# Easy and Intelligent System (EIS) for Selection of a Transport Path to be Used to Move Parts Between Work Stations in FMS During Online Scheduling

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***Abstract - This paper presents the development of easy and intelligent user friendly approach for Selection of a transport path to be used to move parts between stations in scheduling of Flexible Manufacturing systems (FMS). The scheduling of FMS requires a suitable approach with interactive process to suit the change in environments. The complexity and the dynamic nature of the real time operational problems for and FMS are not solved by any mathematical model. However, without a systematic representation of the elements, attributes and relationships, the system cannot 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. In order to help the shop floor personnel in achieving their productivity goals, the easy and intelligent system, which allow the user to request a variety of operational decisions on the real time basis. An attempt has been made in this paper is to illustrate the easy and intelligent system for Selection of a transport path to be used to move parts between stations in scheduling of Flexible Manufacturing systems (FMS).The selection criteria are based on 1. Path distance, 2. AGV blocking, 3. input buffer queue of WC. These parameters are categorized based on numerical values with definite range and corresponding ranks are assigned. Accordingly presented an easy and intelligent system for Selection of a transport path to be used to move parts between stations***

***Keywords - Transport path, work station, intelligent user friendly approach.***

## I. INTRODUCTION

A flexible manufacturing system (FMS) is a production system in which groups of numerically controlled or computer numerically controlled machines and an automated material handling system, work together under computer control. The system can simultaneously process medium-sized volumes of a variety of part types. FMS attempts to achieve both production flexibility and high productivity in order to meet the demands of today's competitive markets [1]. 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 [2]. Artificial intelligence methods were indicated as a useful approach to systematically represent knowledge of planning and control in the control system [3].The increased flexibility, complexity, and automation clearly offer efficiency and productivity in FMS. But these make online scheduling extremely complex [12]. Online scheduling of an FMS requires decision making in various scheduling problems such as selection of an AGV and a work centre from set of work-centres simultaneously requesting the service for transport of a part, selection of new part to be released in to the system, Selection of a transport path etc.

Material handling has been playing an important role in manufacturing systems, and about 13–30% of production cost can be attributed to material handling operations [4] Automated guided vehicles (AGVs) are becoming popular in automatic materials handling systems and flexible manufacturing systems . Since the invention of AGVs, much research has been devoted to the technology of AGV systems, and rapid progress has been witnessed. As one of the enabling technologies, the scheduling and routing of AGVs has also attracted considerable attention(5). Since the level of sophistication and complexity is high in FMS, any improper selection of a transportation path to be used to move parts between stations will necessarily lead to congestion, collision and lengthy delays in manufacturing processes. “the easy and Intelligent system for Selection of a transport path to be used to move parts between stations in online scheduling of FMS” is developed by integration of Excel based knowledge-base with neural networks. This system exhibited better learning capability and the functionality. The system is easy to understand and helps the user to take decisions. These decisions can be implemented for the operation of online scheduling FMS. An attempt has been made to illustrate this.

## II. PROBLEM DEFINITION

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 [9,12].The FMS considered in this work is a hypothetical system, designed for 'N' workcentres and 'M' AGVs, and 03 transportation paths. The problem of selection of a transportation path to be used to move parts between stations is under taken. The problem is described by three parameters, namely Path distance, AGV blocking and Length of the input buffer queue at work centre. The system is scheduled on a real time basis. Only a single part type and its processes are considered in this analysis. There are some important assumptions that need to be mentioned. They are:

1. The number of AGVs in the system are known.

2. The number of Work centres the system are also known.

4. Any AGV can serve any work centre

5. The number of Transportation paths between any two stations are 03.

The FMS considered in this work is a hypothetical system, designed for 'N' workcentres and 'M' AGVs. The problem of selection of a transportation path to be used to move parts between stations is under taken. The problem is described by three parameters, namely Path distance, AGV blocking and Length of the input buffer queue at work centre. These parameters are selected by considering task of the AGV namely

