Concept Paper

Social Dimensions in CPS & IoT based Automated Production Systems

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Abstract: Since the 1970s, the application of microprocessor in industrial machinery and the development of computer systems have transformed the manufacturing landscape. The rapid integration and automation of production systems have outpaced the development of suitable human design criteria, creating a deepening gap between humans and systems in which human was seen as an important source of errors and disruptions. Today the situation seems different: the scientific and public debate about the concept of Industry 4.0 has raised the awareness about the central role humans have to play in manufacturing systems to the design of which they must be considered from the very beginning. The future of industrial systems, as represented by Industry 4.0, will rely on the convergence of several research fields such as Intelligent Manufacturing Systems (IMS), Cyber-Physical Systems (CPS), Internet of Things (IoT), but also socio-technical fields such as social approaches within technical systems. This article deals with different human social dimensions associated with CPS and IoT and focuses on their conceptual evolution regarding automated production systems' sociability, notably by bringing humans back in the loop. Hereby, this paper aims to take stock of current research trends to show the importance of integrating human operators as a part of a socio-technical system based autonomous and intelligent products or resources. Consequently, different models of sociability as way to integrate human into the broad sense and/or the development of future automated production systems have been identified from the literature and analysed.

Keywords: Industry 4.0; Cyber-Physical Systems (CPS); Internet of Things (IoT); Human factors; Automated production Systems; Social interactions; Social Networks

1. Introduction - Ground-breaking changes in Industry worldwide

Today, the German initiative Industrie 4.0 [1][1], along with many other national socio-political programs such as 'Industrie du future' in France [2], 'High Value Manufacturing Catapult' (HVMC) in the United Kingdom [3], 'Made in China 2020' [4], 'Manufacturing USA' [5], etc. are fostering the digitisation of industry and are taken as references for the development of new manufacturing systems. The strong stakes associated to their simultaneous and worldwide emergence make them the foundations of the 4th industrial revolution as it is already considered by experts.

Basically, the technical innovations related to the vision of Industry 4.0 implies the wide-spread adoption of Cyber-Physical Systems (CPS), the integration of products, smart factories, and the introduction of value chains into global business networks [2, 4, 60, 64].

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[1] https://www.plattform-i40.de/PI40/Navigation/EN/Industrie40/WhatIsIndustrie40/what-is-industrie40.html
[2] https://www.economie.gouv.fr/lancement-seconde-phase-nouvelle-france-industrielle
[3] https://hvm.catapult.org.uk/
[4] http://english.www.gov.cn/2016special/madeinchina2025/
[5] https://www.manufacturing.gov/programs/manufacturing-usa

Such technical integration also correlates with a vision of increased control of highly complex and globalised production processes, also motivated by the expectation for a (partial) reshoring of production capacities. Other frequently discussed technologies in the context of Industry 4.0 are adaptive robotics, additive manufacturing and job-related wearables that are slated to contribute to productivity increases [5]. All these technologies are grounded on paradigms such as CPS or Internet of Things (IoT), where the continuous automation of processes plays a huge role [2].

New objectives will be to achieve the networking of humans, objects, and their virtual representations within complex-adaptable socio-technic industrial systems. IoT and CPS are positioned as two essential representations into the study and development of future industrial systems, but equally for the development of the digital society in general. In this context, one of the most advanced examples is the Japanese initiative Society 5.0 presented in 2016 at the Japanese 5th Science and Technology Basic Plan, at the German Center for Office Automation, Information Technology and Telecommunications (CeBIT), and described by Fukuyama [6]. In this vision, technical innovations of the 4th industrial revolution are integrated into every aspect of industrial and social landscapes, as a new 5th wave characterized by the information society. Even though, the described system can be considered as utopian by the complexity and uncertainties attached to its concretization [7]. One of these uncertainties lies in the two kinds of relationships underlying this Society 5.0 identified by Deguchi et al., that are "*the relationship between technology and society and the technology-mediated relationship between individuals and society*" [8].

This debate on the links between society and technology is naturally found in socio-technical systems, such as production ones [2, 5, 24, 40, 55, 58, 65]. The place of human and his consideration into the design of the latter have also become a very important issue, giving rise to several systems engineering visions and approaches. In this context, the generic Human Systems Integration (HSI) concept is both used in research fields interested in human factors and in systems engineering, aiming to associate notions of human performance and technology design [9] to systems' design. In addition HSI concept is echoing the user-centric system (or Human-centred or Anthropocentric) design approach, that can be found under the standard ISO 9241-210:2019, as "*A way of designing interactive systems, aiming to make systems usable and useful by focusing on users, their needs and requirements, and applying human factors, ergonomics and existing knowledge and techniques in terms of usability*" [10].

