Integration of Process Planning and Scheduling Comparison of Models Approach

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Abstract: *Process planning and scheduling are two sequencing rules such as earliest due date and earliest operation due date provide better performance for all the measures higher flexibility levels. In this paper highlights the different approach of integration of process plans flexible manufacturing system. important manufacturing functions involved in any shop floor activities. Integration between process planning and scheduling in flexible manufacturing system (fms) an effective integration improved the potential for increase the system performance and enhanced decision making. The flexibility in process planning including process flexibility, sequence flexibility, and alternative process plans. The benefits of either of these flexibilities diminish at higher flexibility levels. Part*

Keywords: flexible manufacturing system, integration, process planning, scheduling

1. Introduction

Flexible manufacturing systems (FMS) consist of a computer controlled and integrated configuration of numerically controlled (NC) machine tools inter-linked with automated material handling systems. Combining the merits of job shop production and flow shop production, FMS provides a promising technology for mid-volume and mid-variety production [1]. Since each machine in a FMS is quite versatile and capable of performing many different operations simultaneously. The capability of CNC machines, each part may have alternative process plan in the system. Since the selected process plan affect the congestion in the system, selecting the most appropriate process plan for each part becomes a critical issue and has a high impact on the system performance[1]. The complexity due to the random part arrivals makes the real-time process plan selection and control problems multidimensional in nature. Flexible manufacturing technology provides various benefits such as increased machine utilization, reduced work-in-process inventory, increased productivity, reduced number of tools, reduced lead times, less floor space, and reduced set-up costs. but on other hand some difficulties are occur like in design scheduling and control the flexible manufacturing system[2]. This paper aims to highlight the need for the effective integration of process planning and scheduling in FMS in order to increase the potential for enhanced system performance and to improve the decision making during scheduling. Process planning and scheduling are used as bridge in product design and manufacturing of any flexible manufacturing system. A process planning, each operation is assigned to a certain manufacturing tool. It specifies what manufacturing resources and technical operations/routes are needed to produce a product (a job). The conclusion of process planning includes the identification of machines, tools and

fixtures suitable for a job, and the arrangement of operations and processes for the job. Generally, a product may have one or more alternative process plans. With the process plans of jobs as input, where as in scheduling the assignments of manufacturing resources over time to different operations is performed .Although there is a close relationship between process planning and scheduling, the integration of them is still a challenge in both research and applications [3].
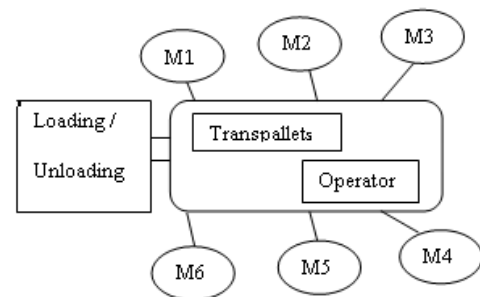

Figure 1: Fms Layout

2. Process planning

A process plan specifies what raw materials or components are needed to produce a product, and what processes and operations are necessary to transform those raw materials into the final product. It provides the information to the shop floor on how to produce the designed [4] .The outcome of process planning is the information required for manufacturing processes, including the identification of the machines, tools and fixtures. Since proposed the method that used computer to aid the selection of process, there have been numerous research efforts in the development of Computer-Aided Process Planning (CAPP) systems. Many systems and many implementation approaches have been reported. There are

two traditional types of approach to CAPP: variant approach and generative Approach. The variant approach uses group technology to retrieve an existing plan for a similar part and makes the necessary modifications to the plan for the new part. This method is especially suitable for companies with few product families and a large number of parts per family [5]. One of the main disadvantages of this method is that the quality of a process plan depends on the knowledge background of the process planners. The generative approach is based on generating a plan for each part without referring to existing plans. It uses a more powerful software program to develop a process plan based on the part geometry, the number of parts and information about facilities in the plant. Generative approach mostly meets the requirements of large companies and research organizations, especially those that have a number of different products but each product type is in small production batches. However, there are still difficulties in developing truly generative CAPP systems to meet industrial needs. Most current CAPP systems use these two approaches [6].

