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MODELMASTER™ FACTORY MODELING SYSTEM TUTORIAL

Beth A. Boling
Marc A. Laymon
General Electric Company
Corporate Research & Development
Schenectady, NY 12301

ABSTRACT

This tutorial will describe the ModelMaster Factory Modeling System, a graphically-enhanced flexible modeling system used to simulate discrete manufacturing facilities. ModelMaster, a programming-free simulation package for IBM PC's and compatibles, is a new product developed and distributed by General Electric. The tutorial will consist of a general discussion of ModelMaster's capabilities, an overview of its operations, and a short history of its development. This will be followed by a live demonstration, using a sample problem to illustrate the Factory Layout model-building approach and the ModelMaster graphical output capabilities.

1. INTRODUCTION

Many discrete-event simulation packages are available today, and almost all of them can be used to analyze discrete manufacturing facilities. Most of them require the user to learn the syntax of a special-purpose or general-purpose language to write and then debug a model. This does not present an obstacle for full-time simulation analysts, who routinely use one or several simulation packages. However, many people with direct involvement in manufacturing operations would like to use simulation themselves to analyze a particular situation, but due to other responsibilities, they cannot spare the days or weeks required to learn and apply a traditional simulation language. ModelMaster has been developed to allow these people to build and run a class of manufacturing simulations quickly and easily.

ModelMaster leads you through a menu-driven Graphical Layout Section and a forms-entry Data Entry Section to specify the characteristics of the system you are modeling. With the ModelMaster graphical layout section you can specify machine cells, machines, queue locations, entry and exit points, job types and job sequences, transporter paths, and aisles. The Data Entry Section gives you the opportunity to specify operation times, unplanned machine breakdowns, planned maintenance, resources, resource shifts, discrete transporter types, scrap, branching, assembly, batching, splitting, and loading options. You are given the capability to model many commonly encountered manufacturing situations in a totally programming-free environment.

Loading options such as inter-arrivals, scheduled arrivals, and initial work-in-process are available to you, as are six standard probability distributions and an option to create user-defined empirical distributions. Maximum input and output queue sizes can be specified, single or multiple input queues can be requested at each cell, and queue ranking criteria such as FIFO, LIFO, or Earliest Due Date can be applied.

A simulation model is automatically built to your specifications, avoiding tedious programming and debugging steps. Transportation times can be calculated automatically based on distances in the graphic layout, or you can enter optional user-defined transport times.

After the simulation is run, results are available in various forms. Summary reports provide traditional output such as queue statistics and utilization of machines, resources, and transporters. Graphics are used to represent the queue contents over time (Queue Graphs), average utilization of machines (Pie Charts), machine states over time (Bar Charts), and a pictorial representation of machine states and material flow over time (Animation).

2. CAPABILITIES

ModelMaster was developed primarily for factory simulation. Therefore, its major capabilities are oriented toward manufacturing applications. The size and complexity of the systems that can be simulated using ModelMaster are determined by the system parameters. Due to space and runtime considerations on the IBM PC and compatibles, parameters were chosen to allow the simulation of small to medium sized manufacturing systems.

ModelMaster contains the following features:

2.1. Menu-driven Graphical Layout Session

- o machine cells and machines
- o queue locations
- o system entry and exit points
- o job types and job sequences
- o multiple operations per job type
- o transporter paths and aisles

2.2. Forms-driven Data Entry Session

- o operation times
- o batching and splitting of jobs
- o assembly of job types
- o branching and scrap
- o resources and resource shifts
- o unplanned downtime and planned maintenance
- o inter-arrivals, scheduled arrivals, WIP
- o multiple transporter types
- o automatic calculation of transport times
- o optional user-specified transport times
- o single or multiple input queues
- o queue ranking by FIFO, LIFO, Earliest Due Date
- o maximum input and output queue sizes
- o job type changeover operations
- o six standard probability distributions
- o optional user-defined empirical distribution

2.3. Simulation Program

- o ability to specify length of run
- o ability to split the run into batches
- o ability to specify time to clear statistics
- o ability to specify times for detailed trace

2.4. Output Options

- o Statistical Summary Report
- o Queue Graphs
- o Pie Charts
- o Bar Charts
- o Animation

2.5. Utilities

- o ability to modify input data using forms entry
- o ability to invoke selected DOS commands

3. OVERVIEW OF OPERATION

The basic steps involved in using ModelMaster are independent of the size or characteristics of the system you are modeling. These steps are described below, and will be demonstrated in the tutorial. The Main Menu is illustrated in Figure 1.

