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# Modrak Algorithm to Minimize Completion Time for *n*-Jobs *m*-Machines Problem in Flexible Manufacturing System

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## ABSTRACT

Flexible manufacturing systems (FMS) n - Jobs and m - Machines problem has been attempted in this paper using the Vladimír Modrák Algorithm. Job operations in FMS performed by more than one machine, In FMS Np hard problems are considered computationally. Automated Guided Vehicles (AGVs) are used to transfer the material between machines which are not allowed to return after each delivery from load/unload station. Its objective is to minimize the completion time. Current demand demarcated by needs of the market survive market industries to essential flexibility and ability by FMS. An FMS includes four or more workstations which are connected by electronically controlled material handling and distributed controlled system.

**Key words:** AGVs, FMS, Johnsons Algorithm, Vladimir Modrak Algorithm

## 1. INTRODUCTION

A Flexible Manufacturing System (FMS) is a highly automated manufacturing system well suited for the simultaneous production of a wide variety of part types in low to mid volume quantities at a low cost while maintaining a high quality of the finished products. FMS executed number of benefits in terms of reducing cost, increased utilization of machine, condensed work-in –process levels, etc. However, there are a number of problems faced during the life cycle of an FMS and these functions are classified into: design, planning, scheduling, and controlling. In particular, the scheduling task and control problem during the manufacturing operation are of importance owing to the dynamic nature of the FMS in respect of flexible parts, tools, assignments Apart from the machines, other resources in the system like Automated Guided Vehicle (AGV) and Automated Storage/Retrieval System (AS/RS) must be considered The AGVs effectiveness depends on vehicle management system. The following elements are considered in FMS to solve the simultaneous scheduling problems. Flexible numerical controlled (NC) machines furnished with automatic tool changing. An automated material handling systems (MHS) such as conveyors, carts, Industrial robots, AGVs or a combination of them are used to move parts and tools. The entry and exit of the parts take place through Loading/Unloading (L/U) stations. Use coordinate measuring machines for inspection purpose. Sufficient buffer space is provided to near by the machine to store the raw and semi-finished work pieces. Provide tool magazine to store the tools on the machine. A hierarchical control system (HCS) is used to harmonize the functioning of the NC machines, tools, MHS and the movement of work pieces. AGV system is a material handling system that uses independently operated, self-propelled vehicles that are guided along defined pathways in the floor.

## 2. LITERATURE REVIEW

Use The term heuristic is used for algorithms which find solutions among all possible ones, but they do not guarantee that the best will be found, therefore they may be considered as approximately and not accurate algorithms. Johnson’s algorithm [1] is of collection of items is to be produced on two machines. Each machine can handle only one item at a time and each item must be produced through machine one and through machine two. The set up time plus work time for each item for each machine is known. A simple decision rule is proposed by author for optimal scheduling of the production for minimizing the total elapsed time and three machine problems is also discussed for restricted case.. Campbell et al. [2] proposed a simple algorithm for the solution of very large sequence problems without the use of computers. It produces approximate solutions to the n job, m machine sequencing problem where no passing is considered and the criterion is minimum elapsed time up to m-1 sequences Gupta [3] proposed a functional heuristic algorithm for seeking a quick and approximate solution to the n-job, M-machine flow shop scheduling problem under the assumptions that all jobs are processed on all machines in the same order and no passing of job is permitted. This algorithm executed by hand for reasonably large size problems and yielded solutions which are closed to optimal solutions than those obtained by palmer slope index algorithm.in this work Scheduling of FMS with Tabu Search algorithm is done for obtaining solutions for simultaneous scheduling problems.

## 3. PROBLEM STRUCTURE AND INPUT DATA

The problem environment and assumptions of the present work are given in Bilge and Ulusoy [4]. Figure 1 represents the layout configurations used in generating the example problem. The distances from load/unload station to machines and distances between a pair of machines are given in metres for all the four different layouts.

