

# Comparative study between methods for selection alternative routings in real time

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*Abstract*—The management of the queues by rules of priorities constitutes one of the simplest approaches and most used to dynamically schedule the tasks in a job shop. Unfortunately, one of the most important problems concerning the use of the rules of priority is the fact that no rule seems overall better than the others. To regulate these problems, we will combine rules of priorities and scheduling with selection of alternative routings in real time rule DMM. This combination will be realized according to the operating conditions, of the production targets and the state of the job-shop. Since the state of the workshop changes during time, we propose to analyze the state of the system each time a decision of scheduling must be taken, in order to take into account the real state of the job-shop. This approach will be implemented on a model of job-shop and will simulate by the simulation software ARENA.

*Job-shop; Real time FMS control; Dispatching rules; Selection of routings; Simulation.*

## I. INTRODUCTION

In general, scheduling involves decisions of allocating resources to tasks over time, and optimizing one or more objectives. Scheduling models can be either deterministic or stochastic. Deterministic models assume that all job data are known exactly in advance. In stochastic models, not all job data but their distributions are known. Static scheduling problems assume that a list of  $n$  jobs are available at the beginning of the scheduling period, while the dynamic scheduling problems deal with an ongoing situation, in which new jobs are continuously added to the system. The general scheduling problem is a NP-hard type of problem [1]. One of the earliest studies on the FMS scheduling problem in the work of Nof and al. [2] who demonstrated the importance of scheduling decisions for system performance. From a traditional viewpoint, scheduling almost immediately subject to inevitable changes. Therefore the traditional off-line scheduling approaches cause increased waiting times, increased work-in-process, low equipment utilization, and eventually degrade the system performance. [3],[4]. Several researchers propose various methods to accommodate flexibility into off-line scheduling in order to increase the system performance [5], [6]. However, real time scheduling has always remained a desirable but elusive goal [7], [8]. real

time scheduling and control FMS have been popular research areas since the beginning of the 1980s when flexible manufacturing systems started gaining acceptance by the industrialized countries [9].

Owing to the lack of successful analytical methods, simulation has been used for real-time scheduling of FMS by several researchers. The framework of simulation based real-time FMS scheduling includes a simulation model linked to a physical system. Many studies in real-time FMS scheduling and control area do not consider the influence of routing flexibility [10]. Most of the studies that consider routing flexibility in FMS focus on the problem of routing selection prior to production [11]. This approach is not applicable to random type FMS. The control system of a random type FMS is required to have the capability to adapt to the randomness in arrivals and other unexpected events in the system by effectively using operation and routing flexibility in real-time. The objective of this study is to test the effectiveness of DMM method with combination between dispatching rules SPT, LPT, FIFO, LIFO and compare these methods with the DMM method and FIFO dispatching rule.

## II. JOB SHOP MODEL

The hypothetical FMS is assumed to be composed of :

1. Two vertical milling machines (VMC).
2. Two horizontal milling machines (HMC).
3. Two vertical turning centres (VTC).
4. One shaper (SHP).
5. One loading station (L).
6. One unloading station (UL).

Each machine in the system has an input and output buffer and there are six part types.

The alternative routes and processing times of each part type and the production ratio of the part types that are randomly arriving at the loading station.

The operation of the FMS model used in this study is based on the following assumptions:

1. The flexible process plan (i.e. alternative routings) of each part type is known prior to production.
2. Processing times are known deterministically and they include tool change, set-up, and machining times.

3. The processing time of an operation is the same on the alternative machines identified for that operation.
4. Each machine can process only one part at a time.

### III. ALGORITHM OF DMM RULE

Through a description of its algorithm, in this section we present the DMM rule proposed by Saygin and *al* [12]. We will show various steps to integrate the DMM rule as a tool for selecting alternative routings in real time.

