Industry 5.0-based methods, tools, and models for managing operator-centric industrial systems

Industry 5.0 (I5.0) aims to elevate the performance of cyber-physical production systems established by the Industry 4.0 (I4.0) paradigm. This advancement is driven by a human-centred approach, highlighting the essential role of human-machine collaboration. [1]. While I4.0 focuses on improving production efficiency and quality through advanced technologies, it fails to address industrial sustainability and operator well-being [2]. Consistent with these principles, I5.0 significantly restructures human tasks, shifting labour from manual to cognitive [3]. In a fifth-generation smart factory, skilled workers are expected to perform high-value production tasks, identify and correct deviations from standard procedures, and comprehensively understand the standards and legal frameworks governing technology, societal issues, and management practices [4]. This new approach emphasizes integrating operators into cyber-physical systems, allowing them to enhance their physical and cognitive abilities [5]. If on the one hand, using technologies to boost the inherent capabilities of operators increases manufacturing system flexibility [6]; on the other hand, it introduces the challenge of managing complex human-machine systems, where operators may suffer cognitive overload due to the complexity of their tasks [7]. In this context, it is essential to renew the management of industrial systems, adapting them to the characteristics and needs of the operators and the evolving nature of tasks. This session aims to explore new methodologies, approaches, guidelines, frameworks, and models for managing industrial systems from a human-centric and I5.0 perspective.

Topics may include, but are not limited to:

- Human-centric design of industrial systems.
- Methodologies, models and approaches for managing the cognitive workload of the operator.
- Tasks assignment models based on the well-being of the operator.
- Assessments of the impact generated by industrial technologies on operator well-being.
- Assessments of the influence of the operator's emotional state on his performance.
- Development of models for system management based on real-time monitoring of operator conditions.
- Assessments of the operator's perception of the complexity of operations and the correlation with the perceived cognitive workload.
- Identification of human factors to be considered for balanced workload management.
- Identification of environmental factors influencing the operator's well-being.
- Development of tools based on operator features.

Organizers:

- Francesco Facchini, Polytechnic University of Bari, Italy francesco.facchini@poliba.it
- Micaela Vitti, Polytechnic University of Bari, Italy micaela.vitti@poliba.it
- Antonio Padovano, University of Calabria, Italy, antonio.padovano@unical.it
- Antonio Forcina, University of Naples Parthenope, Italy, antonio.forcina@uniparthenope.it
- Ferdinando Chiacchio, University of Catania, Italy, ferdinando.chiacchio@unict.it

References

[1] European Commission, "Industry 5.0." [Online]. Available: https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en

[2] S. Huang, B. Wang, X. Li, P. Zheng, D. Mourtzis, and L. Wang, "Industry 5.0 and Society 5.0—Comparison, complementation and co-evolution," *J Manuf Syst*, vol. 64, pp. 424–428, Jul. 2022, doi: 10.1016/j.jmsy.2022.07.010.

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[3] F. Longo, A. Padovano, and S. Umbrello, "Value-Oriented and Ethical Technology Engineering in Industry 5.0: A Human-Centric Perspective for the Design of the Factory of the Future," *Applied Sciences*, vol. 10, no. 12, p. 4182, Jun. 2020, doi: 10.3390/app10124182.

[4] P. K. R. Maddikunta *et al.*, "Industry 5.0: A survey on enabling technologies and potential applications," *J Ind Inf Integr*, vol. 26, p. 100257, May 2022, doi: 10.1016/j.jii.2021.100257.

[5] E. Kaasinen *et al.*, "Empowering and engaging industrial workers with Operator 4.0 solutions," *Comput Ind Eng*, vol. 139, Jan. 2020, doi: 10.1016/j.cie.2019.01.052.

[6] D. V. Enrique, J. C. M. Druczkoski, T. M. Lima, and F. Charrua-Santos, "Advantages and difficulties of implementing Industry 4.0 technologies for labour flexibility," in *Procedia Computer Science*, Elsevier B.V., 2021, pp. 347–352. doi: 10.1016/j.procs.2021.01.177.

[7] C. Guerin, P. Rauffet, C. Chauvin, and E. Martin, "Toward production operator 4.0: Modelling Human-Machine Cooperation in Industry 4.0 with Cognitive Work Analysis," in *IFAC-PapersOnLine*, Elsevier B.V., 2019, pp. 73–78. doi: 10.1016/j.ifacol.2019.12.111.