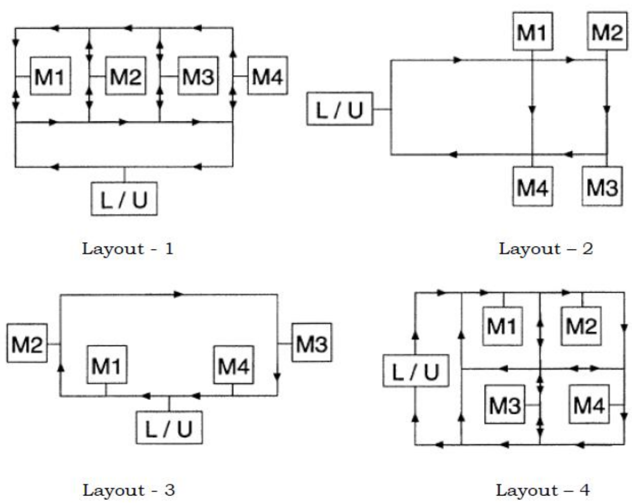


**Figure 1:** The layouts in example problems

Table 1 represents the travel time matrix for this problem. Data for the job sets used in example problems are given in Table 2. Out of 10 job sets, each containing four to eight different jobs to be processed on three to five machines, and the numbers within the parentheses is the processing time of a job on a specified machine [5]-[11]. The load/unload (L/U) station serves as a distribution center for the parts not yet processed and as a collection center for parts finished.

**Table 1**: Travel time matrix for the example problem

| Layout-1 | | | | | |
|---|---|---|---|---|---|
| From/To | L/U | M1 | M2 | M3 | M4 |
| L/U | 0 | 6 | 8 | 10 | 12 |
| M1 | 12 | 0 | 6 | 8 | 10 |
| M2 | 10 | 6 | 0 | 6 | 8 |
| M3 | 8 | 8 | 6 | 0 | 6 |
| M4 | 6 | 10 | 8 | 6 | 0 |
| Layout-2 | | | | | |
| From/To | L/U | M1 | M2 | M3 | M4 |
| L/U | 0 | 4 | 6 | 8 | 6 |
| M1 | 6 | 0 | 2 | 4 | 2 |
| M2 | 8 | 12 | 0 | 2 | 4 |
| M3 | 6 | 10 | 12 | 0 | 2 |
| M4 | 4 | 8 | 10 | 12 | 0 |
| Layout-3 | | | | | |
| From/To | L/U | M1 | M2 | M3 | M4 |
| L/U | 0 | 2 | 4 | 10 | 12 |
| M1 | 12 | 0 | 2 | 8 | 10 |
| M2 | 10 | 12 | 0 | 6 | 8 |
| M3 | 4 | 6 | 8 | 0 | 2 |
| M4 | 2 | 4 | 6 | 12 | 0 |
| Layout-4 | | | | | |
| From/To | L/U | M1 | M2 | M3 | M4 |
| L/U | 0 | 4 | 8 | 10 | 14 |
| M1 | 18 | 0 | 4 | 6 | 10 |
| M2 | 20 | 14 | 0 | 8 | 6 |
| M3 | 12 | 8 | 6 | 0 | 6 |
| M4 | 14 | 14 | 12 | 6 | 0 |

