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# Developing Fuzzy Scheduling System for Jobs Prioritization & Route Selection of Jobs in FMS

**Sumit Chawla**

Assistant Professor, Delhi Technical Campus, Greater Noida, India


| | | | |
|---|---|---|---|
| FMS | | | |
| Manufacturing cell | Medium | 30-500 | 20-500 |
| Stand-alone NC Machine | High | 200 and up | 1-50 |

## 3. Scheduling Concepts

Scheduling is one of the most important functions in a manufacturing firm. It is the allocation of available

types of organization where performance evaluation is significantly important for staff motivation, behavior development, attitude, communicating, aligning individual and organizational aims and developing positive relationships between staff and management. [1]

Hao-Cheng Liu and Yuehwern Yih (2013) focused on the liquid crystal injection (LCI) scheduling problem, which is divided into two sub-problems: automated guided vehicle

(AGV) dispatching and LCI machine scheduling. First sub-problem is solved using a fuzzy based method called self-adjusted fuzzy (SAF) method and second sub-problem is solved using a modified least slack time (MLST) method. [5]

## 5. Fuzzy Methodology

The concept of fuzzy logic was developed by the Lotfi Zadeh in 1965. Fuzzy logic is problem solving control system methodology that gives a simple way to come at a definite conclusion based on missing, uncertain, imprecise, ambiguous and noisy input information. Now days, fuzzy logic approach is used mostly in control problems. Structure of Fuzzy logic system consists of mainly four functional blocks i.e. rule base, fuzzifier, defuzzifier and inference. Structure of Fuzzy logic system is shown in figure 1.

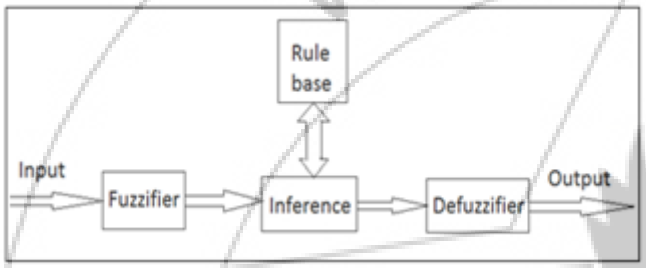


**Figure 1:** Structure of Fuzzy logic system

## 6. Problem Definition

Our Problem is to identify the priority of jobs and find best route of jobs using fuzzy logic system. Table II shows the processing time of jobs on different machines. Three variables that we used as an input in Fuzzy logic in Matlab to identify the job priority are:
(a) Processing time (0 to 30)
(b) Due date (0 to 65)
(c) Profit over cost (0 to 10000)

**Table 2:** Processing time of jobs on different machines

| M/c | Job A | Job B | Job C | Job D | Job E | Job F |
|---|---|---|---|---|---|---|
| 1 | 7 | 6 | 8 | 5 | 4 | 6 |
| 2 | 3 | 6 | 2 | 1 | 4 | 1 |
| 3 | 8 | 4 | 2 | 6 | 2 | 3 |
| 4 | 3 | 9 | 3 | 3 | 9 | 7 |
| 5 | 4 | 6 | 5 | 2 | 1 | 6 |
| 6 | 3 | 2 | 7 | 5 | 2 | 9 |

## 7. Fuzzy Rules For Job Prioritization

Since the input variables such as due date, profit over cost and processing time all have three states each. So total number of rules formed are 3×3×3=27 rules. An easy and convenient way to show all rules is a decision table, which is given below in table III.

**Table 3:** Fuzzy Rules for Job prioritization using three inputs and one output

| Due Date | Profit Over Cost | | | Processing Time |
|---|---|---|---|---|
| | Small | Medium | High | |
| Small | HI | PHI | MAX | Small |
| Medium | PAV | HI | PHI | Medium |
| High | AV | PAV | HI | High |
| Small | AV | HI | PHI | Small |
| Medium | LO | NAV | NAV | Medium |
| High | NLO | NAV | PAV | High |
| Small | NAV | NAV | NHI | Small |
| Medium | NLO | NAV | AV | Medium |
| High | MIN | NLO | NAV | High |

These 27 rules are entered in the Rule editor window of Fuzzy logic system. The output variable is priority variable (having triangular membership function also) divided into 9 parts: minimum (MIN), negative low (NLO), negative average (NAV), average (AV), positive average (PAV), high (HI), positive high (PHI) and maximum (MAX).

