ABSTRACT

Performability Modeling of Systems and Tool Loading, with Applications to Flexible Manufacturing Systems. (December 1995)

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This dissertation addresses two important, related problems common in a flexible manufacturing system (FMS). The effectiveness of an FMS is based on timely completion of different jobs through an FMS. The associated problem is to reduce the amount of down time and non-productive operating time.

The first of these goals, the reduction of down time in an FMS, is addressed extensively through mathematical modeling of the machine repair process. A logical separation of independent systems allows the extremely complicated FMS to be modeled in parts, each with greater detail than otherwise possible. Each particular machine part type is modeled separately, with some interaction.

The first and second models assume exponentially distributed state change rates so that a queueing theory approach may be used to model the machine repair process. The third model is a Markov renewal process that allows general service time distributions. Embedded semi-regenerative processes are used to form the desired steady state probabilities.

The measure of effectiveness for these models is based on a performability measure that is a function of system availability and partial availability. Various system configurations are explored and the methods for obtaining the desired performability measure through the steady state results of any model are presented. An example is

used to demonstrate how these various developments are used together.

A final, very general model allows any failure distribution for any part in the system, under some likely assumptions. Any general repair distribution may also be included.

The second goal, the reduction of non-productive time, is addressed for a single flexible manufacturing machine (FMM). The tool loading problem is defined to be the problem of minimizing the job processing time through job scheduling and tool placement on a tool magazine with a limited capacity. A unique solution is presented that reduces the amount of time wasted on operations that are not directly productive. The approach solves a generalized form of the tool loading problem. Optimal tooling policies for any job schedule are presented for FMM that either allow, or do not allow, job and tool loading concurrently.