ISSN:2229-6247
Ramanbharath VR et al, Int.J.Buss.Mgt.Eco.Res., Vol 2(3),2011,196-204

FUZZY BASED DECISION MODEL FOR SELECTING CAM BASED MACHINING PROCESS

Ramanbharath V R[#1] Manjunaathan S.P[#1], Vijaya ramnath B[#2]
[#1]*P.G.Student,* [#2]*Asst Prof, Sri Sairam Engineering College,*
Anna University, Chennai.

***Abstract*—Product development time is main focus for all companies. In order for a product to be competitive, it needs to be quickly introduced without compromising its performance. Thus reduction of product development cycle time has become an essential goal. In this paper optimization is carried out to reduce product development cycle time of machining processes in piston. In existing process, generation of manufacturing codes for valve pocket milling, dishing operation in piston consumes more time. This results in more time for product release. In order to reduce the machining time here code generation for valve pocket milling, dishing operation are generated using cam software. A fuzzy based decision making model is developed to suggest the cam based machining process.**

Keywords — Product development cycle time; machining process; code generation; Cam Machining

1. INTRODUCTION

In recent years, a number and variety of applications of fuzzy logic have increased significantly. The applications range from consumer products such as cameras, two wheelers, washing machines, televisions, cell phones and microwave ovens to industrial process control, medical instrumentation, decision-support systems, and portfolio selection

MING ZHOU (1998) proposed a new approach to address the difficulties due to the uncertainty of data and lack of quantitative tools. It prioritizes engineering characteristics through a fuzzy ranking procedure and optimizes the improvements using a mixed integer program. Numerical experiments are designed to verify the models and investigate computational efficiency.

Gulcin and Orhan(2004)focused on improving the accuracy of decision-making in NPD under uncertainty. First identified the decision points in the NPD process and the uncertainty factors affecting those points. Next, the necessary decision models and techniques to help the decision makers to reduce their risks are determined. Finally, an integrated approach based on fuzzy logic to shape the decisions and illustrate with an application in software development is proposed.

Yong-Zai,Min He et al (1997) presented the development of a real-time fuzzy expert optimization control system for industrial processes. The focus of this study is the application of fuzzy optimization control to a fluidized catalytic cracking unit (FCCU) in an oil refinery to optimize the cracking product distribution under a variable production environment. The system has been successfully implemented in a large production scale FCCU and the application results show significant benefits through fuzzy optimization control.

Hong et all (2005) developed analytical models that capture essential properties, including uncertainty, iteration and evolution, and estimate the cycle time of each pattern. With the proposed models, the cycle time of a set of patterns (or the whole product development process) can be effectively estimated. As demonstrated in a case study, the model provides valuable insights on how product development process progresses over time, while the corresponding time estimate can help managers to set appropriate manufacturing and marketing strategies.

Naveen Gautam and Nanua Singh (2008) proposed a system with the help of a case study on automotive vehicle development showed how proposed model and method can be used for highest value added change selection. Application of optimization model for perceived value and change trade-off in general is presented along with some special policy cases for different scenarios.

Luis and Felipe(2005) presented a decision-making module based on fuzzy logic for model-based fault diagnosis applications. Fuzzy rules use the concept of fault possibility and knowledge of the sensitivities of the residual equations. A fault detection and isolation system, based on the input–output linear model parity equations approach, and including this decision-making module, has been successfully applied in laboratory equipment, resulting in a reduction of the uncertainty due to disturbances and modelling errors. Furthermore, the experimental sensitivity values of the residual equations allow the fault size to be estimated with sufficient accuracy.

Kun and Chun (2009) presented a fuzzy logic approach for decision-making of maintenance. Some linguistic variables and rules-of-thumb are used to form the fuzzy logic models, based on the domain experts' experiences in production line and maintenance department. The historical production data are used to train and tune the fuzzy models. The tuned fuzzy models are then embedded into an internet-based and event-oriented information system as fuzzy agent. The production controller can easily make suitable production control decisions based on the inference results of fuzzy agents to satisfy the quick response requirement.

