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Editorial

Collaborative and Intelligent Networks and Decision Systems and Services for Supporting Engineering and Production Management

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Collaborative networks and systems (CNS) have received much attention in recent decades to reach a competitive advantage. Many contributions have arisen from the industrial context to service-oriented companies, for instance, in the scope of artificial intelligence. Therefore, many contributions have been put forward related to collaborative and intelligent networks and systems [1–7].

Despite the wide range of existing work in this area, however, it continues to be imperative for companies to understand and anticipate the importance of CNS in manufacturing to enable them to reach a competitive advantage in the current global market and Industry 4.0-oriented manufacturing scenario [8,9].

These main topics strengthen the specific characteristics of CN through collaboration to deliver products and services; decentralize decision-making; and achieve inter- and intra-organizational integration to meet imposed performance requirements in competitive global markets [10–12].

Moreover, in the context of CNS, normalization is a crucial step in all decision models to produce comparable and dimensionless data from heterogeneous data [5]. Therefore, it is of upmost importance to use appropriate data-normalization techniques for each application scenario, for instance, according to the kind of multicriteria or multiobjective optimization methods or algorithms used for networked supply and operations management [2,5,13]. This is even more important in the upcoming increasingly digital era of I4.0, along with the perceived need for big data processing in terms of the need for the vertical and horizontal integration of data and manufacturing processes [6,10,14,15].

This Special Issue intends to contribute to collaborative and intelligent networks and systems supporting engineering and production management, as well as fill the gap in theories and practical applications supporting industrial companies through suitable methods and solutions.

Collaborative Engineering (CE) assumes an important role in Industry 4.0 (or I4.0) [16,17], namely, in the context of Collaborative Networks (CN), which includes a diverse set of companies, business partners, suppliers, and other stakeholders, including customers [7,18,19]. These entities are thus connected and communicate to enable CE practices and accomplish Collaborative Manufacturing and Management (CollM&M). CollM&M further implies sharing something between these entities, including some tangible or intangible asset, e.g., manufacturing resources and/or management information [7]. By doing so, the collaborating entities envision the co-creation of a product and/or service [6,7], for which I4.0's technologies are of utmost importance to enable and promote such joint practices, which include human–human, human–machine, and machine–machine interactions [6,12,20].

The widened set of I4.0 technologies permits the development and application of a varying range of management paradigms, approaches, and methods through the use of appropriate and diverse types of supporting tools, systems, and platforms [6,8,9,11,12,20–24], including:

- Collaboration strategies;
- Learning organizations principles;
- Chaos and complexity management;
- Game theory models and approaches for supporting production management;
- Blockchain technology applied to manufacturing and management;
- Intelligent models, methods, and tools;
- Dynamic and real-time-based decision-support approaches;
- Decentralized and distributed decision-support networks and models;
- Social-network-based models, methods, and tools;
- Hybrid intelligent decision-support and recommendation systems;
- Multiagents models, systems, and platforms;
- Machine- and deep-learning-based approaches and systems;
- Bio-inspired models and algorithms applications;
- Negotiation and group-decision-making approaches;
- Multicriteria and multiobjective models;
- Uncertainty treatment methods and tools;
- Data-normalization and data-fusion methods, techniques, and systems;
- Data analytics for manufacturing systems and management processes;
- Cloud computing, manufacturing, and big data processing approaches and tools;
- Learning and data mining and other data-science-oriented approaches and systems;
- Data visualization models and tools for promoting and supporting digital, intelligent smart factory, and cyber–physical production systems;
- Real-time machine- and process-monitoring, diagnostics, and prognostics methods and tools;
- Real-time management methods, tools, and platforms;
- Manufacturing execution systems;
- Open-source software applications for digital or cyber manufacturing;
- Internet of Things and associated models, devices, means and tools for cyber manufacturing and management.

The accomplishment this widened set of approaches, methods, tools, systems, and platforms implies the use of appropriate CollM&M paradigms, which are related to dynamic, distributed, integrated, intelligent/predictive, parallel, and real-time-based contributions [6,24–28].

Moreover, CollM&M has to ensure the fulfillment of an appropriate set of varying objectives or performance measures, which include companies' internal and external goals, and are frequently contradicting, thus further requiring the application of multicriteria and/or multiobjective and intelligent optimization methods, along with data acquisition, normalization techniques, and tools, to enable further incomplete and uncertain data processing, visualization, and analysis [2,5,13,25,29].

