# REVIEW OF SCHEDULING SEQUENCE AND NETWORK ANALYSIS FOR PRODUCTION SYSTEM

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***ABSTRACT--*** *Production sequencing or scheduling is the planning of production keeping in view various constraints at the organization level. Marketing department of any organization may book the orders, competing against others, but its ultimate production and delivery largely depends on the production or operation department. Sequencing or scheduling of production is done in a way, so that overall interests of every stakeholder (like, customers, suppliers, shareholders or the owners, etc.,) are safeguard. To take an example with the same production facility, a company may cater to varied customer's needs. When orders are booked by the marketing department, they desire to execute the orders one by one; the production department, however, needs to consider more holistically, keeping in view the machine interchangeability time, processing time, etc. For production schedule, various tools are used. In this paper, we have discussed about all such tools and methodologies.*

***KEYWORDS--****Production Scheduling, PERT/CPM, Network analysis.*

## I. INTRODUCTION

Due to increase in global competition and advancement of technology, the task of production in industries more and more important for achieving the goals and objectives. The term, scheduling sequence, is more relevant for production system. Today's industries need to apply the scheduling sequence and networking tools, and methodologies for increase the productivity and utilize the production resources (Time, Man, Machines, Money, etc.)

## II. ASSIGNMENT OR JOB LOADING

Many organizations may have more than one facility available to perform a job. Hence, there is a need to make a choice between different alternative facilities. Jobs should be allocated making cost-effective facility-job combination.one method that helps make the optimum decision on job scheduling is the assignment the optimal cost assignment of jobs to the machine:

1. From the given job-machine combination matrix, a revised matrix is needed to be prepared by allowing subtraction of smallest figure from all figures in the column.

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2. The next stage requires performing the row is subtraction in the similar manner, explained above, i.e., smallest number in any row is subtracted from all the figures in that row. Accordingly, a revised matrix needs to be developed.

3. At this stage, a further revised matrix is prepared to determine the minimum number of lines needed to cover all zeros.

4. If a minimum number of lines are not equal to rows or columns (at this stage), then this would not lead to the optimal solution, as many machines will then remain idle, and in that case, some lines may become redundant. Lines are the array of machines, and usually, in each line some operation or the other is carried out. In such cases, i.e., where it becomes necessary to make some lines redundant, it is further required to prepare a revised matrix.

5. To further reverse the matrix ( in case, the situation is as explained in step -4), we require to add the smallest uncovered number of the earlier matrix to the numbers at the intersection of the covering lines and subtract it from other uncovered numbers, leaving other numbers as they are.

6. Finally, based on the revised matrix above, we can assign the jobs to machines, starting first with those where rows and columns have only one zero.

### *1.1 INDEX METHOD OF JOB LOADING*

Index method is applied to finite job loading cases. It is called finite because job loading is done according to the capacity of the machine. Under this method, the lowest time or the cost required by a particular job-machine combination is taken as the base and the indices for the others are prepared based on the base variation. While doing such allocation, the job with the lowest index is done first followed by the next job and so on. However, such allocation has to be done within the capacity of the respective machine, which should not be exceeded under any circumstances.

## III. JOB SEQUENCING OR PRIORITIZATION

The Sequencing method for the optimal loading decision has to be followed in all cases of infinite loading and in some cases of finite loading. Priority rules help in making the decision regarding which job has to be processed first, and in what order other jobs should be processed. This is applicable in a situation where there may be a number of jobs and one machine or where there may be ‘n’ number of jobs and two or three work centers (Johnson’s Rule).

## IV. 2.1 JOB SEQUENCING MAY FOLLOW ANY OF THE FOLLOWING RULES

### *2.1.1 Minimum Process Time Method (MINPRT) or Shortest Operating Time Method (SOT)*

The first job scheduled is the job with the shortest process time, followed by the job with the next lowest process time and so on.

### *2.1.2 Due Date Method (DD Method)*

Priority is given to the job with the earliest due date.

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#### *2.1.3 First Come First Served Method (FCFS)*

The jobs are scheduled in the order that the company received them.