From another viewpoint, Human Centered Design is presented by G. Boy as an interdisciplinary and systemic approach toward HSI mixing "*cognitive engineering, advanced human–computer interaction (HCI), modeling and simulation, complexity management, life-critical systems, and organization design and management.*" [11]. More recently, the 'Inclusion' concept, grounded on educative sciences and consisting in adapting a given process by considering individual characteristics instead of collective or standard goals, was extended to human manufacturing system inclusion [12, 13].

This development echoes David Lockwood's sociological theory of social systems, defined as social integration. In his works, social inclusion/integration differs from common system integration by considering mutual relationships among individual actors and groups in a system, to achieve "*conscious and motivated interaction and cooperation*", instead of anonymous coordination mechanism [14]. Therefore, the emergence of CPS as new wave of automated production system, motivates to privilege this social integration concept [15, 16]. Notably, the development and use of social interaction between objects and humans could today be envisioned as a key enabler of the extension of the paradigms of CPS and IoT to human beings in industry.

The first contribution of this article is to provide an overview of human social dimensions' place in CPS and IoT in literature, detailing their specificities, contributions, and potential regarding automated production systems in the broader context of Industry 4.0.

The second contribution figures out, *where* automation processes are going on and *how* humans are integrated within these systems. Because ongoing process of automation belongs to the inner logic of industry, this aspect becomes explicit in the following paper, which is structured as follow. Section 2 will detail some fundamentals concerning CPS and IoT paradigms, and the role to be given to them within these automated production systems. Section 3 will discuss different models of sociability defined as the ability to interact with others including human-machine, machine-machine, human-human interactions, to illustrate the purpose of section 2. Due to these complex developments, the hypothesis implicitly is raised that the engineers and developers intend automation on different process levels. Section 4 will conclude by raising open questions concerning work automatization and questioning how automation is today changing work quality.

2. Fundamentals on CPS and IoT – an insight

The notions of CPS and IoT are generally recognized as the main pillar of Industry 4.0. [4, 5] Decades ago, the debate on Computer Integrated Manufacturing (CIM) systems referred intensively to new technological and social dimensions with huge societal impact [15]. However, recent associated technical integration systems encompass this debate with different focus [16, 19, 26, 31, 33]. Technological dimensions are related to the connection between the technical systems while sociological dimension is related to communication and interfacing human and technical systems. In both cases, integration has to consider the following:

    a)   machine-machine interaction,
    b)   human-machine interaction and
    c)   human-human interaction.

The introduction of CIM systems in the 1980s had fundamental effects on the organizational level of work. On the one side, digitization of work processes created a vision about the complete automation of factories without personnel [15]. Yet, on the other side, the high level of technical standards created a discourse about the rising and dependent scope of human actions within working processes [2].

We call 'restrictive' a work organization based on a strict human-machine interaction in delimited workspace, dependent on technical parameters and on rational production lines. This organization disappears while considering the support of qualified and responsible employees, which should be actively involved into the production processes. It must be noted that such flexible work organization is more complex to design than ones restricted to the mechanistic and hierarchical principles of management. The participation of the employees into these processes should imply the introduction of tacit knowledge, planning and operation, group work, as well as decision-making processes.

These criteria are again at stake when the emergent vision on the new automated production systems designed with CPS and IoT are debated [5, 34, 42, 55, 57, 60, 64]. Observations have already shown that these distributed internet-based systems bring path dependencies that may restrict the possibilities for alternative work organization models by automation [25, 27, 30]. If human factor is not included simultaneously with the technological factor into the design process, there is little space for 're-automation' regarding human interference into the work processes [19].

Due to the wide range of its potential applications, this concept of CPS enjoys great popularity in the scientific world although it is rather recent (enunciated by Lee in 2006) [22]. However, popularity and novelty make it a concept whose definition and scope are rather blurred. It is also often associated with the one of IoT, appeared a little earlier, in the 2000s [18].

According to Bril El-Haouzi [19] and Bordel et al. [20], preferences in the use of the terms CPS and IoT are observed from one scientific community to another or from one geographical area to another. Thus, CPS will be preferred to IoT in mechatronics and IoT in computer science communities. The term CPS will also be found more often on the

American continent than on the European or Asian ones, where IoT will be preferred [19,20]. Yet, those two concepts are fundamentally different and need to be differentiated.

The popularity of the IoT concept have provided in literature with many definitions. Notably, Madakam and colleagues made a literature review in 2015, which led them to formulate the following definition: "*an open and comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data, resources, reacting and acting in face of situations and changes in the environment*" [21]. Concerning CPS, Lee initially enunciated the concept as being "*integration of computation with physical processes*" where "*embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa*" [22]. It can be noted that this definition stays consistent with the one fostered more recently by Monostori "*systems of collaborating computational entities which are in intensive connection with the surrounding physical world and its on-going processes*" [23].