**Table 2:** Data for the Job Sets Used in Example Problems

| | |
|---|---|
| **JobSet-1**<br>Job 1: Ml(8) M2(16) M4(12)<br>Job 2: Ml(20) M3(10) M2(18)<br>Job 3: M3(12) M4(8) Ml(15)<br>Job 4: M4(14) M2(18)<br>Job 5: M3(10) Ml(15) | **JobSet-2**<br>Job 1: Ml(10) M4(18)<br>Job 2: M2(10) M4(18)<br>Job 3: Ml(10) M3(20)<br>Job 4: M2(10) M3(15) M4(12)<br>Job 5: Ml(10) M2(15) M4(12)<br>Job 6: M1(10) M2(15) M3(12) |
| **JobSet-3**<br>Job 1:Ml(16) M3(15)<br>Job 2:M2(18) M4(15)<br>Job 3:Ml(20) M2(10)<br>Job 4:M3(15) M4(10)<br>Job5:Ml(8)M2(10) M3(15)M4(17)<br>Job 6:M2(10)M3(15) M4(8)Ml(15 | **JobSet-4**<br>Job1: M4(11) Ml(10) M2(7)<br>Job2: M3(12) M2(10) M4(8)<br>Job3: M2(7) M3(10) Ml (9) M3(8)<br>Job4: M2(7) M4(8) Ml (12) M2(6)<br>Job5: Ml (9)M2(7)M4(8) M2(10)M3(8) |
| **JobSet-5**<br>Job 1: Ml(6)M2(12)M4(9)<br>Job 2: Ml(18)M3(6) M2(15)<br>Job 3: M3(9)M4(3)Ml(12)<br>Job 4: M4(6)M2(15)<br>Job 5: M3(3)Ml(9) | **JobSet-6**<br>Job 1: Ml (9) M2(11) M4(7)<br>Job 2: Ml (19) M2(20) M4(13)<br>Job 3: M2(14) M3(20) M4(9)<br>Job 4: M2(14) M3(20) M4(9)<br>Job 5: Ml(11) M3(16) M4(8) |

| | |
|---|---|
| | Job 6: Ml(10) M3(12)<br>M4(10) |
| **JobSet-7**<br>Job 1: Ml (6) M4(6)<br>Job 2: M2(11) M4(9)<br>Job 3: M2(9) M4(7)<br>Job 4: M3(16) M4(7)<br>Job 5: Ml(9) M3(18)<br>Job 6: M2(13) M3(19) M4(6)<br>Job 7: Ml(10) M2(9) M3(13)<br>Job 8: Ml(l1) M2(9) M4(8) | **JobSet-8**<br>Job 1: M2(12) M3(21)<br>M4(11)<br>Job 2: M2(12) M3(21)<br>M4(11)<br>Job 3: M2(12) M3(21)<br>M4(11)<br>Job 4: M2(12) M3(21)<br>M4(11)<br>Job 5: Ml(10) M2(14)<br>M3(18)M4(9)<br>Job 6: Ml(10)M2(14)<br>M3(18)M4(9) |
| **JobSet-9**<br>Job 1: M3(9) Ml(12)M2(9)<br>M4(6)<br>Job 2: M3(16)M2(11) M4(9)<br>Job 3: Ml(21) M2(18) M4(7)<br>Job 4: M2(20) M3(22) M4(11)<br>Job5: M3(14)Ml(16)M2(13)<br>M4(9) | **JobSet-10**<br>Job1:Ml(11) M3(19)<br>M2(16)M4(13)<br>Job2: M2(21)M3(16)<br>M4(14)<br>Job3:M3(8) M2(10)<br>Ml(14) M4(9)<br>Job4: M2(13) M3(20)<br>M4(10)<br>Job5: Ml(9) M3(16)<br>M4(18)<br>Job6:M2(19)Ml(21)<br>M3(11)M4(15) |

### 3.1 Objective function

The objective is to minimize the makespan and the formulae used are given below:

Operation completion time=Oij=Tij+Pij (1)

Job completion time $(C_i) = \sum_{i=1}^{n} O_{ij}$ (2)

Makespan = max (C1, C2, C3….. Cn)
(3)

Where j=operation, i=job, Tij=travelling time, Pij=operation processing time

## 4. VLADIMÍR MODRÁK HEURISTIC ALGORITHM

Vladimír Modrák et.al [12] Developed one algorithm for flow shop scheduling problems to minimize completion time for n-jobs and m-machines problem to employing local search methods used for mathematical optimization. In this work Vladimír Modrák Heuristic Algorithm is modified to solve simultaneous scheduling problems which are discussed below.

The steps involved in Vladimír Modrák are given below:

1. Find out the sum of processing time of n- jobs in machine $M_1$..

Repeat Step 1 for machines =1, 2, 3,…,m.