Here we show how to apply the DMM rule in FMSs to select a routing among those available for each type of part. The parts that arrive first have the highest priority in accordance with the rule First in First out (FIFO); the other parts will wait in input or output queues of various machines or in the loading station. The algorithm of the DMM rule is as follows:

- Step 1:** All routes are free (available) so  $X(i) = 0$ .
- Step 2:** Calculation of dissimilarity coefficients  $D_{ij}$  between machines.
- Step 3:** Creation of parts.
- Step 4:** Condition: depending on the type of part tested, if there is at least one free routing and at least one free place in the queue of the loading station.
- Step 5:** If the previous condition is not verified, the part is in a queue until the condition is verified.
- Step 6:** If the condition of Step 4 is satisfied, then we calculate the sum:  $S(j) = \sum_{i=1}^q X(i)D(i, j)$
- Step 7:** Find the maximum of  $S(j)$ .
- Step 8:** The routing  $j$  corresponding to the maximum value of  $S(j)$  found in the previous step is selected, so:  $X(j) = 1$ .
- Step 9:** Treatment of the part according to the selected routing  $j$ .
- Step 10:** At the end of the treatment, routing becomes available again,  $X(j) = 0$ .
- Step 11:** The part leaves the system. *Note:* This cycle will repeat itself from Steps 3 to 11 at each part creation, until the end of the simulation time.

### IV. SIMULATION RESULTS

In order to show the improvements made by DMM method with combination between SPT, LPT, LIFO and FIFO dispatching rules, we made several

studies in simulation with variations on the criteria of the studied system. The following results are obtained after the simulation of the Job shop model by ARENA software.

#### A. Work in process

In this section we can see that the results given by DMM/FIFO (original method) is not the best if the system is saturated.

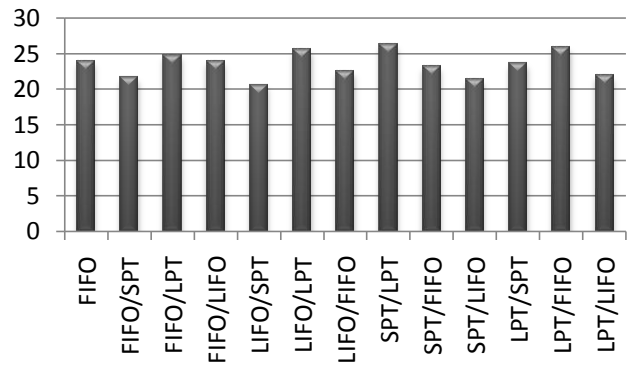


Figure 1. Work in process for queue size=2 and creation of the parts (1/5) min.

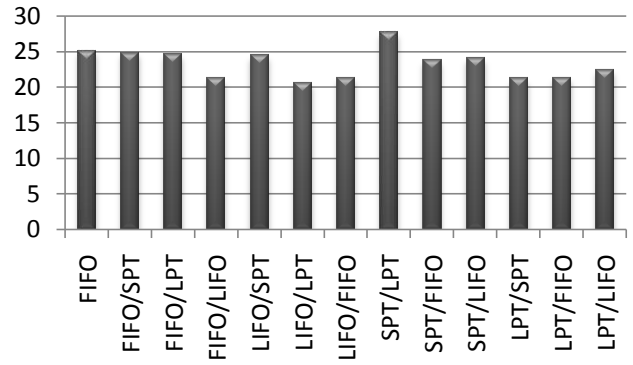


Figure 2. Work in process for queue size=2 and creation of the parts (1/10) min.

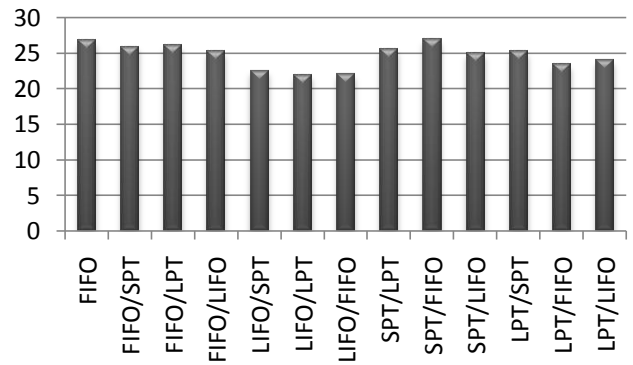


Figure 3. Work in process for queue size=4 and creation of the parts (1/5) min.