These first definitions can be characterized as techno-centred since only technical aspects of CPS and IoT are exposed, while human is not evoked. Hence a system can be considered as being composed of both objects and their cyber representations. In other words, a system can be seen as organized along two axes: he first one representing the physical world; the second one being representing the cyber world. In the one hand, IoT would correspond to the horizontal connectivity and synchronization between physical or cyber objects, performed thanks to Internet data exchange protocols-based technologies (such as TCP/IP). On the other hand, CPS would correspond to the vertical connectivity and synchronization between objects and their cyber representation, performed thanks to cloud and sensors-based technologies [24, 25, 63, 64, 67] (Fig.1).
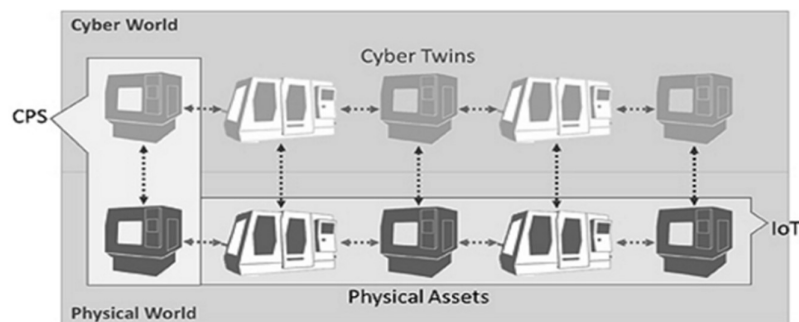

Figure 1. CPS & IoT [24]

Therefore, CPS and IoT can be seen as the two main enabling paradigms for Cyber-Physical systems' networking, and two of the main pillars for Industry 4.0. This representation seems well-suited to describe machine-machine interaction. But as expresses here above, human-human interaction and human-machine interaction (i.e.: HSI) are equally important regarding Industry 4.0 [2, 19].

These aspects have nonetheless been tackled in for both IoT and CPS in the last decades. Chart 1 shows the results for the searches (S1): *"Cyber Physical Systems" AND (Human OR Social OR Anthropocentric)* and (S2): *"Internet of Things" AND (Human OR Social OR Anthropocentric)*. This search was performed with the ScienceDirect scientific database for its practicality of use. No other databased was queried, for the purpose of this search is to provide an overview of the scientific interest for the subject, and not an exhaustive analysis. To get relevant results, the search has been restricted to articles (Research & Reviews), presenting the terms in their title, abstract or keywords. Hence, searches are targeting the articles not only mentioning them, but for which they are the main subject (Fig. 2).
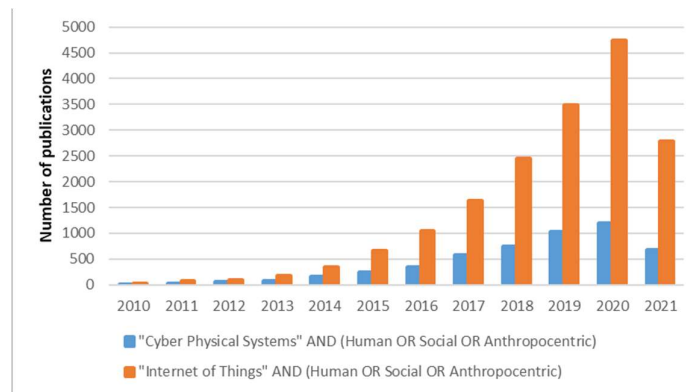
Figure 2. Results for the searches (S1) and (S2) in ScienceDirect scientific Database (04/2021)

The interest shown for this research area has been overall constantly rising for the last decade. The decrease observed for 2020/2021 being due to update delay in database (for instance, results for CPS in 2020 have raised from 45 to 50 between April and May 2021). In a prior paper, Valette et al. have already proposed a study upon the human-integration the evolution of CPS and IoT paradigms regarding human, anthropocentric and social characters [25].

What will be deepened in this paper is the social character, often associated with the development of systems and of their architectures. As Moniz and Krings mentioned, the application of new robotic systems in the manufacturing shop-floor level is widely done without the reference of «real» social implications. Due to the cognitive and perceptual workload for new robot operators in complex and automated working systems, the social dimension is currently defined by developers with the focus on the issues of security and, eventually, qualification. But the social dimension remains in a limbo of the technical debate about interaction systems [26].

The analysis about the impact of automation on work processes is closely connected with the knowledge about social issues at work level. If the term 'social' can be seen as the most generic to express human consideration for production systems design in literature, it is however not unambiguous nor necessarily the mark of an attention paid to the human being. We can especially cite its use in Multi Agent field, where any interaction between two agents, human or not, is called social.

