INTEGRATION POLICIES FOR PREVENTIVE MAINTENANCE AND REPAIRS OF COMPLEX FLOW SHOP

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ABSTRACT : *In this study the preparation tools during the production planning workshop are assumed to be the Integration Policies for the preventive maintenance and repairs of complex flow shop. Preventive maintenance (PM) in the calculation and estimation are then mixed with other regularly scheduled activities during the workshop. For being a very active field of research in this area of production planning is selected in this paper. Optimal periodic preventive maintenance model for maximization of access for devices have been considered. The performance of our algorithm is tested by numerical experiments on a large number of randomly generated problems. A comparison with solutions performance obtained by AIS, SPT, LPT and John shows that the proposed approach performs well for this problem.*

Key Words: *complex flow shop, policies for preventive maintenance, PM*

INTRODUCTION

Production schedule can be defined as the sequencing and time allocation of customer orders to production resources (including personnel, equipment, tools, etc.) in order to perform a set of related operations. Usually, the scheduling objectives such as achieving commitment, minimizing the work in process inventory and work in process, maximization of output and operation centers have been the subject to study. It is noteworthy that these objectives are in conflict with each other, so the timing issues are most likely due to technical problems.

Allocating resources to activities over time is known as the complex compounds. Exact methods are not applicable to this problem because in most cases these computational requirements are unrealistic. This is especially true in the case of complete enumeration techniques (which are often used when there are no analytical methods for solution) .

Lots of activity and resource scheduling to real production is generally. A different set of objectives and constraints in their resource utilization are discussed. Not surprisingly therefore, solve the mathematical programming methods or formulation is relatively heavy and cumbersome. Uncertainty in industrial environments, to produce hardening provides timing issues. In some cases, the rules can be simple or heuristic techniques to solve this problem, but in some cases it is more sophisticated optimization techniques, modeling, or logical.

Akhshabi *et. al.* proposed a genetic algorithm to a Hybrid flow shop Scheduling problem with set up dependent sequence considering the minimization of the maximum completion time with respect to preventive maintenance [1]. Gupta [2] and Hoogeveen [3] proved that the two stage hybrid flow shop scheduling problem is NP-hard in the strong sense even if there is only one machine on the first stage and there are two machines on the second stage. Recently, the multi-stage hybrid flow shop scheduling problem has received attention due to its theoretical and practical importance.

The HFS scheduling has been widely applied in different manufacturing environments like in the iron and steel, the textile, the machine driven and the electronics industries [4]. In literature, it can be clearly seen that most of the researchers have considered the two-stage hybrid flow shop scheduling problems [5]. Brah and Hunsucker [6] proposed a branch and bound algorithm to solve the hybrid flow shop problems. Portmann *et al.*,[5] presented an improvement with genetic algorithms for the Brah and Hunsucker problems lower bound. Riane *et al*.,[7] treated a problem of scheduling n jobs on a three-stage hybrid flow shop of particular structure and proposed two heuristic procedures to cope with the realistic problems. Moursli and Pochet also proposed a branch and bound algorithm for the hybrid flow shop scheduling problem [8]. Soewandi and Elmaghraby presented several heuristic procedures of time complexity and several lower bounds of three-stage hybrid flow shop problems [9]. Neron *et al.*, considered the hybrid flow shop scheduling problem with the objective of minimizing the make span [10]. They showed that the use of satisfaction tests and time bound adjustments based on the energetic reasoning and global operations could enhance the efficiency of branch and bound procedures for solving the hybrid flow shop scheduling problem optimally. A new approach built with the artificial immune system was proposed by Engin and Doyen to solve the hybrid flow shop scheduling problems [11]. Allaoui and Artiba have studied the problem of scheduling a hybrid flow shop to minimize flow time and due date-based criteria under maintenance constraints [12]. They used three dispatching rules LPT, SPT, and EDD, the simulated annealing heuristic, and a flexible simulation model to solve the problem. Tang *et al*. proposed a neural network model and algorithm to solve the dynamic hybrid flow shop scheduling problem [13]. The most commonly used dispatching rules were used as benchmarks. They showed that the performance of the neural network approach was much better than that of the traditional dispatching rules. Zandieh *et al.*, proposed an immune evolutionary algorithm approach to the scheduling of a sequence dependent setup time hybrid flow shop problems [14] . They compared the results obtained with the random key genetic algorithm presented previously.