The cyber–physical (production) systems (C[P]PS) and smart factories, based on intelligent sensing systems, open and networked and distributed manufacturing systems, along with virtual organizations and extended manufacturing environments, play a fundamental role in I4.0 [22,24,29,30]. In such advanced manufacturing systems (AMS), integration, distributivity, virtuality, agility, servitization, digitalization, and decentralization are major issues for reaching suitable collaborative processes and practices in the I4.0. In this regard, the (Industrial) Internet of Things ((I)IoT), along with smart and ubiquitous networks based on cloud technology, enable large and complex networks and their digitalization [2–4,6,10,14] to carry out CollM&M [7]. In this regard, decisions and related actions must be taken promptly and be further supported by appropriate data-visualization systems [6,14,15,31,32].

Cloud-based M&M technology is, therefore, fundamental to enabling enhanced interoperability and collaborative practices (Varela et al., 2019c; Ferreira et al., 2022). Moreover, horizontal and vertical integration between companies, business partners, factories, suppliers, other stakeholders, and clients is fundamental in I4.0 [2,10,13,14,32,33].

Exponential technology, along with advanced processes, high-performance computing, and disruptive technologies (e.g., automation and robotics, autonomous and collaborative robots, advanced mechatronics, micro- and nano-manufacturing, and supercomputing) are key enablers for proper M&M in I4.0 [6,7,12,32,33].

Moreover, advanced interfaces, virtual, augmented, and mixed reality technology, along with simulation and digital twins, further promote and enhance CollM&M among collaborating entities. These technologies enable advanced and integrated decision-support systems (DSS) and databases (DB), along with knowledge engineering and knowledge bases (KB), automatic data acquisition, and a semantic web for enhancing collaboration [7].

In addition, data science, along with business intelligence, big data processing, and data analytics, are essential pillars of I4.0 supporting CollM&M practices [6,7].

All these issues are crucial for enabling advanced, integrated, and intelligent supply networks, projects, businesses, and their interoperable and fully supported implementation, to reach M&M while ensuring high-quality product development and M&M practices based on appropriate standards, means, and communication devices and protocols, to fully ensure appropriate extended supply network management strategies [5,8,10,15,32–34].

This Special Issue aims to provide new insights regarding CollM&M models and practices, aligned with the contemporary needs regarding the capability of co-creation actions supported by I4.0 technology [7].

In this regard, each of the six selected papers of this Special Issue makes a novel contribution to this purpose.

Pombo et al. present expectations and limitations of cyber–physical systems (CPS) for advanced manufacturing in the scope of the grinding industry. In their work, the authors refer to the importance of grinding technology in the manufacturing of high-added-value precision parts, accounting for approximately 20 to 25% of the whole machining costs in the industrialized world and relying heavily on the experience and knowledge of the operatives. Thus, the authors conclude that suitable approaches are needed to overcome these issues, and digital twin technology is promising in this regard by contributing to the reduction and possibly even the elimination of unnecessary trial-and-error strategies through intensive collaboration between all the involved agents from the university to the industry. The authors highlight the successful implementation of this technique in developing new and more realistic models for predicting wheel wear.

Miranda et al. propose a system model for offline seismic event detection in Colombia. The authors put forward an integrated model that includes five sub-models and is based on a machine-learning approach, and they highlight its suitability for identifying P-wave windows in historical records that permit detect seismic events. Their proposed model permits seeking, gathering, and storing seismic data, along with data reading, analysis, sampling, and classification. The authors further provide some recommendations regarding their model's implementation in developing a seismic-event detection system.

Samala et al. put forward a systematic literature review (SLR) about investigating degradation and upgradation models for flexible unit systems. In their work, the authors research the so-called flexible unit systems (FUS) in the current I4.0 era and the context of descriptive, predictive, and prescriptive analysis, aiming at integrating distributed and digitalized systems. The authors highlight that the existing literature mostly focuses individually on the descriptive, predictive, and prescriptive analysis paradigms. Moreover, the authors also claim that the literature is unclear about the integration of degradation and upgradation models for FUS. Thus, the authors carried out an SLR, through which it was possible to identify five main issues about degradation—residual life distribution, workload adjustment strategy, upgradation, and predictive maintenance—as major performance measures to investigate the performance of the FUS. In this study, it was understood that the degradation rate would affect the life and production rate of different configurations of FUS. Moreover, it was possible to realize that the considered upgradation model and predictive maintenance, along with advanced analytics procedures of the manufacturing systems, are valuable and enable the systems to run with higher production rates while increasing the life of systems. Moreover, it was also possible to explore three research objectives related to system configuration flexibility to improve the proposed FUS and identify further research opportunities in this field.

