THE EFFECT OF OPERATIONS OVERLAPPING ON DYNAMIC CELLULAR, PROCESS, AND CELLULAR MANUFACTURING SHOPS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

The proper layout configuration of a manufacturing facility can offer many benefits to an overall production system. Several different types of shop configurations are utilized in modern facilities each having both advantages and disadvantages. Facilities which produce a variety of products in batches are usually configured in one of two ways: either as a process shop (or job shop) or in a group technology (GT) cellular layout, also referred to as cellular manufacturing (CM). Researchers are exploring a third configuration known as dynamic cellular manufacturing (DCM) or virtual cellular manufacturing. Selecting the shop configuration best suited to the manufacturing environment can decrease flow time and work in process (WIP) inventory, as well as provide other benefits which strengthen a manufacturing organization in the current competitive environment.

Selecting the optimum shop configuration requires an analysis of many factors. Both the manufactured products and the manufacturing operations should be examined to identify similarities in design and processing. In addition, the number of part types, part routings, demand volume and variability, processing times, setup factors, material handling issues, job staffing, and various other factors can contribute to the performance of the shop, and therefore should be considered in the shop configuration selection.

Process shops group machines or work centers that perform similar operations in close proximity to each other. Shops which produce a large variety of parts typically favor the process layout. When a process department receives parts, they are routed to an available machine. The intended advantage of the process shop is flexibility, allowing for the production of many different parts. However, because individual work centers often process a sequence of dissimilar parts, long setup times can greatly increase the overall flow time. Additionally, process layouts are not organized to optimize the flow of parts. Theoretically, this can lead to additional move time and higher WIP inventories.

Cellular manufacturing (CM) groups parts into families based on design or processing similarities. Machines or work centers are grouped into cells, which can complete or nearly complete the processing of an entire part family. There are two common types of cells. "Flow cells" arrange the machines for a smooth, unidirectional flow of parts through the system. "Job shop cells" (which are not examined in this study) address situations which require more complex routing within a cell, so there is usually not a unidirectional flow pattern within the cell. Shops which experience long setup times and steady demand tend to favor CM configurations. The intended advantage of CM is the ability to produce a variety of parts in an efficient manner. Flow cells are dedicated to the production of families allowing a unidirectional, efficient flow of materials within the cell. The processing similarities of the parts decrease or eliminate setup times within each cell. However, the dedication of machinery to families can lead to unbalanced equipment utilization. Parts may sit idle waiting to be processed in their dedicated cell while identical machinery is available elsewhere in the shop.

A dynamic cellular manufacturing (DCM) configuration attempts to combine the flexibility of a process shop with the efficiency of a CM shop. The layout is in the form of a process layout with machines grouped into process departments. However, DCM recognizes and utilizes the existence of part families as in CM. Temporary "virtual cells" are created without physically moving any machinery. A "virtual cell" is assigned to a family to take advantage of part similarities and reduce setup times. When a machine is available, it can be assigned to a family. When the family no longer needs a machine, it can be assigned to another virtual cell to process other families. In DCM, machines process parts in the same family, so there is no need for major setup changes. This configuration readily responds to changes in demand patterns by dissolving old cells and creating new cells without the need for relocating equipment.

In each of the three configurations, the strategy which determines when parts are transferred between work centers impacts the system's performance. Often, parts are moved in unbroken batches in which one part is processed while the other parts are sitting idle in an incoming or outbound queue. Operations overlapping provides an alternative. Parts are moved in split batches to allow multiple parts in the same batch to be processed simultaneously. The extreme case of this practice, termed total overlapping, passes single parts within a batch from operation to operation. Partial overlapping, in which batches are split into groups of more than one part, reduces the number of part transfers, but it also reduces the amount of simultaneous processing.

Batch splitting and operations overlapping (both total and partial) can be utilized in all three shop configurations. A well designed CM "flow cell" system is ideal for operations overlapping, with the closeness of machinery and unidirectional flow of material allowing easy part transfer from one workstation to another. Process and DCM shops are not as conducive to operations overlapping. The distance between machines in the part routings is often significant, and the time required to transfer parts could reduce or eliminate the effectiveness of overlapping. Additionally, batch splitting to any degree may not be an effective practice in some process and DCM shops where limited material handling resources are available.

1.2 STATEMENT OF THE PROBLEM

The effects of partial and total operations overlapping on process, CM, and DCM shop configurations have not been fully examined. This research will add to the body of knowledge in this area. The performance of the three shop configurations are compared using flow time and work in process inventory as performance measures. The findings will offer insight into the benefits of operations overlapping in each configuration and identify whether a superior shop configuration exists under the experimental circumstances.

1.3 IMPORTANCE OF THE STUDY

Much of the current literature is in conflict over the superiority of a CM configuration versus a process configuration. Several research studies conclude that CM shops perform poorly when compared to process shops except under certain conditions when flow time is the primary performance measure (Mahmoodi, Dooley and Starr, 1990; Flynn, 1987; Flynn and Jacobs, 1987; Morris and Tersine, 1990; Jacobs and Bragg, 1988). However, only one recent study has been found which has taken operations overlapping into account (Shafer and Charnes, 1993). This study compared a CM system with total overlapping to a process configuration that did not utilize overlapping. This research concluded that CM systems that utilize total overlapping outperform process configurations on the basis of flow time and WIP under a variety of conditions. The assumption was made that process shops are not conducive to overlapping, however this may not always be the case, especially if partial overlapping is considered. For example, any of the three configurations may be able to split a batch in half so that two work centers can work on the batch simultaneously. It may be found that batch splitting and partial or total overlapping can yield flow time and/or WIP benefits in all three configurations. The current literature has only explored the effects of *total* overlapping on a CM system. If benefits of overlapping are found in the process and DCM configurations, then comparisons can be made between the three systems which could lead to improved flow time and WIP performances.

1.4 DEFINITION OF TERMS

Batch splitting - Removing parts from a single large batch and placing them into smaller sub-batches.

Operations overlapping - The simultaneous processing of two or more parts from the same batch at different work centers.

Total overlapping - Operations overlapping in which single parts are passed from work center to work center for simultaneous processing.

Partial overlapping - Operations overlapping in which multiple sub-batches with more than one part are passed from work center to work center for simultaneous processing.

Department (or process department) - a group of machines or work centers with similar processing capabilities which are located in close proximity to each other.

Flow Cell - machines or work centers which are grouped closely together to complete or nearly complete processing of a part family. These cells are arranged for a smooth, unidirectional flow of material through the cell

Virtual cell - a group of machines located in different processing departments which can complete or nearly complete processing of a part family. Virtual cells are created and modified as shop floor conditions dictate.

Repetitive lots concept – a sequencing rule that eliminates some set-ups by taking advantage of batches having the same part numbers. If a batch in a queue has the same part number as the batch currently being processed, then the batch in the queue is moved to the front.

1.5 OBJECTIVE STATEMENT

This research determines the effects of batch splitting and operations overlapping on flow time and WIP inventory in CM, DCM, and process configured shops. In addition, the flow time and work in process inventory performances are compared in each of the three shops when various levels of overlapping are utilized. Simulation models are developed for each configuration. The degree of overlapping is modified for multiple runs from which data is gathered and analyzed.

1.6 DELIMITATIONS

This study examines the effects of operations overlapping on three shop configurations; process, CM with flow cells, and DCM. Other shop configurations are not examined, nor are the effects of other factors (except for shop size) on system performance The performance measures used in the comparison are mean flow time and mean work in process inventory level. Other advantages of the CM configuration (such as reduced manpower, job satisfaction, and increased control) are not considered as factors when stating conclusions. The batch size used in the model is 100 parts. Further delimitations are included in the description of the simulation model in a following section.

1.7 ASSUMPTIONS

Material Handling Assumption - For CM configurations, move time between work centers within a cell is negligible. In the process and DCM configurations, move time adds to the overall flow time. Material handling (MH) resources are required to move parts between work centers. In all three configurations, MH resources are needed to move parts from receiving to the first work center and from the last work center to shipping. The number of MH resources are assumed unlimited so that transfer time rather than MH resource availability is the significant factor.

2. REVIEW OF RELATED LITERATURE

2.1 COMPARISONS OF PROCESS AND CM CONFIGURATIONS

Until recently, evidence that supported claims of superiority of CM systems over process systems were based on survey data in which highly subjective opinions were formed (Pullen, 1976; Ham and Reed, 1977; Hyer, 1982). These studies are interesting at best, but do not offer any empirical evidence that one configuration is better than another. Flynn (1984) suggested that these prior studies made unfair comparisons between the new, optimal cellular configurations and existing process layouts.

A large body of research exists which uses simulation modeling to compare CM layouts to process layouts. The majority of this research concludes that the CM system performs poorly compared to process configurations based on flow time and other measures (Mahmoodi, Dooley and Starr, 1990; Flynn, 1987; Flynn and Jacobs, 1987; Morris and Tersine, 1990). Research which examines factors such as shop size (Flynn and Jacobs, 1987) and sequencing rules (Flynn, 1987) also concludes that CM systems are outperformed by process configurations. In addition to the simulation-based research, Suresh (1992) demonstrates analytically that shop performance deteriorates significantly when process layouts are transferred to CM configurations Much of CM's poor performance is attributed to the dedication of machinery to part families Flynn and Jacobs (1987) determine that machine dedication hampers routing flexibility, and increases queue build up. This leads to poor flow time and WIP performance.

Morris and Tersine (1990) model and compare process and CM configurations under a variety of operating conditions. Their research concludes that process configurations outperform CM layouts except under the following simultaneous conditions:

1. Operations possess a high ratio of setup to process time.
2. Demand is stable.
3. Flow within the cells is unidirectional.
4. A substantial level of material movement times between process departments exists.

2.2 THE EFFECTS OF OVERLAPPING

Batch splitting and operations overlapping has been shown to be beneficial in previous studies. While showing the positive effects of the repetitive lots concept, Jacobs and Bragg (1988) also demonstrated the effects of batch splitting and operations overlapping on a "small" process shop. Their research indicated that splitting batches into smaller sub-batches to allow for operations overlapping decreased flow time and queue time while using repetitive lots.

Although most research has demonstrated the inferiority of CM to process configurations, a recent study by Shafer and Charnes (1993) yields strong evidence that cellular configurations can perform well if batch splitting and operations overlapping is utilized. This study sites several authors who suggest that passing single parts from machine to machine is an advantage that must be realized in CM. Shafer and Charnes first use analytical queuing models to show that CM with total overlapping outperforms process configurations. It should be noted that the transfer times associated with process layouts are not considered in the model, which offers further evidence for CM superiority.

Shafer and Charnes also developed simulation models which compared CM with overlapping to a process configuration. They studied the performance of the CM system while varying four factors:

1. The degree to which natural part families occur;
2. The number of operations required to process the parts;
3. The processing times of the parts at each machine;
4. The lot size.

In all operating environments studied, CM flow time and WIP performance were superior to the process layout.

2.3 COMPARISONS OF DCM WITH PROCESS AND CM CONFIGURATIONS

The DCM concept is currently being studied by Kannan and Ghosh (1995; 1996; Kannan, 1997). DCM methodology attempts to take advantage of the reduced setups of the cellular system without the disadvantage of total machine dedication. The ability of temporary virtual cells to dissolve and reform allows dedicated machines to be "freed" after they are no longer needed by a family. The freed machines can then be assigned to other virtual cells. Simulation modeling and analyses by Kannan and Ghosh (1996) demonstrates that DCM outperforms process families under many conditions, including those which were thought to favor the process shop (i.e., low setup times and unbalanced part mixes). DCM also outperforms CM in the experimental environment, even when the conditions seemed to favor the CM layout (i.e., high setup times and balanced part mix).

2.4 SUMMARY

The results of the previous studies seem to be in conflict. This is potentially attributable to making comparisons based on different conditions. The Flynn and Jacobs (1987)/Morris and Tersine (1990) articles do not consider operations overlapping, nor do they consider DCM in their research. Jacobs and Bragg (1988) study partial overlapping in "small" process shops, but they make no comparisons to other shop configurations or sizes, and they do not consider total overlapping. Shafer and Charnes (1993) do not study the effects of *partial* overlapping on a CM, nor do they study the effects of any type of overlapping on the process layout. In addition, DCM is left out of their study altogether. Although Kannan and Ghosh (1995; 1996; Kannan, 1997) explore all three configurations in their various works, they do not investigate the effects of overlapping in any of their studies. When considering these studies together, more research questions become apparent. Specifically, how does partial *and* total overlapping effect process, CM, and DCM shops and how do these configurations compare when overlapping is utilized? Also, how do these configurations compare if other shop conditions are altered? This research addresses these questions by exploring the effects of total and partial overlapping on all three shop configurations and on two different shop sizes.

2.5 OTHER RELATED LITERATURE

Other studies have introduced layout alternatives that can be utilized in unstable and highly dynamic environments. Though not directly related, these studies do offer alternatives solutions to the "purer" shop configurations examined in this research. A model for forming physically reconfigurable virtual cells is introduced by Rheault, Drolet, and Abdulnour (1995, 1996). They suggest that many work centers, such as assembly tables, small machining devices, and inspection and control stations may in fact be easily moved. The model not only plans the physical reconfiguration, but it creates the cell from the beginning family formulation stage and continues through job scheduling to system monitoring.

Another study by Montreuil and Venkatadri (1991) introduces a linear programming model that is used to generate dynamic manufacturing system layouts. These layouts are used to make the transition from an old layout to a new layout in multiple phases. In a dynamic environment, a manufacturing system undergoes changes during its life cycle. As time passes and conditions change, layouts become inefficient or obsolete. However, simply modifying the layout to optimize the current environment does not ensure future efficiency. Dynamic manufacturing system layouts use predictions of future conditions to generate multiple layouts that are to be implemented in phases over time. This allows for efficiency in the present, while moving toward future layout goals.

3. METHODOLOGY

Simulation models are developed for the analysis. Models of each shop configuration are constructed using SLAM II simulation software created by Pritsker and Associates, Inc. (Pritsker, 1995). Experimental factors are finalized then base models were coded. Next, pilot runs are executed. These runs are validated and verified by tracing entities from trace output and comparing the results with those previously obtained in other studies. Experiments are conducted for each shop configuration and various levels of batch splitting/overlapping. Data from these experiments are gathered and analyzed, and conclusions are drawn.

3.1 EXPERIMENTAL FACTORS - ADJUSTING OVERLAP

Studying the effects of operations overlapping requires modifying the levels of batch splitting in each configuration. One hundred units make up the initial batch. Five levels of splitting are explored:

1. 1% or One Unit - single units are passed between machines (total overlapping)
2. 10% - Parts are passed in sub-batches which are 10 percent of the initial batch size.
3. 25% - Parts are passed in sub-batches which are 25 percent of the initial batch size.
4. 50% - Parts are passed in sub-batches which are half of the initial batch size.
5. No Batch Splitting - Parts are passed in complete batches. No splitting occurs.

Adjusting the levels of batch splitting shows how performance is effected in a variety of overlapping scenarios for each configuration. Also, the "No Batch Splitting" level helps validate the simulation models, since models of this type have been run in previous studies. If the models are valid, the results should be similar to those from previous experimentation.

3.2 THE SIMULATION ENVIRONMENT

Four different models are used for the evaluation:

1. PROC – This model represents a classical process shop that does not consider family similarities when sequencing jobs.
2. PRFAM – This model represents a process shop that uses some family consideration when sequencing jobs. This is similar to the model used by Morris and Tersine (1990). It should be noted that the family consideration makes this process shop very similar to a DCM shop. In fact, the "line" between the two configurations is not exactly clear. It would not be incorrect to label the PRFAM configuration as a DCM shop rather than a process shop. It is labeled as a process shop in this research to be consistent with Morris and Tersine.
3. CM – This model represents a classical cellular manufacturing shop.
4. DCM – This model represents a DCM shop using sequencing and cell creation rules which performed well in Kannan and Ghosh studies (1995 and 1996)

It should be noted that the family consideration makes the PRFAM model very similar to a DCM shop. In fact, the "line" between the process and DCM configurations is not exactly clear. As already stated, both configurations use identical departmental layouts. Also, both configurations utilize departmental queues, and any job that arrives at the department can be processed at any of the departmental machines. To state that "the difference is that only the DCM configuration utilizes family similarities" is not consistent with other research, since Morris and Tersine (1990) used family consideration in process configurations when comparing process and CM shops. It seems apparent that the difference in a DCM configuration and a process shop that considers family similarities is only in the research terminology. Therefore, it would not be incorrect to label the PRFAM configuration as a DCM shop rather than a process shop. It is labeled as a process shop in this research to remain consistent with Morris and Tersine. However, in the Conclusion section of this research, the term "DCM" will be abandoned and replaced with "process layouts that consider family similarities in job sequencing".

Two different shop sizes are studied. Large shops consist of 30 machines of eight different types. Table 1 shows the departmental machine assignments that are used in the large process and DCM shops. The shops produce 40 different part types. Table 2 shows the operations that are required to produce each part. This table also determines the CM system configuration by separating the machinery into cells and the parts into families Five part families and five cells are used in the CM and DCM models. Processing occurs on machines as ordered from left to right in the table. This is consistent with previous research (Kannan and Ghosh, 1995 and 1996; Morris and Tersine, 1990)

Table 1 – Departmental assignments for large shop machinery (Morris and Tersine , 1990).

Process Department	Machine Numbers
1	8, 18, 19, 26
2	2, 25, 27, 28
3	11, 13, 15, 24
4	1, 3, 7, 9
5	17, 21, 23, 30
6	4, 5, 10, 29
7	14, 16, 20
8	6, 12, 22
9	Shipping and Receiving

Table 2 – Large shop machine requirements for each part with cell and family configuration. (Morris and Tersine, 1990).

