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A STUDY AND OPTIMAL SOLUTION FOR PROCESSING EACH OF N-JOBS THROUGH THREE MACHINES

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I. INTRODUCTION

Sequencing problems arise when we are concerned with situations where is a choice as to the order in which a number of tracks can be performed .In such cases; the effectiveness is a function of the order or sequence in which the tasks are performed. We shall deal with the sequencing problems in respect of the jobs to be performed in a factory and study the method of their solution.

In the field of operations research, one of the "classic" problems has been that of sequencing "n" jobs through "m" machines. Sequencing means the determination of the order in which each machine will process the n jobs so that some specific criteria will be maximized or minimized.In this problem there are n!Possible ways to order the jobs on each machine and a total of $(n!)^m$ possible sequences.

There are several different optimizing criterions that can be used. A few of these are

1) Minimization of time required from the start of the first job untilcompletion of the last job on each of the machines.
2) Minimization of the total time required for the entire series of jobs to be completed.
3) Minimization of the total idle time on the machines.
4) Maximization of profit from meeting due dates and not incurring penalties involved in late delivery.
5) Minimization of in process inventory costs In regard to the general sequencing problem very little progress has been made toward the development of a practical algorithm or set of rules which can be followed to arrive at an optimal solution. A more detailed history of work in this area will follow.

1.1 Terminology

1) Number of Machines: The number of machines refers to the number of service facilities through which a job must pass before it is assumed to be completed.
2) Processing Time : It is the time required by a job on each machine.
3) Processing Order : It refer to the order (sequence) in which given machines are required for completing the job.
4) Idle Time on a Machine : It is the for which a machine does not have a job to process ,i.e, idle time from the end of job(i-1) to the start of job I,

5) Total Elapsed Time : It the time interval between starting the first job and completing the last job including the idle time in a particular order by the given set of machines.
6) No processing Rule: it refers to the rule of maintaining the order in which jobs are to be processed on given machines .For example ,if n jobs are to be processed on two machines M_1 and M_2 in the M_1M_2, then each job should go to machine M_1 first and then to M_2.

Key words: Number of Machines, Total Elapsed Time , Processing Time, Optimal solution .

Types of problem:

1) Processing n jobs on two machines
2) Processing n jobs on three machines

Algorithm for solving Sequence Problems: Johnson's Rule :

The method shall be discussed in respect of processing of n jobs through (a) two machines ,(b) three machines .

Method 1 :Processing n jobs on 2 jobs :

As mentioned before, the following information is available :

i) Only two machines A and B are involved.
ii) Each job is to be processed in the order AB so that first the work would be performed on machine A and then on machine B.
iii) The processing times for different jobs on first machine $A_1, A_2 \ldots\ldots\ldots A_n$ are given and so are processing times on the second machine $B_1, B_2 \ldots\ldots B_n$.

The objective is to be determine the sequence in which the jobs should be performed so that the total time taken, known as the elapsed time(T) is the minimum.

Method of Procedure:

The method of solving the above problem is discussed below.

Step1: Select the smallest processing time, considering $A_1, A_2, \ldots\ldots A_n$ and $B_1, B_2, \ldots\ldots B_n$ together.

Step2: a) if the minimum time is for A_r ,that is to say for r^{th}jon on machine A , do the r^{th} job the first.

b) if the minimum is for B s that is ,for s^{th} job on machine B, do the s^{th} job in the end .

c) if there is a tie between $A_r$and B s ,perform the r^{th} job first and s^{th} job in the end .

d) if there is a tie between 2 or more times in either of the series ,select either of the jobs involved and perform the job first or last accordingly as the tie is in $A_1, A_2, \ldots\ldots\ldots A_n$ or $B_1, B_2, \ldots\ldots B_n$.

Step 3: After the job (s) has been assigned, apply step1 and 2 to the reduced set of processing times obtained by deleting the machine times corresponding to the job(s) already assigned.

Step4: continuing in this manner all jobs shall be assigned.

