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REVIEW ARTICLE

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AN OVERVIEW OF THE NETWORKED MANUFACTURING SCHEDULING SYSTEM

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ABSTRACT

Production scheduling is generally considered to be the one of the most significant issue in the planning and operation of a manufacturing system. Better scheduling system has significant impact on cost reduction, increased productivity, customer satisfaction and overall competitive advantage. In addition, recent customer demand for high variety products has contributed to an increase in product complexity that further emphasizes the need for improved scheduling. Proficient scheduling leads to increase in capacity utilization efficiency and hence thereby reducing the time required to complete jobs and consequently increasing the profitability of an organization in present competitive environment.

Keywords—Networked Manufacturing, Scheduling system, Principles, Line Balancing Technique, Scheduling algorithm.

I. INTRODUCTION

A. Networked Manufacturing Networked Manufacturing is the sum of all necessary physical elements and it's abstract in enterprises' activities of products life cycle manufacture and their maintenance. In the macro sense, equipment, knowledge, experience, technology and management methods that are correlative to product manufacture belong to manufacturing resources. However, we only concentrate on the equipment resources in a narrow sense of manufacturing resources and their dynamic management.

B. Categories of Manufacturing Resource

In this paper, we have divided manufacturing resource into two categories, namely hardware resource and software resource (shown in Fig. 1). The hardware (equipment) resource includes kinds of visible equipment and tools, while the software consists of invisible experience and knowledge which needs long-term accumulation and summary.

II. SEQUENCING AND SCHEDULING

Sequencing refers to arranging items or events in a particular order. In other words Sequencing is a technique to order the jobs in a particular sequence. In industries there are different types of sequencing which are followed such as first in first out basis, priority basis, job size basis and processing time basis etc. In processing time basis sequencing for different sequence, we will achieve different processing time. The sequence is adapted which gives minimum processing time.

Scheduling is a decision making process and it concerns the allocation of the limited resources to tasks over time By Scheduling, we assign a particular time for completing a particular job. The main objective of scheduling is to arrive at a

position where we will get minimum processing time.

The priority planning is concerned with the time-phased planning of materials, work-in – process, and assembly of final product. The priorities for the jobs in the shop are determined on a weekly or even daily basis. This is termed scheduling.