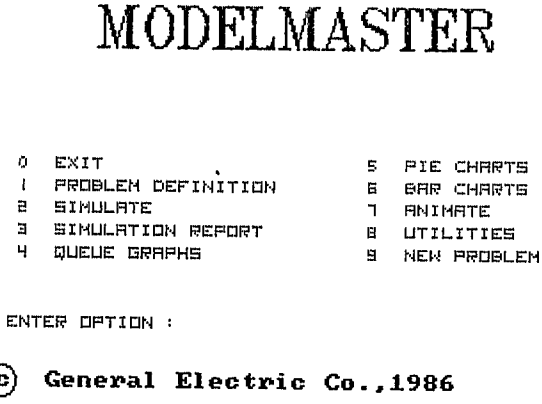

Figure 1: ModelMaster Main Menu

3.1. Option 1, Problem Definition

The graphic layout session and the data entry session will help you create a model to represent your system. The layout is drawn on the monitor using either a mouse input device or the keyboard cursor movement keys. "Rubber-band graphics" are employed to draw representations of machine cells, machines, queue locations, and aisles.

After the system has been represented graphically, a series of forms-entry screens prompt the user for data. The exact questions that will be asked and the sequence of screens that will appear are dependent on the complexity of the problem and the answers to previous questions. Whenever data is requested, a help key is available to further explain the question or to list possible responses. During the entire Problem Definition sequence, no programming commands or memorized responses are required. See Figure 2 for an example of a completed graphic layout.

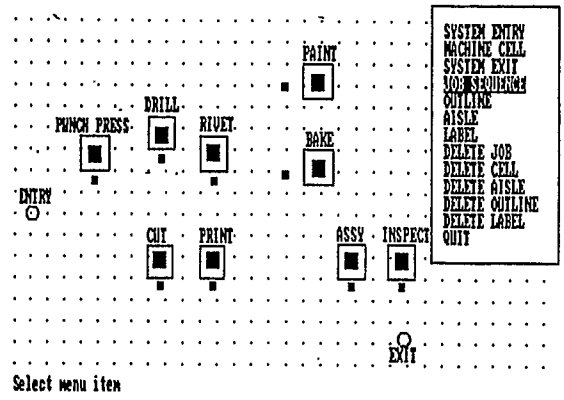

Figure 2: Sample Graphic Layout

3.2. Option 2, Simulate

This selection is used to specify the characteristics of the simulation run and execute the simulation. The simulation run is transparent to the user. Plots appear on the monitor to represent the advancing of the simulation clock and to allow the user to estimate the remaining run time. Output from the simulation is automatically written into files which are used in Options 3 through 7.

3.3. Option 3, Simulation Report

This choice allows the user to view a statistical summary of the system's performance.

3.4. Option 4, Queue Graphs

This choice allows the user to view the number in of parts in queue versus time. See Figure 3 for a sample Queue Graph.

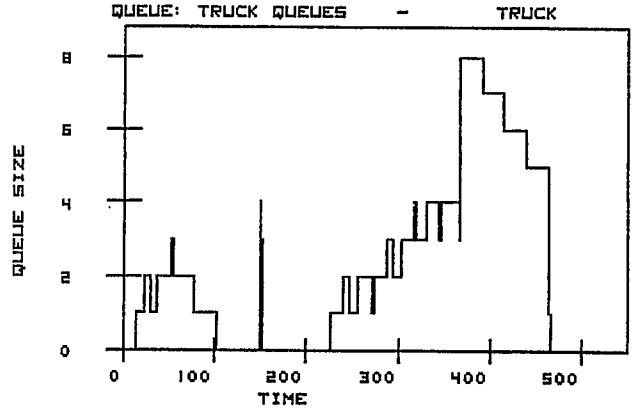

Figure 3: Sample Queue Graph

3.5. Option 5, Pie Charts

This selection allows the user to view machine, resource, or transporter utilization. See Figure 4 for a sample Pie Chart.

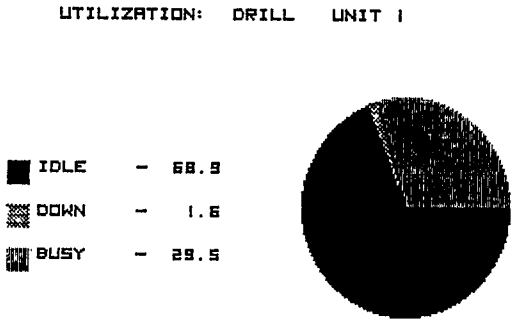

Figure 4: Sample Pie Chart

3.6. Option 6, Bar Charts

This choice allows the user to view machine states versus time. See Figure 5 for a sample Bar Chart.