#### *2.1.4 Longest Process Time Method (LPT)*

The absolute reverse of the MINPRT method, as under LPT, the jobs with the longest processing time are scheduled first.

#### *2.1.5 Dynamic Slack/Remaining Operation (DS/RO) or Minimum Slack per Operation Method (MINSOP)*

In DS/RO, we first calculate the dynamic slack (DS), which is the difference between due time and processing time and then divide this DS by the remaining Operation (RO).Unless specified, RO will be assumed as one. The final scheduling of the job is done as per the ranking of DS/RO. Jobs with the lowest value are attended to first; similar ranking is given in the order of the next lowest and so on.

Which rule is the most appropriate depends on the average job lateness and the average number of jobs in the systems. The least job lateness will ensure satisfaction, optimum utilization of machine, reduced slack time, etc. The above rules enable an organization to choose the best option for job sequencing which causes the least job lateness or slack time.

## V. METHODOLOGIES USED IN SEQUENCING

### *3.1 Johnson's Rule*

S.M.Johnson developed this sequencing process which helps to minimize idle time of different work centers by optimum job allocation. This is applied where a number of jobs have to be processed through different work centers. The basic principles of these rules are as follows

**Step 1:** Listing respective time requirement of each job at each work station.

**Step 2:** We need to consider the job with the shortest processing time. If this job is meant for the first workstation, it can be scheduled first. However, if the job with shortest processing time is meant for workstation 2, it has to be scheduled last. If two or more jobs of work centers 1 or 2 have the same processing time, an arbitrary decision needs to be taken.

**Step 3:** Once the first and last jobs have been identified under the step 2 and have been allocated, we do not consider these jobs further.

**Step 4:** Positions are assigned to all other jobs following the same logic explained in step 2 and 3.

### *3.2 Gantt or Bar Charts*

This method, which was introduced in 1917, is the oldest and the most extensively used method for production planning, scheduling and control. The Gantt chart shows the relationship between different activities over a time span. Time frame, expressed either in terms of hours, days, weeks or months is shown on the horizontal or X-axis and activities are plotted against the Y-axis. The time frame or time scale would depend on the nature of operations and activities, which may be determined by the previous experience or an approximation based on which activities may be scheduled and monitored. The charts may be in the form of any of the following:

a) Scheduling or progress charts, which show the sequence of job progress

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b) Load charts which show the work assigned to a work group or allocated to machines

c) Record charts which track the actual time spent and delays, if any

Gantt charts need to be updated at regular intervals, for instance, when a work is delayed at the start or when work continues beyond its time schedule or if the progress of work is not as per the actual plan. If unforeseen eventualities occur, corrective actions may have to be taken, and this will also need corresponding changes in Gantt Charts.

### *3.3 Dispatching*

Another common technique for job sequencing is dispatching or the dispatch list. In this method, the jobs are ranked and the relative priorities are given, which are based either on due date or critical ratio. Due date has been explained above; critical ratio is computed by dividing time remaining by work remaining, as shown below:

Critical Ratio (CR) = Time Remaining (TR)/Work Remaining (WR)

A CR equals to 1 means that the job is on schedule. a CR of less than 1 indicates that the job is behind the schedule, and a CR that is more than 1 is indicative of slack time.

The production planning department prepares a dispatch list based on the relative priority, and the work responsibility is assigned to the respective shop floor in-charge. Traditionally, such persons are called either dispatcher or planner. It is their responsibility to visit shop floors to collect data on work progress according to the dispatch list and also give the prepared dispatch list to the respective shop floor in-charges. However, due to the increasing reliance on computerized Management Information System (MIS) they are now becoming redundant.

### *3.4 Line of Balance Chart (LOB)*

This chart, which is slightly more complex than the Gantt chart integrates information on delivery dates of the final output with the information on the completion time of sub –assemblies of the final product. It helps to monitor the progress of sub-assemblies or components (both make and buy items) according to the delivery date. Capacity requirement planning is now replacing the LOB technique

### *3.5 Work Breakdown Structure (WBS)*

In order to identify the individual tasks in a project, it is useful to create a work breakdown structure. The method goes as –Get the team together and brainstorm all of the tasks in the project, in no particular order. Write them down on sticky notes and put them on a whiteboard. Once, everyone has thought of as many tasks as possible, they can arrange the sticky notes in to groups under the major areas of activity.