The 1998's work from Sycara can notably be quoted, where 'sociability' is referring to the fact "*that an agent is capable of interacting in a peer-to-peer manner with other agents or humans.*" [27], along with more recent works from Nguyen and Katarzyniak, establishing as social interactions "*all acts, actions and practices that involve more than two agents and affect or take account of other agents' activities, experiences or knowledge states*" [28]. Hence, social integration models/approaches can be divided into the three types: social interactions based on peer-to-peer communication interfaces, Social-Network Services based approach as a media for social interaction and Human-inspired social relationships-based sociability model, detailed in the following sections.

3. Social aspects in IoT and CPS

3.1. Social interactions based on peer-to-peer communication interfaces

The "classic" approach, mostly found in the Multi-Agent Systems (MAS) study field, defines as social any agent able to interact with another one, whether it is artefactual or natural. With Human-integration purpose, the developments we would classify here mainly aims to human physical enhancement, by technological means. Hence, Sowe et al. define a Cyber-Physical Human System as an "*interconnected systems (computers, cyber physical devices, and people) "talking" to each other across space and time, and allowing other*

systems, devices, and data streams to connect and disconnect" [29]. This definition is found in the work of (Schirner et al. 2013), who developed the 'Human-in-The-Loop Cyber-Physical Systems' (HiTLCPS).

This concept consists of an embedded system improving the ability of a human being to interact with his physical environment (Fig. 3). The "loop" is made up of a human, an embedded system, and their environment. Beyond the very concrete translation of the integration of the human factor into systems, they provide here a solution where the system is presented as a physical extension of the human being, via a digital interface.
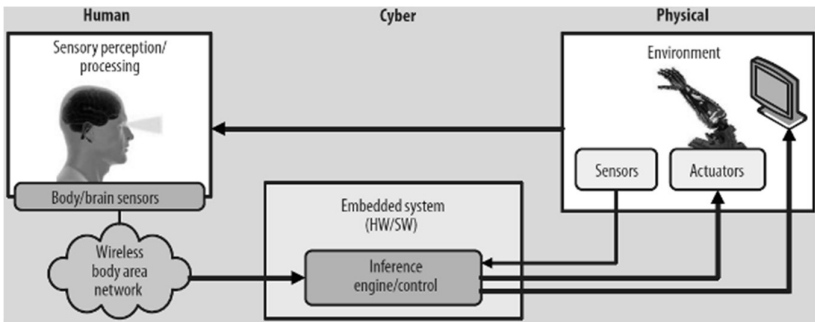

Figure 3. HiTLCPS [30]

With the development of the 'Anthropocentric Cyber-Physical Systems' (ACPS) by Pirvu and colleagues [31], defined as a reference architecture integrating the three physical, cyber / IT and human components (Fig. 4), the search for the integration of the human factor is taken further. The authors present it as an integrated, social, local, irreversible, adaptive, and autonomous system, in line with the continuity of Cyber-Physical Social Systems (SCPS) and Cyber-Physical Social Systems (CPSS). The ACPS is presented as an architecture "*where the humans are not just interactants with a CPS, but elements of the system affecting its lifetime behaviour*" [31]. However, unlike previous contributions offering concrete applications, this one push human integration further but remains, therefore, very conceptual.
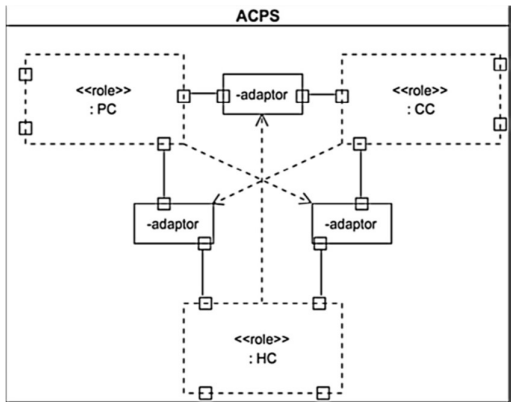

Figure 4. ACPS reference architecture. [31]

The most recent development of these approaches until now is the 'Social Human-In-The-Loop Cyber-Physical Production System' (Social-HITL-CPPS) of [32]. In this paper, the interpretation of human agent's behaviour and its coordination with other agents are identified as the two main challenges of the integration of humans in social (and not just industrial) environments.

