, non-human control, submission to the machine, etc.) and impotence (incapacity to place oneself as subject in the current transformation) (..) Deepening the analysis further, we can notice that the losses underwent affect different levels. As a matter of fact, it regards:*

- objective losses (e.g. the job that also involves the components of one's identity linked to the object (e.g. being a worker);
- loss of the constitutive aspects of one's identity as a worker (e.g. professionalism);
- loss of the "organised mass" (Freud, 1921) (the Trade Union);
- loss of adaptation mechanisms (the identification with the worker's role) (Parin, 1977);
- losses regarding the Ego functions (e.g. the capacity to think).

Beyond the technical jargon what it is clear is that for those workers to afford a process of a disruptive change means to cope with losses regarding:

- objective facts: feared for the future or already experienced, such as his/her employment, unknown health risks, an upside-down change in his/her job's content, etc.
- broader fears due basically to a feeling of impotence in affording processes beyond any possibility of control by the individual.
- In the late 80s', there was a strong feeling of being left alone, without the support of the fellow workers, also because the new technologies privileged an individual interaction with the machine, and with an enfeebled Trade Union at difficulties in understanding and managing this new reality.

This kind of research was somehow supportive for a new trend in Trade Unions organisation and action.

We don't know how is the workers' subjectivity situation today. Also at the end of the 80s', there was a clear difference between the young workers who have never experienced a different situation and the older ones. Today we have the Millennials that are digital natives, so it is likely that they will have a totally different feeling? Or some issues are the same? We need research on this. Not the traditional research which considers workers as objects but a kind of research taking them as thinking and feeling human beings.

The field research should be finalised to a constructive process of social shaping of the technologies to develop what Gill (1996) called a human – machine symbiosis, meaning that the capacity of the machines should be used to empower people, in an emancipatory perspective. It is the same perspective by Ehn on making possible for people to design their systems themselves. Today this perspective is out of reach because of the capitalist direction of the process of change. It doesn't imply that these assumptions should be ruled out; they should be assumed as the founding criteria for action.

The monitoring activity is the way to organise a collective action with a strong and stable participation of the employees. Through the monitoring process is possible to design a set of demands based on the daily experiences of the employees involved in the process of change.

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