1. Transportation path for loading of the AGV (i.e. AGV moves towards work station to pick up the task)
2. Transportation path for unloading of the AGV (AGV move from one Work station to another work station for unloading the task)

The development of The Intelligent hybrid system for selection of a transportation path to be used to move parts between work centre is based on the hierarchical approach. At first level the system, identification of system parameters and categorization in numerical values as ranges , based on ranges of the individual parameters, correspondingly ranks and selection criterion were assigned. (Table-3.1). Path distance, AGV blocking and Length of the input buffer queue at work centre are the system parameters. Each parameter is categorized as three classes. Path distance is categorized as: Shortest distance path with range as '0 to 10' and rank as'6 to 8', Medium distance path with range as '10 to 20' and rank as'4 to 6', Long distance path with range as '20 to 30' and rank as'0 to 4'. AGV blocking is categorized as: Normal blocking AGV with range as '0 to 2' and rank as'6 to 8', Moderately blocking AGV with range as '2 to 4' and rank as'6 to 8', High blocking AGV range as '4 to 10' and rank as'0 to 4'. The input buffer queue of WC is categorized as: Under load Queue with range as '0 to 3' and rank as'6 to 8'.Moderate load queue with range as '3 to 7' and rank as'4 to 6', and under load Queue with range as '7to 10' and rank as'0 to 4'

**Table-.1: The system parameters Ranges and Ranks**

| **Path distance** | | **AGV blocking** | | **input buffer queue of WC** | |
|---|---|---|---|---|---|
| **R** Range **Rrgv1rrUr** | Rank | **R** Range | Rank | **R** Range | Rank |
| 0-10 | ***8-6*** | 0-2 | ***6-8*** | 0-3 | ***8-6*** |
| 10-20 | ***6-4*** | 2-4 | ***4-6*** | 3-7 | ***6-4*** |
| 20-30 | ***4-0*** | 4-10 | ***0-4*** | 7-10 | ***4-0*** |

The second level identifies the important criterion for the decisions namely, Selection of the path with shortest distance path, Normal blocking of the AGV or under loaded input buffer queue. The third level identifies the best way to reach the decision based on the second and first levels.

## III. THE "EASY AND INTELLIGENT SYSTEM" IMPLEMENTATION AND VALIDATION

The decision of selection of a transportation path to be used to move parts between stations is done by using Neuro Solutionsexcel add in. This Neuro Solutions-excel add in 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 . The Intelligent hybrid system is developed for selection of a transportation path to be used to move parts between stations in online scheduling, the Multi -layer perceptron net work was trained in NeuroSolutions excel add -in, by giving the range values and rank values of all the parameters as input values and output values respectively. After training the network, a separate work-table is generated in the excel work sheet for users convenience. Enter the input parameters values in the enter values column of the workl-table, Tag data as input and train data as production system data , then the Neurosolutions will give the out put ranks of these input parameters as output in "Ranks of parameters" column of the work-table. After observing the output ranks, the user will give the selection of a transportation path decisions by using the Intelligent hybrid module” . The steps involved in entering the values of the input parameters and getting the decisions are give bellow:

**Step-1:** Enter the input values of system parameters of each path in the second column of the Input-table ( Table-2). The expert system developed in Excel data-sheet will copy this data as input data in the input Row of the Excel worksheet of Nuero-solutions

Table-2: Input table, the important criterion for the decisions(level-02)

| System parameter of each Path | Enter the value | Selection Criterion |
|---|---|---|
| P1.path distance | 12 | Shortest distance |
| p1AGV blocking | 2 | Normal Blacking |
| P1 Buffer Queue length | 5 | Under load |
| P2.path distance | 25 | Shortest distance |
| P2AGV blocking | 7 | Normal Blacking |
| P2 Buffer Queue length | 9 | Under load |
| P2.path distance | 5 | Shortest distance |
| P2AGV blocking | 6 | Normal Blacking |
| P2 Buffer Queue length | 2 | Under load |

Where:

P1 : Transportation Path-1

P2: Transportation path-2

P3: Transpiration path-3

**Step-2:** Tag data Row(s) of inputs as production

**Step-3:** Apply data as production system data. The module gives the values of output parameters (i.e Ranks of parameters) in the output column of the of the work-table-3

**Table:** -3

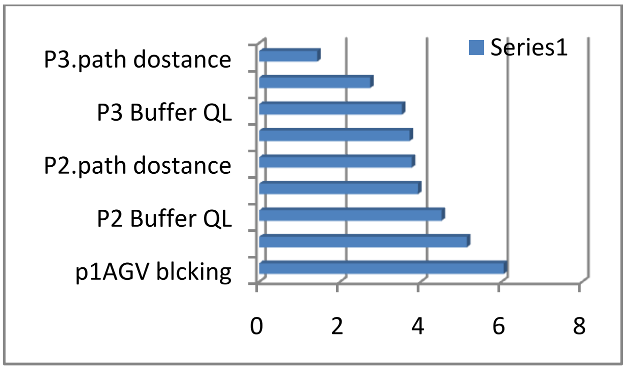
| Input Parameters | Enter value | Criterion | Output |
|---|---|---|---|
| P1.path distance | 12 | Shortest distance | 2.748594717 |
| p1AGV blocking | 2 | Normal Blocking | 6.057587291 |
| P1 Buffer QL | 5 | Under load | 5.143437139 |
| P2.path distance | 25 | Shortest distance | 3.778608507 |
| p2AGV blocking | 7 | Normal Blocking | 3.93105366 |
| P2 Buffer QL | 9 | Under load | 4.517419323 |
| P3.path distance | 5 | Shortest distance | 1.438495073 |
| p3.AGV blocking | 6 | Normal Blocking | 3.723989065 |
| P3 Buffer QL | 2 | Under load | 3.532836051 |

**Step-4:** Copy the table and paste special with values as table-4. Sort the Table-4 with column of output ranks from max. to. Mins. This action gives the priority sequence.

**Table**-4

| INPUT PARAMETERS | ENTER VALUE | Criterion | OUTPUT |
|---|---|---|---|
| **p1AGV blocking** | **2** | **Normal Blacking** | **6.05758729** |
| P1 Buffer QL | 5 | Under load | 5.14343714 |
| P2 Buffer QL | 9 | Under load | 4.51741932 |
| p2AGV blocking | 7 | Normal Blacking | 3.93105366 |
| P2.path distance | 25 | Shortest distance | 3.77860851 |
| p3.AGV blocking | 6 | Normal Blocking | 3.72398907 |
| P3 Buffer QL | 2 | Under load | 3.53283605 |
| P1.path distance | 12 | Shortest distance | 2.74859472 |
| P3.path distance | 5 | Shortest distance | 1.43849507 |

Fig:1- Pictorial illustration Rank of the system parameters is given below




**Step-5:** Find out Maximum rank value parameter with path (First parameter in the table-4) as a transportation path to be used to move parts between stations**.** Fig-1 gives the pictorial illustration.

Final decision: **Transportation Path -1** based on the criterion "**Normal Blocking**" of parameter **"AGV-blocking"** is selected as a transportation path to be used to move parts between stations in online scheduling of FMS by Intelligent Hybrid System

Step-6: Validation: To evaluate empirically, 03 test runs are performed and for a representative set of inputs, the validation of the system was verified through a comparison of the decisions obtained from the developed EIS and expert.