PARTS	MACHINES																													
	18	25	13	3	23	10	16	26	2	15	7	17	4	20	12	22	8	28	24	9	21	29	14	6	19	27	11	1	30	5
34	x	x	x	x	x	x																								
40	x	x		x	x		x																							
38	x	x		x	x																									
39		x	x		x	x																								
33		x		x		x																								
36			x	x	x	x	x																							
37			x	x	x	x	x																							
35			x			x	x																							
24								x	x	x	x	x	x																	
20								x	x	x	x	x	x																	
19								x			x			x	x															
23								x						x	x															
26									x	x	x	x	x																	
22									x	x	x	x	x																	
21									x			x	x	x	x															
25												x	x	x	x															
32																x	x	x	x	x										
30																x	x	x	x	x										
27																x		x	x	x										
31																x		x	x											
28																	x	x	x	x	x									
29																	x			x	x									
17																						x	x	x	x					
15																						x		x	x	x				
13																						x			x	x				
9																						x			x	x				
18																							x			x				
16																							x			x				
12																							x			x				
10																								x	x	x				
14																								x	x					
11																								x	x					
7																											x	x	x	x
6																											x	x		x
4																											x		x	x
2																											x	x	x	
3																											x	x		
8																												x	x	x
5																													x	x
1																													x	x

Small shops consist of 20 machines of eight different types. Table 3 shows the departmental machine assignments that are used in the small process and DCM shops, and Table 4 shows the operations that are required to produce each part. The small shop will also produce 40 different part types.

In the process system, parts are routed to the process departments where they are assigned a machine (if one is available). In the DCM system, virtual cells are constructed from the machines that are available when the cell is formed. Family members are then routed to the machines that are assigned to the virtual cell. The CM system uses the predetermined machine-to-cell assignments shown previously in Figure 2. Alternate routings are not permitted.

3.3 EQUIPMENT CONDITIONS AND ASSUMPTIONS

The machines assigned to a process department are identical and can perform the same processes. Therefore, these machines also have the same processing and setup times for particular operations. Machines only produce one part at a time. When a machine is not processing parts, it is available for use when the routings permit. This assumes that machine breakdowns are insignificant. Also, operations in process can not be interrupted (i.e., no preempting). Finally, operations do not become available until the batch that it is processing is completed.

As shown in Tables 1 and 3, Department 9 is the shipping/receiving department. All batches begin and end in this area. The parts leave from and arrive to shipping/receiving in complete batches. No additional processing occurs in these areas

Table 3 – Departmental assignments for small shop machinery

Process Department	Machine Numbers
1	8, 18
2	2, 25, 28
3	11, 15
4	1, 7, 9
5	21, 23, 30
6	4, 10, 29
7	14, 16
8	6, 12
9	Shipping and Receiving

Table 4– Small shop machine requirements for each part with cell and family configuration.

	MACHINES																			
PARTS	18	25	23	10	16	2	15	7	4	12	8	28	9	21	29	14	6	11	1	30
34	x	x	x	x																
40	x	x	x		x															
38	x	x	x																	
39		x	x	x																
33		x		x																
36			x	x	x															
37			x	x	x															
35				x	x															
24						x	x	x	x											
20						x	x	x	x											
19								x		x										
23										x										
26						x	x	x	x											
22						x	x	x	x											
21						x			x	x										
25									x	x										
32											x	x	x							
30											x	x	x							
27												x	x							
31												x								
28											x	x	x	x						
29											x		x	x						
17															x	x	x			
15															x		x			
13															x					
9															x					
18																x				
16																x				
12																x				
10																	x			
14																	x			
11																	x			
7																		x	x	x
6																		x	x	
4																		x		x
2																		x	x	x
3																		x	x	
8																			x	x
5																				x
1																				x

3.4 THE ARRIVAL PROCESS

Jobs arrive according to a Poisson process (i.e., with exponentially distributed inter-arrival times) in batches of 100 part entities. The mean inter-arrival time is determined such that the average utilization of the shop approximates 80% in the PROC configuration with no overlapping. This is consistent with Kannan and Ghosh's models (Kannan and Ghosh, 1995; Kannan, 1997). Demand is uniformly distributed across part types.

3.5 PROCESSING, SETUP, AND MATERIAL HANDLING TIMES

In the Kannan and Ghosh experiments (1995; Kannan 1997), processing times are normally distributed with a mean of 34.33 minutes per *batch* and a standard deviation of 0.25 minutes per *batch*. However, to model overlapping, times for *individual* parts are used. To maintain consistency with Kannan and Ghosh, the batch processing time is divided by the lot size (100 parts). The mean processing time of 0.3433 minutes per *part* is used in this research. The standard deviation per *batch* of 0.25 minutes (0.7 percent of the mean) seems insignificant and perhaps unrealistically low, even for a stable, predictable flow shop environment. Therefore, the processing time standard deviation per *part* is increased to 25 percent of the mean processing time, or 0.0858 minutes per *part* (calculations are shown in Appendix A). This increase introduces a significantly higher level of processing time variability into the shop environment. The processing times are normally distributed and are independent and identically distributed for all operations.

The simulation conditions require three levels of setup times which can be utilized by each configuration. First, operations require no setup time if the previous part number that was processed was identical to the part number that is now starting the operation. Second, a minor setup time is used when the part number that is starting at an operation is in the same family as the preceding part number. Finally, a major setup time is required if the part number is the first at an operation, or if the part number starting at an operation is in a different family than the preceding part number. Low and high setup times are set at 11.33 and 22.66 minutes respectively. This is consistent with Kannan and Ghosh (1996; Kannan 1997). As with processing times, these conditions hold for all operations.

Material handling times for the process and DCM models are determined by the distance between process departments and the speed of the MH vehicle. The large shops have an area of 10,000 square feet (100' x 100') and the small shops have an area of 5625 square feet (75' x 75'). Each machine has a footprint of 15' x 15'. All layouts (shown in Appendix B) are based on Morris and Tersine's layouts developed using MICRO-CRAFT software (Morris and Tersine, 1990; Morris, 1988). Rectilinear distances between departmental center points are used for MH vehicle travel. The MH vehicle transports parts at 5 mph (7.33 ft. per second). The CM shop also requires MH vehicles for transport to and from shipping and receiving. Loading and unloading times for the transport batches are uniformly distributed in the interval of (1,5) minutes. Transfer times within CM cells are assumed zero because of the closeness of the workstations.

3.6 SEQUENCING AND MACHINE ALLOCATION RULES

PROC Configuration - In the process shop models, a machine becomes available when it has finished processing a complete batch of parts. When the machine becomes available, the departmental queue is searched for a job (batch or sub-batch) with the part number identical to the one just completed. If there is an identical job in queue, then it receives priority (repetitive lots principle). If multiple identical jobs are found, then they were sequenced based on first-in-first-out (FIFO). If there are no identical jobs in the queue, then the shortest processing time (SPT) sequencing rule is used.

PRFAM Configuration – As with the PROC configuration, the repetitive lots principle applies. If no identical jobs are in the queue, then jobs from the same family receive priority. For example, a job with part number 5 and family number 2 is completed at a machine in department 1. To allocate the next job at the available machine, the department 1 queue is examined for an entity with part number 5. If one is found, then it is immediately routed to the machine. Otherwise, the department queue is searched for an entity with family number 2. This rule makes the PRFAM configuration very similar to the DCM configuration, as previously discussed. If neither of the previous rules can be satisfied, then SPT is used.

CM Configuration - In a CM model, the repetitive lots principle still applies. However, the concept of CM eliminates the need for the same family rule. SPT is used if there are no identical jobs in queue.

DCM Configuration – As jobs move through the facility, virtual cells are created and modified. When a job enters a department, it is routed to a machine that is possessed by its part family. If the family does not possess a machine, then the job waits for one to become available. Machines are allocated to part families based on the number of jobs in the departmental queue for each family as follows:

- The family with the most jobs in the queue receives allocation priority, unless that family already possesses a machine.
- If all families in a queue possess a machine and there is a machine available, then the machine is allocated to the family with the most jobs in the queue.
- If a family has multiple machines in a department and a job arrives from a family that does not possess a machine, the family with multiple machines gives one up as soon as a job is finished.

Sequencing within families that possess a machine follows the repetitive lots principle or FIFO if repetitive lots requirements are not satisfied. To illustrate DCM machine allocation, suppose a job with part number 5 and family number 2 is completed at a machine in department 1. Currently, this machine is possessed by family number 2 (which only possesses one machine in this example). To find the next job to be processed at the machine, the department 1 queue is examined for a job with part number 5. If one is found, then it is immediately routed to the machine. Otherwise, the department queue is searched for an entity with family number 2. If no entity from family 2 is found, then the machine is allocated to another family in the departmental queue. Say families 3 and 4 don not posses a machine in the department, but family 3 has 2 entities and family 4 has 1 entity in the department 1 queue. Since family 3 has the most entities in the queue, a job from this family is routed to the machine for processing. Family three now possesses the machine.

In addition to the sequencing/allocation rules discussed previously, no jobs in process are interrupted i.e., preemption is not allowed. Also, a machine processes all sub-batches from a batch until the entire batch has been completed on that machine. Sub-batches from other batches are not allowed to use the machine until the original batch is complete.

The identical job (all configurations) and same family rules (PRFAM only) are consistent with Morris and Tersine (1990). The use of SPT (all configurations) is used by Kannan and Ghosh (1996). All DCM rules are consistent with a model which performed well in Kannan and Ghosh (1995).

3.7 WARM-UP PERIOD

The warm up period is determined using Welch's procedure as described in Law and Kelton (1991). This procedure identifies a point in time when the model reaches steady state based on the performance measure values. Each model configuration and size is tested with each level of batch splitting. Five replications are used for each model. A moving average is calculated and plotted, and the steady state point is identified when the curve "flattens". A safety factor of 10,000 minutes is added to the steady state point to determine the warm-up period. The warm up periods range from 15,000 to 34,000 minutes. For simplicity and added insurance that the model is at steady state at the end of the warm-up, 35,000 minutes is used as the warm-up period for all models. Further details of the warm-up are described in Appendix C.

3.8 RUN LENGTH AND NUMBER OF REPLICATIONS

The run length and number of replications considerations attempt to balance the need for sufficient data with the desire for timely data. Longer run lengths generate more data, thus that average of the performance measures have a higher probability of approaching the actual means (i.e., better point estimates of performance measures). More replications tighten the confidence intervals of the performance measure, allowing for strong statements regarding the validity of the results. However, the size and complexity of the models, the number of models in the experiment, and the long warm-up time cause the actual run time in the computer network to be extreme. Therefore, rather than setting a run length based on the warm-up period (as commonly practiced), pilot runs were conducted to determine a sufficient number of entities to send though the system for a run. Using the PROC model with no overlapping, the pilot runs were set to allow for at least 1000, 1500, and 2000 entities through the system. The resulting average Time in System performance measures for the three runs were 286, 278, and 281. The similarity of these results suggests that the shorter run length creates sufficient data for the experiments, therefore the model is set to gather at least 1000 data points for the Time in System measurement. Running the model for 10,000 minutes after the warm-up period is more than sufficient to accomplish this goal. Ten replications are run for each model. The pilot runs indicate that ten replications would generate confidence interval widths which are less than ten percent of the of the mean time in system. This result seems reasonable and adequate for drawing valid statistical conclusions in this research.

3.9 PERFORMANCE MEASURES

Data is collected and analyzed for two performance measures – average time in system (mean flow time) and mean WIP inventory. Average time in system is an important measure by itself, however it is also a good indicator of other time related statistics such as mean lateness, mean waiting time, and the mean number of jobs in the system (Conway, Maxwell, and Miller, 1967). WIP inventory is defined as the number of full *batches* than are in the system at one time. It is an important measure as it is directly related to production costs. These two measures are consistent with many previously cited experiments (Morris and Tersine, 1990; Shafer and Charnes, 1993; Kannan and Ghosh, 1995).

3.10 ANALYSIS OF RESULTS

The effects of overlapping on mean flow time and mean WIP are determined using analysis of variance (ANOVA) under the various treatment combinations. Confidence intervals are then used to compare the performances of the four models. All analyses are performed at $\alpha = 0.05$. Conclusions are drawn to determine how overlapping effects the three configurations and which (if any) shows superior performance.

4. MODEL DESCRIPTIONS

4.1 MODEL DESCRIPTIONS FOR PROCESS SHOPS

The two process shop models used the same SLAM II programming statements, however their FORTRAN subroutines differ slightly. The partial network diagram for the models, an example model (50% batch split), and the FORTRAN subroutines are shown in Appendix D. The "partial" diagram and "example" model are shown rather than the complete versions in order to conserve space. All models are available from the author. The descriptions of the attributes, files, resources, global variables, arrays, and activities are shown in Tables 5 through 10.

Table 5 - Attribute descriptions for the process shop models.

ATTRIBUTE(S)	DESCRIPTION
1-7	Defines the routing for the entity (ATRIB(1) is the first machine/dept)
8	Defines the part family of the entity
9	Defines the part number of the entity
10	Counts the number of operations that the entity has finished
11-18	Processing times at departments 1-8
19	Entity identification # - Mark attribute (time that an entity enters the system)
20	Indicates set-up time (0 = no set-up, 1 = short set-up, 2 = long set-up
21-27	Indicates move times between departments (21 is the first move time)
28	Indicates the number of sub-batches per batch
29	Indicates the number of entities per sub-batch

Table 6 - Variable descriptions for the process shop models.

XX	DESCRIPTION
1-8	Set-up time indicators at each department
9	Indicates the number of entities currently in the system

Table 7 - File descriptions for the process shop models.

FILE	DESCRIPTION
1-8	Queue for machines assignments in departments 1-8
11-18	Queue for processing after machine has been assigned to the start-batch

Table 8 - Resource descriptions for the process shop models.

RESOURCES	NUMBERS	CAPACITY	DESCRIPTION
X1 - X6	1-6	4	Start batch resources for departments 1-6
X7 - X8	7-8	3	Start batch resources for departments 7 and 8
D1 - D7	1-7	4	Machine resources for departments 1-6
D7 – D8	7-9	3	Machine resources for departments 7 and 8

Table 9 - Activity descriptions for the process shop models.

ACTIVITIES	DESCRIPTION
1-8	Machine processing in departments 1-8
11-18	Short set-up times in departments 1-8
21-28	Long set-up times in departments 1-8
31-38	Loading times at departments 1-8
41-48	Unloading times at departments 1-8
51-57	Move times from receiving to depts (operations ordered 1-7 on routing)

Table 10 - Array descriptions for the process shop models.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	No. OF ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	4	Machine indicators	Part # of last or current entity on machine
11-18	Department	4	Machine indicators	Entity # of last or current entity on machine
21-28	Department	4	Machine indicators	Number of sub-batches processed
31-38	Department	4	Machine indicators	Part family of entity on machine
41-48	Department	4	Machine indicators	Indicates if machine is idle(0) or busy(1)

The model begins by setting initial global variable, array values, and resource characteristics (refer to Tables 6 through 10). All global variables are initially set at zero. All values of arrays 1 through 8 and 31 through 38 are set at an initial value of 1. This simply states that all machines are currently set to produce part number 1 of family 1. All values of arrays 11 through 18 and 41 through 48 are initially set at zero, indicating that there was not a "last entity" on a machine and that all machines will begin idle and empty. All values in arrays 21 through 28 are set to one over the number of sub-batches per batch. This is used for counting purposes to determine when a machine can be released by a batch.

Next, the resources are configured for the model. There are 16 total resources (two for each department). The resources capacities (see Table 8) represent the number of machines in each department. Each department has two resources because one is used as a machine allocation for an entire batch, while the other allocates machines to sub-batches. This is necessary to route all sub-batches of the same batch to the same machine.

The model network begins with entity creation at the CREATE node. Entities represent entire batches (which are split later) which have exponential inter-arrival times with a mean of 8 minutes. The mark attribute [ATRIB(19)], which is used as a unique entity identifier is assigned as the time an entity is created. After arriving into the system, the value of 1 is added to the global variable XX(9), which represents the number of entities currently in the system. Attributes 28 and 29 (the number of sub-batches per batch and the number of parts per sub-batch) are then assigned to the entities. These attributes are the same for all entities.

The entity is next assigned a family [ATRIB(8)], and then a part number [ATRIB(9)] (demand is uniformly distributed across part numbers). The entity is assigned a routing (attributes 1 through 7) based on its part number. For example if ATRIB(1) = 5 and ATRIB (2) = 6, then the entity will first be routed to department 5 and then to department 6. In addition to routings, processing times are also assigned to entities. The value represents the processing time at a certain department. For example, ATRIB(15) represents the processing time for part entities at department 5. Move times are also assigned. ATRIB(21) represents the first move time, ATRIB(22) represents the second, etc. ATRIB(27) always represents the move time from the last department to the shipping/receiving area.

Entities undergo the first move activity (ACT/51) after being routed to node labeled R1. The entities are then routed to the correct processing department based on ATRIB(1). A network diagram of Department 1 is shown in Appendix D. All departments are structurally the same. Differences occur in specific values which are representative of each department. The remainder of the departmental model description refers to Department 1.

The entity undergoes an unloading activity (ACT/31) when it arrives at Department 1 (node label D1). Next, the entity is routed in one of two ways:

1. If the entity is already split into sub-batches, it is routed to a queue [AWAIT(1)] to wait for a machine to become available.
2. If the entity has not been split into sub-batches, it is routed to an UNBATCH node (UNBATCH,28) where it is split into multiple sub-batch entities based on attribute 28. For example, when ATRIB(28) = 2, then the entity is split into two identical entities. Then the sub-batch entities are routed to the queue represented by AWAIT(1).