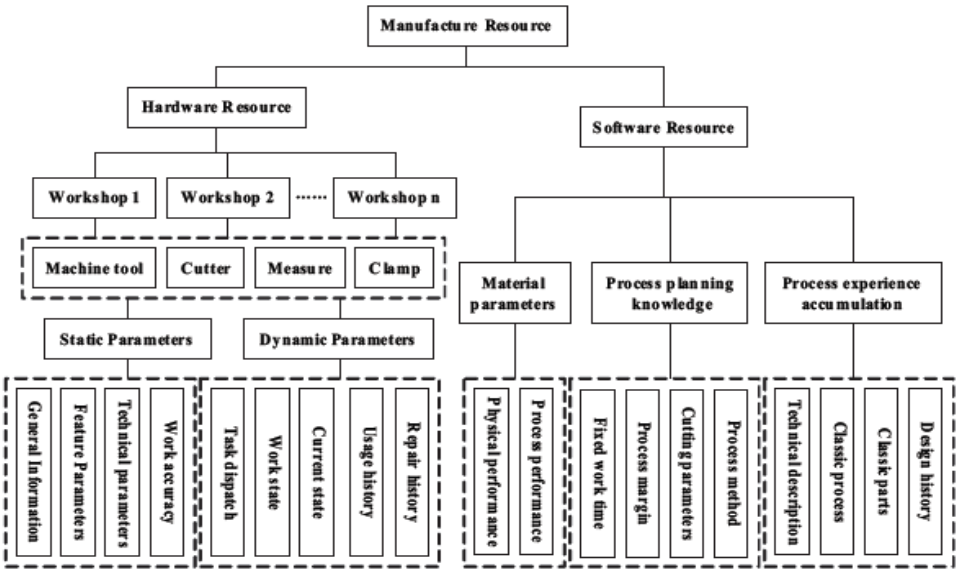

Fig. 1. Categories of Manufacturing Resource

III. SHOP FLOOR CONTROL SYSTEM

The factory-wide information control system is shown in fig.2

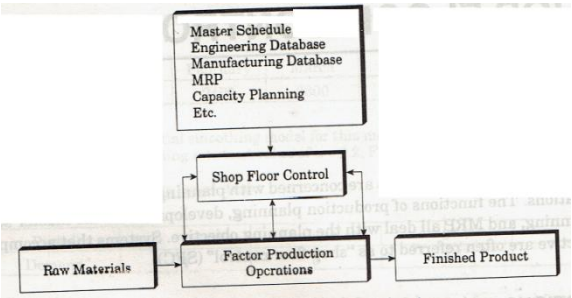

Fig. 2

The input to the SFC system is the collection of production plans (e.g. results of process Planning, MRP, capacity planning,etc.).A typical SFC system consists of three phases : order release, order scheduling and order progress. In Networked Manufacturing, these phases are augmented by computer. The three phases and their connections to other functions in the production management system are illustrated in fig 3.

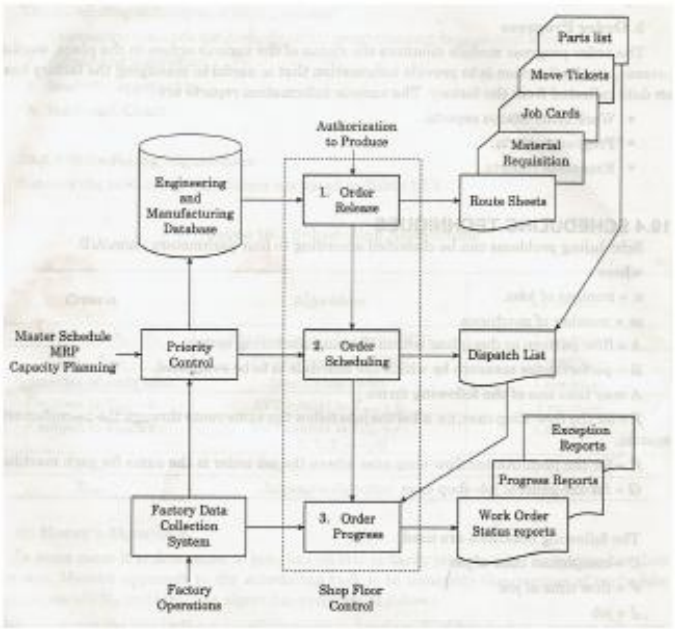

Fig. 3

A. Order Release

The order release phase of SFC provides the documentation needed to process a production order through the factory. It consists of :

- Route sheet

- Material requisitions
- Job cards
- Move tickets
- Part lists

For automated methods, these documents are unnecessary. The order release is driven by authorization to produce and engineering/manufacturing data base.

B.Order Scheduling

The order schedule in module assigns the production orders to the various work centres in the plant.It executes the dispatching function in production planning and control.It is used to solve two problems in production control : Machine loading and sequencing.

Allocating the orders to the work centres is termed as machine loading or shop loading.Job sequencing involves determining the order in which the jobs will be processed through a given work centers. To determine the sequence,priorities has to be fixed.some of the priority rules are:

- Earlist due date (higher priority)
- Shortest processing time (higher priority)
- Least slack time (higher priority)
- Critical ratio (higher priority for lowest critical ratio)

Slack time is defined as the difference between the time remaining until due date and the process time remaining.

Critial ratio is defined as the ratio of the time remaining until due date divided by the process time remaining.

C.Order progress

The order progress module monitors the status of the various orders in the plant, work-in-process, etc.Its function is to provide information that is useful in managing the factory based on data collected from the factory. The various information reports are :

Work order status reports

Progress reports

Exception reports.