To meet these challenges, a three-layer architecture has been proposed. This architecture connects, on the one hand, human users to the cyber part via user interfaces,

and on the other hand, the physical parts (i.e., non-human agents and the environment) to the cyber part via a network (Fig. 5).
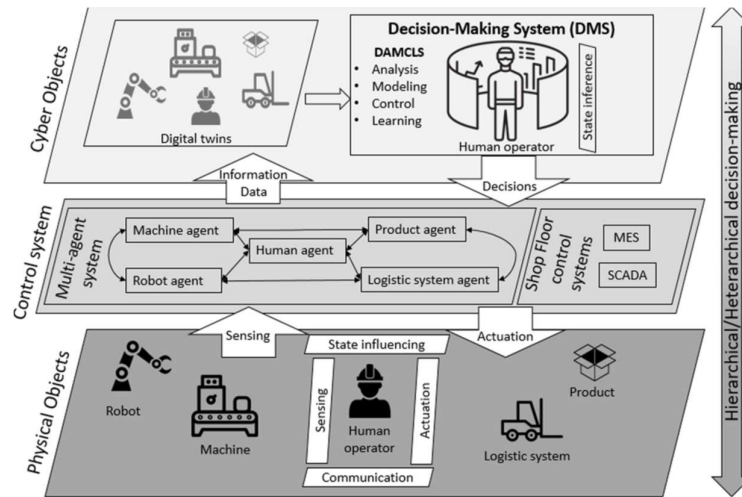

Figure 5. Social cyber-physical manufacturing system architecture integrating humans into the loop. [32]

Under these conditions, the social interaction with automated systems (i.e.: CPS) integrates several features, like human perception, sensing, haptic interaction, or communication. When people interact with robots and other CPS it must exist some degree of awareness of the human in the loop, in terms of sensing abilities and/or interfaces and abilities of the technical system to interact and communicate with people [33, 62, 63].

The fact that robots with such 'cognitive' abilities are introduced in a working environment means the relation between humans and these machines also evokes the relation between co-workers and the human resource management strategies in a company [34]. Once the socialisation (the ability to interact with others, or to socialize) of the automated production systems is achieved, several scientific questions that can only be resolved through further research remain open. In particular, as the capacities and abilities of humans and intelligent systems are not similar; thus, the recognition of differences is most relevant for a balanced architecture, with a better allocation of competencies and complementarities based on new technologies as Augmented Reality, IIoT [66, 70].

3.2 Social-Network Services based approach as a media for social interaction

This second approach is based on the use 'Social Network Services' (SNS) type applications (e.g., Facebook, Twitter, Instagram, etc.) as a media for social interaction between human-human, machine-human or machine-machine. Between 1995 and 2020, a consequent raise of internet users and internet-connected devices has been observed [35, 36](« Internet World Stats » 2020) (Fig.6).

Nomadic communicating objects such as laptops, smartphones, and tablets, have become omnipresent in our everyday life. SNS, whose development have been fostered by these devices, have been defined by [37] as "*web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system*".
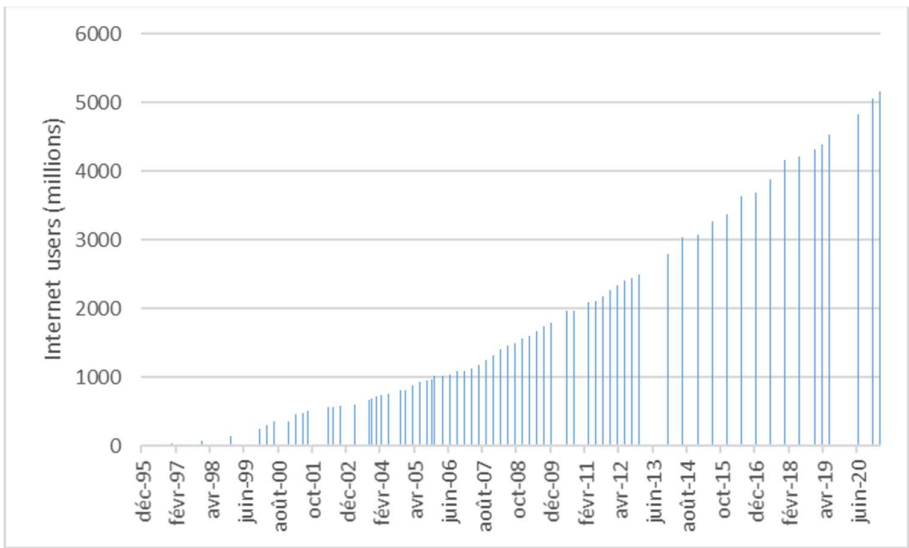
Figure 6. Internet users growth from 1995 to 2020 [35, 36]

First consequence of this raise has been the generation of a huge data among, posing data structuration issues, leading Guinard et al. to the idea of using the structures of existing SNS to connect IoT devices into a 'Social Web of Things' (SWoT) [40] (Fig. 6). The SNS's ability to collect and process data to support the creation or maintenance of social relationships between their users, is there seen as a new way to structure data exchanges within a network of intelligent connected objects (i.e., artefact agents).