**Test run-1 for selection of a transportation path to be used to move parts between work stations**

The test run-1 results of EIS and expert results for selection of a transportation path to be used to move parts between work stations is given below in table 5

Table 5: Comparison of output rank values by EIH and expert for test run

| Input parameter | Input value | Output rank value by EIS | Output rank value by expert |
|---|---|---|---|
| P1 Path distance | 12 | 3.74859472 | 3.6 |
| P1 AGV blocking | 2 | 6.05758729 | 7 |
| P1 Buffer QL | 4 | 5.14343714 | 5 |
| P2 Path distance | 25 | 7.77860851 | 7.5 |
| P2 AGV blocking | 7 | 1.93105366 | 2 |
| P2 Buffer QL | 0 | 9.11741932 | 9 |
| P3 Path distance | 5 | 1.43849507 | 1.5 |
| P3 AGV blocking | 6 | 3.02398907 | 3 |
| P3 Buffer QL | 7 | 1.98283605 | 2 |

Table 6: Comparison of sequence of sub-parameters by EIS and expert for test run

| Sequence of sub-parameters by EIS | Output rank value of EIS | Sequence of sub-parameters by expert | Output rank value by expert |
|---|---|---|---|
| P2 Buffer QL | 9.11741932 | P2 Buffer QL | 9 |
| P2 Path distance | 7.77860851 | P2 Path distance | 7.5 |
| P1 AGV blocking | 6.05758729 | P1 AGV blocking | 7 |
| P1 Buffer QL | 5.14343714 | P1 Buffer QL | 5 |
| P1 Path distance | 3.74859472 | P1 Path distance | 3.6 |
| P3 AGV blocking | 3.02398907 | P3 AGV blocking | 3 |
| P3 Buffer QL | 1.98283605 | P2 AGV blocking | 2 |
| P2 AGV blocking | 1.93105366 | P3 Buffer QL | 2 |
| P3 Path distance | 1.43849507 | P3 Path distance | 1.5 |

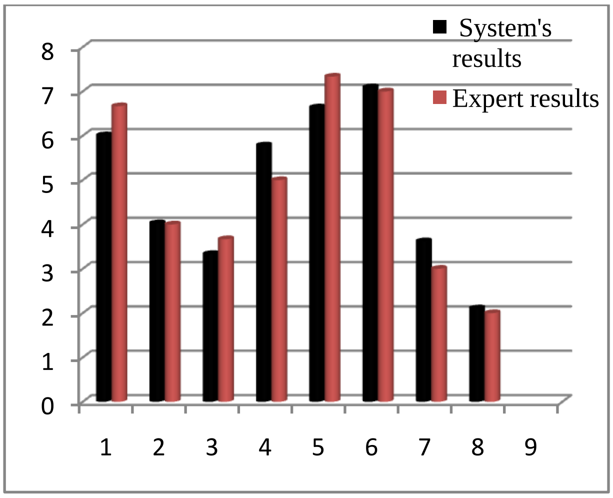



Fig.2 Comparison of output rank values by EIS and expert for test run 5.8.1

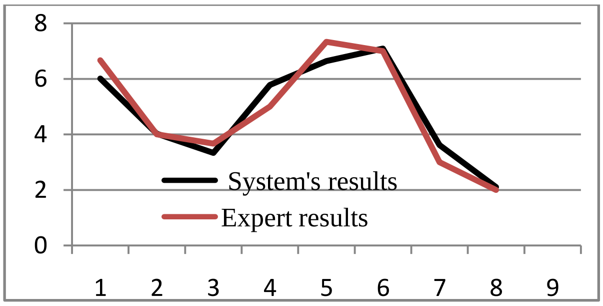



Fig. 3 Comparison of output rank values by EIS and expert for test run 5.8.1

Table 7: Comparison of decision by EIS and expert for test run 5.8.1

| | | | |
|---|---|---|---|
| Selection sequence by EIS | Transportation path 2 | Transportation path 1 | Transportation path 3 |
| Selection sequence by expert | Transportation path 2 | Transportation path 1 | Transportation path 3 |

The decisions of expert and decisions of EIS are matching, hence validated

## IV. CONCLUSION

The developed EIS for Selection of a transport path to be used to move parts between work stations in FMS during online scheduling can improve productivity levels by selecting optimal transportation path between the workstations and increasing machine utilization, reducing the inventory required, increasing utilization of AGVs, Facilitate the scheduler in avoiding bottlenecks and reduce the long queue lengths in the system.

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