



## Design and evaluation of a cooperative supervision system based on supervisory control theory and human centered design

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## Topic:

The PHD thesis is in line with the problem of Industry 4.0 and the massive use of cyber-physical systems to design intelligent manufacturing systems (IMS) with self-organizing properties allowing greater flexibility of production and better adaptation to hazards. Nevertheless, these approaches do not guarantee an overall optimization of the performance as well as its safety of operation. Moreover, the use of a self-organized command approach can generate behaviors emerging from the operative part leading, for example, to blocking or congestion situations, which could be difficult to understand for a supervisory operator, in particular during slow drifts of settings.

The research to be carried out should therefore consider the Human Operator (HO) at the center of the plant to monitor, understand, decide and pilot by proposing to him advanced supervisory tools which allow him to optimize production on the one hand, and on the other hand, to manage abnormal and unanticipated situations and which constitute a crucial stake for the safety of the HMS. The multiple levels of constraints of the manufacturing process and its dynamic nature involve identifying and combining information in a meaningful way so that the operator retains control of this system.

The approach will be dual by combining Discrete Event Systems approaches (SCT, logical filter, etc.) and the human centered automation approach (Human-Machine Cooperation, Assistance tools, etc.), with application to the flexible cell of the AIP at Valenciennes, and digital twins:



- In the first approach, the control is considered as a black box. The SCT-oriented methods and tools developed by CReSTIC are based on the definition of a filter, checked offline by model checking, to guarantee the safety of the production system, independently of the controller. Therefore, it is possible to formally guarantee the safety of self-organized control systems, whose behaviors, by definition, are not predictable. In addition, during failures of the IMS, manual or semi-automatic resumption by the HO will be necessary. The filter approach offers interesting possibilities for the design of human-machine cooperation tools, which should be developed. Finally, the filter relies on identification and modeling of the process through the definition of logical constraints. The latter have a strong explanatory power and can a priori allow the development of identification, monitoring and prediction tools providing the HO with pertinent information to guarantee its understanding of the situation and to support its decision making.
- On the contrary, the second approach seeks to modify the current algorithms of self-organized control so as to create points of possible interaction with the supervision operator, these points allowing, on the one hand, this operator to access Information enabling it to understand the situation other than by considering the outputs of this system and on the other hand by giving it the possibility of controlling the operative part with higher-level controls than those acting directly on the physical system. To do this, the Cognitive Work Analysis (CWA) method will be deployed to define the human information needs and the LAMIH human machine cooperation approaches used to define the tools and associated interfaces.

These proposed algorithms and H-M Interfaces will be tested using simulation tools, implemented on the AIP cell and FACTORY I/O software, evaluated with supervisory operators.

The PHD student will be located on Valenciennes University but several trips are to be expected to Reims University.

#### Financing:

Public: ANR Project HUMANISM



#### Salary range:

< 25,000 € annual gross

**Skills / Candidate profile:** candidates must have a strong background in Automation and Industrial Computing, especially in discrete events systems, and be fluent in English.

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Applications must be sent before 15 september 2019 to: [serge.debernard@uphf.fr](mailto:serge.debernard@uphf.fr). A detailed CV including the notes of M1 and M2 will be requested, as well as a motivation letter and any documents deemed useful by the candidate (letters of recommendation, references of course supervisors...).

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