The sequence of jobs to be performed obtained this way shall be optimal .i.e, if shall involve the least aggregate time for completion of the job.

Example : In a factory ,there are six jobs to perform ,each of which should go through two machines A and B ,in the order AB. The processing timing (in hours) for the jobs is given below .you are required to determine the sequence for performing the jobs that would minimize the total elapsed time ,T .what is the value of T?

Jobs	Machine A	Machine B
1	7	3
2	4	8
3	4	6
4	5	6
5	9	4
6	8	1

Solution : The least of all the times given in the table is for 6 on machine B . So, perform job 6 in the end .It is last in the sequence .Now delete this job from the given data.

i) Of all timings now, the minimum is for job 3 on machine A ,so do the job 3 first.

ii) After deleting job 3 also ,the smallest time of 3 hours is for 1 on machine B .thus ,perform job 1 in the end (before job 6).

iii) Having assigned job1 ,we observe that the smallest value of 4 hours is shared by job 2 on machine A and job on machine B so, perform job2 first and job 5 in the end.

iv) Now, the only job remaining is job 4,it shall be assigned the only place left in the sequence.

The resultant sequence of jobs is therefore, as follows:

3 2 4 5 1 6

The sequence is the optimal one .the total elapsed time T is obtained in table as equal to 36 hours.

Table: calculation of Total Elapsed Time(T)

Job	Machine A		Machine B	
	In	out	In	Out
3	0	2	2	8
2	2	6	8	16
4	6	11	16	22
5	11	20	22	26
1	20	27	27	30
6	27	35	35	36

As shown in this table, the first job 3, starts at time O on the machine A and is over by time 2. Which o=is passed to machine B to be worked on till time 8 . The job 2 starts on the machine A at time 2 as the machine is free at that time . It is completed at time 6 and has to wait 2 hours before it processed on machine B , starting at time 8 when this machine is free , Similarly ,the various jobs are assigned to the two machines and the in and out times are obtained.

Method 2 : Processing n jobs on 3 Machines

There is no solution available for the general sequencing problems of n jobs through 3 machines .However we do have a method under the circumstance that no passingof jobs is permissible and if either or both the following conditions are satisfied.

1) The minimum time on machine A is greater than or equal to the maximum time on machine B.
2) The minimum time on machine C is greater than or equal to the maximum time on machine B .

i.e to say if either $Min.A_i \geq Max.B_i$

$Min.C_i \geq Max.B_i$

Or both are satisfied that the following method can be applied.

Method of Procedure:

Step1: First of all, the given problem is replaced with an equivalent problem involving n jobs and 2 fictitious machines G and H .define the corresponding processing times G_i and H_i by

$G_i=A_I+B_I$

$H_i=B_i+C_i$

Step2: to the problem obtained step1 above ,the method for processing n jobs through 2 machines is applied .The optimal sequence resulting this shall also be optimal for the given problem.

Example: There are five jobs which must go through these machines A,B and C n th order ABC .Processing times of the jobs on different machines given below.

Jobs	A	B	C
1	7	5	6
2	8	5	8
3	6	4	7
4	5	2	4
5	6	1	3

Determine a sequence for 5 jobs which will minimize elapsed time(T) .

Solution: according to given information

$Min.A_i=5$

$Max.B_i=5$

$Min.C_i=3$

Here since $Min.A_i=Max.C_{i,}$ the first of the conditions is satisfied.

We shall now determines Gi and H_i and from them find the optimal sequence.

In accordance with the rules for determining optimal sequence in respect of n jobs processing on 2 machines , the sequence for above shall be :

3 2 1 4 5

Table : Calculation of Total Elapsed Time(T) .

Jobs	Machine A		Machine B		Machine C	
	In	out	In	out	In	out

3	0	6	6	10	10	17
2	6	14	14	19	19	27
1	14	21	21	26	27	33
4	21	26	21	28	33	37
5	26	32	32	33	37	40

Total elapsed time (T) =40 hours.

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