At the AWAIT node, a machine (resource) is allocated to a batch using an ALLOC(I) subroutine (where I is, the department number, AWAIT file number, and resource number). The node is triggered whenever a resource is freed, or when an entity arrives at the AWAIT node. After setting initial values, the subroutine retrieves the identification number (mark attribute) for the entity that possesses the "first" machine. [It should be noted that though SLAM does not keep track of the actual machines being used in a resource, the array values are being set as an entity seizes a resource, and after a resource is released. For example, the ARRAY(41,2) tells whether machine two in department 1 is busy or idle. By counting entities, tracking the entity/family currently and previously on a machine, and determining the machine's state (busy or idle), the arrays enable the model to determine the appropriate action when a machine becomes idle.]. An NFIND statement is then used to see if there are any sub-batch entities that match the identification number (this would imply that the sub-batch comes from the batch that possesses the machine resource). If a matching sub-batch is found, it is removed from the queue and moved to an ENTER node in the SLAM II model (ENTER, I+10). Otherwise, the subroutine uses a DO loop to identify the possession batches of the other machines and then attempts to identify a match. If no match is found, the subroutine checks whether there are any machines that are not possessed by a batch [If statement that checks the value of NNRSC(I)]. If at least one machine is free, then an array value [ARRAY (I+20)] representing the one plus the number of sub-batches processed on a machine is compared to the number of sub-batches per batch [IF (B.GT.C)] If the array value is greater, then an array value representing the part number of the last batch on the machine is retrieved, otherwise, a DO loop repeats the comparison with other array values until the "free" machine is found. This value is compared to the part numbers in the queue. If a match exists, then the setup time indicator [XX(I)] is set to zero (indicating no set up time which demonstrates the Repetitive lots principle), the array value representing the number of sub-batches processed is set to zero, a machine is seized, and the entity is removed from the queue and placed in an ENTER node (ENTER,I). If no match is found, then the next event is dependent on the type of process shop. This event attempts to allocate a machine based on a family match. The PROC model does not consider family relationships, so this step is left out of the subroutine. For the PRFAM shop, the subroutine retrieves an array value representing the family that last possessed a machine and the checks to see if there are any matches in the queue. If a match exists, then the setup time indicator XX(I) is set to 1 (indicating a short set up because of the family relationship), the array value representing the number of sub-batches processed is set to zero, a machine is seized, and the entity is removed from the queue and placed in the ENTER,I node. If no match is found or if the shop is the PROC configuration, then the subroutine will search the queue for the entity with the shortest processing time [ATRIB(I+10)]. If an entity is found, then the set-up indicator is set to 2 (indicating a long set up time), the array value representing the number of sub-batches processed is set to zero, a machine is seized, and the entity is removed from the queue and placed in ENTER,1 of the SLAM program.

As previously stated, entities emerge from the AWAIT queue at either ENTER 1 or ENTER 11. An entity enters ENTER 1 if it is the first sub-batch of a batch to be processed. This sub-batch entity has seized the machine resource for processing by the entire batch in the ALLOC subroutine. Next, a set-up time attribute [ATRIB(1)] is assigned to the sub-batch entity based on the set-up time indicator variable XX(1) set in the subroutine. An EVENT subroutine now assigns the new entity characteristics to the appropriate array locations. After the initial values are set in the subroutine, the subroutine will search the array representing the number of sub-batches processed for the value set at zero. It will then set the corresponding arrays appropriately. For example, if ARRAY(21,3) =0, (which means machine three in department one has not processed any of the current sub-batch), then the subroutine sets arrays (1,3), (11,3), (31,3) and (41,3) to their appropriate values. ARRAY(1, 3) is the part number of the entity, ARRAY(11,3) is set to the entity identification number, ARRAY(31,3) is set as the family of the entity, and ARRAY(41,3) is set to zero indicating that the machine is currently idle (processing has not yet begun even though the machine is possessed by the entity). After the arrays are set, the program returns to SLAM II.

An entity bypasses the previous EVENT subroutine if it is sent to the ENTER 11 node (rather than ENTER 1) from the ALLOC subroutine. This occurs when the sub-batch is not the first of its batch to be processed on the machine. The set-up indicator attribute ATRIB(20) is assigned a value of zero to indicate the absence of a set-up time (the machine is already set up for the part).

The "paths" that began at ENTER 1 and ENTER 11 converge at a GOON node which routes the entity to one of three conditional activities based on the set-up indicator attribute ATRIB(20). If ATRIB(20) is set at zero, then the entity goes through a conditional route which is not assigned an activity or a duration. When ATRIB(20) = 1, the entity is routed through activity 11 which has a duration of 11.33 minutes. If ATRB(20) = 2, the entity is route to activity 21 which has a duration of 22.66 minutes.

Sub-batch entities are split into identical individual part entities at an UNBATCH node after the set-up activities. The number of parts is determined by ATRIB(29). Then the part entities wait in an AWAIT queue for the machine to become available.

The AWAIT(11) node uses the same ALLOC subroutine that was used in the previous AWAIT node, however, an IF statement at the beginning of the subroutine moves the focus to a different area of code. The subroutine first checks to see if there are any available machines (NNRSC is not zero). If so, then the busy/idle array is examined to determine if a machine is idle. A DO loop allows the subroutine to examine all busy/idle array values. If a machine is set at idle, then the queue is searched for an entity whose batch possesses the machine using an NFIND function. For example, ARRAY(41,3) = 0 indicates that machine three in department 1 is currently idle. Say that the machine is currently possessed by an entity with an identification number 123 [ARRAY(11,3)=123]. The subroutine will search the queue for an entity with an identification number of 123. If a match is found, then the busy /idle array is set to 1 (busy), the machine resource is seized, and the entity is removed from the queue and placed in ENTER 21.

Operations processing time is modeled following the ENTER node. Activity 1 occurs with a duration represented by ATRIB(11), which was assigned earlier in the model. An event subroutine (EVENT 11) follows the activity.

As with the ALLOC subroutine, the EVENT subroutine is the same one used previously. An IF statement sends the focus of the program to a different part of the code. This section of code is responsible for freeing the machine from a part entity and setting it to idle. It identifies which machine has finished processing by comparing the "identification number on a machine" array values with the identification number [ATRIB(19)] of the part that has activated the event. When the machine is identified, the corresponding busy/idle array value is set to "idle" (0) and the machine resource is freed.

Part entities are combined into sub-batches at the BATCH node. The entities are identified by the entity identification attribute ATRIB(19). When the sub-batch is complete, another subroutine (EVENT,21) counts the number of sub-batches that arrive to it and free a machine from a batch when the entire batch has complete processing.

Again, this is the same EVENT previously cited. The If statements at the beginning set the focus at the correct code location. The subroutine looks up the array values that show the entity identifications that possess each machine. If the value in the entity identification array matches the entity identification of the sub-batch entity that activated the EVENT, then the subroutine increases by one the array value which counts the number of entities sub-batches that have been processed. If this new value is greater than the number of sub-batches per batch, then a machine resource is freed.

An unloading operation activity occurs to move the sub-batch out of the department (ACT/41). Then one is added to ATRIB(10), indicating that the sub-batch has completed the operation. The part is then routed to the next department based on the value of ATRIB(10) (see Node labels R1 through R6). The move times (determined by attributes 21 through 27) occur during the routing.

Each department in the process models is identical to department 1 (previously described) except the values of the activities, attributes, arrays, files, resources, and variables change to reflect the department. For example when modeling department 4, the activity numbers are 4, 14, 24, 34, and 44. Modifications for other values occur likewise.

The sub-batch entities go to the shipping area of the model (node label SR) after completing processing at all work centers on the routing. An UNBATCH node splits the sub-batch entity into identical part entities, and then a BATCH node combines the newly formed part entities into a full batch entity of 100 parts. The entities are then moved to the shipping /receiving area (ACT/57 with move time based on ATRIB(27). The global variable XX(9) which counts the number of entities in the model at any given time (WIP) is reduced by one since one batch entity is leaving the system. Data is collected for Time in System measurements, then the entity leaves the network.

The model described is used for all levels of batch splitting/overlapping with a few minor modifications. Attributes 28 and 29 change to reflect the number of sub-batches per batch and the number of parts per sub-batch respectively. Also, the initial values in arrays 21 through 28 represent the one plus number of sub-batches per batch. All other code is the same.

A slight modification in the resources is made to model the small shops. Each department has fewer machines in the smaller shop. This is reflected in the resource capacity shown below in Table 11. An example of a small process shop model (100% batch split) is shown in Appendix D.

Table 11 - Resource descriptions for the small process shop models.

RESOURCE	NUMBER	CAPACITY	DESCRIPTION
X1	1	2	Start batch resources for department 1
X2	2	3	Start batch resources for department 2
X3	3	2	Start batch resources for department 3
X4 - X6	4-6	3	Start batch resources for departments 4 through 6
X7 - X8	7-8	2	Start batch resources for departments 7 and 8
D1	11	2	Machine resources for department 1
D2	12	3	Machine resources for department 2
D3	13	2	Machine resources for department 3
D4 - D6	14-16	3	Machine resources for departments 4 through 6
D7 - D8	17-18	2	Machine resources for departments 7 through 8

4.2 MODEL DESCRIPTIONS FOR CM SHOPS

The simulation model built to represent the CM shop configurations is outlined in this section. The partial network diagram for the models, an example model (25% batch split), and the FORTRAN subroutines are shown in Appendix E. The descriptions of the attributes, files, resources, global variables, arrays, and activities are shown in Tables 12 through 16.

Table 12 - Attribute descriptions for the cellular manufacturing (CM) model.

ATTRIBUTE	DESCRIPTION
1-30	Processing times at machines 1-40
31	Entity identification # - Mark attribute (time that an entity enters the system)
32	Indicates set-up time (0 = no set-up, 1 = short set-up, 2 = long set-up
33	Indicates the number of sub-batches per batch
34	Indicates the number of entities per sub-batch
35	Indicates part number
36	Counts entities that enter system (entity number)

Table 13 - Variable descriptions for the cellular manufacturing (CM) model.

XX	DESCRIPTION
1-30	Entity number of entity that was last or is currently on a machine
31-60	part number of entity that was last or is currently on a machine
61-90	counts sub-batches that have been completed at station 1-30
91	Number of entities in the system
92	Set up indicator
93	Routes sub-batches to appropriate machine from event node

Table 14 - File descriptions for the cellular manufacturing (CM) model.

FILE	DESCRIPTION
1-30	Queue for start batch resource at machine 1-30
31-60	Queue for processing after machine has been assigned to the start-batch

Table 15 - Resource descriptions for the cellular manufacturing (CM) model.

RESOURCE	NUMBER	CAPACITY	DESCRIPTION
M1 - M30	1-30	1	Start batch resources for departments 1-30

Table 16 - Activity descriptions for the cellular manufacturing (CM) model.

ACTIVITIES	DESCRIPTION
1-30	Processing at machines 1-40
31-60	Set-up times in departments 1-40
61-65	Move times from receiving to cells 1-5
66-70	Move times from cells 1-5 to shipping
71-75	Loading times at cells 1-5
76-80	Unloading times at cells 1-5

The CM shop begins by setting initial values for all global variables to zero. Next the resources are defined and their initial capacities are identified. Each resource represents one machine with a capacity of one since machines are not separated by type as in the process configuration. This greatly simplifies the programming logic.

Batch entities which arrive based on exponentially distributed inter-arrival times are created by a CREATE node. One is added the variable XX(91) which tracks the number of entities currently in the system. Attributes 33 and 34 are then set to signify the number of sub-batches per batch and the number of parts per sub-batch.

Fist, the entity is assigned a part number [ATRIB(35)] (demand is uniformly distributed across part numbers). A series of ASSIGN nodes determine routings (see Table 2) by assigning a processing time for each machine number that is on the routing. Then the entity is routed to the appropriate cell. For example, part number 1 is produced in cell number 5. Which has four machines numbered 11, 1, 30, and 35 (in routing order). Part number 1 only requires processing at machines 30 and 5, so attributes 1 and 11 equal zero, while attributes 30 and 5 equal the processing time used in the model (generated from the normal distribution with a mean of .3433 minutes and a standard deviation of .0858 minutes). The entity is then routed to cell 5 (node label C5).

Each entity that arrives to a cell undergoes a moving operation from shipping/receiving to the cell represented by activities 61 through 65 (for example, a move to cell 3 is activity 63). Next, a loading operation is performed represented by activities 71 through 75. Next, all entities are routed to the first machine in the cell, though some will not perform an operation at this machine. All sub-batches are created here, using an

UNBATCH node. The sub-batch entities are then either sent to the next machine in the cell based on the routing attributes, or they remain at the first machine to be processed.

Those that remain at the machine enter a queue (AWAIT node) where machine resources are assigned to batch entities by an ALLOC(I) subroutine. The subroutine first examines the queue to see if there are any sub-batch entities that are part of the batch that currently possesses the machine. This is accomplished by comparing the identification/mark attribute with the global variable XX(I) (where I is the machine number). XX(I), which is set later, is used to determine what batch entity posses the machine. If a match is found, then the sub-batch entity is removed from the AWAIT queue and placed in ENTER 31. If no match is found, then the subroutine determines if the machine resource is possessed by a batch entity by using an IF statement and the "current resource capacity" variable NNRSC(I). If it is not, then the subroutine searches the AWAIT queue for an entity that has the same part number as the entity that previously possessed the machine. The part number of the possessing entity is stored in variable XX(I+30). If a match is found, then the set-up time indicating variable XX(92) is set to zero to indicate no setup time. Otherwise, the subroutine searches the queue for the entity with the shortest processing time and assigns the set-up time indicator a value of one. After the set-ups are determined, XX(I) is set to zero, the part number is stored in XX(I+30), and the machine resource is seized by the entity. Then, the entity is removed from the AWAIT queue and placed in ENTER(I).

Entities that are sent to ENTER 31 from the subroutine are routed back to their cell area, then sub-batch entities are split in to part entities at UNBATCH 34 (this bypasses the set-up operation). The other entities are sent to ENTER(I) from the subroutine. Here, the entities undergo a set-up operation based on variable XX(92) which was set in the subroutine. Then the sub-batch entities are split into part entities at UNBATCH 34.

An EVENT subroutine occurs after the individual part entities are created. This subroutine removes part entities from the AWAIT queue if their batch possessed the machine. It uses the NFIND function to see if XX(I) (the identification number of the batch that possesses the machine) matches the entity identification number [ATRIB(31)]. If a match is found, then the entity is removed from the AWAIT queue and move to ENTER,31 and the subroutine ends. The route from ENTER 31 was discussed in the previous paragraph.

Following the event, part entities whose batch possesses the machine will wait in a QUEUE node for the machine to become available. Then the machine will process the entities (ACT\I, where I is the machine number) using a duration determined in the entity's attributes. The part entities are then combined into sub-batches at a BATCH node, followed by another EVENT subroutine. As with the process model, this EVENT subroutine is actually the same program as the one used earlier. This EVENT node sends the focus of the program to a different area of the code using IF statements at the beginning of the subroutine. This area of the subroutine counts the number of sub-batches processed on the machine and frees it after an entire batch has been completed. It counts the number of batches processes in the global variables XX(I+60) (where I is the machine number). If the number of sub-batches per batch [ATRIB(33)] equals XX(I+60), then the machine resource is freed and XX(I+60) is set to zero. The program then returns to SLAM II, where the sub-batch entities are routed to the next machine in the cell.

With the exception of the first and last machines in each cell, all machines in all cells are identical except where variables are used for machine/cell identification (see Table 13). As previously discussed, the first machine is responsible for splitting batches into sub-batches. The last machine in the cell is responsible for unloading sub-batches (activities 76 through 80) and moving them to shipping/receiving (activities 66 through 70).

Sub-batch entities are split into part entities at the shipping/receiving area (node label SR) and then combined into full batches. The global variable XX(91) which counts the number of entities in the model at any given time (WIP) is reduced by one since one batch entity is leaving the system. Data is collected for Time in System measurements, then the entity leaves the network.

The CM model only slightly changes with varying levels of batch splitting/overlapping. In fact, only two attributes are changed (attributes 33 and 34) to modify the number of sub-batches per batch, and the number of entities per sub-batch. Everything else is left unchanged.

The model for the small CM shop configuration is identical to the large shop, except that 10 machines are removed. This is noticed in the resource assignments and in the model itself, where a machine and all the code associated with it are deleted from the program. Slight adjustments are made also when the first or last machine of a cell is removed. An example of a small CM shop model (10% batch split) is shown in Appendix E.

4.3 MODEL DESCRIPTIONS FOR DCM SHOPS

The simulation model built to represent the DCM shop configurations is outlined in this section. The partial network diagram for the models, an example model (no batch split), and the FORTRAN subroutines are shown in Appendix F. The descriptions of the attributes, files, resources, global variables, and activities are identical to those of the process shops (see Tables 5 through 11). The array descriptions are shown in Table 17.

Table 17 - Array descriptions for the dynamic cellular manufacturing (DCM) model.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	1-4	Machine indicators	Part No. of last or current entity on machine
		2-8	Machine indicators	Part family of entity on machine
11-18	Department	1-4	Machine indicators	Entity No. of last or current entity on machine
		2-8	Machine indicators	Indicates if machine is idle(0) or busy(1)
21-28	Department	1-4	Machine indicators	No. of sub-batches processed
31-38	Department	1-5	Family indicators	No. of sub-batches from families 1-5 in the queue
41-48	Department	1-5	Family indicators	No. of machines possessed by families 1-5

The model begins by setting the initial values of all global variables to zero. Next, the initial array values are set. Arrays 1 through 8 are set to 1, indicating that all machines are currently set up for part number one from family one. All values of arrays 11 through 18 are set to zero indicating that there are currently no entities on the machines and that they are idle. Values in arrays 21 through 28 are set to one over the number of sub-batches per batch. This is used for counting purposes to determine when a machine can be released by a batch. Arrays 31 through 38 are set to zero to indicate that all queue files start empty, and arrays 41 through 48 are set at zero indicating that no family currently possesses a machine.

