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# Scheduling By Using Fuzzy Logic in Manufacturing

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**Abstract**
This paper represents the scheduling process in furniture manufacturing unit. It gives the fuzzy logic application in flexible manufacturing system. Flexible manufacturing systems are production system in furniture manufacturing unit. FMS consist of same multipurpose numerically controlled machines. Here in this project the scheduling has been done in FMS by using fuzzy logic tool in Matlab software. The fuzzy logic based scheduling model in this paper will deals with the job and best alternative route selection with multi-criteria of machine. Here two criteria for job and sequencing and routing with rules. This model is applicable to the scheduling of any manufacturing industry.
**Keywords**: Scheduling, FMS, Fuzzy logic, matlab, sequencing, processes, routing.

## I. Introduction

As we know whenever we planned the manufacturing system we consider the design criteria such as the system efficiency , the system will be efficient in all the way in production. All such criteria cannot be achieved untill the design production , planning scheduling and controlling steps work well.
A FMS can be defined as production system consisting of identical multipurpose numerically controlled machine (work stations). FMS is a manufacturing system in which there is some amount of flexibility that allows the system to react in the case of changes. FMS works for automated material and tools handling system , load and unload stations, inspection stations , storage areas and a hierarchical control system. Generally when time is being planned , the objective is to design a system which will be efficient in the production of the entire range of parts.
A FMS provides the efficiency of automated high-volume mass production. Scheduling in an FMS environment is more complex and difficult than in a conventional manufacturing environment. Scheduling of FMS determine an optimal schedule and controlling an FMS is considered as difficult task.
Fuzzy set theory was introduced in 1965 by zadeh. Fuzzy logic approaches easily deal with uncertain and incomplete information and human experts, knowledge can be easily coded into fuzzy logic approaches for scheduling FMS is consider due to its ability to deal uncertain and incomplete information and with multi objective problem.

## II. Review of Literature

**2.1.JIPING NIU, JOHN DARTNALL.[1]** gives the idea regarding fuzzy –mrp-ii deals with uncertantity and imprecision. Fuzzy –mrp –II shows all of the information for the decision makers allowing them to consider all possibilities of the orders.

**2.2 SANJOY PETROVIC and CAROLE FAYAD[2]** This paper deals with the load- balancing of m/c in a real-world job scheduling algorithm allocates jobs ,splits into lots on identical m/c with objectives to reduce job total throughput time and to improve m/c utilization.

**2.3. RIPON KUMAR CHAKRABORETY AND MD.A.AKHTAR HASSEN.[3]** This paper work demonstrated interactive fuzzy based genetic algorithmic approach solving a two products and two period aggregate production planning with some vulnerable managerial contraries like imprecise demands, variable manufacture cost etc… here the Author Employee different unique genetic algorithm parameters scrupulously for solving non deterministic Polynomials problem like app problems**.**

**2.4 PARAMOT SRINOI,A/PROF. ABRAHIM SHAYAN, DR. FATMAEH GHOTB[4].** This paper present research project under taken as industrial institutes switchburne in the area of fuzzy scheduling. In this paper fuzzy based schedule model deal with the parts routing problem. Model with select best alternative route with multi criteria scheduling through an approach based on fuzzy logic.

**2.5. DUSAN TEODORNIC.[5].** the paper represent classification and analysis the result achieved using fuzzy logic to model complex traffic and transportation process. fuzzy logic is shown to be very promising mathematically approach to modeling traffic and transportation process characterized by subjectivity, ambiguity, uncertainty and imprecision.

**2.6 by MANISH AGRAWAL.[6]** Here washing machine are common feature today Indian household. The most important utility customer can drive from washing machine. the paper represent idea of controlling the washing time using fuzzy logic control. The paper describes the produce that can be used to get the suitable time for different cloths. the process is based entirely on principle of taking no precise inputs From the sensor, subjecting them to fuzzy arithemats and obtaining crisp value of washing time. It is quite clear from the paper itself that this method can be used in practice to further automates the washing machine. Never the less, this method though with much larger number of inputs parameters and further complex situation is be used qty the giants like LG and Samsung.