Tang and Xuan investigated the problem of scheduling n jobs on parallel identical machines in J successive stages with finite buffer capacities between consecutive stages in a real-time environment [15]. They developed a Lagrangian relaxation algorithm combined with a speed-up dynamic programming approach. Allahverdi and Anzi addressed the problem of scheduling on multi-stage parallel processor architecture in computer centers with the objective of minimizing average completion time of a set of requests [16]. They proposed a new three phase heuristic approach. Allaoui and Artiba investigated the two-stage hybrid flow shop scheduling problem with only one machine on the first stage and m machines on the second stage to minimize the make span [17]. They considered that each machine is subject to at most one unavailability period. They used the branch and bound model for that problem. Vob and Witt considered a real world multi-mode multi-project scheduling problem in which the resources form a hybrid flow shop consisting of 16 production stages [18]. They presented a mathematical model based on the resource constrained project scheduling problem to provide a formal description of the problem. Caricato *et al.*, focused on a variant of the hybrid flow shop problem, in which the jobs to be processed were grouped into predefined, ordered batches [19]. They used a TSP-based approach to model the system. Janiak *et al*., studied the flow-shop scheduling problem with parallel machines at each stage [20]. The scheduling criterion consisted of three parts; the total weighted earliness, the total weighted tardiness, and the total weighted waiting time. They proposed some approximation algorithms for this problem with the complex, cost-related criterion.

Jin *et al* have considered the multistage hybrid flow shop scheduling problems [21]. They studied two metaheuristic algorithms that were based on shop partitioning and simulated annealing, and the proposed approaches had been implemented in a real-life printed circuit board assembly line. Alaykıran *et al*, presented an ant colony optimization model to solve HFS problems [22]. Also, Kahraman *et al.*, proposed a genetic algorithm for HFS problems[23].

Due to the importance of the multiprocessor task scheduling problem, it has been extensively studied by many researchers. Edwin *et al.*, proposed a genetic algorithm for the multiprocessor scheduling problem that was based on the deterministic model [24]. The proposed genetic algorithm was tested with random task graphs and the task graphs of the Newton–Euler inverse dynamic equations for the stand ford and elbow manipulators.

In this paper, an efficient memetic algorithm was developed to solve the hybrid flow shop scheduling with multiprocessor task. The effectiveness of the proposed method was tested with the hybrid flow shop scheduling with multiprocessor task problems. The computational results indicated that the proposed approach was effective.

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Optimal periodic preventive maintenance model for maximization of access for devices

Maintenance in the classical theory, the optimal preventive maintenance interval for a production system to the maximum limit access by formula (1) is determined. This model available, the effects of a failure, repair and preventive maintenance of downtime is achieved by combining.

We suppose that the failure time follows the Weibull probability distribution. The amount of time required for preventive maintenance is Nmyr and processing time. Performing preventive maintenance, equipment and machinery of the state (as well) returns. Number of failures during any period of renewal processes can be modeled as follows: The time interval between two successive preventive maintenance. The purpose of this policy is to maximize system availability.Optimal maintenance interval can be calculated by the following

$$T_{PMop} = \theta \cdot \left[\frac{t_p}{t_r(\beta - 1)} \right]^{1/\beta} \qquad (1)$$

In the following example for a better understanding of how Pkparchh Nkhdary preventive maintenance and production schedules in the policy, is presented. This is the way the car is calculated on the total hours of work. The processing time of job i can gather, the total being greater than 50 primarily Nkhdary operations and preventive maintenance performed, then ith job do.

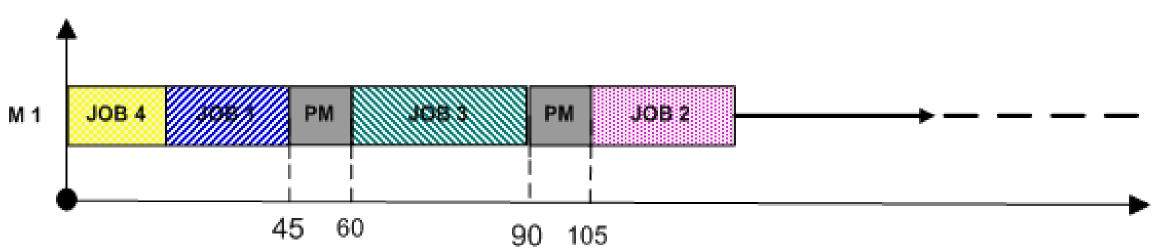

Figure 1: Gantt chart in this policy

Profile scheduling problem with time-dependent sequence of hybrid flow shop system and limitations of preventive maintenance