Next, the resources are configured for the model. There are 16 total resources (two for each department) The resources capacities (see Table 8) represent the number of machines in each department. Each department has two resources because one is used as a machine allocation for an entire batch, while the other allocates machines to sub-batches. This is necessary to route all sub-batches of the same batch to the same machine.

The model network begins with entity creation at the CREATE node. Batch entities arrive based on exponentially distributed inter-arrival times. The entity identification/mark attribute is set in ATRIB(19). Next, one is added the variable XX(9) which tracks the number of entities currently in the system. Attributes 28 and 29 are then set to signify the number of sub-batches per batch and the number of parts per sub-batch. Entities are then assigned family numbers, part numbers, routings, move times, and processing times using identical code to that of the process shop models. Entities are also routed to departments in the same manner as in the process shops. The following is a description of department 1.

As with the process configuration, entities are routed to departments for processing. On arriving at a department, the entity undergoes a loading operation (ACT/31). Then if this is not the first operation for the entity, it is routed to EVENT 1. Otherwise, the entity is separated into sub-batches and then routed to EVENT 1. This EVENT subroutine counts the number of entities in the queue by families and stores the value in the appropriate array. Note that the entity which triggers EVENT 1 is included in the count, since it goes to the AWAIT 1 queue immediately after EVENT 1 (though in simulated time, these things happen at the same time). For example, if the entity arriving at EVENT 1 belongs to family 2 [ATRIB(8) =2] then one is added to the number of sub-batch entities in the queue for this family [ARRAY(31,2)]. The program then returns to SLAM II. The entities are put in an AWAIT(1) queue following the event. An ALLOC(1) subroutine then sends through any entities that possess a machine, and/or allocates a machine to a batch and/or family.

Entities whose batch already possesses a machine are removed from the queue in the same manner as in the ALLOC(1) subroutine for the process shop. These entities are sent to ENTER 11. After this step, the subroutine will check for any machines which are not possessed by a batch. If all machine resources are currently utilized, then the program returns to SLAM. Otherwise, a complex series of tests is carried out to determined weather to allocate the machine resource to a new family/virtual cell or to allocate to the family that already possesses it. The tests checks the number of the machine types possessed by the family and if there are currently family members in the queue.

The first tests determine if the machine will stay with the same family, or if there will be competition for it. If the family only possesses the one free machine and has at least one sub-batch entity in the queue, then the machine will stay in the possession of the family and a family entity will be routed to the machine based on the sequencing rules previously discussed. To carry out this test, the part family possessed by a machine is determined in the same manner as with the process shop. The number of machines possessed by a family is found by looking in arrays 41 through 48 For example, to find the number of department 1 machines possessed by family 5, the subroutine looks up the value of ARRAY(41,5), an IF statement is used to test if there are family members in the queue and if the number of machines possessed is one. If so, the appropriate entity to send is determined in a manner similar to the CM shop's ALLOC subroutine.

Anther series of tests is carried out which are almost identical to the ones described in the previous paragraph to determine if a family possesses more than one machine. The difference occurs when the IF statement tests if the number of machines possessed is greater than one (rather than equal to one). If test result is positive, then the program jumps to a competition area of code to determine which family gets the machine. The competition is discussed later.

A second test determines if there are entities in the queue whose family does not possess a machine in the department. Again this is the identical test as the two previous with a slight modification of the IF statement. If a family is found to have entities in queue, but no machine, then the program goes to the competition for the free machine.

A final test determines if a family that possesses the free machine does not have any entities in queue. This also follows the same methodology (with modifications in the IF statement) and a positive result leads to a competition for the free machine.

The competition is based on the machine allocation rules previously discussed in the "Sequencing and Machine Allocation Rules" section. The competition is carried out in stages. The first stage records the number of entities in the queue in an F# variable (where # is the family number) for the families that do not possess a machine. The machine is awarded to the family with the greatest F# value. For example, say families 2 and 4 do not posses a machine in department 1, and family 2 has one entity in queue, while family 4 has none. The F# values are as follows:

F2 = ARRAY(41,2) = 1

F4 = ARRAY(41,4) = 0

Note that the other families are not considered in the competition since they possess at least one machine. The free machine will be awarded to family 2 since it has the greatest F# value.

The competition is carried out using a series of IF statements which compare all F# values to determine the winner. The number of machines possessed by the winning family is then changed to reflect an increase of one machine. Also, the number of machines possessed by the family that gave up the machine is altered to reflect the loss. This is done using PUTARY statements to change the values of the appropriate arrays.

This completes the first stage of the competition, however it is possible that a winner was not selected. For example, if all the families of all entities in queue possess a machine, then the above test will not have a winner. The next stages are the identical tests, except the second stage tests families with only one machine, the third with two machines, etc. These stages will ensure that a machine is allocated to a family with the fewest machines and/or the greatest number in queue as stated in the machine allocation rules.

After the test are complete and the number of machines per family are modified, the machine resource is seized by the appropriate entity/family, the entity is removed from the queue and placed in ENTER 1 and the number of sub-batches processed is set to zero for the machine. The program then returns to SLAM.

Entities that arrive at ENTER 1 undergo assignments for the set-up indicating attribute [ATRIB(20)]. Next, EVENT 11 uses another part of the EVENT subroutine to set machine indicating arrays for the new entity that possesses it. The procedure is identical to the corresponding process shop model EVENT, except that the array numbers have changed (see Table 17).

The entities that emerge from EVENT 11 skip some SLAM code and arrive to EVENT 21 at node label P1. Recall, however, that some entities are routed to ENTER 11 from the ALLOC subroutine. The batches of these entities already possess a machine, so the set-up indicator ATRIB(20) is set to zero. Then the sub-batch entities are routed to EVENT 21 at P1.

EVENT 21 is responsible for modifying the number of family entities that are in the queue. The value is kept in the queue count array for the family of the entity that arrives at the event. Modifications are accomplished using GETARY and PUTARY functions.

A setup operation follows the event. The model coding for this operation is identical to the set-up from the process model. Sub-batch entities are then split into part entities at the UNBATCH 29 node. Part entities then wait in an AWAIT(11) queue for processing. The ALLOC(11) subroutine used by the AWAIT(11) node is identical to the one used in the process shop model. Entities that are removed from the queue from the subroutine are sent to ENTER 21. The processing activity with duration determined by the processing time attribute follows. Next, the EVENT 31 uses part of the EVENT subroutine to free the machine resource and set the idle/busy array to zero (idle). This is the same as the EVENT used in the process model. Part entities are then combined into sub-batches at the BATCH node. Next, EVENT 41 uses another part of the EVENT subroutine to count the sub-batches processed by a machine and frees a machine resource when the batch is complete. Again, this is the same as the EVENT used in the process model. The unloading operation activity follows, then the number of operations processed on the sub-batch is determined by adding one to ATRIB(10) at the ASSIGN node. Sub-batch entities are then routed to the next department using the same code that was used in the process shop.

Each department in the DCM model is identical to department 1 (previously described) except the values of the activities, attributes, arrays, files, resources, and variables change to reflect the department. For example when modeling department 4, the activity numbers used will be 4, 14, 24, 34, and 44. Modifications for other values occur likewise.

The sub-batch entities go to the shipping area of the model (node label SR) after completing processing at all work centers on the routing. An UNBATCH node splits the sub-batch entity into identical part entities, and then a BATCH node combines the newly formed part entities into a full batch entity of 100 parts. The entities are then moved to the shipping/receiving area [ACT/57 with move time based on ATRIB(27)]. The global variable XX(9) which counts the number of entities in the model at any given time (WIP) is reduced by one since one batch entity is leaving the system. Data is collected for Time in System measurements, then the entity leaves the network.

The model described is used for all levels of batch splitting/overlapping with a few minor modifications. Attributes 28 and 29 change to reflect the number of sub-batches per batch and the number of parts per sub-batch, respectively. Also, the initial values in arrays 21 through 28 represent the one plus number of sub-batches per batch. All other code is the same.

A slight modification in the resources is made to model the small shops. Each department has fewer machines in the smaller shop. This is the same as the process models (see Table 11). Also, the machine indicator arrays are altered to reflect fewer machines as shown in Table 18. This slightly modifies the subroutines. An example of a small process shop models (100% batch split) and the small shop subroutines are shown in Appendix F.

Table 18 - Array descriptions for the small dynamic cellular manufacturing (DCM) model.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	1-3	Machine indicators	Part # of last or current entity on machine
		4-6	Machine indicators	Part family of entity on machine
11-18	Department	1-3	Machine indicators	Entity # of last or current entity on machine
		4-6	Machine indicators	Indicates if machine is idle(0) or busy(1)
21-28	Department	1-3	Machine indicators	Number of sub-batches processed
31-38	Department	1-5	Family indicators	Number of sub-batches from families 1-5 in the queue
41-48	Department	1-5	Family indicators	Machine number possessed by families 1-5

5. MODEL VERIFICATION AND VALIDATION

Verification and validation procedures ensure that the simulation models function as intended, and that they are a fair representation of the actual system being modeled. Four steps are taken in the verification/validation process. First, in the model building/debugging process, the logic of the model is traced in step-by-step programming analysis. Also, while debugging, WRITE statements in the Fortran subroutines are used to verify (and correct when necessary) the values of the arrays, attributes, and variables. Write statements are also used after debugging is complete to verify that the correctness of the subroutine logic.

The second step is to run the models and generate output. The output is generated for all models and sizes with all levels of overlapping to perform the following functions:

1. Send one entity through the system.
2. Send 100 Entities through the system.
3. Run the model for 10,000 simulated minutes.

Sending one entity through the system verifies the initial conditions of the models. Also, the part routing logic is examined by comparing the activities/resources used with the predetermined part routings from Tables 2 and 4. Examination of the File Statistics for the AWAIT and QUEUE nodes also reveals how batches are split into sub-batches and part entities. Finally, the output verifies that the correct activities were used to represent plant operations such as moves, set-ups, and processes. The 100 entity and 10,000 minute models are used to verify that the appropriate mix is seen at the activities (especially the set-up activities), queues, and resources. Fortran subroutines with WRITE statements are used at the end of the 1 and 100 entity models to verify the array and variable values after entities have left the system. In addition, the 10,000-minute model indicated that there were no errors that would stop the model from reaching completion. An example of the output for a CM shop with 25% overlapping is shown in Appendix G.

The third verification step includes running and analyzing trace models. The size of the models and the limitations of the MONTR statement (which activates the trace) make tracing an entire model practically impossible. In addition, the large number of part entities that are generated for overlapping make tracing some areas of the model an unreasonable task (trace output for the small PROC shop with no batch splitting exceeds 80 pages when tracing only two departments). For these reasons, tracings are performed only on existing node labels, excluding those that create and combine *part* entities. Also, the trace is conducted for only two batch entities per model. The trace models verify that the order of travel for the entities is correct and that simulated time is elapsing between the various nodes. The part number is displayed throughout the trace for easier tracking through the trace output. Even though the trace shows how the entities travel through the models and the elapsed times, it does not show exactly which queues/activities/resources were used. However, this can be found using the Summary Report that comes with the trace output. Together, these reports verify that the model is functioning as described in the previous sections. A sample of the trace output from the PROC shop with 10% batch splitting is shown in Appendix H.

The final step in the verification/validation procedure occurs after all the data has been gathered and analyzed. The results are compared to the results of other studies to validate the model. This is shown in the *Validation Through Results* section later in this report.

6. ANALYSIS OF RESULTS

The simulation models are run for each shop configuration and size using the five levels of batch splitting previously discussed. Analyzing the results of these runs shows how batch splitting/overlapping effects each shop and how the shops compare to each other. The Time in System and WIP data from the simulation runs are shown in Tables 19 and 20, and samples of the simulation output are shown in Appendix I.

Table 19 - Time in System data from simulation runs.

		RUNS											
SHOP	O.L.	1	2	3	4	5	6	7	8	9	10	AVG	S
PROC	100	304	280	288	283	306	268	280	288	296	297	289.0	11.87
	50	168	167	171	172	164	168	168	165	169	182	169.4	5.04
	25	118	119	115	119	120	118	118	120	119	117	118.3	1.49
	10	97.1	93.3	92.5	89.6	93.3	92.2	90.1	94	94	89.5	92.6	2.36
	1	82	80.6	81.8	79.3	79.1	79.5	76.8	80.2	78.1	78.8	79.6	1.60
SMALL PROC	100	198	173	186	179	183	194	179	183	180	179	183.4	7.53
	50	111	107	110	109	110	110	111	111	113	112	110.4	1.65
	25	86.8	87.3	86.3	85.7	85.8	85.5	85	87.1	89.5	88.5	86.8	1.41
	10	74.5	73.9	76.4	72.8	76.1	74.3	73.1	74.5	74.9	73.9	74.4	1.15
	1	68	67.5	67	69.4	66.1	68.2	66.2	66.8	69.1	64.6	67.3	1.46
PRFAM	100	267	269	271	276	266	274	274	261	270	281	270.9	5.67
	50	163	165	167	166	165	164	164	165	166	164	164.9	1.20
	25	119	118	118	116	118	117	115	125	116	120	118.2	2.82
	10	93.6	95	91.7	91.4	93.6	101	93.9	93.5	91.9	93.4	93.9	2.73
	1	76.6	77.5	78.4	78.9	79.3	82.1	79.3	79.8	81.6	79.4	79.3	1.66
SMALL PRFAM	100	172	174	178	173	173	173	173	171	169	170	172.6	2.46
	50	115	110	111	117	111	111	115	110	114	112	112.6	2.46
	25	90.2	85.2	84.3	84.4	89.6	86.3	83.8	86.3	87.7	87.5	86.5	2.21
	10	73.2	71.2	73.8	77.1	73.3	76.2	72.7	76.7	73.7	75.5	74.3	1.93
	1	66.3	68.8	67.1	69	67.1	67.6	66.9	66.3	65.9	65	67.0	1.24
CM	100	288	311	289	295	317	293	295	285	305	283	296.1	11.36
	50	255	247	230	254	247	255	243	231	224	262	244.8	12.66
	25	226	226	225	215	212	225	233	216	232	237	224.7	8.22
	10	214	194	211	215	209	197	203	227	211	196	207.7	10.27
	1	195	214	198	186	217	215	200	206	211	207	204.9	10.00
SMALL CM	100	180	198	176	179	172	181	187	179	174	182	180.8	7.38
	50	145	153	149	150	158	159	154	155	156	159	153.8	4.64
	25	142	153	137	154	145	158	145	161	148	135	147.8	8.65
	10	135	135	143	142	137	147	137	145	133	138	139.2	4.73
	1	141	122	135	128	124	140	141	135	146	130	134.2	8.00
DCM	100	278	266	258	270	284	266	271	256	268	269	268.6	8.29
	50	177	161	160	161	161	162	165	166	158	158	162.9	5.59
	25	117	119	115	116	122	116	114	117	113	118	116.7	2.58
	10	94.7	92.3	89.1	91.1	93.2	90.2	90.7	93.2	94.1	90.5	91.9	1.86
	1	80.3	77	78.5	77.7	79	75.5	78.7	80.3	77.8	79.2	78.4	1.47
SMALL DCM	100	176	170	173	173	169	163	175	181	163	180	172.3	6.20
	50	107	111	107	110	108	111	113	109	108	111	109.5	2.01
	25	87	93	89.9	86.2	85.6	83.6	84.2	92.3	97.7	88.8	88.8	4.46
	10	72	72.7	79.1	72.6	85.1	78	74.3	76.4	90.7	73.6	77.5	6.14
	1	64.7	72.6	70.7	70.1	66.2	68.1	65.6	66.3	68	65.4	67.8	2.62

Table 20 - Work in Process data from simulation runs.

