

Université de Lorraine

École doctorale IAEM (Informatique, Automatique,
Électronique - Électrotechnique, Mathématiques)
Laboratoire de Génie Informatique, de Production et de Maintenance

INTEGRATED AND MULTI-CRITERIA APPROACHES FOR PROCESS PLAN
GENERATION IN RECONFIGURABLE MANUFACTURING SYSTEMS WITH
CONSIDERATION OF SYSTEM CAPABILITIES AND PRODUCT CONSTRAINTS

MUHAMMAD AMEER

Devant le jury composé de :

M. Bertrand ROSE, Professeur des Universités. Université de Strasbourg, Rapporteur,
M. M'hammed SAHNOUN, Maître de Conférences HDR. CESI Rouen, Rapporteur,
Mme. Gülgün ALPAN-GAUJAL, Professeure des Universités. INP Grenoble, Examineur,
Mme. Alice YALAOUI, Professeure des Universités. Université de Technologie de Troyes, Examineur,
M. François PEREZ, Professeur des Universités. Toulouse INP-ENIT, Examineur,
M. Hichem HADDOU BENDERBAL, Maître de Conférences. Aix-Marseille Université, Examineur,
M. Mohammed DAHANE, Maître de Conférences HDR. Université de Lorraine, Directeur de thèse,

ABSTRACT

Modern manufacturing systems are going through a paradigm shift where the focus is on integrating digital technologies in production systems to address the challenge of uncertain market demands. Manufacturing systems need a certain amount of responsiveness to address these uncertainties by adapting accordingly. To achieve this goal, manufacturing systems require more changeability at physical and logical levels. For this purpose, modern-day manufacturing systems are designed with dynamic resource capabilities with modular components to provide the required amount of reconfigurability. From the perspective of "industry 4.0", reconfigurability is vital for effectively adapting manufacturing systems in a complex environment. Reconfigurability provides the quick adaptation of these systems and quick responsiveness towards socio-techno-economical competitiveness. The objective is to respond to modern-day challenges (both external and internal) i.e mass customization, globalization, product variety management, system reconfiguration management, and reducing the lead time.

In this thesis, the design problem of reconfigurable manufacturing systems (RMS) is considered, which meets the requirements mentioned above. The goal is to design a responsive system based on two key features modularity and reconfigurability. We study the RMS design problem as the development of a process plan for a particular part of the part family and the selection of the system's dynamic resource capabilities to produce that part.

This work is divided into three sections. (1) Co-generation of process and setup plan for a part in the reconfigurable environment. (2) Minimisation of reconfiguration effort in process design. (3) Minimization of the under-utilization of modular reconfigurable machines in RMS design problem.

Keywords: Reconfigurable Manufacturing System (RMS), reconfigurable machines tool (RMT), Process plan generation, reconfigurability, modularity, multi-criteria optimization, reconfigurable fixtures, performance indicators, Reconfiguration effort.