**2.7 ZIAUL HASSAN SERNEABAT, NABILA CHOUDHURY, DR. A.K.M.MASUD[7].** This paper gives the study of simulation of FMS.FMS is the production system consisting of identical multipurpose numerically controlled m/cs. Here the model prioritize the job and select the best alternative route with multi-criteria scheduling through an approach based on fuzzy logic and with the help of rules the sequence of the jobs are done and the best route is selected.

## III. Fuzzy logic Approach to FMS

The present industrial trend of manufacturing low cost low-to-medium volumes of modular products with high variability demands manufacturing systems with flexibility and low delivery times. This lead to manufacturing systems with small batch productions, low setup times and many decisional degrees of freedom. The scheduling problem consists of several decisional points. A first division into three parts can be made:

**Timing**: that is, when to insert a part into the system;
**Sequencing**: that is, defining the order with which different parts (batches, orders) are inserted into the system;
**Routing**: that is, defining the route (machine) for a part in presence of alternatives.

Fuzzy logic has the ability to simultaneously consider multiple criteria. Furthermore, the advantage of the fuzzy logic system approach is that it incorporates both numerical and linguistic variables. In this paper, we apply fuzzy logic to simulate FMS. The fuzzy based simulation, in this paper, is designed to solve the problem of determine the job sequence and selecting the best part route. In particular, we will show how to obtain the simulation via a proposed fuzzy model as shown in figure 1.

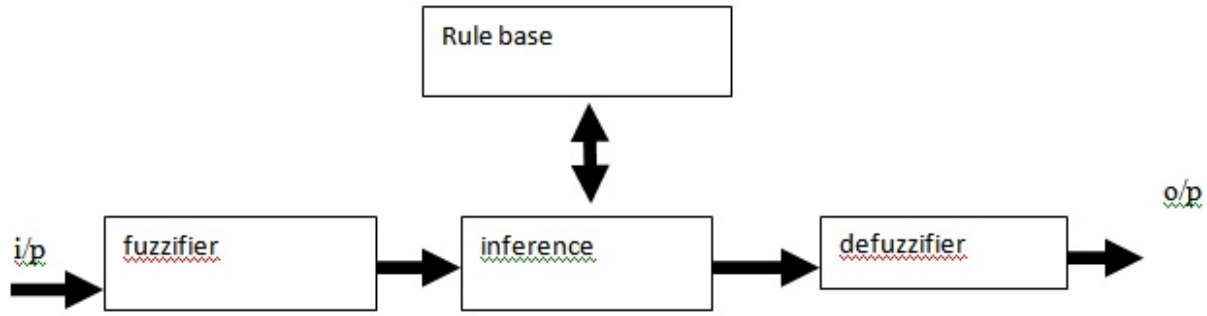


Fig. 1 Structure of a Fuzzy Logic System

## IV. A CASE FOUND IN INDUSTRY

As the space wood is the furniture manufacturing industry ,here we found the various problem related scheduling after visiting the industry. For tackling the various problem we applying the fuzzy logic application to get the schedule for performing various operation in manufacturing unit. The Fuzzy scheduler considers two particular rules in the scheduling problem: Sequencing of job and routing. The sequencing of jobs was approached using fuzzy controllers having rules with two parameters (Processing time and, Due date) and one consequent.

The fuzzy system determine the route for each job loading in a machine , so that whenever the load station or the machine are free the job with the highest priority go through various operation. The decisional point that was considered is the routing problem, that is, the choice of one among many possible routes. In the problem considered this is equivalent to choosing the machine for next processing of a job, among the possible alternatives for that job

The various operation done in industry:.
1-cutting
2-cnc operation
3-moulding
4-laying
5-sanding
6-glueing
7-foiling
8-inspection
9-packing

The following assumptions on the Flexible Manufacturing System were made:

1. Tool management is not considered, i.e. it is supposed that all the tools are available where needed.
2. Failure of workstations and/or transport systems is not considered, i.e., the machines and/or transport subsystem are not subject to failure.
3. Orders arrive to the FMS as Poisson processes with a fixed inter-arrival time.
4. Production of orders occurs in batches, and the movement of the whole batch is considered, so that batch dimensions are not important.
5. Setup times are independent of the order in which operations are executed, i.e. they are constant and embodied in the operation times of each job (batch).
6. There are as many pallets and fixtures as are needed (this assumption is mitigated by the fact that the number of jobs in the system is constantly controlled).
7. The routing of every job is random and directly defined as a sequence of workstations the job has to go through. Thus, the route of a job is not defined in terms of the operations needed by the job. In other words, every operation corresponds directly to the workstation that will execute it, i.e., the routing is defined as a sequence of workstations.
8. There can be multiple routing choices, i.e. at a certain point a job can be equivalently sent to different workstations (as specified in its routing plan) having different processing times.
9. Loading, unloading and processing times are random.
10. Due dates are assigned according to the total processing time of a job.
11. Each workstation can work only one job at a time.
12. The transport system is composed of fork lift truck and each fork lift truck can transport only one sheet at a time.
13. Neither the weight of a piece nor the dimension of a batch affects the speed of fork lift truck which is assumed to be constant.
14. Every workstation has one input buffer and no output buffer, therefore it will be free as soon as there is one free trolley that can transport the processed job to another workstation.
15. Delays in accessing the state information are neglected.
16. Among all the possible scheduling rules the following are considered:
    - Sequencing for a job (selection of a piece among those waiting to receive service from a machine);
    - Routing decisions concerning the next required workstation.

## V. Problem Definition

When a manufacturing unit produce a product as per customer order. For production process they need schedule, planning. They schedule to placed product at right time. As problem found in industry is improper scheduling. There is no allocation of job at proper machine at proper time. When the job is available at the machine the other machine were idle and the due to this the productivity of the industry lack behind. As there are 4 CNC machine which are fully automated as program feed to the machine they work but after completion of one job the machine were idle and this cause the less productivity. To reduce the such kind of problem this model gave the proper schedule for every job.

The FMS described in this paper consists of 4 different CNC machining centers ,three panel saw with finite local buffer capacity, all capable of performing the required operations on each part type, a load/unload station and material handling system with a fork lift truck which can load one pallet at a time. The system produces two different part types, A and B as shown in Table 1. It is assumed that it takes 3 minutes to load and unload a part on a pallet at load/unload station. The time to cross the distance between two consecutive MCs is assumed to be 0.5 minute. The arrangement of the FMC hardware is shown in Figure 2.

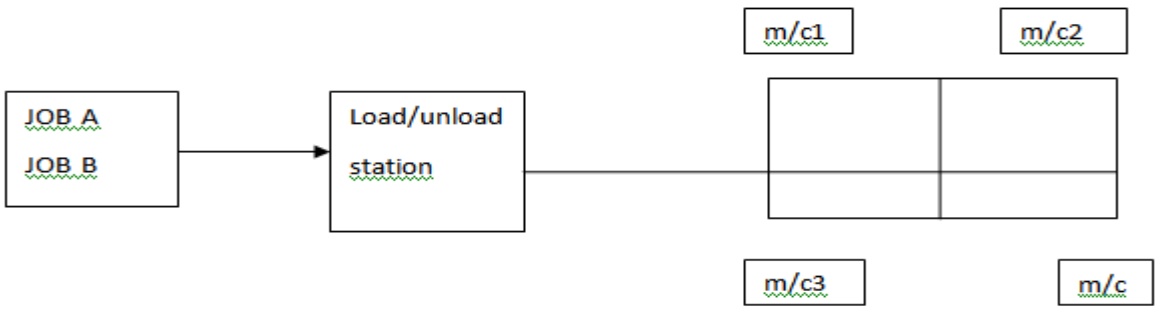


Fig. 2 Diagram of the Case Study

Each machine is capable of performing different operations, but no machine can process more than one part at a time. Each part type has several alternative routings. Operations are

not divided or interrupted when started. Set up times are independent of the job sequence and
can be included in processing times. The scheduling problem is to decide the sequence of the
jobs and which alternative routes should be selected for each job.