Yang et al. (2008) proposed an integrated fuzzy multiple criteria decision making (MCDM) techniques for vendor selection problems. Jiann utilized triangular fuzzy numbers to express the subjective preferences of evaluators with respect to the considered criteria. In addition, a relationship map is constructed to identify the independence or interdependence of the sub-criteria of a criterion by using interpretive structural modeling (ISM).

A fuzzy based decision model is expressed by the following equation' suitability of cam machining' = f [Quality, Program generation time, Rate of production] - (Eq. 1)

Therefore the above equation is optimized with use of fuzzy logic.. Here the work focuses on identifying the suitability of cam machining by Fuzzy Based Simulation (FBS) model. Therefore, the most important factors like Quality, Program generation time, Rate of production are taken into account. Fuzzy Logic Toolbox with MATLAB is a tool for solving problems with fuzzy. The result shows that the selection of modified model is acceptable and suitable for the case situation considered.

2. FUZZY INFERENCE SYSTEM

The fuzzy inference system contains the following major five steps. They are i) Fuzzifier, ii) Rule base, iii) Fuzzy inference engine, iv) Defuzzifier and v) output quantity. The fuzzy inference system is shown in Figure 1.

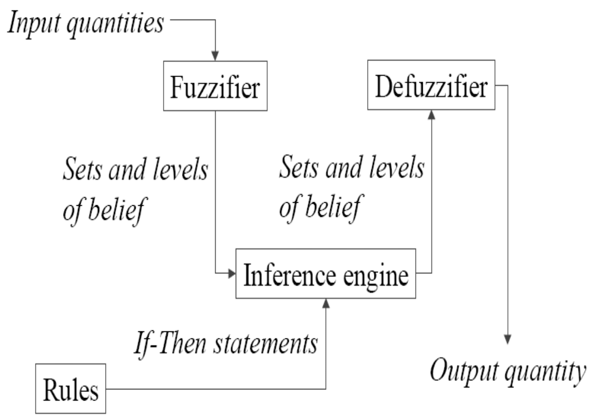

Figure 1

2.1Fuzzification for suitability of modified model:

The fuzzification process is performed during run time and consists of assigning membership degrees to Quality, Program generation time, Rate of production. The Figure 2 shows the fuzzification process of a fuzzy logic system with input and output being fuzzified with suitable membership function. Here the inputs are the factors like Quality, Program generation time, Rate of production. The output is the result whose value shows whether to accept satisfactory or reject the selection of modified model as shown in Figure 3.

