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Title of the Keynote Address:
"Collaborative Automation Systems and the Corresponding Enabling I&C Technologies"

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Abstract

We speak about *automation* when a computer or another artifact executes certain functions that are normally performed by a human agent. At present, we can notice that automation has changed under the influence of the new business and enterprise modes, and under the new enabling I&CT (Information and Communication Technologies).

Automation has an ever broader scope at present. It has pervaded not only most safety or time critical process control systems, such as: aviation, steelworks, power systems or refineries, but also transportation, libraries, robotized homes, libraries, medical surgery, and even intelligent cloths. The relation of the human and automata has evolved in the XXI Century from substitution to updating human skills and practice. Initially, "substitution [of the human agent] assumed fundamentally uncooperative system architecture in which the interface between human and machine has been reduced to a trivial "you do this; I do that" barter…. Currently, "Quantitative "who does what" allocation does not work because the real effects of automation are qualitative: it transforms human practice and forces people to adapt their skills and routines." (Dekker, Woods 2002)

The *controlled object* and the *control schemes* have been evolving from the traditional hierarchical systems (Mesarovic et al, 1970) and can be modelled as *collaborative networks (*CN). A CN is defined by Camarinha-Matos & Afsarmanesh (2005) as "a network consisting of a variety of entries (e.g. organizations, people and even machines) that are largely autonomous, geographically distributed and heterogeneous in terms of their operating environment, culture, social, capital, and goals, but collaborate to better achieve common or compatible goals and whose interactions are supported by computer networks." The *cooperative control systems* show many advantages such as: openness (they are easier to build and change), reliability (e.g. fault tolerance), higher performance (due to distributed execution of tasks), scalability (incremental design is possible), flexibility allowing heterogenity and redesign), potentially reduced cost, spatial distribution of separated units. There are several possible drawbacks of such schemes: communication overhead (e.g. time and cost of information exchange), lack of guarantee for data security and/or confidentiality, decision "myopia" (caused by local optima), chaotic behaviour (e.g. "butterfly effects" and bottlenecks); complexity of analysis in comparison to centralized and even hierarchical schemes **(**Monostori *et al* 2015). A new discipline, namely *Collaboration Engineering*/ *Control* (Nunamaker et al 2015; Nof 2017), has emerged.

All the above evolutions were enabled by the progress in I&CT (Filip et al 2017). The talk surveys several new disciplines and technologies which have a major impact, such as *Big Data* (Shi, 2015), *IoT/WoT* (Guinard, Trifa 2016), and *Artificial Intelligence* (Bughin et al, 2017). It is organized as follows. In the first part, several evolutions to be noticed in automation such as: broadening its scope, "distribution of labour" between human and machine, evolution of the control schemes toward cooperative ones are reviewed and a definition of *collaborative automation* is proposed. In the second part of the talk, various I&C T are described with a view to highlighting their relevance to collaborative automation.

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