Today, this idea is fuelling the development of resilient data collection and sharing methods aiming to improve reputation, trust, and security between IoT devices [38, 39, 68] (Fig. 8). These methods are based on Graphs, to structure data-connection between devices, Degree distribution to quantify a node's solicitation, and Local Clustering Coefficient to group interlinked nodes as network clusters. Combining these methods to friendship-like relationships ultimately leading to a "social" SNS-based approach.
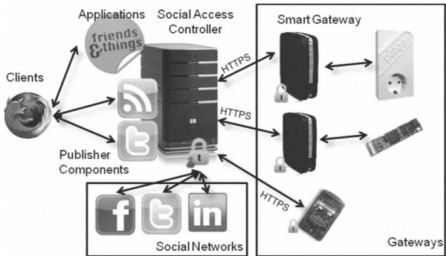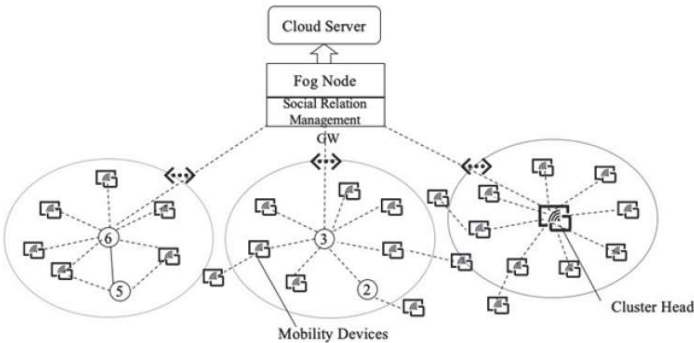

Figure 7. Social Web of Things [40]

Figure 8. Data Collection Model [39](Zhukova et al. 2020)

But Data structuration is not the only use that has been found for SNSs into systems' design. Social networking can equally be used as a way to organise manufacturing systems into distributed Dynamic Resource Communities (DRC) as a "*new cyber-physical-social-connected and service-oriented manufacturing paradigm*" [41]. This Social Manufacturing (SocialM) approach is based on the use of both socialized resources, social media, and social community inspired self-organization for resources (Fig. 9).

Resource agents (here named Production Service Providers or PSPs) are interacting with each other through a global social relationship network (i.e.: the SNS), enabling them to self-organize into these distributed DRC, aimed to bring resiliency and flexibility to production systems.
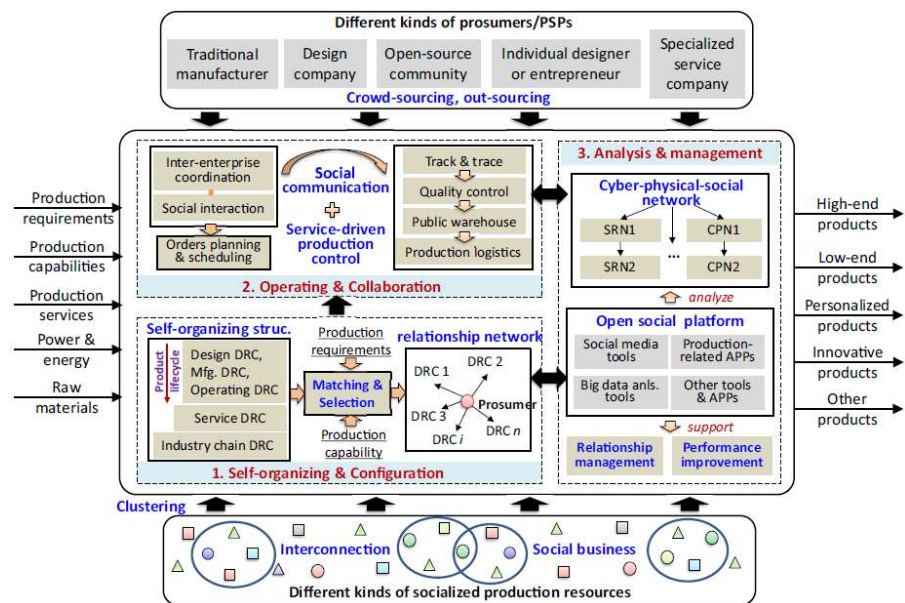

Figure 9. Logic framework of SocialM [41]

The notion of social manufacturing can be found again on the work of Romero et al on Social Factory Architecture based on Social Networking Services and Production Scenarios. They define the Social Operator 4.0 as a "*type of Operator 4.0 that uses smart wearable solutions together with advanced human-machine interaction (HMI) technologies to cooperate with other 'social operators', 'social machines' and 'social software systems' to communicate and exchange information for mutual benefit and align/alter activities as well as share resources so that more efficient results can be achieved at the smart and social factory of Industry 4.0*" [42].

This will increase the complexity of data management and recurrent amalgamation of roles (as today occurs with domestic bots of IOS or Google, as examples). Thus, it will be critical to understand the central role of humans in (also) complex organizational settings. The new communication tools and platforms can imply new needs of management for social relations and integrate them with connected objects through IoT. It can be imperative not to mix the functions of social media and services with humans as social actors. Together it can transform CPS systems in an "uncanny valley" already described by Mori several decades ago [43].