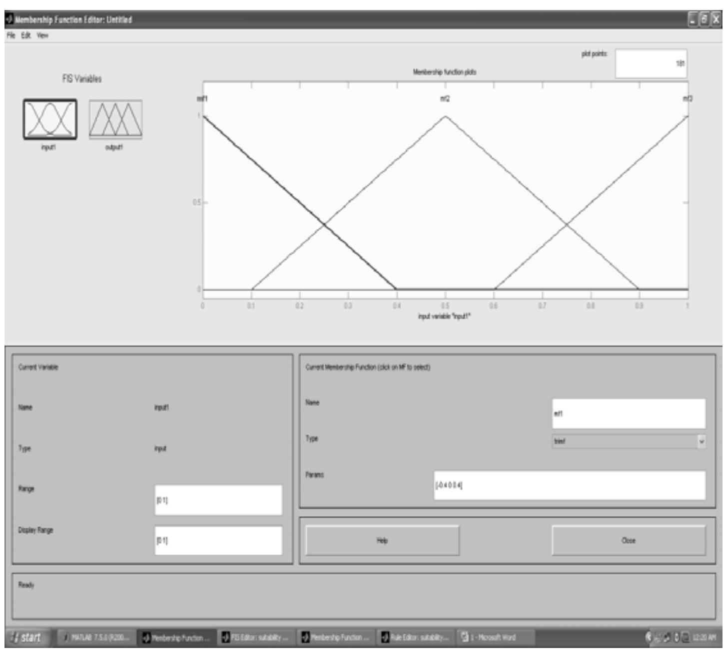

Figure 2

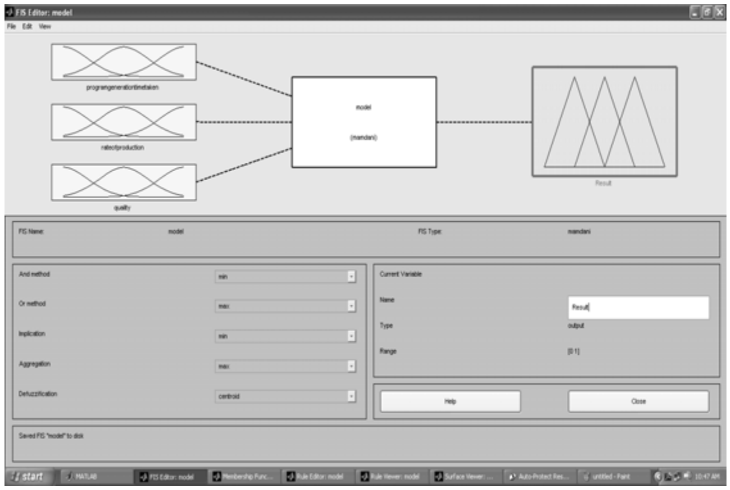

Figure 3

2.1.1Program generation time:

Program generation time is the time required to generate the NC programme for the components. The categories in the measure are less, medium, high. For the linguistic variable less, then range is 0 to3 , for range 3 to 7 then the linguistic variable is medium and for the linguistic variable high then range is 7 to 10.The transfer function in fuzzy format is shown in Figure 4.

Table 1. Range for Program generation time

Fuzzy	Linguistic Variable	Range
1.	less	0 to 3
2.	medium	3 to 7
3.	high	7 to 10

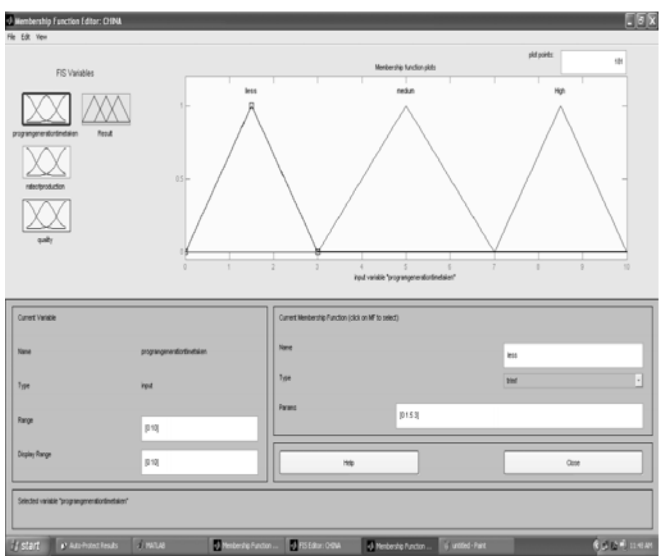

Figure 4

2.1.2Rate of production:

Rate of production is how much the products are produced in the company. The categories in the measure are less, medium, high. If the linguistic variable is slow then range comes from 0 to3 , if the range is 3 to 7 then the linguistic variable is medium and for linguistic variable is fast the range is 7 to 10.The transfer function in fuzzy format is shown in Figure 5.