2. Make two groups from machines in such a way that
$$\sum_{j=1}^{X} T_i \sim \sum_{j=x+1}^{m} T_i \rightarrow \text{minimum}$$
3. Find out the total number of machines in each group. Let the number of machines in Group I = a, and the number of machines in Group II =b.
4. Calculate total operational time of jobs in each group using the formula:
   a) for the Group I and Job ($j_1$)
$$T_{j1}^{I} = (a.t_{11}) + [(a-1).t_{12}] + [(a-2).t_{12}] + \cdots + (1.t_{1a}).$$
   Similarly calculate these values for jobs $J_2$, $J_3$, $J_{n.}$
$$T_{j1}^{II} = (a.t_{1m}) + [(b-1).t_{1m-1}] + [(b-2).t_{1m-2}] + \cdots + (1.t_{1a+1}).$$
   Similarly calculate these values for jobs $J_2$, $J_3$, $J_{n.}$
5. Tabulate these values in two rows.
6. Apply final step of Johnson's rule to find out the best sequence.
7. Calculate the make-span time for the sequence obtained in step 6.
8. Store the results.

## .5. IMPLEMENTATION OF MODRAK ALGORITHM

For implementation of Vladimír Modrák algorithm, Job set 5 and Layout 1 are considered as an example. Vladimír Modrák computes the process times for different jobs and the sequences are obtained based on the sequence of machines. The Vladimír Modrák algorithm is explained in the following steps for the job set 5:

Step 1: Consider the job set with processing times

| Job Set No | Layout | No of Jobs | No of operations | Sequence of Machines |
|---|---|---|---|---|
| 5 | 1 | 5 | 13 | Job 1: 1-2-4<br>Job 2: 1-3-2<br>Job 3: 3-4-1<br>Job 4: 4-2<br>Job 5: 3-1 |

Step 2: Considering the process time values for each job as:

| | Job 1 | Job 2 | Job 3 | Job 4 | Job 5 |
|---|---|---|---|---|---|
| M1 | 6 | 18 | 12 | 0 | 9 |
| M2 | 12 | 15 | 0 | 15 | 0 |
| M3 | 0 | 6 | 9 | 0 | 3 |
| M4 | 9 | 0 | 3 | 6 | 0 |

Step 3: Find out the sum of processing time of jobs in machine

| | Job 1 | Job 2 | Job 3 | Job 4 | Job 5 | $T_i$ |
|---|---|---|---|---|---|---|
| M1 | 6 | 18 | 12 | 0 | 9 | 45 |
| M2 | 12 | 15 | 0 | 15 | 0 | 42 |
| M3 | 0 | 6 | 9 | 0 | 3 | 18 |
| M4 | 9 | 0 | 3 | 6 | 0 | 18 |

Step 4: Make two groups from machines in such away that
$$\sum_{j=1}^{X} T_i \sim \sum_{j=x+1}^{m} T_i \rightarrow \text{minimum}$$
(X= the arbitrary value from 1 to 5)

Consider X=2

$$\sum_{j=1}^{2} T_i \sim \sum_{j=3}^{4} T_i \rightarrow \text{minimum}$$

Thus, the total number of machines in each group is identified. The number of machines in Group I, = 2 (M1 and M2 are in Group-I, noted as I). The number of machines in Group II, = 2 (M3, M4, are in Group-II, noted as II). a b

Group I consisting of two machines I

| | **Job1** | **Job2** | **Job3** | **Job4** | **Job5** | **$T_i$** | **$\sum T_i$** |
|---|---|---|---|---|---|---|---|
| M1 | 6 | 18 | 12 | 0 | 9 | 45 | 87 |
| M2 | 12 | 15 | 0 | 15 | 0 | 42 | |

Group II consisting of two machines II.

| | **Job1** | **Job2** | **Job3** | **Job4** | **Job5** | **$T_i$** | **$\sum T_i$** |
|---|---|---|---|---|---|---|---|
| M3 | 0 | 6 | 9 | 0 | 3 | 18 | 36 |
| M4 | 9 | 0 | 3 | 6 | 0 | 18 | |

