Intelligent Module for Selection of New Part to be Released in to the System for Online Scheduling of Flexible Manufacturing System

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Abstract

The first stage in the development of any intelligent control system is to analyze the problem thoroughly and identify the important system parameters involved. In this work, the problem is described by four parameters, 1)Due date, 2) Job value, 3)Batch size and 4).Processing time. The Intelligent module is developed by using NeuroSolutions based on the hierarchical approach for "the selection of new part to be released in to the system for online scheduling of FMS". The system was defined with system parameters and their known range of values. For a typical set of inputs of a test problem, the correctness of the module is verified by empirical approach.

Keywords: *FMS, scheduling, Due Date, Batch size, Processing time*

1. INTRODUCTION

Flexible Manufacturing systems (FMS) is being adopted by many discrete-parts manufacturing industries in an attempt to solve the current problems of high cost, low productivity and low variety. Successful functioning of FMS will require human decision making in three levels. The first level, called strategic level consists of long term decision making done by higher management. This level deals with design problems of FMS. The second level, called tactical level consists of medium term decision making i.e. planning of FMS. The third level called operational level or shop floor level concerns short term decisions, i.e. operational problems of FMS. It is concerned with the detailed decision making required for on-line scheduling of FMS. The on-line scheduling, suitably changes the production program to take all unexpected events into account, as soon as they are known. Operational problems would be easier to solve if manufacturing activities occur as planned. However, due to the dynamic nature of the shop floor, the operational problems are always unstructured and complicated. The decisions for these problems are based on large amounts of information and are always `made under pressure of time. Most manufacturing systems use simple heuristic rules to solve their control problems in shop floor by off-line scheduling method. However, FMS is more complex, implies the use of more and more advanced methods for management and control, the FMS control is a complex and challenging problem[1,2]. The increased flexibility, complexity and automation clearly offer efficiency and productivity in FMS. But these make online scheduling extremely complex [3]. There is a dynamic change of states in FMS with multiprocessing environment. The operation control of FMS requires a suitable approach with interactive process to suit the change in environments. In FMS, various parts are to be performed simultaneously and an efficient decision support system is needed to organize the processing of various parts efficiently. Because of the inherent flexibilities in an FMS, operational problem is a complex process. It may be formulated as a multi-criteria problem involving scheduling of parts, pallets, tools and the material handling devices. The operational problem is concerned with running the system efficiently in on line scheduling policy. Online scheduling policy for FMS is more appropriate with operational decision based on the real state of the system[4]. Iwata, et al, enumerated the desired online scheduling decisions of FMS[5]. Kodali R reviewed the required control decisions and

presented a list of decisions determined on a realistic basis for online scheduling of FMS[6].

The decisions are:

1. Selection of a new part to be released into the system.
2. Selection of an AGV and a workcentre from a set of work centers simultaneously requesting the service for transport of a part.
3. Selection of a workcentre to perform a requested operation, if more choices are available.
4. Selection of a cutting tool to be used.
5. Selection of a part from the input queue of a station for processing the next operation.
6. Selection of a transportation path to be used to move parts to next station.
7. Selection of an operator if necessary.
8. Selection of next operation to be performed for the part, if no predetermined sequence of operations is available.
9. Selection of an alternative action under any unforeseen situation.

Managers at a shop floor have made their decisions mainly from their experiences and intuition, which are human abilities. Off line program and priority control policy can not operate FMS efficiently. It would be more appropriate to have a online scheduling system where the control decisions are made according to the actual state of FMS. The inefficiency of offline control methods have stressed the need for a online scheduling on line control which can take care of the dynamics of FMS. The complexity and the dynamic nature of the real time operational problems for and FMS is not solved by any mathematical model. However, without a systematic representation of the elements, attributes and relationships, the system can not be integrated or manipulated to support the decision requirements for unstructured problems. Artificial intelligence methods were indicated as a useful approach to systematically represent knowledge of planning and control in the control system. Intelligent system approach can easily manage online scheduling decisions of FMS Here, an attempt has been made to use 'knowledge-base data' and 'Artificial neural networks' for development of an Intelligent- Module to find out the solution for one of the FMS scheduling decision 'selection of new part to be released into the system'. for online scheduling of flexible manufacturing systems.