Table 2. Range for Rate of production

Fuzzy	Linguistic Variable	Range
1.	slow	0 to 3
2.	medium	3 to 7
3.	fast	7 to 10

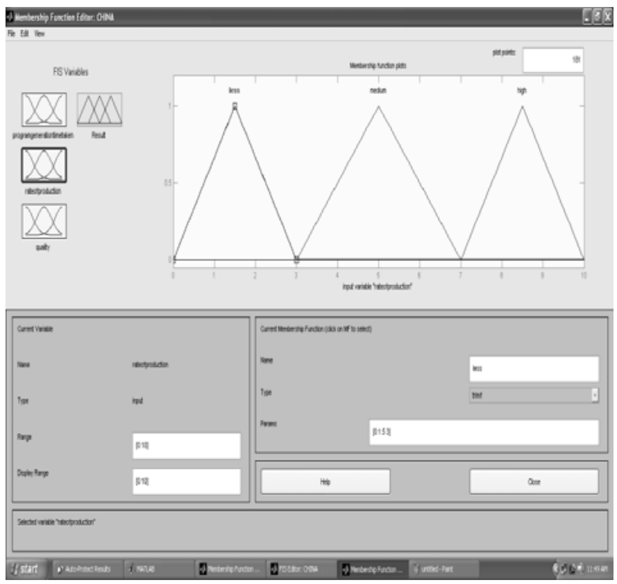

Figure 5

2.1.3Quality of service:

Quality is measured by how extent the product serves for its use. The categories in the measure are less, medium, high. If the linguistic variable is less then range comes from 0 to2 , if the range is 2 to 6 then the linguistic variable is medium and for linguistic variable high then range is 6 to 10.The transfer function in fuzzy format is shown in Figure 6.

Table 3. Range for quality of service

Fuzzy	Linguistic Variable	Range
1.	less	0 to 2
2.	medium	2 to 6
3.	high	6 to 10

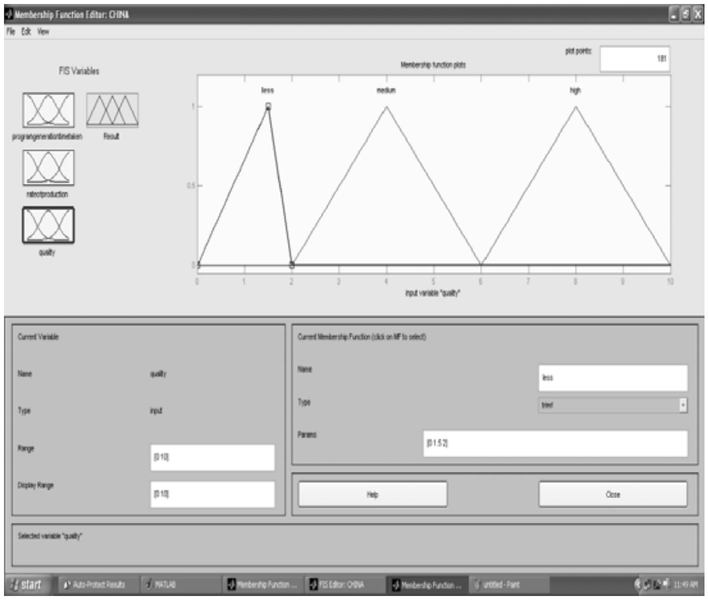

Figure 6

2.1.4Result

The result is to decide whether to select the cam based machining or not. The result value lies between 0 to 3 is considered as reject, between 3 to 6 is considered as satisfactory and between 6 to 10 is considered as accept the system. The transfer function in fuzzy format is shown in Figure 7.

Table 4. Range for Result-output measurement

Fuzzy	Linguistic Variable	Range
1.	Accept	6 to 10
2.	Satisfactory	3 to 6
3.	Reject	0 to 3