SHOP	O.L.	RUNS 1	2	3	4	5	6	7	8	9	10	AVG	S
PROC	100	37.383	37.101	34.164	35.954	38.748	33.796	36.777	34.979	38.422	32.874	36.020	2.0052
	50	21.766	20.655	22.757	19.328	20.825	21.577	19.713	21.038	22.833	22.765	21.326	1.2483
	25	14.614	15.550	14.154	14.527	13.833	14.855	15.513	15.041	15.027	15.520	14.863	0.5891
	10	12.892	11.743	12.152	10.920	11.469	10.775	12.074	11.667	10.994	12.118	11.680	0.6629
	1	10.848	10.098	9.565	9.891	10.622	10.823	9.857	10.221	10.133	9.383	10.144	0.5004
SMALL PROC	100	21.488	25.806	20.606	23.921	21.653	22.141	22.663	21.894	22.161	21.896	22.423	1.4614
	50	13.923	14.229	13.482	13.838	13.737	13.896	12.974	13.551	12.747	13.102	13.548	0.4737
	25	10.954	11.368	10.815	11.407	10.679	10.670	10.503	10.354	10.379	10.598	10.773	0.3718
	10	10.103	9.427	9.392	8.995	9.710	9.264	9.119	10.407	9.396	10.092	9.591	0.4694
	1	8.626	8.493	8.357	8.864	8.259	8.713	8.212	8.180	8.932	7.805	8.444	0.3490
PRFAM	100	33.179	32.993	34.006	34.673	32.278	34.438	35.317	30.417	34.588	35.704	33.759	1.5826
	50	21.201	20.987	21.061	20.805	20.525	20.174	20.858	21.337	20.596	20.083	20.763	0.4170
	25	15.517	14.328	14.799	14.293	14.543	14.669	14.154	16.628	14.132	15.084	14.815	0.7718
	10	12.106	12.699	11.500	11.050	11.615	13.212	12.385	11.950	11.811	11.279	11.961	0.6634
	1	9.305	9.367	9.786	9.994	10.117	10.444	10.112	10.142	10.385	10.028	9.968	0.3818
SMALL PRFAM	100	21.835	22.138	22.988	21.139	22.020	21.721	21.294	20.941	20.667	20.901	21.564	0.7110
	50	14.750	13.419	13.994	13.793	13.677	15.208	13.128	15.124	14.820	13.928	14.184	0.7355
	25	11.254	10.212	10.195	10.034	11.938	10.855	10.729	11.158	10.833	10.312	10.752	0.5918
	10	9.098	8.678	9.018	9.772	9.097	9.922	9.160	9.254	9.718	9.812	9.353	0.4201
	1	7.920	8.905	8.244	8.632	8.524	8.589	8.259	7.868	8.123	7.626	8.269	0.3975
CM	100	35.297	38.710	35.057	36.029	40.588	36.444	36.532	35.171	37.943	33.911	36.568	1.9960
	50	32.545	31.444	27.781	31.175	31.222	33.304	29.745	28.409	27.019	34.040	30.668	2.3714
	25	28.450	28.598	26.733	25.292	28.709	30.428	25.678	29.514	28.789	29.697	28.189	1.7232
	10	27.398	22.815	26.583	26.556	26.235	24.377	24.932	24.932	25.803	22.969	25.260	1.5445
	1	24.309	27.394	24.762	22.820	28.618	28.514	24.830	26.749	27.346	26.066	26.141	1.9198
SMALL CM	100	21.586	25.160	21.808	22.510	20.933	22.902	23.892	22.034	21.598	23.802	22.623	1.3132
	50	17.178	19.038	18.016	18.448	19.118	19.945	18.915	19.239	19.799	19.095	18.879	0.8210
	25	17.580	19.762	17.058	19.776	17.530	20.751	17.971	20.644	18.186	16.185	18.544	1.5801
	10	16.216	16.487	18.662	17.378	18.905	16.986	18.759	15.876	17.650	18.383	17.530	1.1202
	1	17.772	14.128	17.168	15.639	15.379	17.640	17.475	16.858	19.037	15.715	16.681	1.4450
DCM	100	35.773	33.804	31.312	33.576	36.062	33.399	34.564	30.838	32.884	33.438	33.565	1.6728
	50	22.092	19.053	19.869	19.565	20.377	20.007	20.414	21.327	21.574	19.123	20.340	1.0352
	25	15.112	14.386	13.778	15.137	13.571	15.196	15.044	13.632	14.823	14.835	14.551	0.6584
	10	12.153	11.143	9.676	11.721	10.709	11.385	11.865	10.906	11.676	12.232	11.347	0.7736
	1	12.232	12.062	9.870	9.345	9.319	9.629	9.920	9.695	9.588	10.360	10.202	1.0683
SMALL DCM	100	22.628	21.360	21.624	21.922	21.113	22.794	22.309	23.590	19.290	19.800	21.643	1.3292
	50	12.893	14.251	13.175	13.778	13.812	13.752	14.175	13.888	12.881	14.121	13.673	0.5113
	25	11.077	11.944	11.776	10.677	10.410	10.296	10.161	12.057	11.198	11.478	11.107	0.7009
	10	9.177	8.668	9.100	10.646	9.411	12.236	10.205	9.428	9.966	11.676	10.051	1.1633
	1	7.819	9.113	9.171	8.896	8.053	8.662	7.876	8.280	8.414	7.670	8.395	0.5474

6.1 THE EFFECTS OF BATCH SPLITTING/OVERLAPPING

The averages from the model runs are shown on the previous tables. They are presented graphically in Figures 1 through 4. These graphs, show that the averages of Time in System and Work in Process decrease as the level of batch splitting increases. Also, the graphs show that the CM shop has higher values of the performance measures at all levels of overlapping.

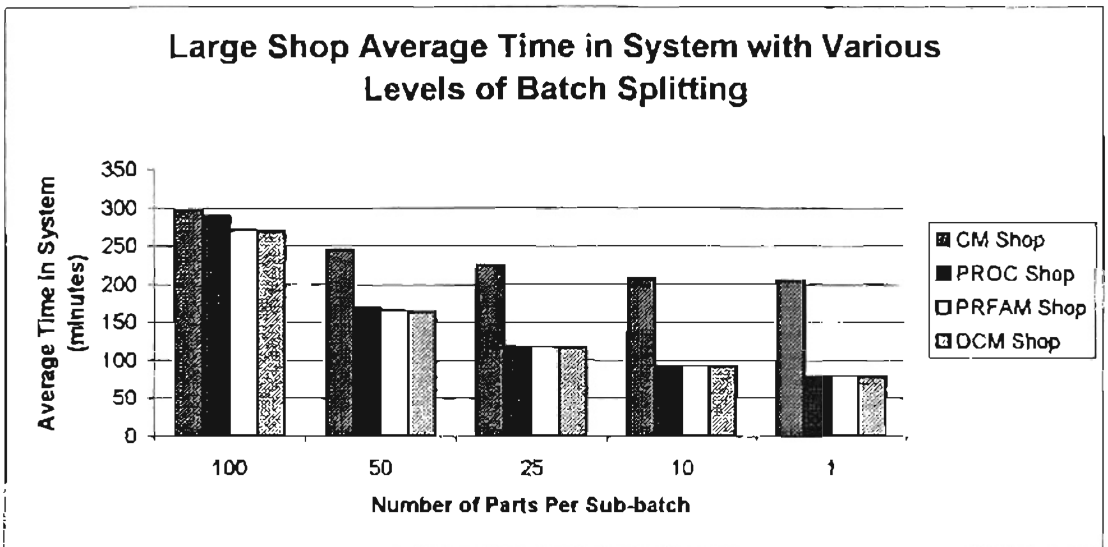

Figure 1 - Average time in system for large shops with different levels of batch splitting.

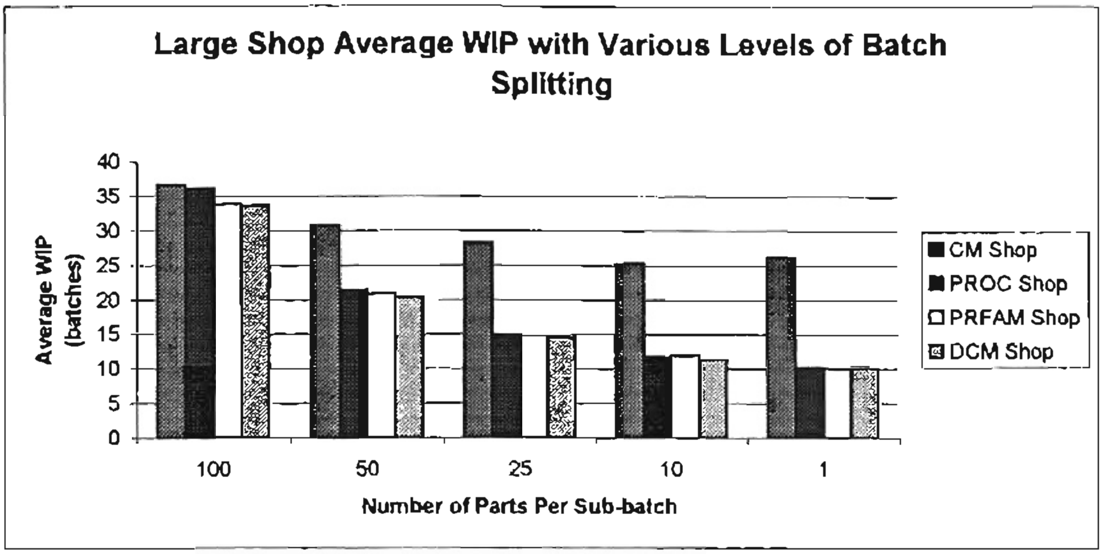

Figure 2 - Average work in process for large shops with different levels of batch splitting.

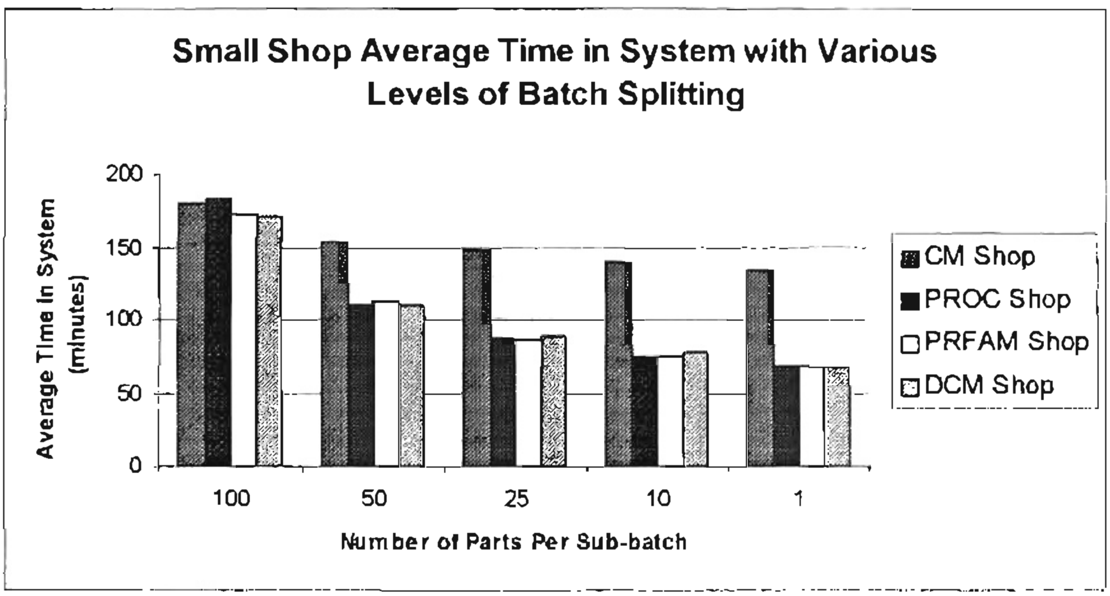

Figure 3 - Average time in system for small shops with different levels of batch splitting.

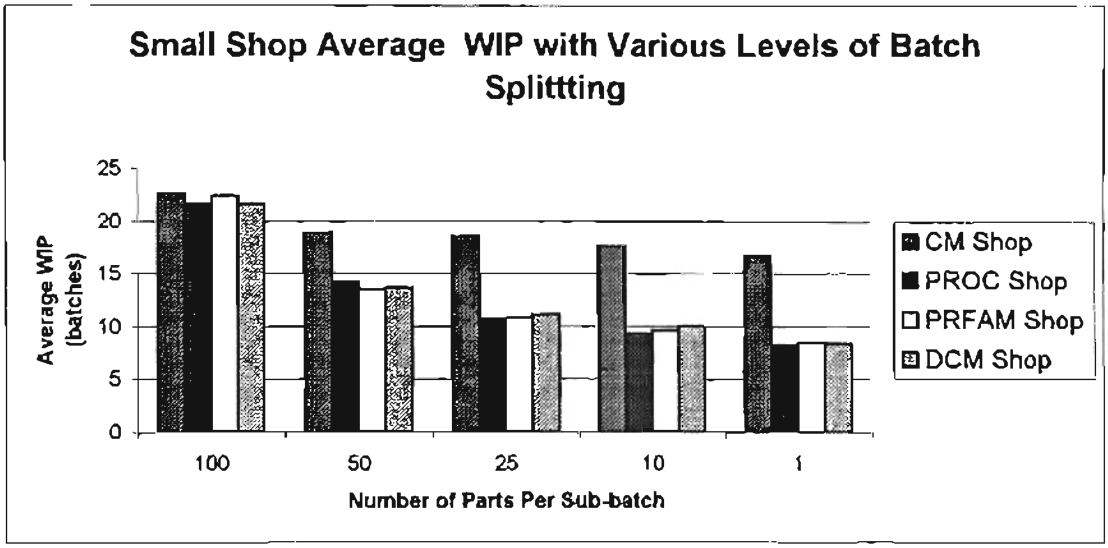

Figure 4 - Average work in process for small shops with different levels of batch splitting.

Analysis of variance (ANOVA) was also used to verify that batch splitting/overlapping effects the two performance measures. The batch splitting levels act as the treatment combinations in the analysis. The hypothesis being tested is as follows:

$$H_o: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$
$$H_A: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5$$

ANOVA yields a calculated F-value that is compared to the critical value for F. If the calculated F-value is greater than the critical F-value, then the null hypothesis (H_o) is rejected. This verifies with a specified level of confidence that the level of batch splitting/overlapping does in fact effect the value of the performance measure. The level of significance used is $\alpha = 0.05$, which yields a critical value for F = 2.5787. Microsoft Excel's ANOVA data analysis tool is used to perform all ANOVA calculations. ANOVA tables for all shops are shown in Tables 21 through 36.

Table 21 - ANOVA table for large PROC shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	289547	4	72386.74	2049.068	2.86E-50	2.578737
Within Groups (error)	1589.7	45	35.32667			
Total	291136.7	49				

Table 22 - ANOVA table for large PROC shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	4440.106	4	1110.026	838.9054	1.27E-41	2.578737
Within Groups (error)	59.54329	45	1.323184			
Total	4499.649	49				

Table 23 - ANOVA table for large PRFAM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	238931.1	4	59732.79	5773.279	2.35E-60	2.578737
Within Groups (error)	465.589	45	10.34642			
Total	239396.7	49				

Table 24 - ANOVA table for large PRFAM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	3668.001	4	917.0003	1187.877	5.54E-45	2.578737
Within Groups (error)	34.73845	45	0.771965			
Total	3702.739	49				

Table 25 - ANOVA table for large CM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	55845.92	4	13961.48	124.0751	1.07E-23	2.578737
Within Groups (error)	5063.6	45	112.5244			
Total	60909.52	49				

Table 26 - ANOVA table for large CM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	822.1488	4	205.5372	55.10931	8.96E-17	2.578737
Within Groups (error)	167.8332	45	3.729628			
Total	989.982	49				

Table 27 - ANOVA table for large DCM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	236439.4	4	59109.86	2633.793	1.04E-52	2.578737
Within Groups (error)	1009.929	45	22.44287			
Total	237449.4	49				

Table 28 - ANOVA table for large DCM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	3647.147	4	911.7867	754.3881	1.33E-40	2.578737
Within Groups (error)	54.38898	45	1.208644			
Total	3701.536	49				

Table 29 - ANOVA table for small PROC shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	88632.61	4	22158.15	1707.807	1.68E-48	2.578737
Within Groups (error)	583.858	45	12.97462			
Total	89216.46	49				

Table 30 - ANOVA table for small PROC shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	1264.232	4	316.0579	556.369	1.12E-37	2.578737
Within Groups (error)	25.56326	45	0.568072			
Total	1289.795	49				

Table 31 - ANOVA table for small PRFAM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	73242.32	4	18310.58	4114.018	4.71E-57	2.578737
Within Groups (error)	200.285	45	4.450778			
Total	73442.6	49				

Table 32 - ANOVA table for small PRFAM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	1153.342	4	288.3355	832.7704	1.49E-41	2.578737
Within Groups (error)	15.58064	45	0.346236			
Total	1168.923	49				

Table 33 - ANOVA table for small CM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	13274.72	4	3318.68	69.98154	9.8E-19	2.578737
Within Groups (error)	2134	45	47.42222			
Total	15408.72	49				

Table 34 - ANOVA table for small CM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	207.7204	4	51.93011	31.51873	1.57E-12	2.578737
Within Groups (error)	74.14178	45	1.647595			
Total	281.8622	49				

Table 35 - ANOVA table for small DCM shop with time in system as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	69393.4	4	17348.35	811.5411	2.64E-41	2.578737
Within Groups (error)	961.967	45	21.37704			
Total	70355.37	49				

Table 36 - ANOVA table for small DCM shop with work in process as performance measure.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups (treatments)	1086.296	4	271.5739	325.4398	1.4E-32	2.578737
Within Groups (error)	37.55172	45	0.834483			
Total	1123.847	49				

As shown on the ANOVA Tables, all calculated F-values are greater than the critical F-value. Therefore, the null hypothesis is rejected and it can be said with 95% confidence that batch splitting and overlapping do have an effect on the average time in system and work in process for all shop configurations and sizes in this experiment.

6.2 SHOP COMPARISONS

The shop configurations are compared based on average time in system and average work in process. First, the shops are compared using the graphs is Figures 1 through 4. Confidence intervals (95%) are then used to make comparisons. The following equation is used to calculate the intervals:

Lower C.I. Limit = $\bar{x} - t_{\alpha/2} \cdot s / n^{1/2}$

Upper C.I. Limit = $\bar{x} + t_{\alpha/2} \cdot s / n^{1/2}$

where

$\bar{x}$ = the grand average of the performance measure.

α = .05 (for a 1 - α) confidence interval.

s = the sample standard deviation of the performance measure.

n = the number of observations (10).

$t_{\alpha/2}$ = value from a t-distribution table (2.262)

The upper and lower confidence interval values are shown in Tables 37 through 40.

Table 37 - 95% confidence interval limits for time in system in large shops.

SHOP	# OF PARTS PER SUB-BATCH	AVG	s	95% CONFIDENCE INTERVAL LOWER C.I. LIMIT	UPPER C.I. LIMIT
PROC	100	289.0	11.87	280.510	297.490
	50	169.4	5.04	165.797	173.003
	25	118.3	1.49	117.231	119.369
	10	92.6	2.36	90.871	94.249
	1	79.6	1.60	78.476	80.764
PRFAM	100	270.9	5.67	266.847	274.953
	50	164.9	1.20	164.044	165.756
	25	118.2	2.82	116.182	120.218
	10	93.9	2.73	91.944	95.856
	1	79.3	1.66	78.100	80.480
CM	100	296.1	11.36	287.976	304.224
	50	244.8	12.66	235.741	253.859
	25	224.7	8.22	218.820	230.580
	10	207.7	10.27	200.351	215.049
	1	204.9	10.00	197.743	212.057
DCM	100	268.6	8.29	262.671	274.529
	50	162.9	5.59	158.904	166.896
	25	116.7	2.58	114.852	118.548
	10	91.9	1.86	90.583	93.237
	1	78.4	1.47	77.346	79.454

Table 38 - 95% confidence interval limits for work in process in large shops.