3. Scheduling for FMS

Decisions and tasks concerning the management of production are categorized into three interrelated functions: planning, scheduling and control Planning is basically concerned with decisions related to specifying the part types and quantities to be produced as well as allocating machines with tools to form the desired machine groupings. The request for producing a certain part type with a specified quantity represents a planned job [7]. A plan delivered from planning to schedule includes the set of jobs to be produced over a period of time. A schedule for executing this plan is generated by assigning jobs to resources in real time and is delivered to shop floor control for execution. Scheduling is the process to allocate the operations to time intervals on the machines. A scheduling problem can be classified into different types based on four parameters: job arrival patterns, number of machines in the shop, flow patterns in the shop and the criteria by which the schedule is to be evaluated [8]. Among various scheduling types, job shop scheduling is one of the most important scheduling types. Job shop Scheduling Problem (JSP) can be defined as: given a set of n jobs, which are to be processed on m machines with defined technological constraints for each job, find a sequence in which jobs pass between machines such that it satisfies the technological constraints and it is optimal with respect to some performance criteria.

4. Integration of Process planning and scheduling

Automated process planning and scheduling have been receiving noteworthy attention from the research community since they are two of the major activities in a manufacturing system. Computer-aided processes planning (CAPP) systems developed in the past two decades or so, were intended to bridge the gap between computer- aided manufacturing (CAM) and computer-aided design (CAD), and to provide fast feedback

to designers regarding detailed manufacturing information. A process plan specifies what raw materials are needed to produce a product, and what processes and operations are necessary to transform those raw materials into the final product [9]. The outcome of process planning is the information for manufacturing processes and their parameters, and the identification of the machines, tools, and fixtures required to perform those processes. Scheduling is another manufacturing system function that attempts to assign manufacturing resources to the processes indicated in the process plans in such a way that some relevant criteria, such as due date and make-span are met. Although there a strong relation between process planning and scheduling, conventionally the two functions have been studied independently. As a common practice, process planning and scheduling tasks are performed separately [10].

Working steps of integration of process planning and scheduling

1. CAPP system is working based on the ideal shop floor resources, and generates all initial alternative process plans for each job. Shop floor module provides the current shop floor status to the CAPP system.

2. Based on the shop floor resource information by given optimization criteria ,the CAPP system optimizes all the alternative process plans and select the near optimal process plans for each job .Because there may be many alternative process plans for each job

3. The integration of process planning and scheduling is optimized based on the current shop floor status, generating the optimal scheduling plan and selecting one optimal process plan for each job from the selected process plan in above step2.

4. CAPP is system is used to generate the detailed process plan for each job, and scheduling system is used to generate the detailed scheduling plan
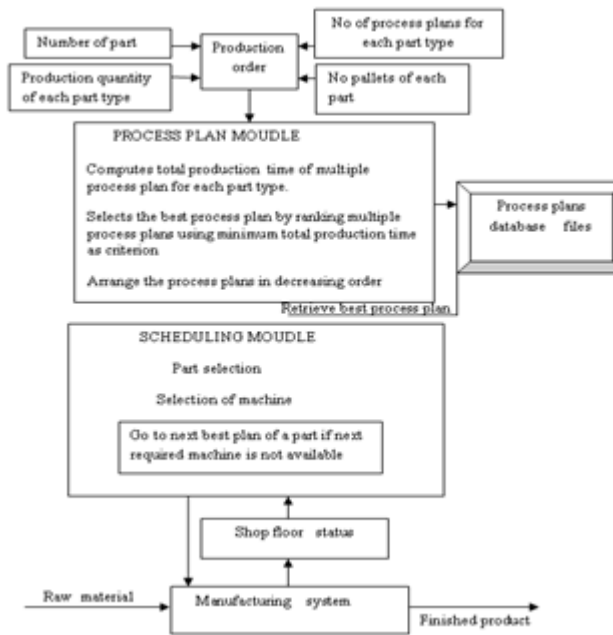
Figure 2: Integration of process planning and scheduling