Subsequently, for the identified groups I and II the values of $T_{ji}^{I}$ and $T_{ji}^{II}$ (for =1 to n ) are calculated for all five jobs

$$T_{j1}^{I} = (2X6) + 12 = 24$$
$$T_{j2}^{I} = (2X18)+15 = 51$$
$$T_{j3}^{I} = (2X\ 12) + 0 = 24$$
$$T_{j4}^{I} = (2X\ 0) + 15 = 15$$
$$T_{j5}^{I} = (2X\ 9) + 0 = 18$$
$$T_{j1}^{II} = (2\ X\ 9) + 0 = 18$$
$$T_{j2}^{II} = (2\ X\ 0) + 6 = 6$$
$$T_{j3}^{II} = (2\ X\ 3) + 9 = 15$$
$$T_{j4}^{II} = (2\ X\ 6) + 0 = 12$$
$$T_{j5}^{II} = (2\ X\ 0) + 3 = 3$$

Step 5 : Tabulate the values of $T_{ji}^{I}$ and $T_{ji}^{II}$

| | **Job 1** | **Job 2** | **Job 3** | **Job 4** | **Job 5** |
|---|---|---|---|---|---|
| $T_{ji}^{I}$ | 24 | 51 | 24 | 15 | 18 |
| $T_{ji}^{II}$ | 18 | 6 | 15 | 12 | 3 |

Step 6: According to Johnson's rule the sequence is

Min Pij = $P_{52}$= Eliminate Job 5

Min Pij = $P_{22}$= Eliminate Job 2

Min Pij = $P_{42}$= Eliminate Job 4

Min Pij = $P_{32}$= Eliminate Job 3

Min Pij = $P_{12}$

The optimum job order sequence is 5-2-4-3-1

For the above job order operation sequence is

12-13- 4-5-6- 10-11- 7-8-6-1-2-3 makespan: 192

For the above sequence makespan calculation is as follows in table 3

**Table.3:** Operations schedule (for Job set 5 and layout 1)

| **Oper Num** | **Machine Number** | **Vehicle Number** | **Travel Time** | **Job Ready** | **Job Reach** | **Make Span** |
|---|---|---|---|---|---|---|
| 12 | 3 | 1 | 0 | 8 | 8 | 18 |
| 13 | 1 | 2 | 8 | 28 | 28 | 43 |
| 4 | 1 | 1 | 14 | 18 | 43 | 63 |
| 5 | 3 | 1 | 18 | 67 | 67 | 77 |
| 6 | 2 | 2 | 32 | 89 | 89 | 107 |
| 10 | 4 | 1 | 73 | 79 | 79 | 93 |
| 11 | 2 | 1 | 79 | 103 | 107 | 125 |
| 7 | 3 | 2 | 97 | 105 | 105 | 117 |
| 8 | 4 | 1 | 105 | 119 | 119 | 127 |
| 9 | 1 | 2 | 107 | 135 | 135 | 150 |
| 1 | 1 | 1 | 123 | 127 | 150 | 158 |
| 2 | 2 | 1 | 127 | 160 | 160 | 176 |
| 3 | 4 | 2 | 137 | 180 | 180 | 192 |

Computations for completion time for various combinations of job sets and layouts for three heuristic algorithms with t/p > 0.25 are done and tabulated in 4