SHOP	# OF PARTS PER SUB-BATCH	AVG	s	95% CONFIDENCE INTERVAL	
				LOWER C.I. LIMIT	UPPER C.I. LIMIT
PROC	100	36.020	2.0052	34.585	37.454
	50	21.326	1.2483	20.433	22.219
	25	14.863	0.5891	14.442	15.285
	10	11.680	0.6629	11.206	12.155
	1	10.144	0.5004	9.786	10.502
PRFAM	100	33.759	1.5826	32.627	34.891
	50	20.763	0.4170	20.464	21.061
	25	14.815	0.7718	14.263	15.367
	10	11.961	0.6634	11.486	12.435
	1	9.968	0.3818	9.695	10.241
CM	100	36.568	1.9960	35.140	37.996
	50	30.668	2.3714	28.972	32.365
	25	28.189	1.7232	26.956	29.421
	10	25.260	1.5445	24.155	26.365
	1	26.141	1.9198	24.768	27.514
DCM	100	33.565	1.6728	32.368	34.762
	50	20.340	1.0352	19.600	21.081
	25	14.551	0.6584	14.080	15.022
	10	11.347	0.7736	10.793	11.900
	1	10.202	1.0683	9.438	10.966

Table 39 - 95% confidence interval limits for time in system in small shops.

SHOP	# OF PARTS PER SUB-BATCH	AVG	s	95% CONFIDENCE INTERVAL LOWER C.I. LIMIT	UPPER C.I. LIMIT
SMALL PROC	100	183.4	7.53	178.013	188.787
	50	110.4	1.65	109.222	111.578
	25	86.8	1.41	85.742	87.758
	10	74.4	1.15	73.617	75.263
	1	67.3	1.46	66.243	68.337
SMALL PRFAM	100	172.6	2.46	170.841	174.359
	50	112.6	2.46	110.841	114.359
	25	86.5	2.21	84.948	88.112
	10	74.3	1.93	72.957	75.723
	1	67.0	1.24	66.114	67.886
SMALL CM	100	180.8	7.38	175.524	186.076
	50	153.8	4.64	150.482	157.118
	25	147.8	8.65	141.612	153.988
	10	139.2	4.73	135.815	142.585
	1	134.2	8.00	128.480	139.920
SMALL DCM	100	172.3	6.20	167.864	176.736
	50	109.5	2.01	108.059	110.941
	25	88.8	4.46	85.642	92.018
	10	77.5	6.14	73.062	81.838
	1	67.8	2.62	65.894	69.646

Table 40 - 95% confidence interval limits for work in process in small shops.

SHOP	# OF PARTS PER SUB-BATCH	AVG	s	95% CONFIDENCE INTERVAL LOWER C.I. LIMIT	UPPER C.I. LIMIT
SMALL PROC	100	22.423	1.4614	21.378	23.468
	50	13.548	0.4737	13.209	13.887
	25	10.773	0.3718	10.507	11.039
	10	9.591	0.4694	9.255	9.926
	1	8.444	0.3490	8.194	8.694
SMALL PRFAM	100	21.564	0.7110	21.056	22.073
	50	14.184	0.7355	13.658	14.710
	25	10.752	0.5918	10.329	11.175
	10	9.353	0.4201	9.052	9.653
	1	8.269	0.3975	7.985	8.553
SMALL CM	100	22.623	1.3132	21.683	23.562
	50	18.879	0.8210	18.292	19.466
	25	18.544	1.5801	17.414	19.675
	10	17.530	1.1202	16.729	18.331
	1	16.681	1.4450	15.647	17.715
SMALL DCM	100	21.643	1.3292	20.692	22.594
	50	13.673	0.5113	13.307	14.038
	25	11.107	0.7009	10.606	11.609
	10	10.051	1.1633	9.219	10.883
	1	8.395	0.5474	8.004	8.787

The graphs (Figures 1 through 4) showing time in system performance for the large shop indicates that with no overlapping, DCM and PRFAM shops perform the best followed by the PROC shop and then the CM shop. When batch splitting/overlapping is introduced, the time in system performance improves for all shop configurations, however the PROC, PRFAM, and DCM shops benefit to a much higher degree than the CM shop. The graph also indicates that as the level of batch splitting increases, the difference in performance between the PROC, PRFAM, and DCM shops becomes less apparent, while the difference between the CM and other shops increases. Finally, the graph shows that overlapping in a CM configuration (which is conducive to overlapping) does indeed outperform the other three configurations (which are not conducive to overlapping) with no overlapping. However, the CM configuration with total overlapping (where the CM shop yields its best results) does not outperform any of the other configurations when overlapping is utilized. These statements are echoed when discussing the WIP performance for the large shops.

The graphs displaying the small shops' time in system performance is similar to the large shops' with one exception. The CM configuration appears to outperform the PROC configuration when no overlapping is used. The WIP performance for the small shops is also slightly different than the large. With no overlapping, the PROC and DCM configurations outperform the other two, though all values appear close together. Besides these differences, the small shop results mirror those of the large shops.

The confidence intervals shown previously are used to statistically verify the statements made by analyzing the graphs. If the intervals do not overlap, then it can be said with 95% confidence that the two averages are not equal, and that one is superior to another. If the intervals do overlap, then it is not statistically sound to state that the averages are different within the level of confidence.

Using the confidence intervals shown previously, the following conclusions are drawn for the large shops using the time in system measurements:

1. With no overlapping, The DCM and PRFAM configurations have lower average values than the CM and PROC shops. At this level, there is no statistical difference between the DCM and PRFAM configurations. The same is true for the CM and PROC shops.

2. With 50% batch splitting, the DCM and PRFAM shops are not statistically different. Also, the DCM and PROC configurations are statistically equal. All three of these shops outperform the CM configuration at this level of batch splitting.

3. With 25% batch splitting, the DCM, PROC, and PRFAM configurations are statistically equal, and they all outperform the CM configuration.

4. The 10% and 1% batch splitting levels had the same results as the 25% level.

5. The CM shops with 50%, 25%, 10%, and 1% batch splitting are superior to all other shops with *no* overlapping. This is the only condition where the CM shop outperforms any of the other configurations. This is significant since CM configuration is more conducive to overlapping than the other shops.

When considering WIP as the performance measure and *all* levels of overlapping, the shops compare the same as the 25% batch splitting level using time in system at the performance measure. Also, the CM configuration with 50%, 25%, 10%, and 1% batch splitting is superior to the all other shops with *no* overlapping, just like when the time in system measure is used.

The small configurations are also compared using confidence intervals. The comparisons are as follows:

1. With no overlapping, The PRFAM and DCM shops are statistically identical. The DCM and CM confidence intervals also overlap, however, the PRFAM time in system performance is superior to the CM performance. Also, the CM

and PROC performances are the same, but the DCM shop outperforms the PROC configuration.

2. With 50%, 25%, 10%, and 1% batch splitting, the PROC, PRFAM, and DCM configurations all have the same statistical performance which is superior to the CM shop performance.
3. As with the larger shop, the CM shops with 50%, 25%, 10%, and 1% batch splitting are superior to all other shops with *no* overlapping. This is the only case where the CM configuration shows superior performance.

When WIP is examined for the small shops, there is no statistical difference in the performance of any shop when there is no overlapping. At all other levels of batch splitting, the PROC, PRFAM, and DCM shop performances are statistically equal and superior to the CM configuration performance.

7. MODEL VERIFICATION THROUGH RESULTS

The results of the experiments are used to further validate the models. They are compared to results from other research in the literature review that ran some of the same experiments. Not only does this validate this model, but it supports the other research.

Several simulation-based studies dispute the claim that CM configurations outperform process shops when overlapping is not used (Mahmoodi, Dooley, and Starr, 1990; Flynn, 1987; Flynn and Jacobs, 1987; Morris and Tersine, 1990). This research is consistent with these studies, since it shows with 95% confidence that the CM model does not outperform the PROC shop (the "pure" process shop) and the PRFAM shop (that considers family relationships when sequencing jobs) for both WIP and Time in System when comparing large shops (as was compared in the other experiments). In fact, all cases show that the average Time in System and WIP measures are superior (though not statistically) in the large process (PROC and PRFAM) models.

Other studies examining dynamic cellular manufacturing determined that it was superior to the process and CM configurations when no overlapping was utilized in a shop similar to the large shop used in this study (Kannan and Ghosh 1995, and 1996; Kannan, 1997). Again, the results of this research show that the DCM shop outperforms the PROC (which is similar to the process shop used in Kannan and Ghosh's experiments) and CM configurations when using the Time in System measure and 95% confidence. When using WIP, the average value for DCM is less the averages of the CM and PROC models (though not statistically significant for PROC). These results are consistent with the Kannan and Ghosh studies.

Finally, a Shafer and Charnes study (1993) shows that a CM shop configuration which utilizes 1% batch splitting (the batch is split into 100 sub-batches of one entity) and operations overlapping is superior to a process shop with family considerations (similar to the PRFAM model) and no overlapping. That study is supported by this research with results showing that the CM shop with 1% batch splitting does outperform the PRFAM shop (with 95% confidence) when they do not implement any overlapping.

8. CONCLUSIONS

Several conclusions are drawn from the results of this research and previous studies. First, splitting batches to allow for operations overlapping should be considered in process, cellular, and dynamic cellular shop configurations when designing systems. This and other research (Jacobs and Bragg, 1988; Shafer and Charnes, 1993) has shown that introducing overlapping into the manufacturing system is beneficial. Though total overlapping may be impractical in many cases (especially with process and DCM shops), this study shows that performance can improve if a batch is only split in half. Batch splitting should be considered to the degree that an organization's material handling allows.

If the amount/cost of material handling negates any possibility of batch splitting, in process or DCM configuration, then a CM shop is a competitive alternative. The unidirectional flow and closeness of machines allow for easy "handoff" of parts from one work center to the next. This makes the CM configuration more conducive to overlapping. This study, shows that a CM shop with any level of batch splitting/overlapping outperforms the other two configurations with no batch splitting. The Shafer and Charnes study (1993) also shows that a CM shop with total overlapping is superior to a process configuration with no overlapping.

Finally, this study verifies that family consideration in sequencing can benefit a manufacturing configuration when no overlapping is utilized. Other studies have shown that creating virtual cells in a DCM configuration can yield results that are superior to a process and cellular configuration (Kannan and Ghosh, 1995 and 1996; Kannan, 1997). This study also shows that a simpler process configuration that does not make a clear effort to form virtual cells, but does attempt to utilize family similarities in sequencing can be as beneficial as a DCM shop. However, as stated before, the "line" that divides a DCM shop and a process shop that takes advantage of family similarities in sequencing is vague at best. Therefore further research which models process shop configurations should be clear on the sequencing rules used, and should provide background information of the effects of using family based rules.

When overlapping is utilized, family consideration (in both the DCM and PRFAM models) did not yield a statistical benefit. The average values of the performance measures for the PRFAM and DCM shops were better than the PROC shop with 50% batch splitting, though there was not a statistical difference. Also, the noticeable (graphical) difference between the DCM, PRFAM, and PROC shops diminished as the batches were split into smaller sub-batches.

The previous conclusions hold true for both shop sizes, except that family considerations did not yield an improvement in the WIP performance in small shops with no overlapping. Also, the statements are true when considering both time in system and WIP as performance measures. Finally, these conclusions are only valid for the conditions of the models.

To summarize, this research has demonstrated the following:

- Batch splitting/operations overlapping to any degree improves time in system and WIP performance in process, CM, or DCM configurations.
- CM configurations that utilize batch splitting/operations overlapping to any degree outperforms the process and DCM shops that do not utilize overlapping.

- When there is no batch splitting, process shop *layouts* (including DCM configurations) that consider family similarities in sequencing outperform process shops that do not take advantage of family similarities.
- When overlapping is utilized, family consideration in process *layouts* do not outperform process configurations that do not consider family similarities.

For the practitioner, the primary lesson that can be gained from this study is that batch splitting and operations overlapping can provide significant benefit for improving shop performance (lower average WIP and average time in system). When designing or redesigning a production system, batch splitting should be considered to the degree that material handling resources allow. If material handling resources allow for batch splitting, then a process layout (with or without family consideration) will outperform a CM layout. If MH resources are scarce, or if batch splitting in a process type layout is impossible, then a cellular manufacturing layout (which is more conducive to batch splitting/overlapping) with batch splitting to any degree is better than any layout with no batch splitting. Even if the batch is only split in half, performance could still improve.

9. IDEAS FOR FUTURE RESEARCH

This study can be expanded in many ways in future studies. The most obvious areas of study stem from the model's limitations and assumptions. First, the assumption that material handling resources are unlimited is unrealistic, although it allowed the results to be based on shop configuration and overlapping alone. Reasonable levels of material handling equipment may render more realistic results. Also, altering the demand level, product mix and batch size could show how overlapping effects shops under different conditions. Additional variation in the processing, set-up, and move times, as well as batch size could also yield valuable results. Finally, the effects of overlapping could be studied using other types of layouts. Currently, the performances of two emerging configurations, fractal and holonic, are being studied and compared to process and CM shop configurations. Complete results for these approaches are still emerging, however initial results[1] suggest that additional research is warranted. Batch splitting and overlapping could prove beneficial to these layouts as well.

[1] INFORMS Conference, October 26 to 29, 1997, "A Comparison of Process, Fractal, and Holonic Layout Strategies," R.G. Askins, F.W. Ciarallo, N. Lundgren, University of Arizona.

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APPENDIX A

Calculations for the Mean and Standard Deviation of Individual Part Processing Times

A.1 MEAN PROCESSING TIME FOR INDIVIDUAL PARTS

x_i = processing time for an individual part   Batch size = 100 parts

Mean processing time for a batch = $E[\Sigma x_i] = 34.33$ minutes

$E[\Sigma x_i] = 100 * E[x_i]$

$34.33 = 100 * E[x_i]$

$E[x_i]$ = **.3433 minute per part = μ**

A.2 STANDARD DEVIATION OF PROCESSING TIMES FOR INDIVIDUAL PARTS

Standard deviation of the processing times is 25% of the average processing time.

$\sigma = .25(.3433) =$ **.0858**

APPENDIX B

SHOP LAYOUTS

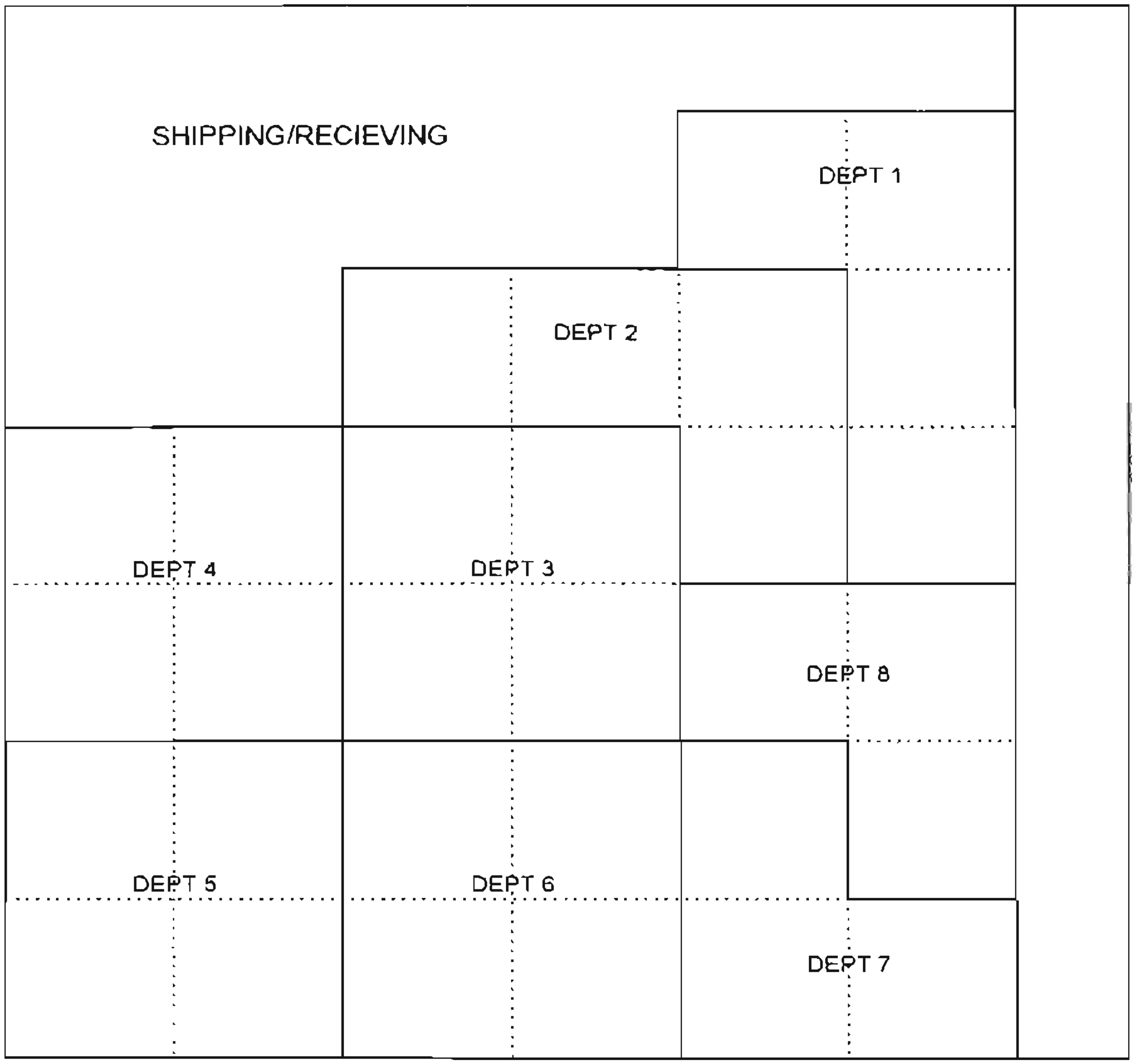


FIGURE 5 - Large process and DCM shop.