To conclude, social interaction will become more complex with SNS and CPS [68]. But IA applications on manufacturing environments under the concept of Industry 4.0 should not amalgamate the function of humans as social actors. In other words, the

Operator 4.0 will remain a human and not just a "thing" connected with other cyber-physical devices.

3.3. Human-inspired social relationships-based sociability model: from social integration to system integration

This third approach consists in a transposition of human-inspired social relationships into a technical (e.g., SIoT) or socio-technical system (associating objects and humans). Some years before, the advent of Industry 4.0, [44] noted a certain lack of consideration for human factors in the field of CPS, and developments were being focused on networked & next-generation embedded systems [2, 18, 66]. Therefore, he proposed the concept of 'Cyber Physical Social System' (CPSS) as a "*tightly conjoined, coordinated, and integrated with human and social characteristics*" development of CPS.

CPSS being supported by the addition of physiological, psychological, social, and mental spaces to those of cyber and physical spaces [45, 46, 63] (Fig.10). Written as the Word from the Editor for the first issues of the CPSS department of IEEE Intelligent Systems journal, this first approach necessarily stays conceptual. Yet, it has quickly be followed by much more concrete works.
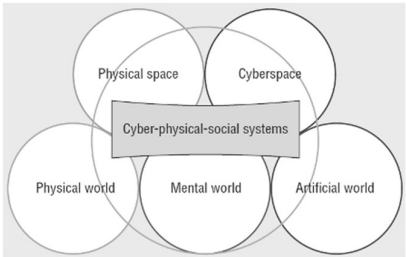

Figure 10. From Popper's three worlds to cyber-physical social systems. [44]

We can notably cite the 'Social Internet of Things' (SIoT), developed by [47] (Fig. 11). Equally based on the identification of the need to structure data into the growing Internet, the goal of this development differs from [48], for it does not focuses on the reuse of existing SNS structures, but rather on the development of a new architecture that would be "*a social network of intelligent objects bounded by social relationships*" [49]. This is based on 5 main social relationships inspired by human systems, such as those developed by [50].
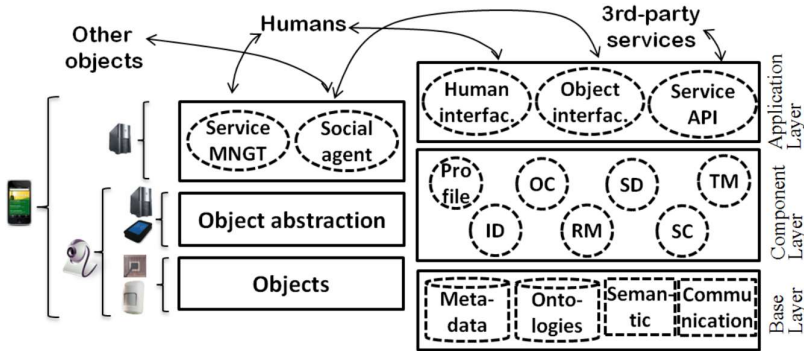

Figure 11 - Architecture for SIoT: client side (left) and server side (right) [51]

According to Fiske [50], human societies are regulated by four elementary forms of sociability, namely: Communal Sharing (CS), Authority Ranking (AR), Equality Matching (EM), and Market Pricing (MP). This work represents a first attempt to create a typology of social relations, which Atzori and colleagues used as a basis to develop their own

typology [51]. They defined the following five inter-object relationships: Parental Object Relationship (POR), Ownership Object Relationship (OOR), Co-Working Object Relationship (C-WOR), Social Object relationship (SOR) and Co-Location Object Relationship (C-LOR).

Simultaneously, Atzori and colleagues [47, 51] have developed a support architecture for object-object interactions and the discovery of services and resources within a network of connected objects. Social relationships are established and exploited among objects, but not between their human beneficiaries.

Contrasting with previous social approaches, this one relies on human inspired social mechanisms to improve the integration of purely technological systems. However, the relationships expressed in SIoT pave the way for the realization of a paradigm evoked earlier: the 'Cyber-Physical Society'. It encompasses the definition of Society 5.0 already referred above. Valette et al. [69] have proposed a transposition of those relationships to a Social Holonic Manufacturing control in CPS based factories

