Thesis Subject: Planning of reconfigurable production (manufacturing) systems for mass customized products

1. CONTEXT AND SCIENTIFIC OBJECTIVES:

Industries nowadays are facing difficult socio-economic environment due to more demanding customers, shorter product life cycle, increased product variety, severe competition, exponential technological development, internet evolution, etc. Agile, flexible and reconfigurable manufacturing systems as well as product variety management are methods permitting to reduce costs and complexity in such a changing environment (El Maraghy et al., 2013). They are based on modularity which can be defined as building a complex product or process from smaller subsystems that can be designed independently. It has been proven to reduce costs, and improve quality and flexibility (Shaik and Rao, 2014). A reconfigurable manufacturing system is defined as a system designed at the outset for rapid change in structure, as well as in hardware and software components, in order to quickly adjust production capacity and functionality within a part family in response to sudden changes in market or regulatory requirements (Koren et al. 1999).

According to Farid (2014), over the last years, many technologies and design approaches have been developed to enable reconfigurability in manufacturing systems. These works included the development of modular machine tools and material handlers, distributed automation and a wide set of artificially intelligent paradigms such as multi-agent systems, and holonic manufacturing systems (Farid, 2014) . Yet there are very few works on production planning for reconfigurable manufacturing systems. Which is normal, since first research works in this domain focused on the design of reconfigurable manufacturing systems rather than on their control and management. Yet, proposing methods for production planning for RMS is of outmost importance since current production planning methods cannot quickly realize the production-side adaptions available in RMS and are limited in flexibility (Hees at al., 2017).

Research works in the field of production planning and control for reconfigurable manufacturing systems focused on optimizing the reconfiguration of the manufacturing system using mainly mathematical programming. Few works focused on capacity planning, or on machine scheduling and the design of adaptable process plans. Nevertheless, these works are still very modest (Hees at al., 2017). One of the very recent research works in this field, is the one of Hees et al. (2017) who proposed a novel production planning method to optimize the potential of RMS. They have identified the key characteristics and planning requirements for an RMS then determined a feasible configuration, using a planning method based on mixed integer linear programming (MILP). Their method is adapted for mass produced products, and is very limited in the case of mass customized products where every product is unique. The aim of this research work is to propose a planning method for RMS but also for mass customized products.

2. THESIS RESEARCH PROGRAM

2.1. LITERATURE REVIEW

This task consists of the following:

- Analysing and comparing existing production planning methods (clustering approaches, fuzzy analysis, Heuristic methods, genetic algorithms, mathematical programming, graphs, etc.).
- Identifying production-planning methods for reconfigurable manufacturing systems.
- Identifying production-planning methods for mass customization.
- Defining all evaluation criteria and characteristics for an RMS and for MC.
- Analyzing and comparing these methods for reconfigurable manufacturing systems.
- Analyzing these methods and approaches for mass customization.
- Proposing best suitable approaches for RMS and MC.

2.2. PROPOSITION DEVELOPMENT

This task consists of the following:

- Proposing a full approach for production planning and control for reconfigurable manufacturing systems and for mass customized products.

- Identifying evaluations criteria to measure the performance of the proposed approach.
- Develop the required tools for implementing this approach.

2.3. VALIDATION

This task consists of:

- Collecting all necessary data for the use case. A huge amount of data is required to validate the developed concepts, methods and tools in this research. These are related to the product bill of material, functional description, customer preferences, production processes, etc.
- Implementing the proposed method on the chosen use case. This will lead to different iterations and improvements/modifications to the proposed method.
- Evaluating the proposed production planning method. After the final iteration, limits of the proposed method as well as its main advantages will be identified.

3. RESEARCH LABORATORY

Mécanique, Acoustique et Matériaux (Roberval) - FRE UTC-CNRS 2012
Computational Mechanics, Acoustics & Materials Science (Roberval) - FRE UTC-CNRS 2012

The UTC Roberval Laboratory promotes the development of innovative computational and experimental protocols and tools for reliable and robust analysis-based design, of mechanical engineering systems and structures.

4. CONTACT

Joanna Daaboul, PhD.
Assistant Professor
Responsible for Integrated Production and Logistics Specialty
Sorbonne Universités, Université de Technologie de Compiègne,
Department of Mechanical Engineering, Roberval,
Rue du Dr Schweitzer, CS60319, 60203 Compiègne Cedex, France.
Tel: +33 3 44 23 79 21 - Fax: +33 344 235 229
Mob: +33 6 60 08 16 29 - Skype: joanna.daaboul

http://www.utc.fr/~jdaaboul/

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