Carchiolo et al. focus on co-authorship networks analysis to discover collaboration patterns among Italian researchers. Through their study about the analysis of behaviors of a large community of researchers and their correlations between the underlying environments, the authors determined a set of grouping rules by law or specific institutional policies that enabled conclusions about their performance and, importantly, affecting metrics to evaluate the quality of their research carried out. To this end, the coauthors created a procedure to craft a large dataset of Italian academic researchers by considering a set of performance indices and co-authorship information. Through their study, the authors could automate the association of profiles and the mapping of publications to reduce the use of computational resources. Moreover, the authors presented several examples of how the information extracted from the datasets can help better understand the dynamics influencing scientific performances.

Fior, Cagliero, and Garza refer in their work to leveraging explainable AI to support cryptocurrency. The authors clarify that this research area has been attracting the attention of many researchers and continues to be a very important research focus for private and professional traders and investors. They further mention that forecasting financial markets can be properly approached by using algorithmic trading systems based on AI models, which are becoming more and more developed. Moreover, the authors state that such approaches usually suffer from a lack of transparency, thus hindering domain experts from directly monitoring the fundamentals behind market movements. Additionally, they mention that this is particularly critical for cryptocurrency investors because studying the main factors influencing cryptocurrency prices, including the characteristics of the blockchain infrastructure, is crucial for driving experts' decisions. Thus, in their paper, the authors propose a new visual analytics tool to support domain experts in explaining AI-based cryptocurrency trading systems. To further describe the rationale behind AI models, their proposed approach exploits an established method, the SHapley Additive exPlanations, which, according to their results, allows experts to identify the most discriminating features and provides them with an interactive and easy-to-use graphical interface.

Orlova approached design technology and AI-based decision-making models for digital twin engineering. This study proposes comprehensive technology (methodological approach) for digital twin design to accelerate its engineering. The author clarifies that this kind of technology consists of design steps, methods, and models and provides systems synthesis of digital twins for a complex system (object or process) operating under uncertainty that can reconfigure in response to internal faults or environment changes and perform preventive maintenance. The author mentions that the proposed technology structure was developed based on a simulation model using situational "what-if" analysis and based on fuzzy logic methods. The author applied this technology to develop a digital twin prototype for a device at a creation life cycle stage to reduce the consequences of unpredicted and undesirable states. Through the study, it was possible to realize unforeseen problems and device faults during its further operation. According to the author, the proposed model identifies a situation as a combination of failure factors of the internal and external environment and provides an appropriate decision about actions with the device. Further, the authors mention that the practical significance of the research is the developed decision support model, which is the basis for control systems to solve problems related to monitoring the current state of technical devices (instruments, equipment) and supporting adequate decisions to eliminate their dysfunctions.

Undertaking this Special Issue, "Collaborative and Intelligent Networks and Decision Systems and Services for Supporting Engineering and Production Management", was a challenging and rewarding task for the Editors. The diversity of the manuscripts demonstrates the broad scope and relevance of the research theme in fostering performance and transformation for achieving collaborative practices in I4.0.

List of Contributions:

1. Pombo, I., Godino, L., Sánchez, J.A., and Lizarralde, R. (2020). Expectations and limitations of Cyber-Physical Systems (CPS) for Advanced Manufacturing: A View from the Grinding Industry.
2. Miranda, J., Flórez, A., Ospina, G., Gamboa, C., Flórez, C., Altuve, M. (2020). Proposal for a System Model for Offline Seismic Event Detection in Colombia.
3. Samala, T., Manupati, V.K., Varela, M.L.R., and Putnik, G. (2021). Investigation of Degradation and Upgradation Models for Flexible Unit Systems: A Systematic Literature Review.
4. Carchiolo, V., Grassia, M., Malgeri, M., and Mangioni, G. (2022). Co-Authorship Networks Analysis to Discover Collaboration Patterns among Italian Researchers.
5. Fior, J., Cagliero, L., and Garza, P. (2022). Leveraging Explainable AI to Support Cryptocurrency Investors.
6. Orlova, E.V. (2022). Design Technology and AI-Based Decision Making Model for Digital Twin Engineering.

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