IV. SCHEDULING TECHNIQUES

The scheduling techniques widely used are:

- Operations research methods-dynamic programming, branch and bound.
- Scheduling algorithms
- Heuristic approaches
- The Gantt Chart

A. SCHEDULING ALGORITHMS

Some of the scheduling algorithms are listed in the table below

Table.1

Criteria	Algorithms	Problem
$\bar{C},\bar{F},\bar{W},\bar{L},\bar{N}u,\bar{N}W$	Shortest Processing time	1 machine
Lmax,Tmax	Earliest due date(EDD)	1 machine
NT(Number of tardy jobs)	Moore's algorithm	1 machine
$\bar{F}$ subject to Tmax = 0	SPT subject to Tmax = 0	1 machine
$\bar{F}$ subject to Tmax ≤ r	SPT subject to Tmax ≤ r (r = 0,1,2,----,r)	1 machine
Fmax	Johnson's algorithm	2 machine
Fmax	Johnson's algorithm	3 machine

1. Moore's Algorithm

In some cases it makes sense to penalize all late or tardy jobs equally, no matter how late they are. Moore's approach to the scheduling task is to minimize the number of tardy jobs (NT), i.e. an n/1/NT problem. The algorithm proceeds as follows:

1.Sequence the jobs in the order of the earliest due date (EDD) to find the current sequence (Ji(1), Ji(2), -------, Ji(n)) such that di(k) ≤ di(k+1 for k = 1, 2, -----, n-1.

2. Find the first tardy job, say ji(l) , in the current sequence. If no such job is found, go to step 4.

3. Find the job in the sequence (Ji(1), -------, Ji(l) with the largest processing time and reject this from the current sequence. Return to step 2 with a current sequence one shorter than other.

4. Form an optimal schedule by taking the current sequence and appending to it,the rejected jobs, which may be sequenced in any order. The rejected

jobs which are placed at the end of the schedule will be tardy jobs.

2. Johnson's algorithm for n/2/F/Fmax Problem.

John's algorithm constructs a schedule which minimize the maximum flow time for a two machine flow-shop. The algorithm tries to push products with the shortest processing times on to the first machine as near to the beginning of a sequence as possible, so that the first job will be available as soon as possible for machine two to start work. Likewise, it tries to push jobs with the shortest processing times on to machine two as near to the end of the schedule as possible. This is to reduce the time that machine one is left idle having completed its schedule, compared to the time that machine two tapes to complete its schedule. Thus the algorithm generates the processing sequence by working from both ends of the schedule towards the middle.

3. Johnson's algorithm for n/3/F/Fmax Problem.

John's algorithm for the n/2/F/Fmax problem may be extended to a special case of the n/3/F/Fmax problem when all of the processing times for all the jobs on machine two are either:

1. All less than the minimum processing times of all time on machine one; or
2. All less than the minimum processing times of machine three.

In other words, the maximum processing time on the second machine cannot be greater than the minimum processing time on either the first or the third machine. In effected, a special two machine problem is constructed from the data. The processing times on machines one and two are added for each job to give the times for the first machine of the constructed problem. Likewise, the times on the second and third machines are added to give the times for the second machine. Then the problem is treated as an n/2/F/Fmax problem.

B. Heuristic Approaches to Scheduling

A heuristic is a 'rule of thumb'. In other words, these methods are purely based on experience.

1. SPT heuristic

The job with the shortest processing time is queued first. The schedule developed using this rule minimizes the mean flow time through the system, for a one machine problem. The SPT heuristic also develops optimal schedules for one machine systems with respect to the following criteria:

- n/1/$\bar{C}$ (minimizes the mean completion time)
- n/1/$\bar{W}$ (minimizes the mean job waiting time)
- n/1/$\bar{L}$ (minimizes the mean job lateness)
- n/1/Nu (minimizes the mean number of unfinished jobs)
- n/1/Nw (minimizes the mean number of jobs waiting between machines)

2. EDD heuristic

For a single machine problem the maximum job lateness is minimized by sequencing such that

$$di(1) \leq di(2) \leq \text{-----} \leq di(n)$$

Where di(k) = due date of the job that is processed kth in the sequence.