## VI. The Fuzzy Based Model :

Proposed approach of this research is to identify different scheduling parameters such as, Processing time, for Job sequencing and processing time for routing and construct their membership functions and fuzzy rules. Using these membership functions and fuzzy rules a fuzzy interference system (FIS) is developed to identify the best route using MATLAB fuzzy logic toolbox. The variables are selected to identify the job, named, processing Time (PT),. All the variables are assigned with triangular membership function and divided into three zones: Small, Medium and High. The output of these variables is priority varying from 0 to 1. The priority variable is also assigned with triangular
membership function and divided into 9 portions. Minimum (MN), Negative Low (NL), Low
(LO), Negative Average (NA), Average (AV), Positive Average (PA), High (HI), Positive
High (PH) and Maximum (MX).The variable are selected to identify the best route,
Processing Time (PT). All the variables are assigned with triangular
membership function and divided into three zones : Small, Medium and High. The output of
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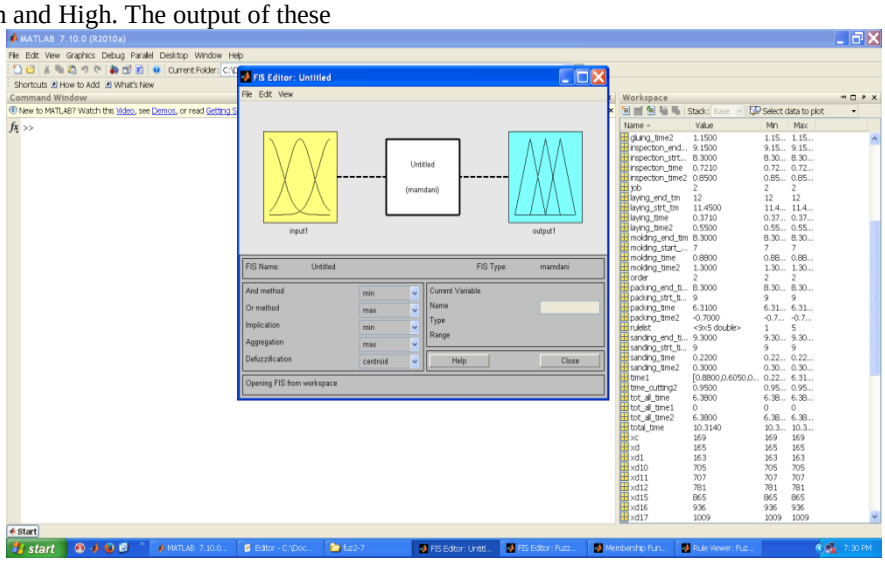


