International Conference
on Industrial Engineering and Systems Management

**IESM' 2009**

May 13 - 15, 2009

MONTREAL - CANADA

# A new human-machine system for group sequencing *

Guillaume PINOT [a], Nasser MEBARKI [a], Jean-Michel HOC [a]

[a] *IRCCyN, Institut de Recherche en Communications et Cybernétique de Nantes, UMR CNRS 6597, Nantes, France*

*Abstract*

The group sequencing method is a proactive reactive scheduling method which aims at bringing flexibility as well as quality. This method is based on a human-machine system allowing to choose in real-time the next operation to perform in a group of permutable operations. In this paper, we propose a new method to improve the cooperation between the human operator and the machine for group sequencing. This new method intends to favor the activity of the operator. To evaluate the pertinence of this new method, an experiment is planned. The factors and the expected results of this experiment are discussed in this paper. Depending on the results of this experiment, changes in the reactive phase of the group sequencing will be done in order to improve the cooperation between the operator and the machine.

*Key words:* Scheduling, Human-machine cooperation, Group sequencing, Human factors

## 1 Introduction

The job shop problem is an optimization problem composed of resources, jobs, operations, and constraints. A job $i$ has a set of operations ($O_{i,j}$), each operation $O_{i,j}$ is executed on at least one resource during a processing time $p_{i,j}$ with precedence constraints: the operation $O_{i,j+1}$ cannot be executed before operation $O_{i,j}$ is completed.. A resource, also named machine, can execute only one operation at a time. An operation $O_{i,j}$ has a starting time denoted $t_{i,j}$ and a completion time denoted $C_{i,j}$ with $C_{i,j}= t_{i,j}+ p_{i,j}$. A job $i$ has a completion time $C_i$ which corresponds to the completion time of the last operation of the job. A job $i$ has also a release date $r_i$ before which the job cannot be executed and a due date $d_i$ used to compute the lateness $L_i$ of the job: $L_i = C_i-d_i$. If $L_i$ is positive, the job is late. Generally, the job shop problem uses a regular objective function $f$ that is an increasing function of the $C_i$. The goal is to minimize this objective function. The makespan, denoted by $C_{max}$, calculated $max_i C_i$, which corresponds to the total time of execution of the schedule, is a classical regular objective. Another classical regular objective is the maximum lateness noted $L_{max}$, calculated $max_i L_i$.

Actually, manufacturing problems are not so deterministic. Most of times they present uncertainties, which are due to the lack of precision of the model or to hazardous phenomenon very frequent in manufacturing systems (e.g., machine breakdown, new operations to be done urgently, etc...). To cope with these uncertainties, systems which favor cooperation between human and machine are appropriate ([2], [3]).
This is why group sequencing was created by [4]. This method aims at describing a set of feasible schedules in order to delay decisions to take into account uncertainties. Group sequencing is used according to two stages: a predictive phase and a reactive phase.

* This paper was not presented at any other revue. Corresponding author Guillaume PINOT. Tel. +33 (0)240376975. Fax +33 (0)240376930
*Email addresses:* guillaume.pinot@irccyn.ec-nantes.fr, nasser.mebarki@irccyn.ec-nantes.fr, jean-michel.hoc@irccyn.ec-nantes.fr