## VI. NETWORK ANALYSIS

Network analysis is a managerial technique which helps to identify the interconnecting links in a single system. It is a useful tool in the systems design which assists in recognizing or identifying the relationships that exist among the sub-systems.

It is done by describing each segment or linkage of the system in terms of other components or activities of the system. Thus, it makes explicit the total system and the interrelationships among the parts. A network is illustrated by a flow chart or diagram. The flow of materials and/or information is measured as volume, specification or time.

#### *4.1 Different Forms of Network Analysis*

There are different forms of network analysis, which may be simple or complex, may be very generalized or may be exclusively designed for specific types of projects. PERT/PEP and CPM are the most widely used techniques used in network analysis.

#### *4.1.1 Critical Path Method (CPM)*

This technique is used for planning, scheduling, estimating and controlling engineering and construction. This method was used by Du Pont in 1959 to schedule plant maintenance shutdowns during changeovers. The lessons learned through this application, later on, were used to plan building construction and other large construction projects.

#### *4.1.2 PERT/PEP Technique*

The PERT/PEP technique is based on critical-path scheduling. The PERT/PEP technique is applicable where there is no established system for doing the task and, therefore, no exact basis for estimating the required time to complete each task. Critical path scheduling, on the other hand, usually is applied to jobs which are established or have been done before and where it is possible to predict performance accurately. Consequently, more sophisticated mathematical models must be used in the PERT/PEP technique.

PERT may, Therefore, be defined as follows:

PERT is a statistical technique diagnostic and prognostic for quantifying knowledge about uncertainties faced in completing intellectual and physical activities essential for timely achievement of program deadlines. It is a technique for focusing management attention on danger signals that require remedial decisions, and on areas of effort for which trade-offs in time, resources or technical performance, might improve capability to meet major deadlines.

The PERT technique is, therefore, based on the concept that in any program, there are three variables:

(a) Time

(b) Resources (HR, Facilities, funds)

(c) Performance specifications

Any one of these may vary within certain limits established for such program, while, holding the other two constant. To take an example, holding time and performance constant, the requirements for resources may be determined.

It is, therefore, clear that both PERT and CPM have similarities in terms of concepts and methodology. We use these techniques in project scheduling program. However, we use PERT in analyzing project scheduling, where completion time is not certain and CPM, where activity derations are known with certainty. In essence, therefore, PERT is probabilistic in nature and more appropriately used in R&D projects, whereas, CPM is a deterministic technique and thus finds application more appropriately in the construction projects.

## VII. 4.2 Different Time Estimates of PERT

#### *4.2.1 Optimistic Time (a)*

This is the shortest time a particular activity can take to complete and is, therefore, an ideal estimate.

#### *4.2.2 Most Likely Time (m)*

This is the model time, which is expected to be taken to complete a job and is based on the past record.

#### *4.2.3 Pessimistic Time (b)*

This is the longest time and it occurs with a probability of less than 1 percent. This, therefore, is the worst time estimate, for any eventualities. with these three time estimate, a single expected time to complete a project is determined with the following weighted average formula:

$T= a+ 4m + b / 6$

Where, t= expected time of the activity

a = Optimistic time

m = most likely, or modal time

b = Pessimistic time

The standard deviation, of the completion time of an activity is calculated as follows:

$\sigma = b - a / 6$

Variance $\sigma = (b-a) / 6$

## VIII. CONCLUSION

Scheduling the sequence and network analysis of the operations function (both manufacturing and services), relates to the use of equipment and facilities, it encompasses utilization of manpower and receipt of materials. It is the final stage in the process of transformation before getting the actual output. Operations managers take scheduling decisions within the constraints of a long-term plan. Through scheduling sequence organization makes tradeoffs among conflicting goals for efficient utilization of labor and equipment, lead time, inventory level and processing time.

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