Fig a

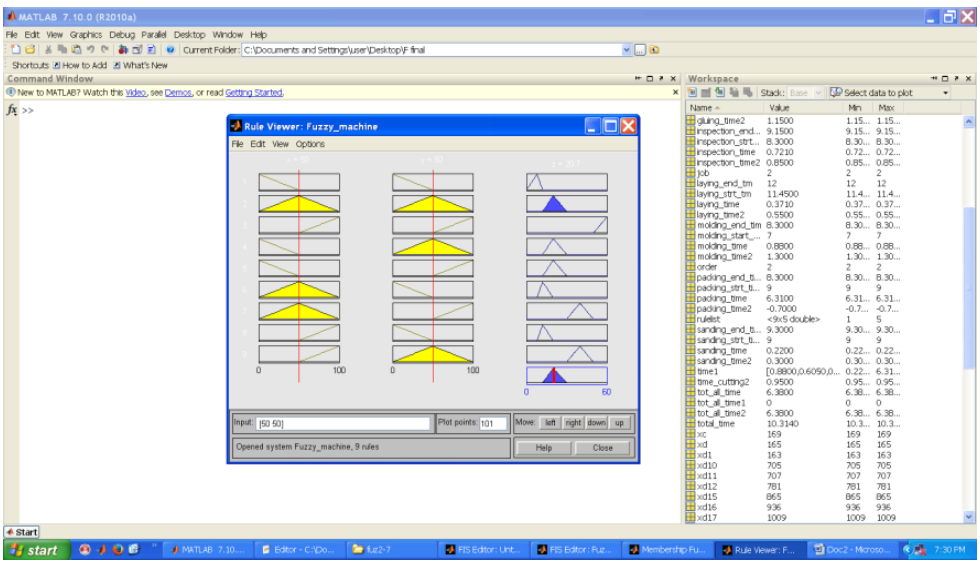


Fig b

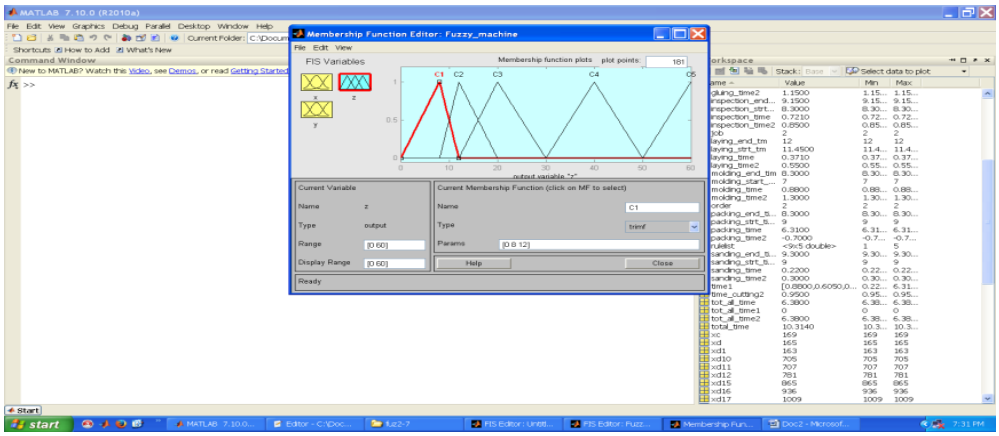


Fig c

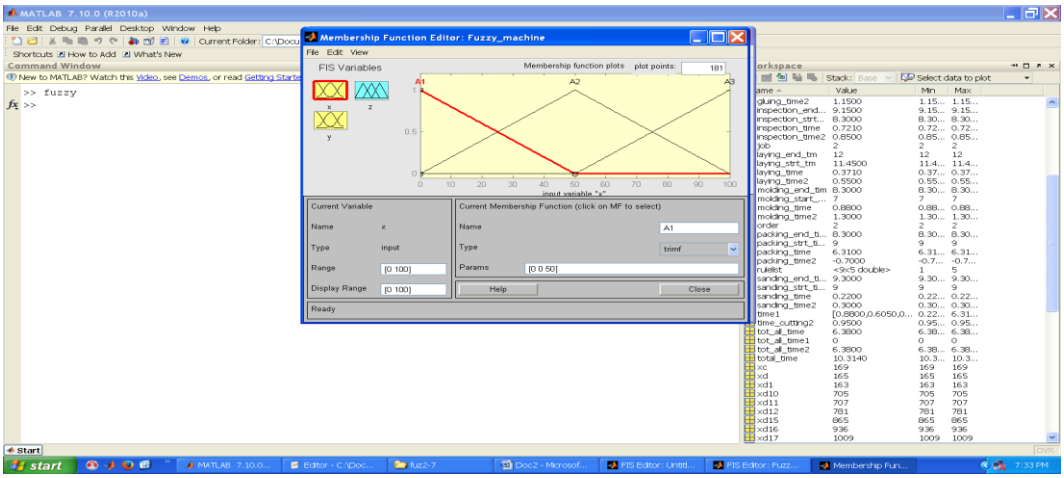


Fig d

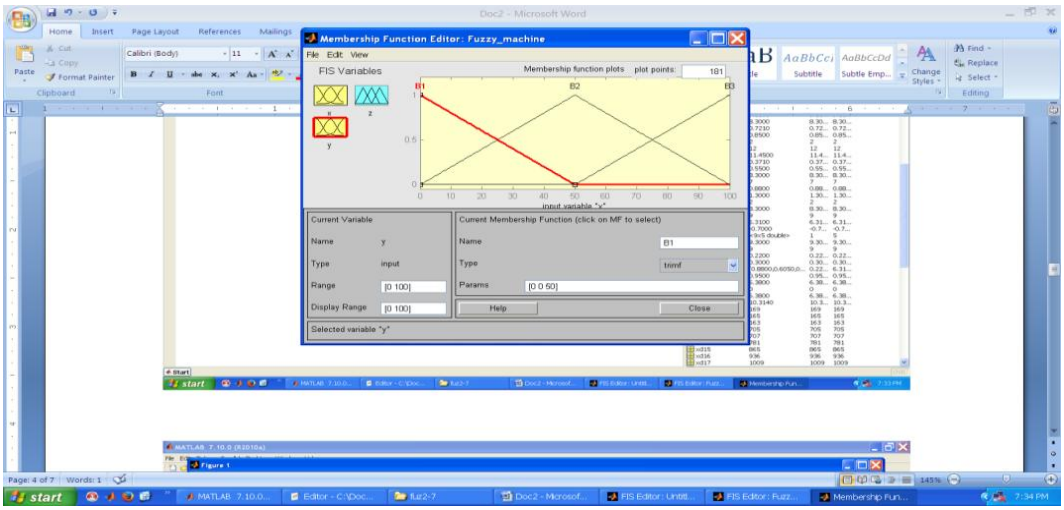


Fig e

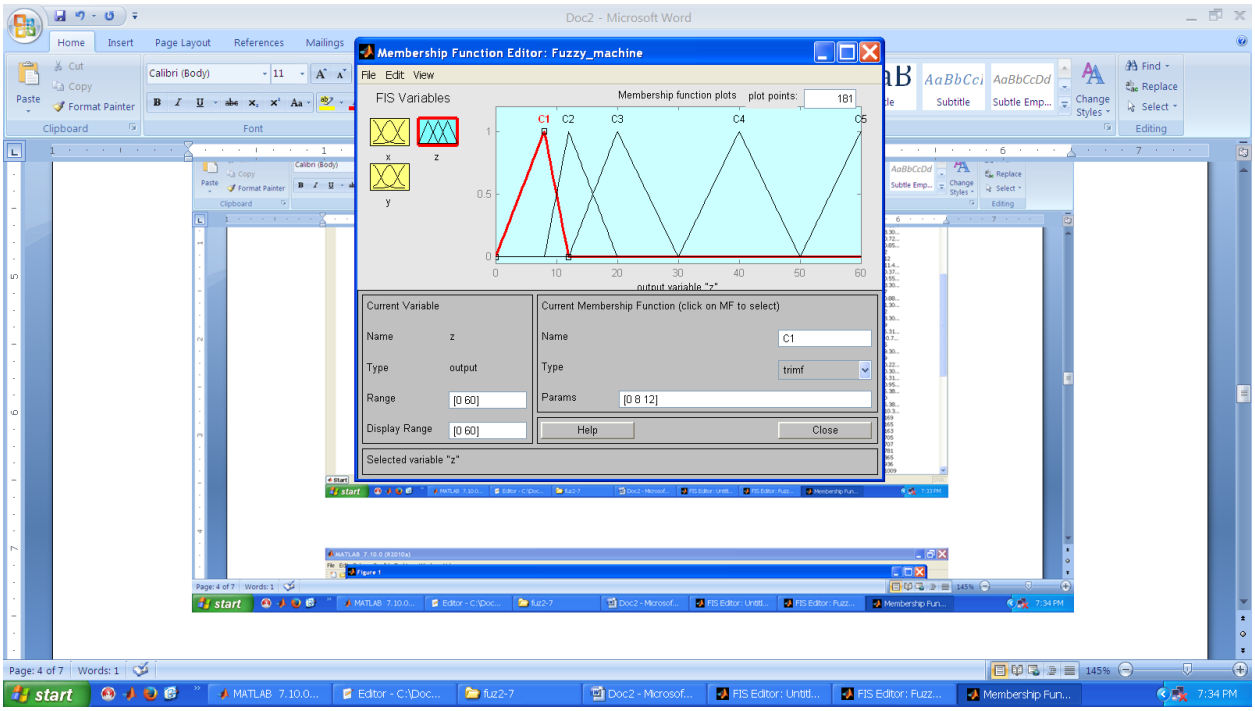


Fig f

Fig. Membership functions of fuzzy input variables

In case of route selection, the variables of processing time, Similar to job sequencing, the total number of possible ordered pairs of these states is 27 and for each of these ordered pairs of states, we have to determine and appropriate state of variable route priority. The decision table is given below:

Inference Rules for Route Selection using two Inputs and One Output

The route priority criteria now used to derive fuzzy inference rules shown as an example:

1. If (Processing Time is Small) then (Route Priority is Maximum)

.....

27. If (Processing Time is High) then (Route Priority is Minimum)

## VII. The experiment and Result

Two jobs are considered here with different processing times, due dates. They are determined based on customer requirements and the cost of the raw materials needed to finish the jobs. Processing time here is the ideal time, means time needed if it was machined in just one machine. The overall system comprises 4 different CNC machining centers (MCs), all capable of performing the required operations on each part type, a load/unload station and material handling system with one fork lift truck which can carry one pallet at a time. The system produces two different part types, A, B . It is assumed that it takes 3 minutes to load and unload a part on a pallet at load/unload station.