5. Need of process planning and Scheduling

Many problems may arise with the manufacturing system where process planning and scheduling are performed separately. Process planners usually assume that the shop is idle and that there are unlimited resources in the shop, and repeatedly select desirable machines. Thus when a process plan is going to be carried out, some constraints (such as limited resources or non-availability of machines) will be encountered, making the generated 'optimal' process plan infeasible or sub-optimal. Even if the dynamic shop status is considered, time delay between the planning phase and the plan execution phase may cause some troubles. Owing to the dynamic nature of a production environment, it is likely that by the time a part is ready to be manufactured [11], constraints that were used in generating the process plans may already have been changed to some degree, and thus the process plan has become sub-optimal or even totally invalid. Owing to the complexity of the real production environment, neither the process plans nor the planning schedules are truly followed in the shop. Without the feedback from the shop, it is difficult to measure the quality or effectiveness of a plan for future enhancement. To eliminate the problems mentioned above, the integration of process planning and scheduling has become essential and attracted great research interests in the past decade [12] .Over the last decade, there have been numerous research efforts towards the integration of process planning and scheduling. In general, the reported methods emphasize on two different approaches. The first one is based on the idea of using the dynamic just-in-time information of the job shop as input for generating process plans for incoming jobs. Such process plans are expected to be implemented with little or no modification [13]. The second approach is based on the idea of exploring the alternative process plans for a given job in achieving a good schedule solution. This is a rather promising approach as it is designed towards achieving optimal process plans while satisfying the delivery requirements in the final schedule. Following this direction, the reported approaches, in general, can be further classified into two categories: the iterative approach and the simultaneous approaches.

6. Models used in integration process plan

6.1. Non-Linear process planning (NLPP).
6.2. Closed Loop process planning (CLPP).
6.3. Distributed process planning (DPP).

6.1. Non-Linear process planning: - It refers to a method for alternate plans with due preference according to process planning optimization criteria. NLPP approach is based on static shop floor conditions, means to realize the integration between process planning and scheduling. The first-priority plan is likely ready for submission when the job is required and also makes scheduling for the Real Decision. It has suitability of second priority plan to scheduling when first-priority plan is unsuitable for current shop floor status. NLPP also known as flexible process planning, Multi-process planning or Alternate process planning [14]. NLPP can be implemented in a company when it comprises multiple process plans for each part type available in that company. It only uses alternate process plans to enhance the flexibility of the manufacturing system. It is very simple method that's why, excellent work is going on integration model for its improvement and implementation of this model[15].Here, when we have large no. of process plans ,it increase exponentially and creates storage problem. NLLP has one-way information flow, from process planning to production process and not provide optimal inferences.
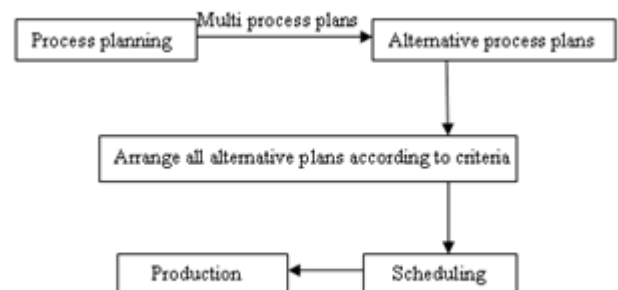

