THE EFFECTS OF A FIXED CONTROL PERIOD ON THE JOB SHOP SEQUENCING PROBLEM

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CHAPTER 1

1.1 Introduction

The amount of literature which has appeared concerning the problems of scheduling and dispatching jobs with diverse routings in a shop or the "job-shop problem", is quite large. The problem has been reviewed with the intent of developing and evaluating queue discipline techniques for pure job shops, pure flow shops (where all jobs follow what is essentially the same route through a shop), shops of a configuration falling between these extremes, single-queue, single-machine shops and numerous other models. The major theme in the literature has ranged from progress reports of the research (15, 5) to presentation, documentation and application description of simulation models of systems in real time operation in a plant (16, 22). Of major concern has been the attempt to develope a simple method of queue discipline that will allow jobs to be completed on assigned due dates or, failing this, with minimal total job lateness. The major conclusions and a description of the models of those reports that are relevant to the aims of this thesis will be presented. Before presenting the aims or embarking on a review of the literature, a few terms will be defined.

A priority rule assigns a priority or scheduling preference to a job when it queues in front of a machine. The job with the highest priority is the preferred job. A local priority rule assigns priorities on the basis of the attributes of jobs in a queue in front of a single machine; if all available jobs and/or other operations in the shop are examined as a basis for assigning job priority, the rule is called a global priority rule. Some priority rules which have received considerable

attention are the first-in, first-out (FIFO) rule, the shortest operation time (SOT) rule and the remaining slack per operation (RSPO) rule. The FIFO rule is an essentially random rule where priorities are assigned according to the arrival of jobs in the shop. The first jobs to arrive are given the highest priority. The SOT rule orders jobs according to predicted or assigned processing times. The lowest priority number (highest preference) is given to the job with shortest operation time for the current operation. For the RSPO rule the time remaining before a job's due date (slack) is determined each time a job is to be put on a machine. This number is then divided by the number of remaining operations, job priority is then assigned according to the values of this number. The highest priority is assigned to the minimum number. Aczel (2) has examined, mathematically, the effect of introducing priority rules as opposed to a random assigning of priorities. He found that the mean queue length can be effectively reduced but actual work content remains the same when priority rules are used, which is consistent with logical expectations. In order to evaluate the operation of these and other priority rules some measures of performance are needed. These measures are merely techniques which evaluate the performance of the priority rules on the basis of preselected criteria. These criteria can be based on individual job performance, e.g. job progress as indicated by the mean and variance of job flow time. Overall shop performance in terms of in-shop inventory, for example, can also serve as a criterion. Since the measures of performance are based on different criteria conflicting evaluations of priority rules can and do occur. It is up to the analyst to determine which criterion are most

relevant and choose the measure of performance accordingly.

A machine limited shop model assumes a finite number of machines are available. There are sufficient operators for each machine. Thus scheduling problems center around the availability of machines. In a labor limited shop, a new resource limitation is introduced to the shop model. The number of available machine operators is limited to some number less than the number of available machines. There are now two limited resources, i.e. machines and labor. The interaction of these two resources and the behavior of the shop with these limitations are of considerable interest.

A control period may be regarded as a shift, a day, several days, weeks, etc. It is an imposed period of time during which only one operation may be performed on a job, i.e. jobs which have an operation completed during this period are not available for reassignment on a machine until the next control period. Also, jobs are released to the shop only at the start of a control period. These definitions should be sufficient for now.

1.2 Thesis Goals

The primary purpose of this thesis is to examine the effects of an artificially imposed control period on the operation of a job shop. To date, almost all research on the job shop problem has been restricted to the simple job shop. Conway (6) has enumerated the following as the properties of a simple job shop:

1) There is a single limiting resource for which the jobs compete and wait.
2) The synchronization of two or more machines is never required to perform an operation.