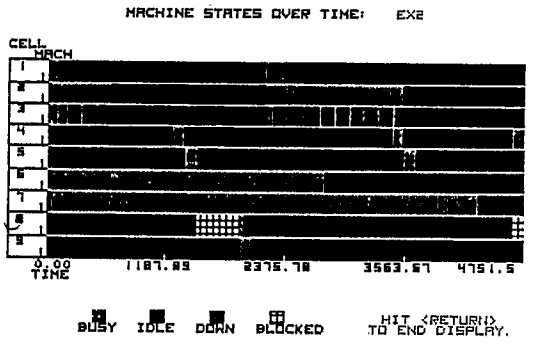

Figure 5: Sample Bar Chart

3.7. Option 7, Animate

Animation allows the user to view machine states, material flow, transporter movement, number complete, and queue contents, as they change over time.

3.8. Option 8, Utilities

This choice allows the user to invoke the DOS copy, delete, rename, or list utilities.

3.9. Option 9, New Problem

This selection allows the user to select a different problem name.

3.10. Multiple Runs

The user may repeat Steps 2 through 7 to make other simulation runs of the same configuration for statistical analysis.

3.11. Modifications

The user may repeat Steps 1 through 7 to modify the input data and to model alternative configurations.

3.12. Option 0, Exit

Select this option when you are ready to exit from ModelMaster.

4. HARDWARE

ModelMaster Factory Modeling System runs on IBM PC's and compatibles. The software is available on 5 1/4 inch and 3 1/2 inch diskettes. Your computer must have the following minimum configuration:

- o 640K bytes of memory
- o Two disk drives or a hard disk
- o An RGB color monitor, or enhanced color display monitor with appropriate adapter
- o IBM standard color graphics card or IBM enhanced graphics card
- o A keyboard for data input
- o DOS version 2.1 or higher

The following options are suggested but not required:

- o Intel 8087 coprocessor (or 80287 for the IBM PC AT) to increase execution speed
- o Input device (Microsoft or Mouse Systems)
- o Printer with graphics capabilities

5. SUMMARY

ModelMaster Factory Modeling System, developed by General Electric Company, is a simulation package that brings the power of simulation to the non-programmer, using hardware that is relatively inexpensive and accessible. In an easy-to-learn format, menus and graphics direct the user through a simulation study from model development to output generation.

Note: ModelMaster is distributed and supported by GE's Automation Controls Operation in Charlottesville, VA.

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Note: IBM PC, XT, and AT are trademarks of International Business Machines Corporation.

Note: ModelMaster is a trademark of General Electric Company.

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AUTHORS' BIOGRAPHIES

BETH A. BOLING is an Industrial Engineer in the Simulation and Modeling Program at General Electric's Corporate Research & Development Center. She received a Master of Engineering in Operations Research / Industrial Engineering from Cornell University and a BS in Industrial Engineering from Purdue University. Ms. Boling was involved in the development of the user interface for ModelMaster, and is currently applying simulation analysis and economic analysis to assist various GE components in manufacturing decision-making. She is a member of ORSA, SCS, Tau Beta Pi, and IIE, and is Vice-President of the Capital/Berkshire Chapter of IIE.

General Electric Company
Corporate Research & Development Center
PO Box 8, Building K-1, Room 5B37
Schenectady, NY 12301
(518) 387-6951

MARC A. LAYMON is currently a computer scientist in the Simulation and Modeling Program at General Electric's Corporate Research & Development Center. He is involved in the design and implementation of computer programs to allow users easier access to simulation technology. His efforts focus on interactive graphical interfaces for both input of data and display of simulation results. He has also been involved in the development of a general purpose parameter-driven factory simulation model. Mr. Laymon received a BS in Industrial Engineering from Purdue University, an MS in Computer Science from Union College and is a graduate of GE's Manufacturing Management Program. He worked as a manufacturing systems analyst before becoming involved with simulation and is co-author of several papers and internal reports on the subject of graphical interfaces for simulation.

General Electric Company
Corporate Research & Development Center
PO Box 8, Building K-1, Room 5B32
Schenectady, NY 12301
(518) 387-6909