Figure 3: The flow chart of NLPP

6.2. Closed Loop process planning:-It is a method in which Dynamic feedback from production scheduling system. It is a dynamic simulation system which enhances the Real time, intuition and manipulability of process planning system. It is also known as Real time process planning or dynamic process planning. It can bring the integration process planning to a real time integration system very well. It overcome of limitation of NLPP and generates plan by mean of dynamic feedback from production scheduling and the available resources. It divided the dynamic process planning into the static phase and the dynamic phase. It is a Dynamic process planning system which gives gave process plans based on feedback of scheduling system [16].
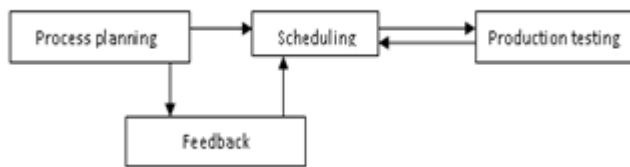
Figure 4: The flow chart of CLPP

6.3. Distributed process planning: This is a method which uses concurrent engineering approach; perform both the process planning and the scheduling simultaneously. It divides the process planning and scheduling into 2 phases;

Initial planning phases:-characteristics of parts and the relationship between the parts are analyzed and resources are evaluated simultaneously [16].Detailed planning phase:-process plans are adjusted to the current status of floor shop floor..It is also known as Just-in-time process planning, concurrent process planning collaborative Process planning
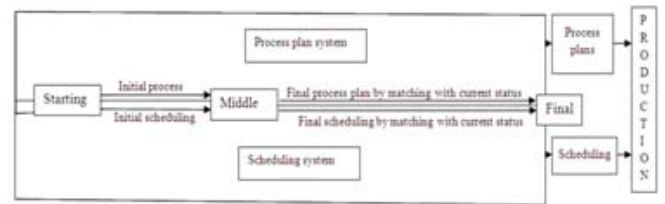

Figure 5: The flow chart of DPP

Factor	NLPP	CLPP	DTPP
Working	Static shop floor	Current shop floor	Collaborative and cooperative way
Process plan flexibility	Process plan cannot change on shop floor	Change on shop floor by dynamic feedback system	Use best process plan
Hardware /software capacity and capability	Low capability required	Low capability required	High capability and capacity required
Advantage	NLPP Providing all the alternative process plans of, and enhancing the flexibility and the availability of process plans	CLPP Based on the current shop floor status, the process plans are all very useful	DPP This model works in an interactive, collaborative, and cooperative way
Disadvantages	Because of the need to give all alternative process plan of the parts this will cause a combinational explosive problem.	CLPP needs the real-time data of the current status, if it has to re-generate process plansin every scheduling phase, the real-time data is hard to be assured and updated	Because the basic integration principle of DPP is a hierarchical approach, it cannot optimize the process plans and scheduling plans as a whole

Table 1: NLPP vs CLPP vs DTPP

7. Conclusion and future aspects

Integration of process planning and scheduling has been recognized as playing an important role to form integrated manufacturing. The lack of integrated methodologies in the connection with multi process plan, the main driving force behind this paper. Various integration models have been proposed several researchers have examined many aspects of integration of process plans but there are still many problems in these models. Ex. How to develop the real IPPS system for the manufacturing system? If properly addressed, may lead to significant progress in the study of IPPS, and can improve the productivity of the manufacturing system greatly. From the above study we found following results:-

(1)For eliminating the disadvantages, integrating these models to exploit their advantages we can use the simulation technique to propose better and more practical integration models.

(2) Most current researches ignore the impact of set-up and transportation time. However, in the modern business

environment, the customs need the products with small batches and multi-type. In this case, the set-up and transportation time cannot be ignored.

(3)Most existing approaches used make span as their objective and did not consider the orders' due dates. However, the models that consider the orders' due dates are more in line with the requirements of the modern business environment. And, this has not been very well studied.

(4)The manufacturing system cannot require only one criterion. Therefore, the IPPS is a multi-objective problem. Some other evaluation criteria except make span, such as total processing cost, total weighted tardiness, lateness, earliness and the weighted number of tardy jobs, which are also of practical interest and importance, have not been very well studied. Therefore, another important future research trend is the research on the multi-objective IPPS.

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