Three variables that we used as an input in Fuzzy logic in Matlab to identify the best route of jobs are:

(a) Work in queue (WIQ) (0 to 20)
(b) Processing time (0 to 40)
(c) Travel time (0 to 10)

## 8. Fuzzy Rules For Route Selection

Since the input variables such as work in queue, travel time and processing time all have three states each. So total number of rules formed are 3×3×3=27 rules. An easy and convenient way to show all rules is a decision table, which is given below in table IV.

**Table 4:** Fuzzy Rules for route selection of jobs using three inputs and one output

| Travel Time | Work in queue | | | Processing Time |
|---|---|---|---|---|
| | Small | Medium | High | |
| Small | MAX | PAV | NAV | Small |
| Medium | MAX | PAV | LO | Medium |
| High | PHI | AV | LO | High |
| Small | PHI | AV | LO | Small |
| Medium | PHI | AV | NLO | Medium |
| High | HI | AV | NLO | High |
| Small | HI | AV | NLO | Small |
| Medium | HI | NAV | MIN | Medium |
| High | PAV | NAV | MIN | High |

## 9. Results

The values of processing time, due date and profit over cost of different jobs all having equal contribution on outputs are put in fuzzy scheduling system of Matlab and priority using FLS is find out. Rule viewer in fuzzy logic system for Jobs prioritization is shown below in figure 2.

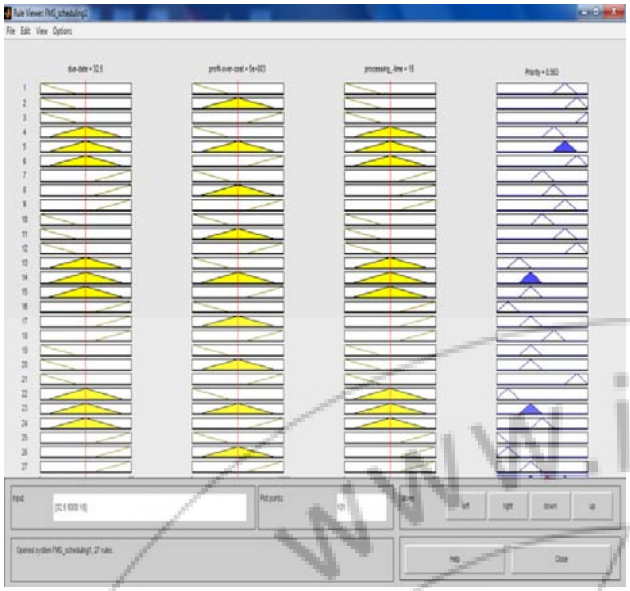

**Figure 2:** Snapshot of Rule Viewer window for Jobs Prioritization

**Table 5:** Jobs priority using fuzzy logic approach

| Jobs | Priority using FLS |
|---|---|
| A | 0.601 |
| B | 0.605 |
| C | 0.610 |
| D | 0.609 |
| E | 0.500 |
| F | 0.602 |

Using fuzzy logic system, we can find out the best route of jobs. Rule viewer in fuzzy logic system represents inputs on the left hand side and output on the right hand side. Rule viewer in fuzzy logic system for route selection is shown below in figure 3.

**Figure 3:** Snapshot of Rule viewer window for Route Selection of Jobs

Third input in the surface viewer is taken as reference input with constant average value. It can vary according to the customer requirements and different surface can be generated. Snapshot of surface viewer for route selection of jobs are shown below in figure 4.

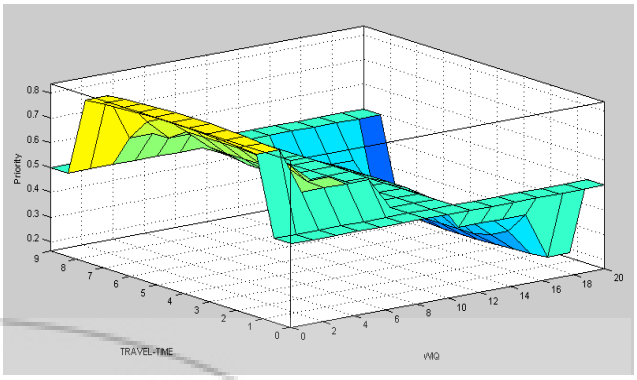


**Figure 4:** Impact of WIQ and Travel time on Route selection of Jobs

## 10. Conclusion

This study shows the application of fuzzy logic approach as a decision aid in the short-term control of flexible manufacturing systems. A fuzzy scheduling system was developed in Matlab for job prioritization and route selection. This scheduling system uses fuzzy rules as well as fuzzy multiple attribute decision-making techniques. The study was done to increase performance by using fuzzy techniques and also in giving a systematic design procedure that takes into account multiple objectives and needs no interface with linguistic directions from human experts.

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