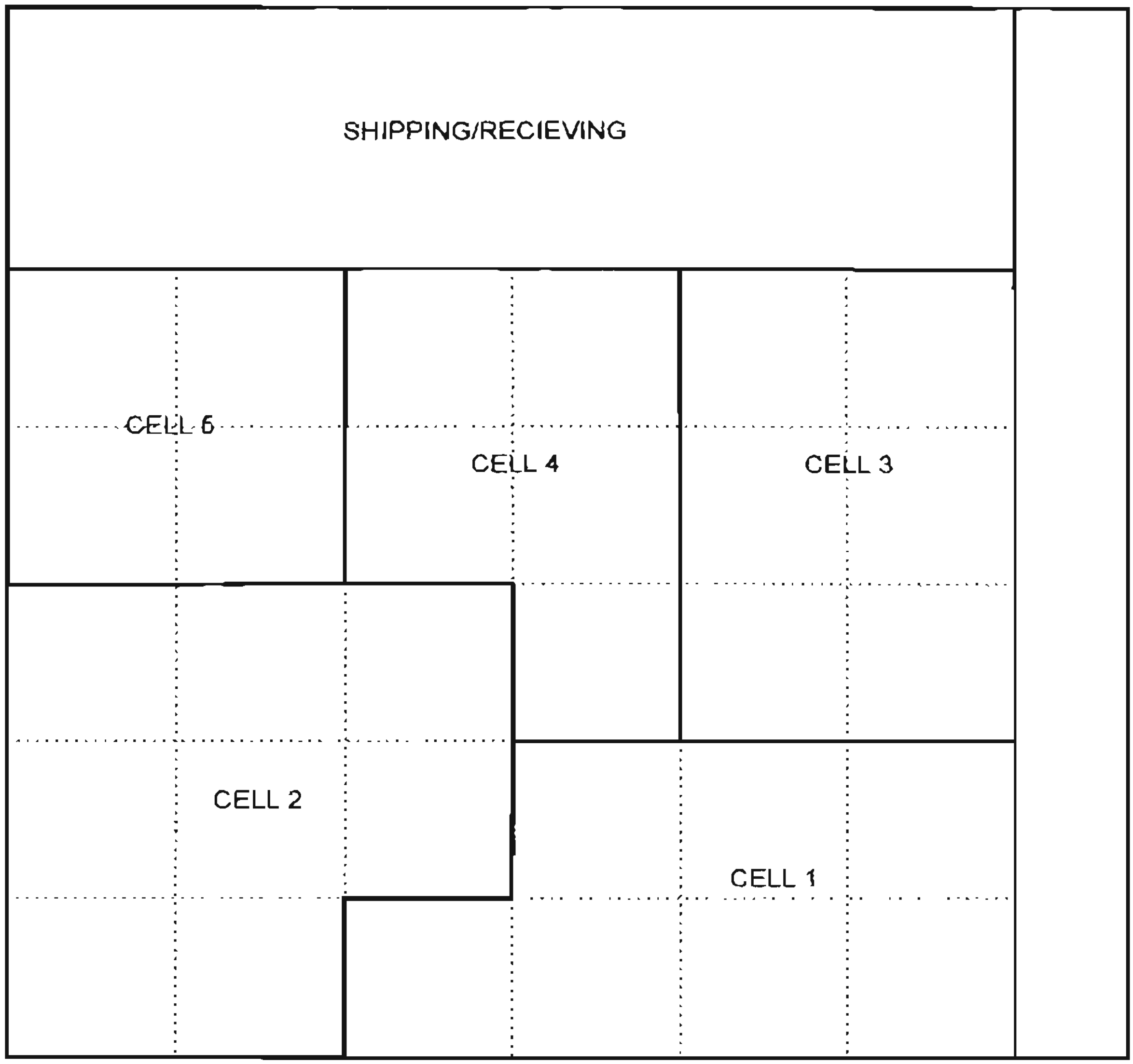


FIGURE 6 - Large CM shop.

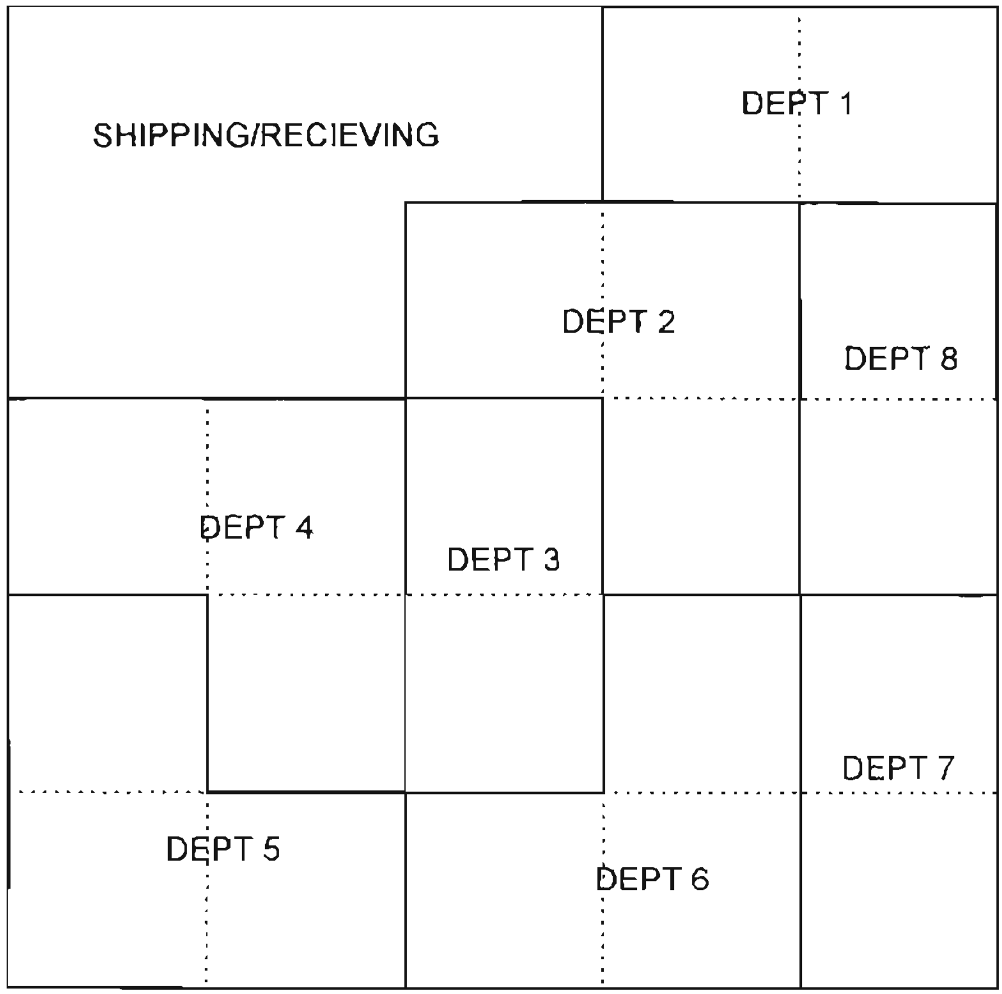


FIGURE 7 - Small process and DCM shop.

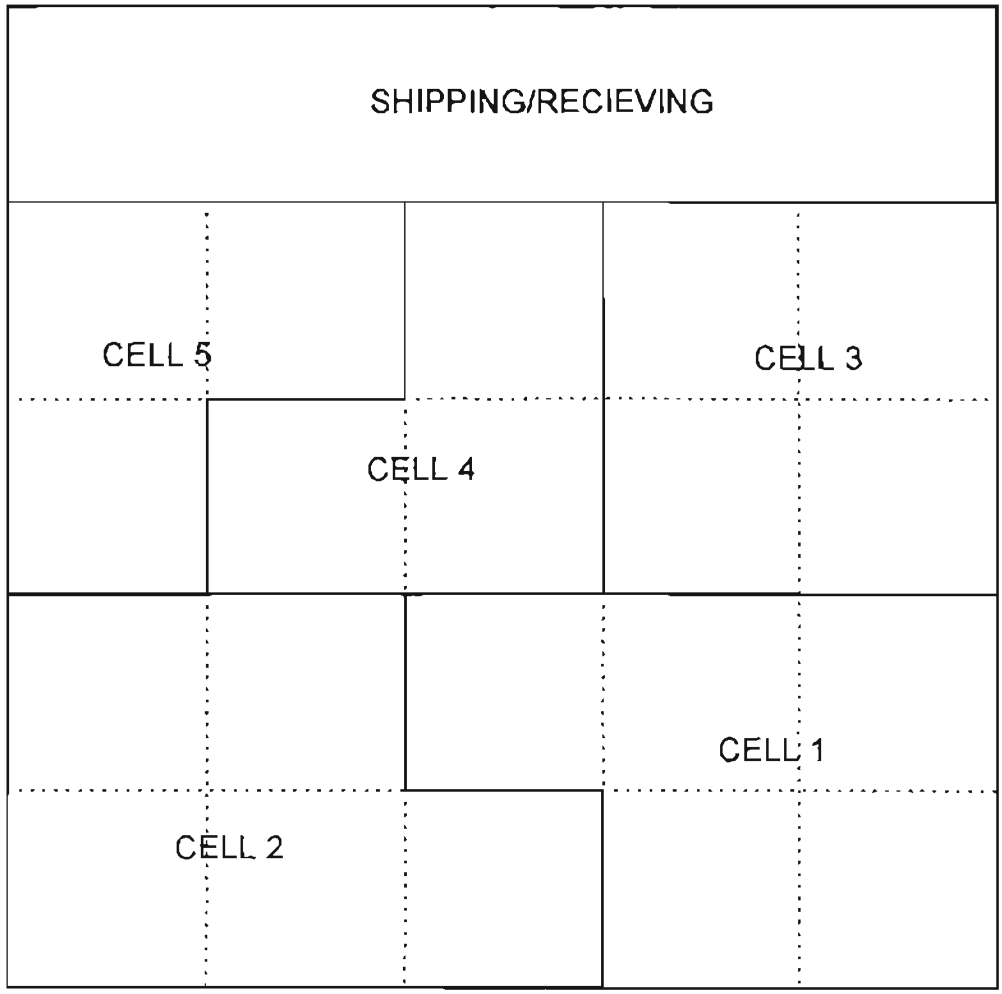


FIGURE 8 - Small CM shop.

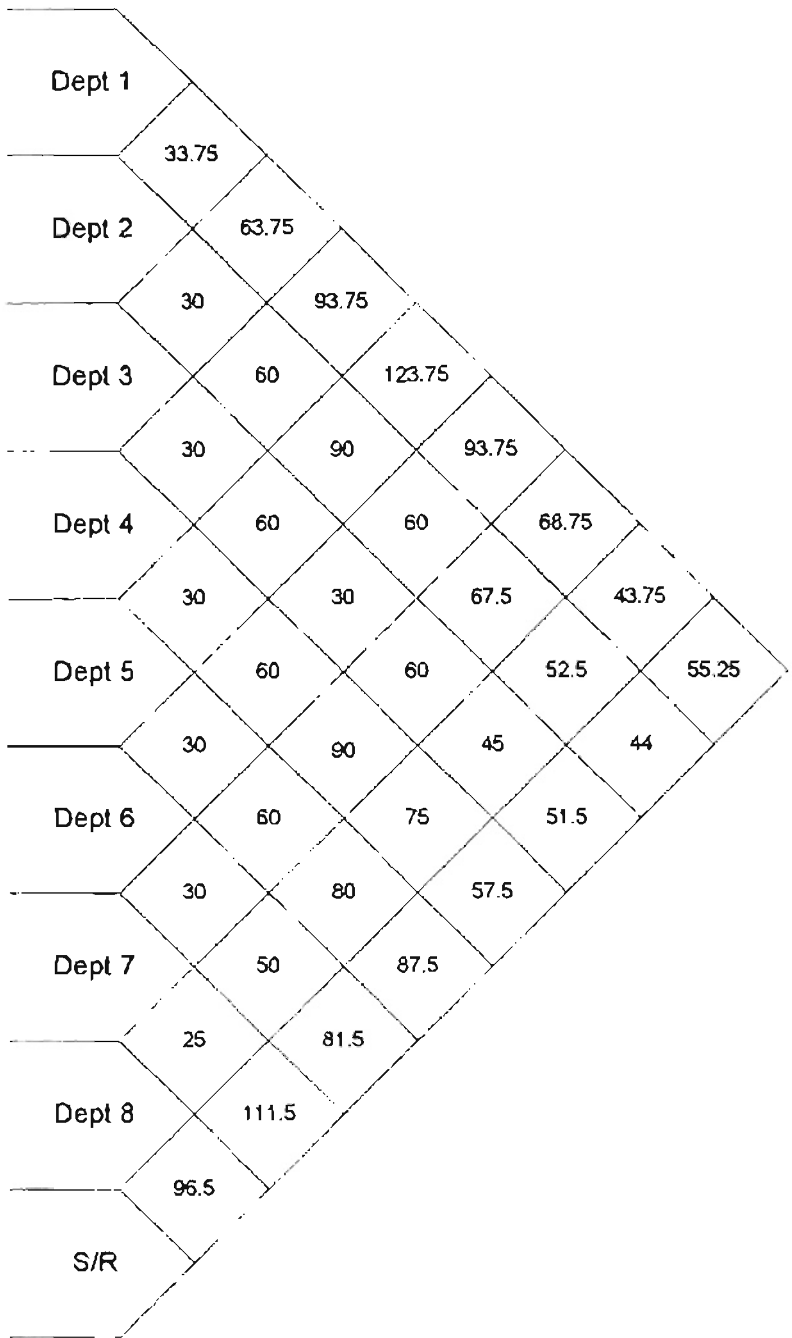


FIGURE 9 – Large process shop distance between departments.

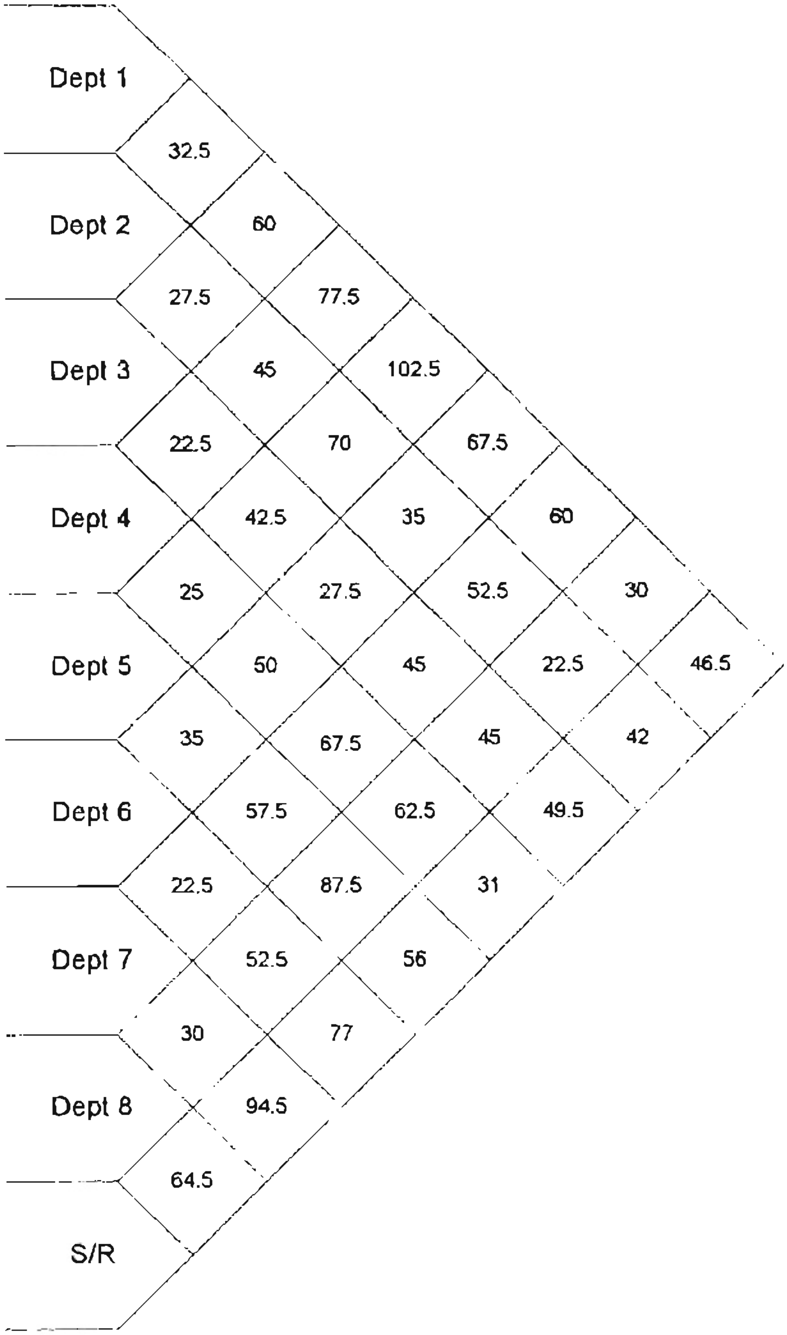


FIGURE 10 – Small process shop distance between departments.