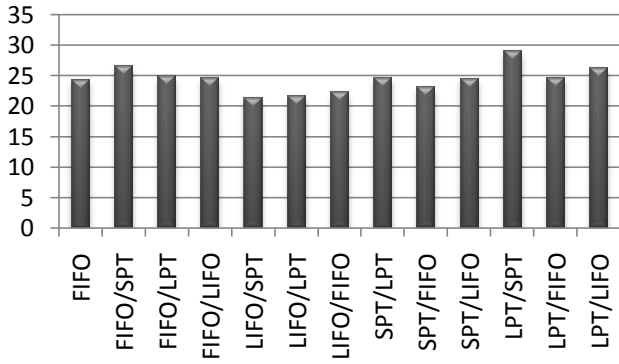


Figure 4. Work in process for queue size=4 and creation of the parts (1/10) min.

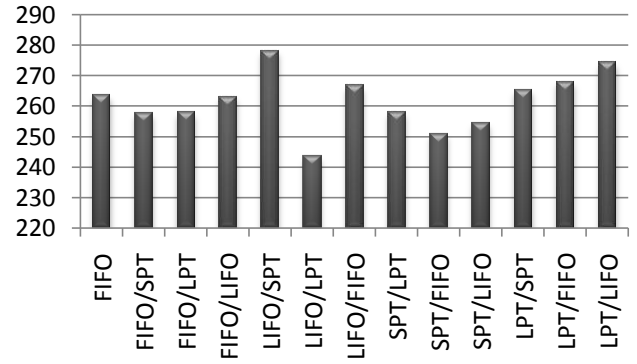


Figure 7. Cycle Time (min) for queue size=4 and creation of the parts (1/5) min.

### B. Cycle Time

In the case of cycle Time we can say that the cases where are the rules SPT or LPT give the best results.

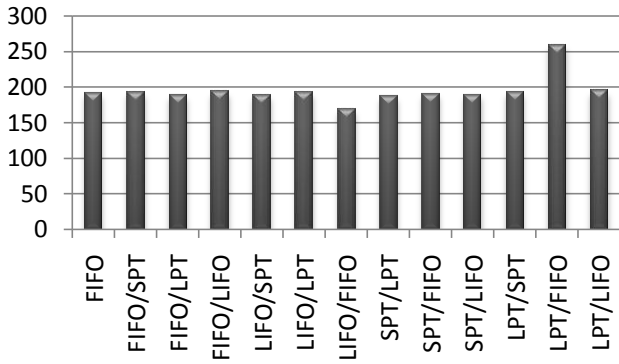


Figure 5. Cycle Time (min) for queue size=2 and creation of the parts (1/5) min.

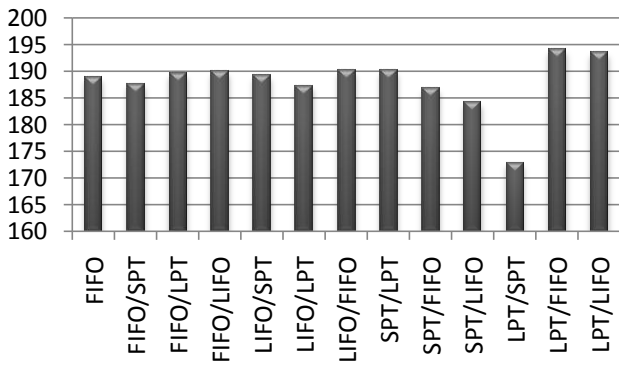


Figure 6. Cycle Time (min) for queue size=2 and creation of the parts (1/10) min.

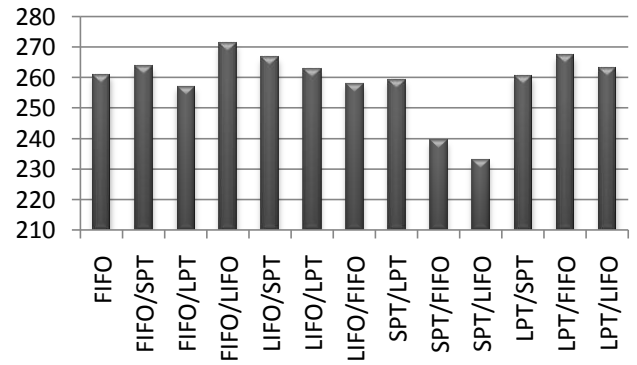


Figure 8. Cycle Time (min) for queue size=4 and creation of the parts (1/10) min.

## V. CONCLUSION

In conclusion we can say that the DMM/FIFO method give not the best results if the system is in saturation case and the other combinations studied here give more significant results.

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