It was defined by Shi and Zhuge (Fig. 12) as a 'Cyber-Physical Socio-Ecosystem' (CPSE) where natural physical space, social space, mental space and cyberspace interact and co-evolve with each other [46]. CPSE deals with the relationships between individuals in a cyber-physical environment and cyber-physical social system.
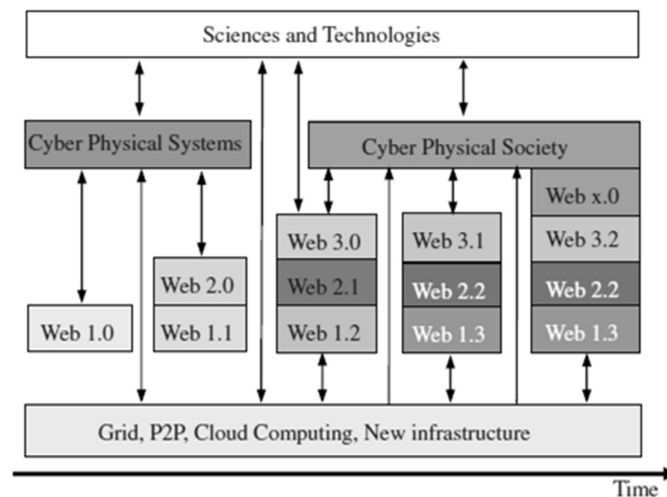

Figure 12. Cyber-Physical Society and other systems [46]

If a robot, or other machine with AI can be equipped with general information about social behavior, than it should be able to detect situations as appropriate in which certain classes of social behaviors and apply them. That is specially the case, where it is needed to include information about possible human operator actions in the programming phase.

With more developed devices, such capacity can also feature the intuition capacity in the interaction with humans [33]. In such case, machines can have an autonomous "reasoning'" about how best to achieve its goals in a given social context and should have the ability to express itself in ways that will help it complete tasks in a wide range of social situations. The expression must not be verbal but can be in written forms to become understood by the human operator.

The frames of goal achievement must be settled in work environments. In other words, the "higher the capacity is for 'autonomous reasoning', the higher must be the intuition for humans to interact with robots" [33]. This means the cyber-physical space must be designed and programmed according to the social system, for example, the one presented in a model of work organization [19, 26, 52, 61]. In such way, we can talk about a potential symbiosis between the physical space (machinery, tools) and social space (mental references, identities, communication language, organizational roles, decision-

making) referred also as Cyber-Physical Society or Socio-Ecosystem, or even Social System (CPSS), as mentioned above.

This logic is also found in the work of Pintus and colleagues [53]. These authors define the 'Humanized Internet of Things' (HIoT) as a classic Machine-Machine oriented IoT coupled with SIoT and the 'Internet of People' (IoP) [53]. In manufacturing environment, the goal is to propose a social factory supporting human workers under any condition and engaging him to contribute to knowledge creation. In such a system, human, machine, and software agents would be considered as equal and provided "*just in time*" and "*just in quality*" with necessary information [54, 56, 57, 58, 62].

It is easy to perceive, behind this assemblage of paradigms, a larger vision of a socio-technical system of agents, artefacts, and human beings, organized governed by a set of social relations. Nevertheless, there is still a lot of work to be done before reaching a better acceptability of these systems, to reduce their complexity while guaranteeing their agility when facing changes of environment and to allow a better integration of the human being either as an individual with its variabilities and as a part of a collective society through the concept of social inclusion [55, 64].

4. Conclusion and Prospects

Automation has been, significantly, increasing in most production sectors, and the question remains, whether there remains space for human autonomy and creativity at working level. Does automation increase the dependency of the workers within these new systems? What are the qualitative changes of work on shop floor level with regard to speed, expectations, demands and complexity of work? How are workers integrated into the configuration of these working arrangements? Why the ongoing process of automation is still implicitly part of development?

Today's new technological advances, associated with CPS and IoT, are paving the way of the new generation of automated production systems with promising objectives of efficiency, agility, and adaptation to user needs. New levels of automation will be accomplished based on these systems with better balance between human and machine works. This is a promise of industry 4.0.

The purpose of this study was to explore how human/social dimension was considering in CPS and IoT based production System. The focus was done on the sociability models to ease the human social/system integration into automated production systems. The first model is dealing with the classical Human-System interaction interfaces where many works are done to propose new interactive interfaces or embedded sensing systems. The second model is aiming to take advantage of the form of existing Social Network Services (as social websites like Facebook, Twitter …) that offer a variety of features facilitating the socialization based on internet. The last model is relating to the design of industrial system as a society linking smart connected objects through a typology of social relations and paving the way to a good human system integration.

Certainly, all these models, described above have as its aim to increase productivity. At the same time the systems are increasing the possibilities for intuitive interaction between humans and machines, and to contribute to ease the working conditions for operator in complex environments. The design of these elements may be a need for most automated environments that apply the concept of industry 4.0 and articulate most CPS in production systems.

When reflecting on such automatization processes is necessary to mention the economic, political, and ethical challenges. There are not only technical ones. The economic challenges have implications on society, and the political and ethical have direct influence on the legal framework. Taking these issues in consideration, number of scientific questions remain open to develop and explore future perspectives for a conscious and human cyber-physical society to reinforces the role and the contribution of industry to society leading for what today we name Industry 5.0

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