Another EDD based rule is the critical ratio rule, in which the jobs are scheduled in descending order of their critical ratios.

Critical ratio = Due date – date now/lead time remaining.

3. First in first out (FIFO) rule

The FIFO rule performs substantially the same as a random selection with respect to mean flow time or mean lateness.

C. The Gantt chart

A Gantt chart is a manual means of scheduling. It works by placing a time scale on one axis of a graph and machines or work centers on the other axis. A simple Gantt chart is shown in fig.4 given below

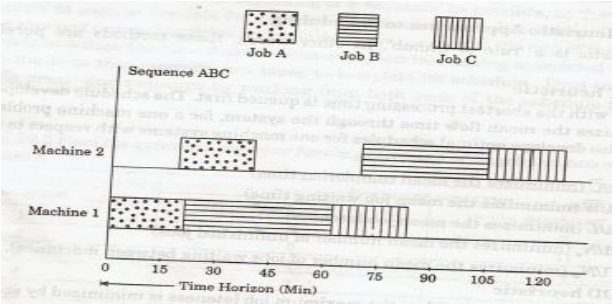

Fig.4

Each job has a process route through some or all of the machines. The user simply places a block on the correct machine axis for the particular job being scheduled at the time he wishes it to be processed. The length of the block corresponds to the process

time of the operation. The process route for each job is worked through in this fashion, until the chart is full. Once this first attempt has been made at scheduling the different jobs, there will be gaps between the blocks of the various machine axis .these correspond to time intervals when the machines are not being utilized. Sum of these gaps can fill by rearranging the blocks. His done and the chart is re-examined to determine if any further improvements can be made. The process is continued till and acceptable result is achieved.

This method is used for small number of jobs requiring batch type operations.

V. LINE BALANCING TECHNIQUES

The following Techniques used in line Balancing,

1. Largest Candidate Rule
2. Ranked Positional weights methods (RPW)
3. Computerized methods

VI. CONCLUSION

This paper presented through a literature review key concepts, structure, brief description of its integration with other production planning and control systems, implementation process and key benefits of Networked Manufacturing scheduling systems for companies.

In recent times, with the great transformations imposed by globalization, companies deal with increasingly demanding markets in relation to cost, schedule, quality, reliability and everything else that represents competitiveness. Their managers are constantly pressured to get progressive gains.

The lack of alignment among the various companies' productive resources can cause confusion in production schedules, which entails, among other problems, low productivity, and low level of service and loss of customers, with negative impacts on their finances.

After reviewing previous studies, some research background are suggested for future studies. The first gap of study in this matter is the shortage of study about the impact of Networked Manufacturing scheduling system on organizational outcomes which has affected the behavior of some manufacturing firms. It is, very difficult to convince some managers to invest in scheduling system when its impact on the bottom line is unclear at best. Therefore, to solve this problem, exploring the influence of Largest Candidate Rule of Line Balancing Technique is suggested for future studies.

The other proposed future research is investigation about the cause and effect relationships between scheduling system and different organizational factors and examination of their behavior in long time by utilization of simulation like COMSOAL-Computer Method of Sequencing Operations for Assembly Lines. (developed by A.I.Arcus).

It is possible for companies, that with the use of Networked Manufacturing scheduling systems, they achieve improvement in treatment to the delivery deadlines, fines and special freights reduction, raw materials, WIP and finished goods stocks reduction, production lead times reduction, better care of customer requests, improvement in productivity and overall efficiency of productive resources, purchases and hiring of outsourced services rationalization. In spite of possessing some limitations, this literature review aims to generate new knowledge and information through by rescuing of gaps that have already been addressed in previous researches (MARIANO; GUERRINI; REBELATTO, 2012). More detailed studies can be carried out and contribute to the development of this theme, because according to Gil (2008), exploratory researches constitute the first step of a broader Investigation.

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