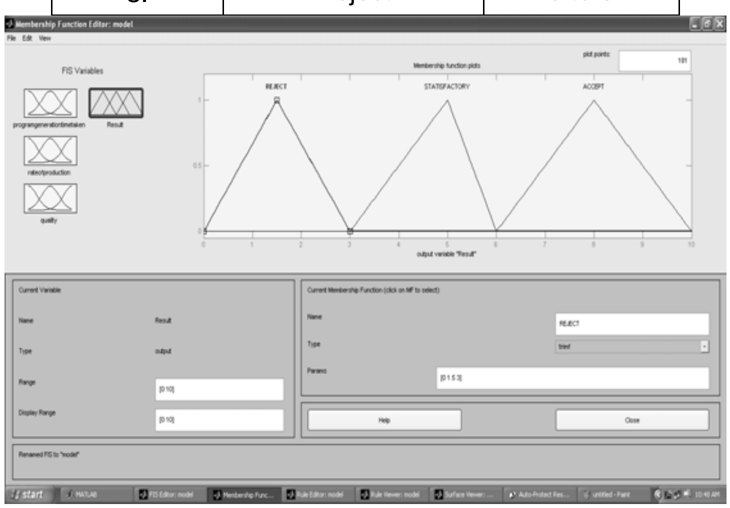

Figure 7

3. FUZZY EVALUATION RULES (IF- THEN RULES)

These if-then rule statements are used to formulate the conditional statements that comprise fuzzy logic. A single fuzzy if-then rule assumes the form “if x is A then y is B” where A and B are linguistic values defined by fuzzy sets. The if-part of the rule “x is A” is called the premise, while the then-part of the rule “y is B” is called the conclusion. There are 27 rules following the format ‘if (condition a) and (condition b) and (condition c) then (result c)’ corresponding to the combination of input conditions is shown in Figure 8. For example, ‘if delivery time is less’ and ‘cost required is acceptable less ‘ and ‘quality is less’ then the result is ‘the system is acceptable’. The rules are formed with the expert knowledge, feedback and guidance given by experts in the manufacturing industries and are further refined with experienced persons in the field of operation, production management and are further refined, following real life application and appraisal which will either confirm them or require them to be modified. The following Tables 5, 6, and 7 show the formation of fuzzy rules.

Table 5. Fuzzy rule for Program generation time is less:

production / rate quality for service	less	medium	high
less	Reject	Reject	Reject
medium	Reject	satisfactory	Accept
high	Reject	Accept	Accept

Table 6. Fuzzy rule for Program generation time is medium:

production / rate quality for service	less	medium	high
less	Reject	Reject	Accept
medium	Reject	satisfactory	satisfactory
high	satisfactory	Accept	Accept

Table 7.Fuzzy rule for Program generation time is High:

production rate / quality for service	less	medium	high
less	Reject	satisfactory	satisfactory
medium	Reject	satisfactory	satisfactory
high	Reject	satisfactory	satisfactory

Figure 8

4.Fuzzy Solution Results

A continuum of fuzzy solutions for equation (1) is presented in Figure 9 using the fuzzy tool box of MATLAB. The three inputs can be set within the upper and lower specification limits and the output response is calculated as a score that can be translated into linguistic terms. In this instance the order output of 8 indicates “Accept” linguistically from Table 4

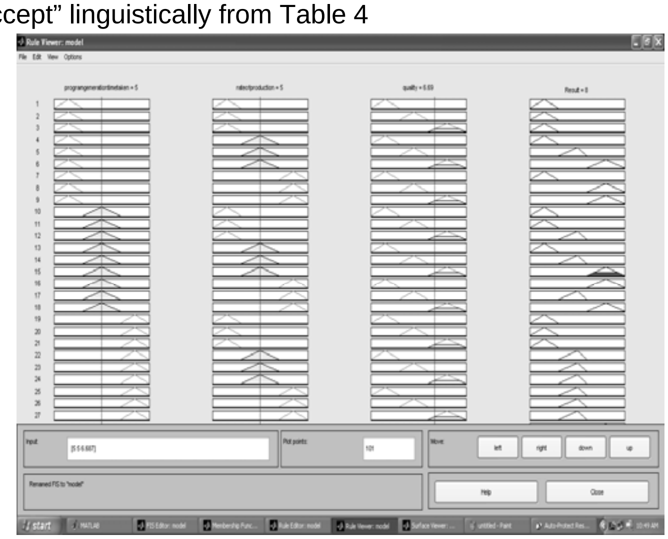

Figure-9

CONCLUSION

This paper introduced a new model known as 'Fuzzy Based Simulation' (FBS) for finding suitability of modified model in leading automobile concern.The model considered the important factors like Quality, Program generation time, Rate of production. This has been seen that the value of result is above 5. As per the Fuzzy range for result, the modified model is suitable and acceptable for the case situation considered in this paper.

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