**Table 4:** Comparison of make span values (for t/p>0.25)

| Job. No | t/p | Palmer | Gupta | Vladimir Modrak |
|---|---|---|---|---|
| 1.1 | 0.59 | 198 | 190 | 173 |
| 2.1 | 0.61 | 175 | 172 | 158 |
| 3.1 | 0.59 | 211 | 211 | 214 |
| 4.1 | 0.91 | 265 | 268 | 264 |
| 5.1 | 0.85 | 160 | 160 | 192 |
| 6.1 | 0.78 | 221 | 225 | 225 |
| 7.1 | 0.78 | 199 | 190 | 192 |
| 8.1 | 0.58 | 261 | 261 | 261 |
| 9.1 | 0.61 | 273 | 273 | 273 |
| 10.1 | 0.55 | 315 | 312 | 312 |
| 1.2 | 0.47 | 190 | 164 | 144 |
| 2.2 | 0.49 | 137 | 124 | 124 |
| 3.2 | 0.47 | 178 | 175 | 171 |
| 4.2 | 0.73 | 225 | 232 | 224 |
| 5.2 | 0.68 | 149 | 143 | 140 |
| 6.2 | 0.54 | 179 | 154 | 154 |
| 7.2 | 0.62 | 139 | 140 | 142 |
| 8.2 | 0.46 | 181 | 181 | 181 |
| 9.2 | 0.49 | 249 | 249 | 249 |
| 10.2 | 0.44 | 284 | 273 | 273 |
| 1.3 | 0.52 | 192 | 162 | 143 |
| 2.3 | 0.54 | 139 | 130 | 130 |
| 3.3 | 0.51 | 176 | 173 | 172 |
| 4.3 | 0.8 | 231 | 234 | 230 |
| 5.3 | 0.74 | 151 | 145 | 138 |
| 6.3 | 0.54 | 181 | 156 | 156 |
| 7.3 | 0.68 | 143 | 142 | 148 |
| 8.3 | 0.5 | 183 | 183 | 183 |
| 9.3 | 0.53 | 251 | 251 | 251 |
| 10.3 | 0.49 | 290 | 279 | 279 |
| 1.4 | 0.74 | 209 | 210 | 189 |
| 2.4 | 0.77 | 195 | 172 | 174 |
| 3.4 | 0.74 | 225 | 225 | 224 |
| 4.4 | 1.14 | 299 | 299 | 299 |
| 5.4 | 16 | 182 | 182 | 182 |
| 6.4 | 0.78 | 235 | 237 | 237 |
| 7.4 | 0.97 | 223 | 212 | 227 |
| 8.4 | 0.72 | 285 | 285 | 285 |
| 9.4 | 0.76 | 295 | 295 | 295 |
| 10.4 | 0.69 | 353 | 348 | 348 |

In the optimal sequence [13]-[15] of machines and AGVs are determined by using Palmer, Gupta and Vladimir Modrak for T/P >0.25 are shown in table no 4 From table 4 , out of 40 problems 21 problems gives improved results using Palmer in comparison with Gupta and Vladimir Modrak , 22 problems gives improved results using Gupta in comparison with Palmer and Vladimir Modrak and 35 problems gives improved results using Vladimir Modrak in comparison with Palmer and Gupta. Computations for completion time for various combinations of job sets and layouts for Tabu Search heuristic algorithms with t/p < 0.25 are done and tabulated in 5.

Table 5: Comparison of make span values (for t/p<0.25)