Processing time for Job A - 11.96 hrs

processing time for job B -11.86.hrs

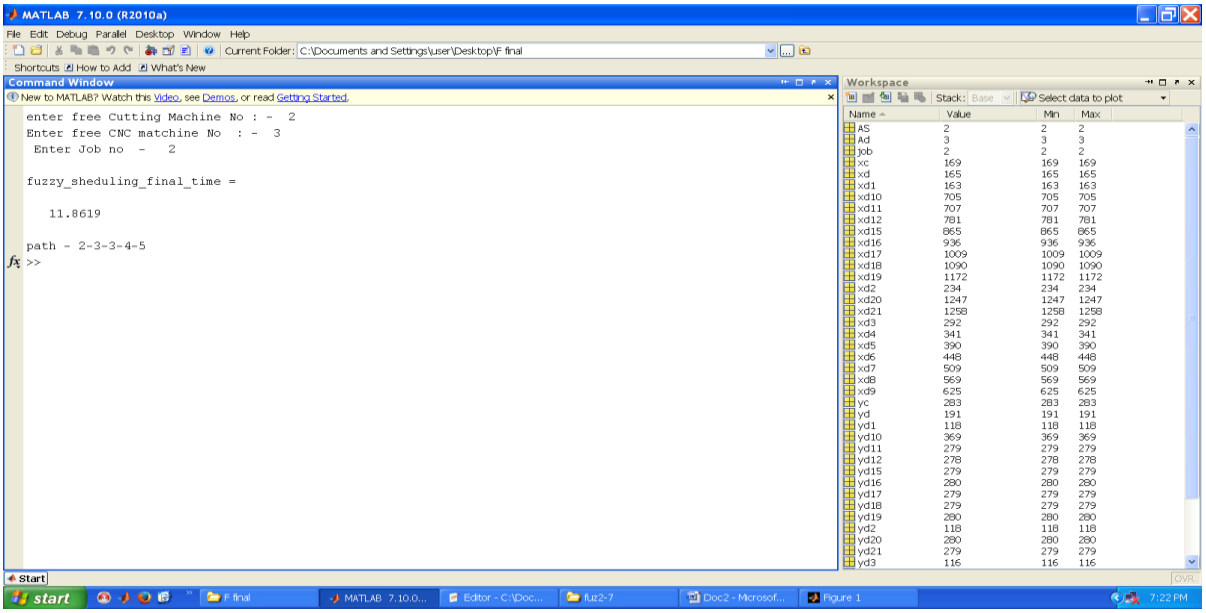


Fig for job B


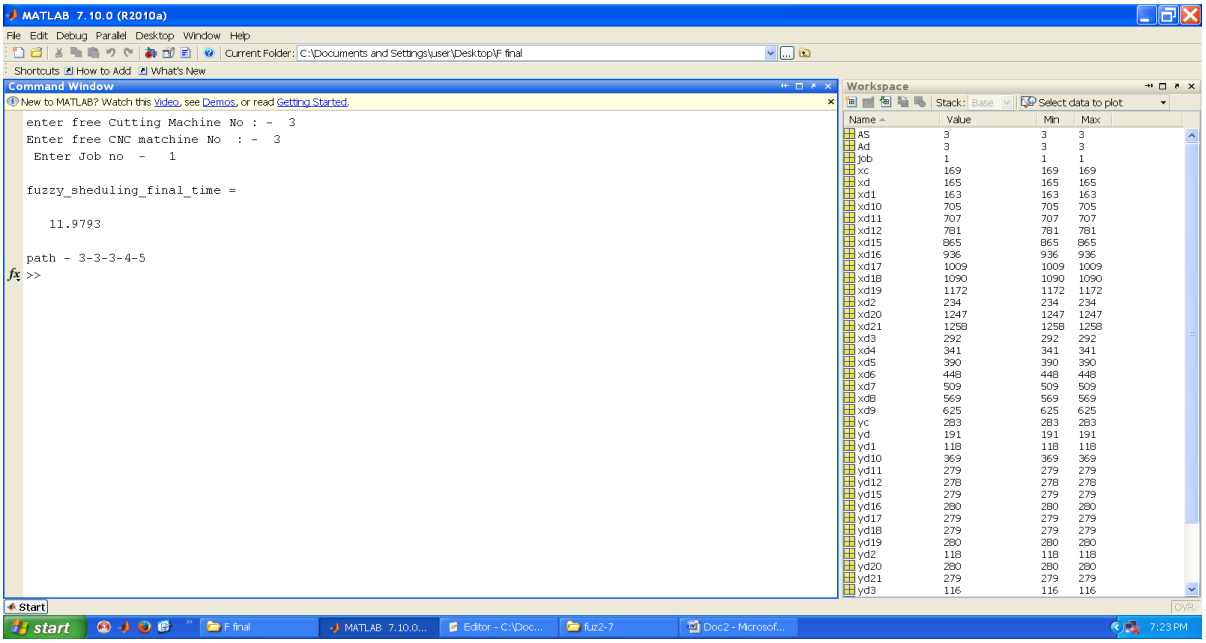


Fig for job A

Routes obtained:
Job A:
1-1-3-4-5
1-2-3-4-5
1-3-3-4-5
1-4-3-4-5
2-1-3-4-5
2-2-3-4-5
2-3-3-4-5
2-4-3-4-5
3-1-3-4-5
3-2-3-4-5
3-3-3-4-5
3-4-3-4-5

FOR JOB B:
1-1-3-4-5
1-2-3-4-5
1-3-3-4-5
1-4-3-4-5
2-1-3-4-5
2-2-3-4-5
2-3-3-4-5
2-4-3-4-5
3-1-3-4-5
3-2-3-4-5
3-3-3-4-5
3-4-3-4-5

Routes obtained by fuzzy model

## VIII. Conclusion and Recommendation

The work presented in this paper was directed towards investigating the applicability of fuzzy techniques as a decision aid in the short-term control of flexible manufacturing systems. For this purpose a flexible manufacturing system for two jobs composed of four machines, one fork lift truck, one load and one unload station and with routings and arrivals with fixed statistical characteristics was considered. A fuzzy scheduler for job sequencing and routing was developed. This scheduler uses fuzzy logic systems as well as fuzzy multiple attribute decision-making techniques. The thesis 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.

In this research, job A having the first priority and routing.. Again, only job priority and routing are taken into account, some other criteria's can also be added. Several parameters are used to design the problem, but, yet there may be other parameters which can be added to make the model more accurate. Here, triangular membership functions were used. There are some other membership functions which could give different results. All possible rules are taken, but if more parameters were added, number of the rules would have been increased. All this changes may lead the model to better results.

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