2.Problem Definition

Because of the nature of the FMS structure, more complex communication and control systems were required than those needed for traditional manufacturing methods [7, 8]. It is impossible to make good decisions without information. Due to the unavailability of large problem sets the researchers studying on the FMS mostly generate their specific system [8]. The first stage in the development of any intelligent control system is to analyze the problem thoroughly and identify the important system parameters involved. The problem is described by four parameters, namely 1).Due date,2) Job value,3)Batch size and 4).Processing time. The decision of selection of new part type to be released in to the system is based on these four parameter. The system was defined with system parameters and their known range of values in a knowledge based system and with this information the Artificial neural networks' multi layer percepron network was trained to formulate an Intelligent module for selection of new part to be released in to the system for online scheduling of flexible manufacturing system.

3.Problem development

The development of Intelligent module for selection of new part to be released in to the system for online scheduling of flexible

manufacturing system is based on the hierarchical approach. At first level the system parameters are categorized in numerical values, based on ranges of the individual parameters, correspondingly ranks are given in Table-01. The second level identifies the important criterion for the decisions namely, 1). due date, 2).Batch size , 3). Job value, 4). Processing time. The third level identifies the best way to reach the decision based on the second and first levels.

Table-01: The system parameters, values ranges, ranks range and Criterion:

Sr. No.	Parameter	Value Range	Rank range	Criterion range
01	Due Date(min)	-1000 to 2000	10➔0	Over Due—Normal
02	Batch size	0 to 1000	10➔ 0	Low--large
03	Job Value($)	1000 to 0	10➔ 0	High—Normal
04	Processing time(min)	0 to 300	10➔ 0	Low—large

4.The Intelligent-module - Implementation and validation

The decision of selection of new part to be released into the system is done by using "Excel Add-ins" of NeuroSolutions. This Excel Add-ins gives you the ability to visually tag your data as Training, Cross Validation, Testing, or Production, train a neural network, and test the neural network's performance directly from within a Microsoft Excel worksheet. Intelligent-module was developed for selection of new part to be released in to the system for online scheduling of flexible manufacturing system, the Multi -layer perceptron network was trained in "Excel add ins" of NeuroSolutions[9] by giving the range and rank values of all the parameters as input and output values respectively. After training the network, the user will fin out the part to be released in to the system by using "the intelligent module". The steps involved in entering the values of the input parameters as production data and getting the decisions are give bellow:

Step-1: Enter the input data of part number, due date, batch size, job value and processing time in the input table. (This input data will appear as the input Row of the Excel worksheet of Nuero-Solutions.)

Step-2: Tag data in input row as production data system

Step-3: Apply production system. The module gives the values of output parameters (i.e. Ranks for each parameter) in the output table.

Step-4: Find out maximum from 'rank value parameter' and 'rank value' among four parameters of each job and place in a table.

Step-5: .Sort the data of table no.04 from max. to min by Rank Value .

Step-6: The max. rank part is the new part to released in to the system.

Illustration: Let us consider the system, consisting of 20 jobs and the values of Due date, Batch size, Job value and processing time of each job are known.

Step-01: The input values of Due date, Batch size, Job value and processing time are entered Table no.02, which is input table. This input data will appear as the input Row of the Excel worksheet of Excel ad ins.

Table-02: The input values of system parameters. (Input-Table).