| Job. No | t/p | Palmer | Gupta | Vladimir Modrak |
|---|---|---|---|---|
| 1.10 | 0.15 | 318 | 279 | 228 |
| 2.10 | 0.15 | 314 | 217 | 217 |
| 3.10 | 0.15 | 300 | 299 | 267 |
| 4.10 | 0.15 | 329 | 352 | 323 |
| 5.10 | 0.21 | 236 | 213 | 117 |
| 6.10 | 0.16 | 302 | 267 | 266 |
| 7.10 | 0.19 | 329 | 233 | 220 |
| 8.10 | 0.14 | 338 | 338 | 338 |
| 9.10 | 0.15 | 369 | 382 | 382 |
| 10.10 | 0.14 | 403 | 420 | 420 |
| 1.20 | 0.12 | 314 | 272 | 219 |
| 2.20 | 0.12 | 204 | 200 | 194 |
| 3.20 | 0.12 | 285 | 285 | 255 |
| 4.20 | 0.12 | 315 | 340 | 309 |
| 5.20 | 0.17 | 232 | 207 | 169 |
| 6.20 | 0.12 | 285 | 243 | 251 |
| 7.20 | 0.15 | 208 | 216 | 202 |
| 8.20 | 0.11 | 319 | 319 | 319 |
| 9.20 | 0.12 | 357 | 372 | 372 |
| 10.20 | 0.11 | 393 | 416 | 416 |
| 1.30 | 0.13 | 315 | 271 | 218 |
| 2.30 | 0.13 | 207 | 203 | 197 |
| 3.30 | 0.13 | 284 | 284 | 254 |
| 4.30 | 0.13 | 316 | 339 | 310 |
| 5.30 | 0.18 | 233 | 208 | 168 |
| 6.30 | 0.24 | 286 | 244 | 252 |
| 7.30 | 0.17 | 209 | 217 | 203 |
| 8.30 | 0.13 | 320 | 320 | 320 |
| 9.30 | 0.13 | 358 | 373 | 373 |
| 10.30 | 0.12 | 396 | 419 | 419 |
| 1.40 | 0.18 | 321 | 277 | 232 |
| 2.41 | 0.13 | 322 | 316 | 307 |
| 3.40 | 0.18 | 305 | 303 | 269 |
| 3.41 | 0.12 | 435 | 437 | 388 |
| 4.41 | 0.19 | 470 | 504 | 464 |
| 5.41 | 0.18 | 344 | 309 | 252 |
| 6.40 | 0.19 | 308 | 270 | 270 |
| 7.40 | 0.24 | 241 | 240 | 223 |
| 7.41 | 0.16 | 329 | 335 | 307 |
| 8.40 | 0.18 | 343 | 343 | 343 |
| 9.40 | 0.19 | 380 | 388 | 388 |
| 10.40 | 0.17 | 419 | 430 | 430 |

In the optimal sequence [16]-[17] of machines and AGVs are determined by using Palmer, Gupta and Vladimir Modrak for T/P < 0.25 are shown in table no 5.From table 5, out of 42 problem 7 problems gives improved results using Palmer in comparison with Gupta and Vladimir Modrak, 34 problems gives improved results using Gupta in comparison with Palmer and Vladimir Modrak and 32 problems gives improved results using Vladimir Modrak in comparison with Palmer and Gupta. Comparison of the makespan for different job sets and with different layouts and Vladimir Modrak are shown graphically in Figure 3 and Figure 4.