- Machine operation planning of preventive maintenance, some sections is not available.
- Cars are parallel.
- Cars are equal and the same processing speed.
- Each jump is possible at each stage.
- Any work at any point, at most on a machine, is analyzed.
- Each job step may have already met, not met again.
- Tasks are processed without problems, i.e. no interruption of business processes (job cuts is not allowed).
- do not have any priority over me.
- There are infinite buffers between the stages before and after the first stage of the final stage, machines cannot be stopped.
- The procedures, time does not move.
- Works on any stage, immediately after completing the first stage of the process, the process is available.
- Preparation time jobs, more than 0, and the processing time before it is completed.
- Preparation time depends on the sequence of tasks in each stage is no waiting time.
- After completing the work and before processing the next task, some preparation time is calculated.
- Preparation time is dependent on the current and previous (preparation time is dependent on the sequence).
- Time available to any machine with previous work on the time machine.

Analysis of the objective function value of the five algorithms for Analysis of the results of the objective function in the proposed algorithm, we used sample problems as in [1] that conform Preventive maintenance intervals predetermined and fixed police. The results and classified according to the number of tasks and the number of stages is shown in Table 1.

The relative deviations of the genetic algorithm and the immune system would be 0.13% and 0.49% respectively, while the results relative deviation of 7.86% for SPT and 14.16% for LPT and the 4.49% for John . It can be concluded that the heuristic algorithm has better results compared to two other heuristic algorithms. The results indicate that the immune genetic algorithm for the flow shop and mixed

Preparation time constraints associated with the sequence of operations, preventive maintenance

When the Optimal periodic preventive maintenance model for maximization of access for devices policy is applied to perform better than other algorithms,

. Table 1: Average percentage deviation for the five algorithms

Instance	GA	AIS	SPT	LPT	John. (g/2, g/2)
40×2	0.15	0.55	7.79	14.19	3.94
40×4	0.14	0.56	10.00	17.70	7.04
40×8	0.15	0.55	10.33	16.42	6.56
70×2	0.13	0.46	6.62	12.46	3.35
70×4	0.08	0.55	7.92	14.42	4.36
70×8	0.13	0.62	9.34	15.83	5.10
100×2	0.10	0.30	4.56	10.52	2.62
100×4	0.09	0.41	6.83	12.95	3.83
100×8	0.18	0.45	7.32	12.96	3.58
Average	0.13	0.49	7.86	14.16	4.49

Due to the close genetic algorithm and immune responses requires careful analysis of the results. Therefore, ANOVA test was used for statistical analysis. ANOVA showed that the algorithm is not uniform. Further analysis and the next phase we find a better algorithm. At this stage, the LSD test was used. This analysis is done using Minitab 14 software. Figure 2shows the 95% confidence interval of LSD.

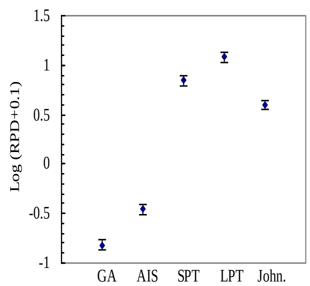

Figure 2: Showing Mean and Range LSD (95% confidence level) for the two algorithms in this policy

CONCLUSIONS

In last Chapter GA ,AIS, SPT, LPT and John for flow shop scheduling problem with a complex sequence of time-dependent treatment and preventive maintenance was developed. In 2835 sample operation preventive maintenance scheduling policy provided was performed. The results of the objective function in Table 2 are summarized:

The table so it is for example in this policy in 61% of 405 samples have been solved by genetic algorithm, less than the immune algorithm system and moderate genetic algorithms in 61% of 405 samples, 13 units of time The algorithm has less immunity. In 13% of 405 samples, with the difference between these two algorithms are less than 2 times. In 25% of the 405 samples immune algorithm with genetic algorithm is less than the average amount of time a unit is equal to 12.it is show that GA have better result than immune algorithm system for Cmax in Proposed policy than last policy [1].

Table 2: Comparison of objective function values (Cmax) of AIS algorithm, GA

Further Decrease average	Problem percent	equal Decrease average	Decrease average	less Problem percent	Number of jobs	PM
21	37%	8%	18	55%	40	
25	41%	6%	34	53%	70	last policy [1])
39	36%	8%	45	56%	100	
9	26%	13%	13	61%	40	
12	25%	9%	18	66%	70	Proposed policy
15	26%	9%	20	65%	100	

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