Part no.	Due date	Batch size	Job value	Processing time
1	25	10	190	10
2	-520	800	320	90
3	370	210	50	23
4	1140	430	810	13
5	-190	360	550	157
6	210	20	380	41
7	150	400	40	247
8	-960	930	70	92
9	830	570	210	165
10	50	310	370	299
11	210	411	306	214
12	27	364	580	247
13	-328	20	870	30
14	546	401	8	169
15	-2	543	169	19
16	200	67	700	205
17	134	356	876	65
18	231	19	378	87
19	-50	34	876	98
20	23	45	78	200

Step-02: Tag the data in the input row (i.e. entered date) as production data

Step-3: Apply production system. The module gives the values of output parameters (i.e. Ranks for each parameter). The cells of out put table are defined in a such a way that the out-put values also appear in the out table as output ranks of system parameters.

Table -03: Output ranks of system parameters.

(Output –Table)

Part No.	due date	batch size	job value	ptime
1	6.5872	9.9000	1.9	9.66667
2	8.4	2.2001	3.2	7.0
3	5.4333	7.9	0.50	9.23333
4	2.8666	5.7	8.10	9.56667
5	7.3	6.4	5.50	4.76667
6	5.9667	9.8	3.80	8.63333
7	6.1666	6.00	0.40	1.76667
8	9.8666	0.7001	0.70	6.93334
9	3.9	4.3001	2.10	4.50001
10	6.5	6.9	3.70	0.03334
11	5.9745	5.82433	3.06	2.86667
12	6.5655	6.3665	5.80	1.76667
13	7.7655	9.8	8.70	9.00
14	4.8452	5.9996	0.08	4.36667
15	6.6755	4.5666	1.69	9.36667

16	6.00	9.3337	7.00	3.16667
17	6.2222	6.4654	8.76	7.83334
18	5.8990	9.8125	3.78	7.100
19	6.8333	9.666	8.76	6.73334
20	6.5732	9.5432	0.78	3.33334

Step-4: Find out maximum from rank value parameter and Value among four parameters of each job and place in table no.04

Table-04: Maximum rank & Max. rank parameter

Part No. (Ji)	Max.Rank Value among 04 parameters of job(Ji)	Max.Rank parameter of job(Ji)
1	9.9	batch size
2	8.4	due date
3	9.23333	ptime
4	9.56667	ptime
5	7.3	due date
6	9.8	batch size
7	6.16667	due date
8	9.86667	due date
9	4.50001	ptime
10	6.9	batch size
11	5.9745	due date
12	6.5655	due date
13	9.8	batch size
14	5.9996	batch size
15	9.36667	ptime
16	9.3337	batch size
17	8.76	job value
18	9.8125	batch size
19	9.666	batch size
20	9.5432	batch size

Step-5: .Sort the data of Table-04 from max. to min by Rank Value and place in table-5

Table-5: Decision table

Part No./part sequence	MAXI.RANK	Criterion
1	**9.9**	**batch size**
8	9.86667	due date
18	9.8125	batch size
6	9.8	batch size
13	9.8	batch size
19	9.666	batch size
4	9.56667	ptime
20	9.5432	batch size
15	9.36667	ptime
16	9.3337	batch size
3	9.23333	ptime
17	8.76	job value

2	8.4	due date
5	7.3	due date
10	6.9	batch size
12	6.5655	due date
7	6.16667	due date
14	5.9996	batch size
11	5.9745	due date
9	4.50001	ptime

Step-6: The max. rank part is the new part to released in to the system. That is part no- 09 having max rank with criterion due date is the new part to be released in to the system.

Decision: The new part to be released is Part no.01, With rank **9.9** based on Batch size criterion

The Intelligent module is evaluated by empirical approach. The approach is to test a set of selected test problems. For a typical set of inputs of a test problem, the correct ness of the Intelligent module is verified and the decision obtained is suitable and correct..

5.Conclusion

"Intelligent module for selection of new part to be released in to the system for online scheduling of flexible manufacturing system" is a novel approach to find out the solution for selection of new part to be released in to the system. It is quick, easy to operate and gives the optimum solution to the problem by considering four system parameters, Due date, Job value, Batch size and Processing time.

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