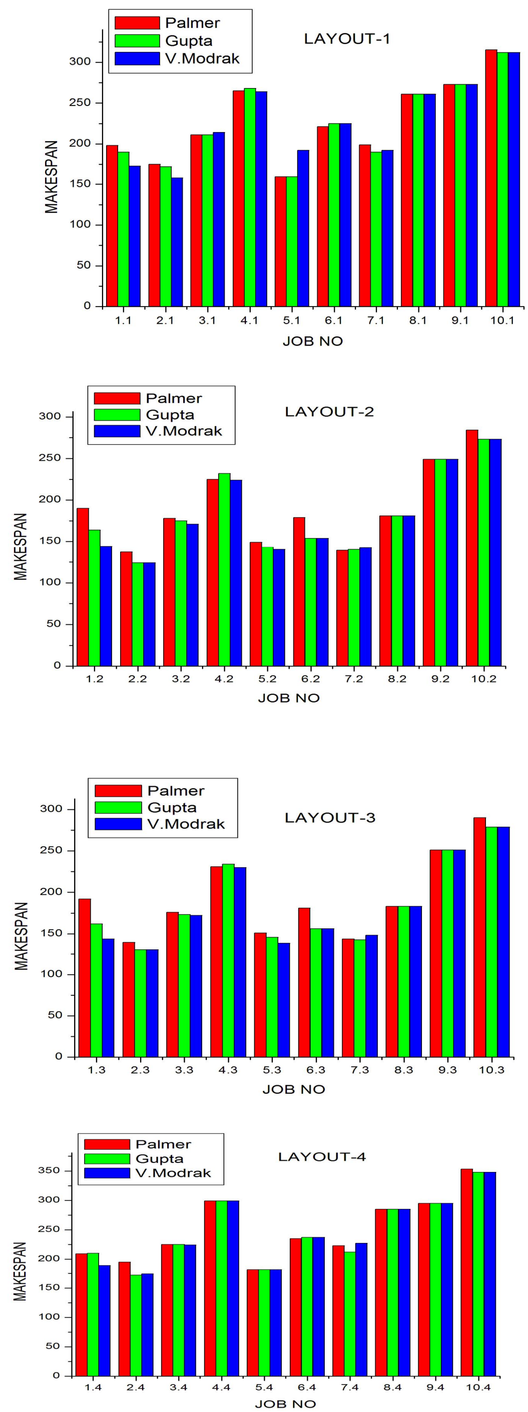


**Figure 3:** Performance of Vladimir Modrak for t/p>0.25

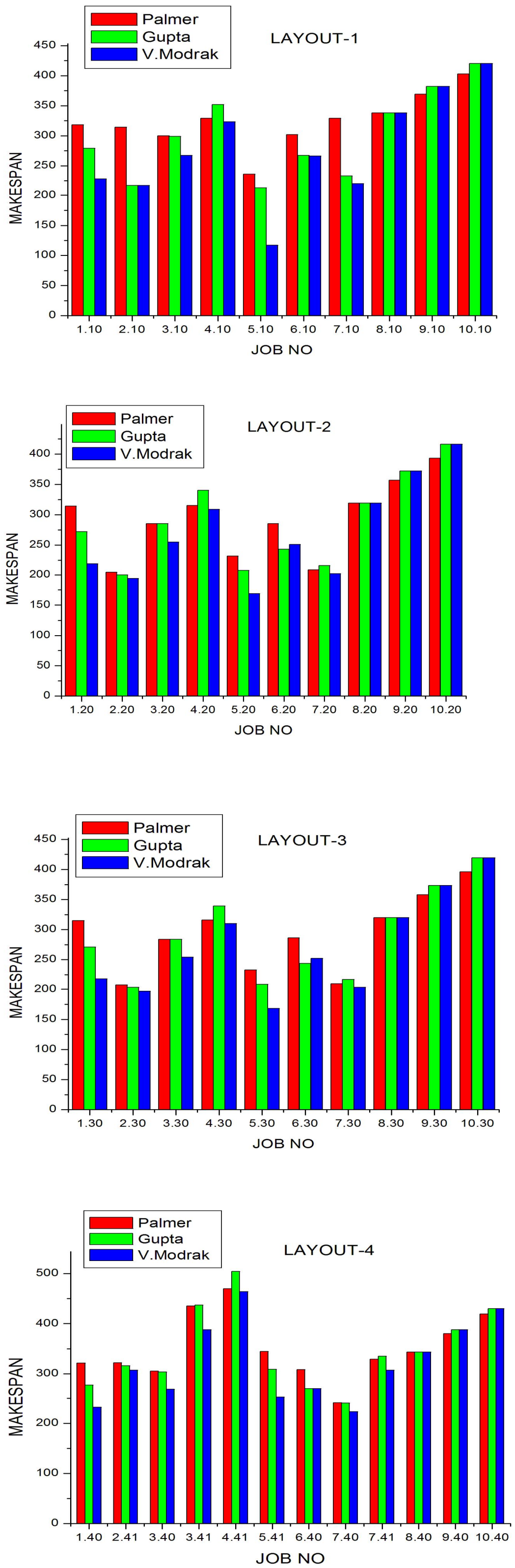


**Figure 4:** Performance of Vladimir Modrak for t/p<0.25

It is observed from the above graphs that majority of the problems the Vladimir Modrak performed better than others, except in few problems where Gupta is reported to be better.

## 6. CONCLUSION

Flexible Manufacturing system is believed as better option to face the tasks of global contest. But for effective enactment effective scheduling is important. Scheduling of an FMS is a very complicated problem because of additional requirements like material handling. In this paper an effort has been affected to solve the NP hard problems by Vladimir Modrak algorithm the subsequent conclusions are extracted from this work. Accomplishments of Vladimir Modrak are assessed by studying 82 benchmark problems entailing of different job sets and layouts. From the evaluation of these results Vladimir Modrak algorithm gives best results

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