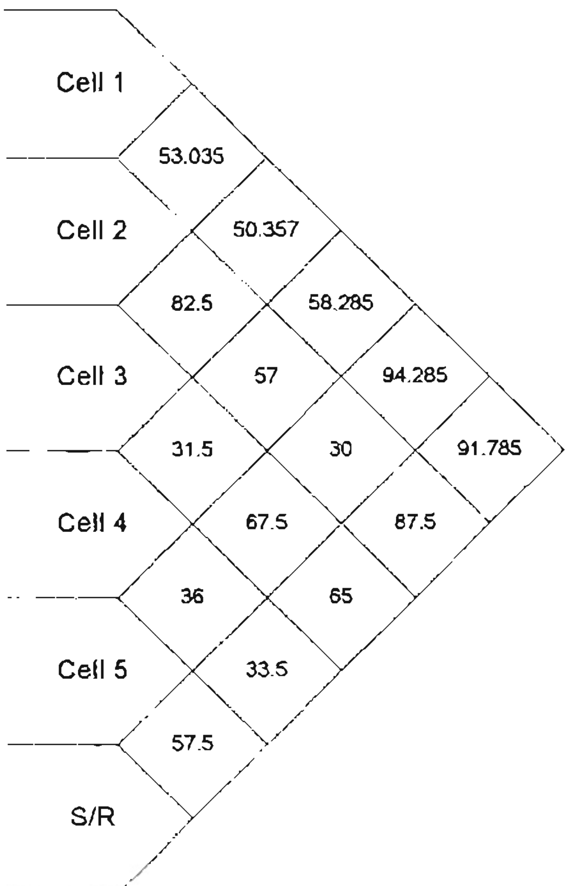


FIGURE 11 – Large CM shop distances between cells.

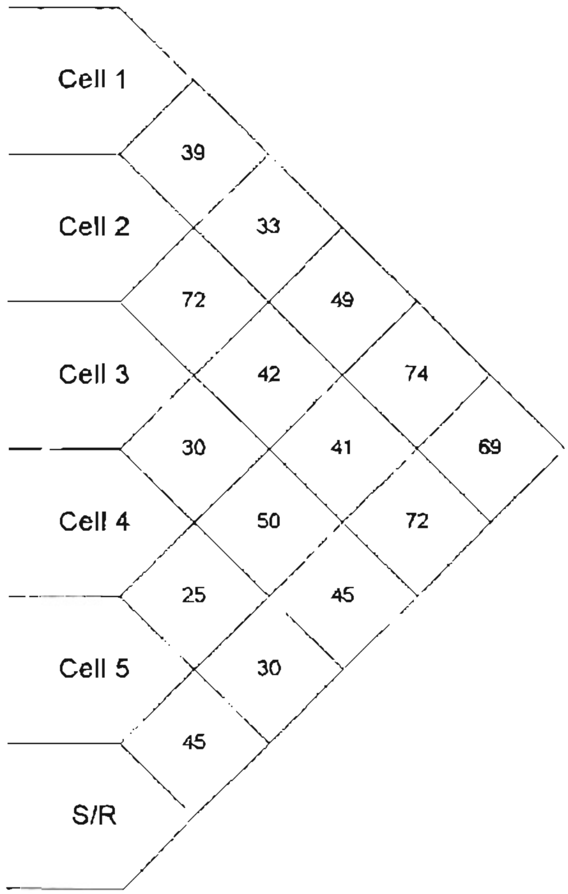


FIGURE 12 – Small CM shop distances between cells.

APPENDIX C

WARM-UP TIME DETERIMINATION

The warm-up periods are determined using Welch's procedure as described in Law and Kelton (1991). This procedure determines steady state based on the plot of a performance measure vs. time curve. When the curve "flattens", the model is said to be at steady state.

The example used in this appendix if from the large DCM shop with no batch splitting/overlapping. The first step is to gather output from n replications of the simulation [Law and Kelton (1991) suggest using $n \geq 5$. Five replications were used in this experiment.]. The run length is set at 30,000. The average for each data reading i is calculated and the plotted (data was collected every 30 minutes). The data from the five replications is shown in Table 42 (the table only shows 250 of 1000 data points to conserve space) at the end of this Appendix, and the plot of average time in system vs. time is shown in Figure 17.

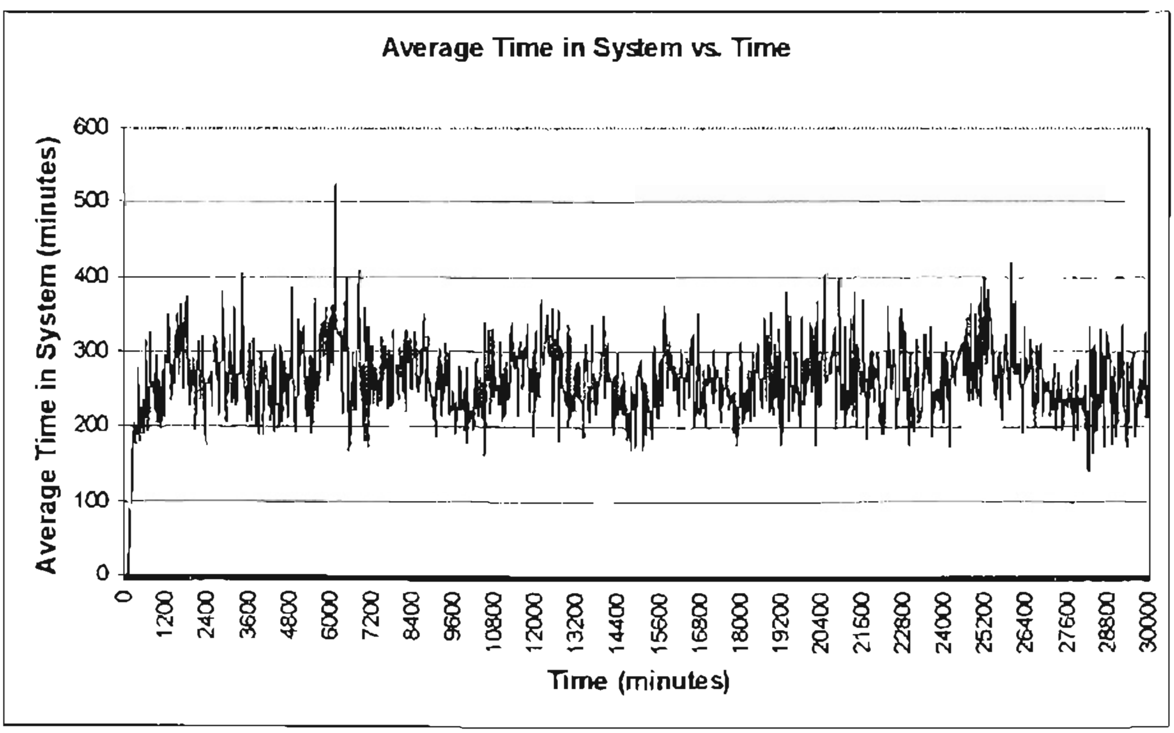


Figure 13 - Warm-up analysis plot of Average Time in System vs. time for the DCM shop with no overlapping.

Since the average time in system is extremely variable over time, moving averages are calculated and plotted to smooth the curve. The moving averages are calculated as follows:

$$\bar{Y}_i(w) = \begin{cases} \dfrac{\sum_{s=-w}^{w} Y_{i+s}}{2w+1} & \text{if } i = w+1, \ldots, m-w \\[2ex] \dfrac{\sum_{s=-(i-1)}^{w} Y_{i+s}}{2i+1} & \text{if } i = 1, \ldots, w \end{cases}$$

Where

$Y_i(w)$ = the moving average.
i = the data observation.
w = the window of observations used for the moving average.
m = the number of observations.

The moving averages were calculated using a spreadsheet for window (w) sized at 5, 20, 50, 100, 150, and 200 data points. The results are shown in Table 42 (which shows only the first 250 if 1000 records to conserve space) at the end of this Appendix. Plotting this data shows that the curves flatten considerably as the window increases (see Figures 18 through 23). The w=200 plot (Figure 23) shows that the moving average remains steady after about 7000 minutes. For safety, a more conservative value was selected on the plot (16,500minutes) as the time that the model reaches steady state. The same procedure is followed using WIP as the performance measure, which yields a steady state time of 21,000 minutes. The critical steady state time value is the larger of the values from Time in System and WIP measurements. In this case, 21,000 minutes is used. An additional

10,00 minutes is added as an additional safety factor to give the minimum warm-up period of **26,500** minutes.

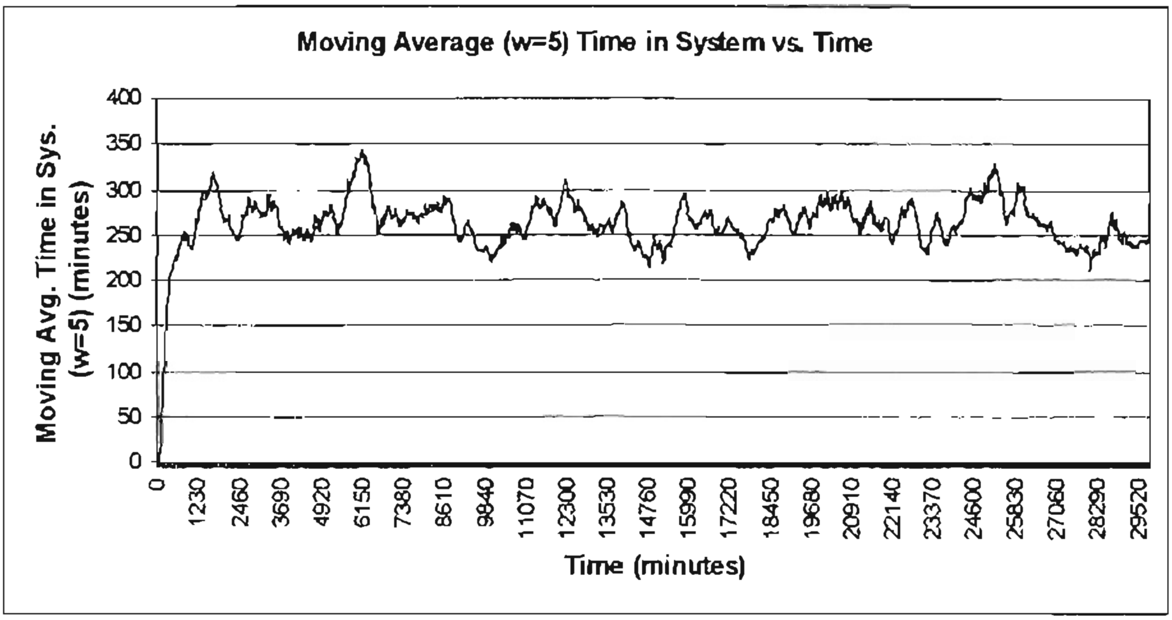


Figure 18 - Warm-up analysis plot of Moving Average Time in System (w=5) vs. time for the DCM shop with no overlapping.

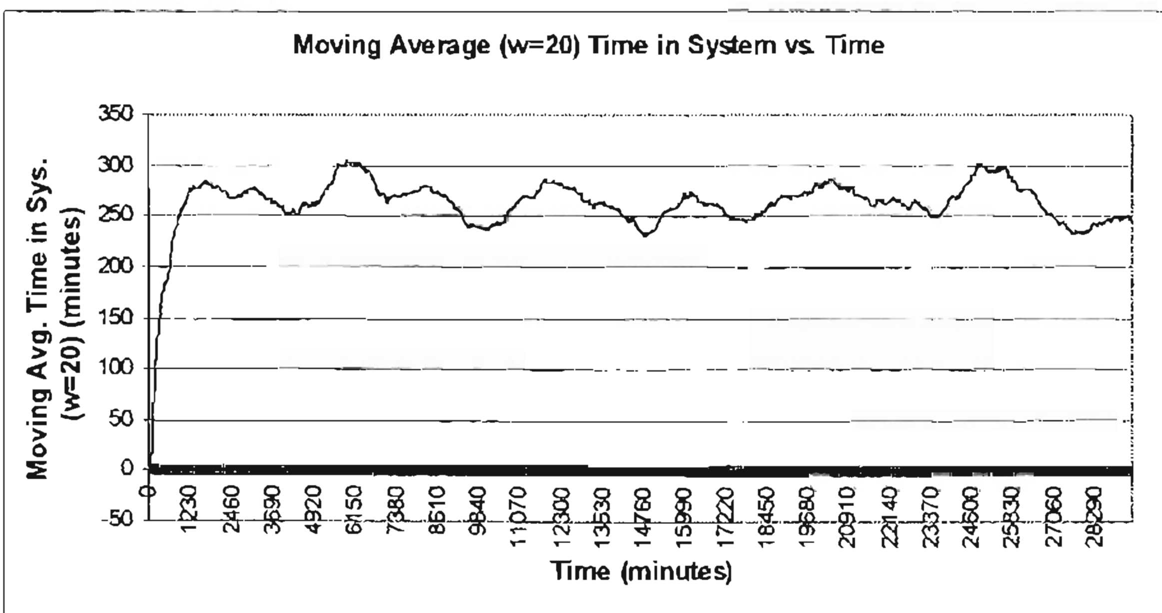


Figure 15 - Warm-up analysis plot of Moving Average Time in System (w=20) vs. Time for the DCM shop with no overlapping.

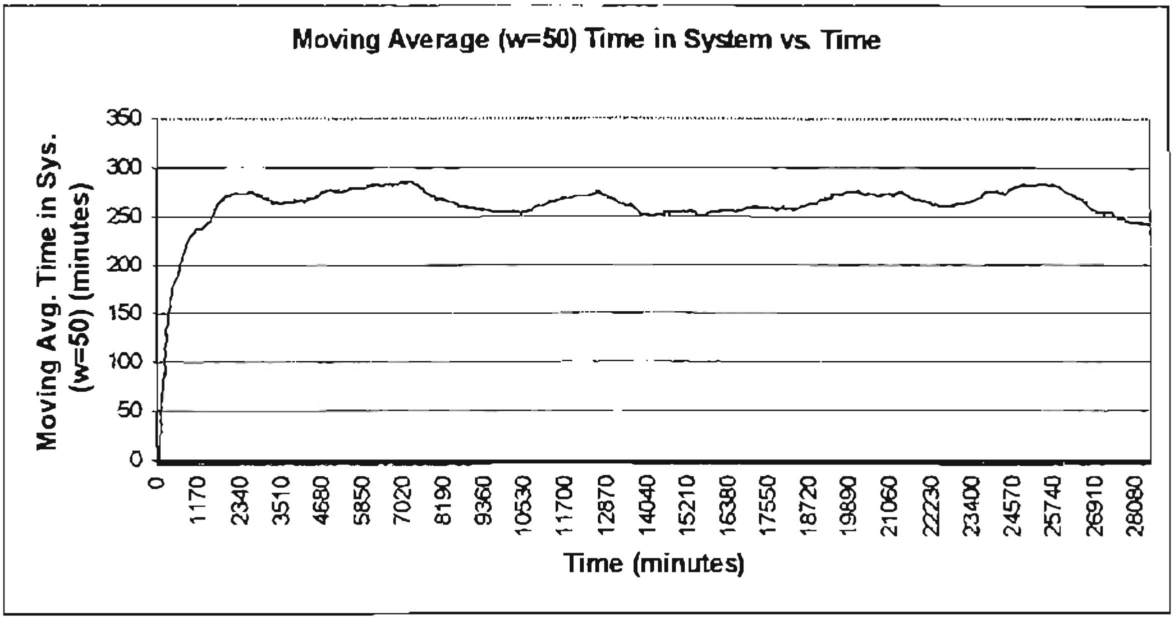


Figure 16 - Warm-up analysis plot of Moving Average Time in System (w=50) vs. Time for the DCM shop with no overlapping.

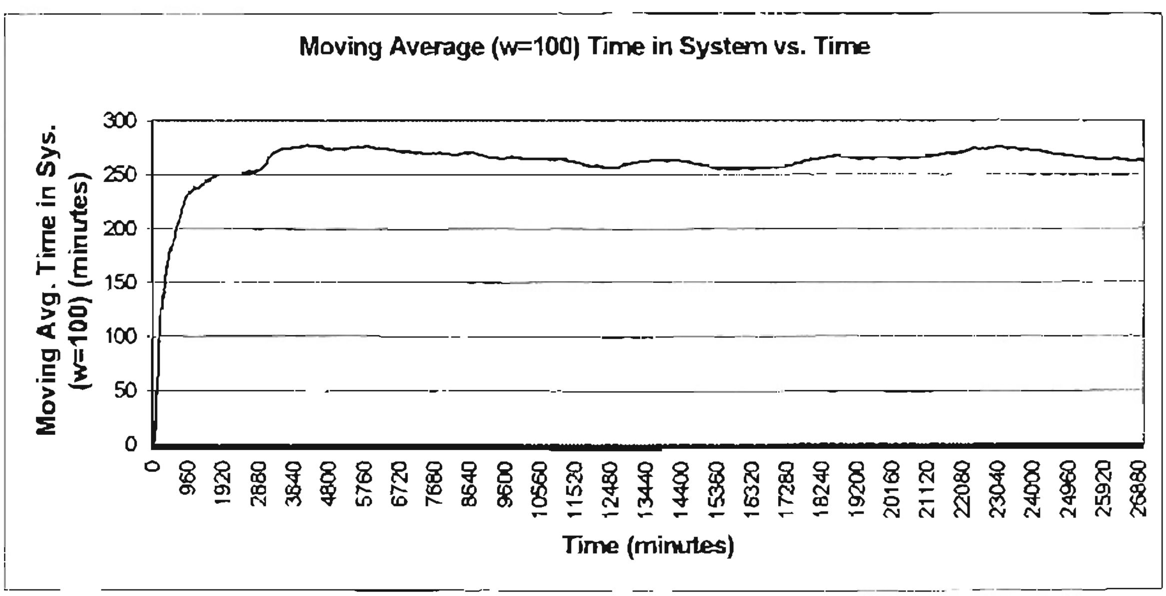


Figure 17 - Warm-up analysis plot of Moving Average Time in System (w=100) vs. Time for the DCM shop with no overlapping.

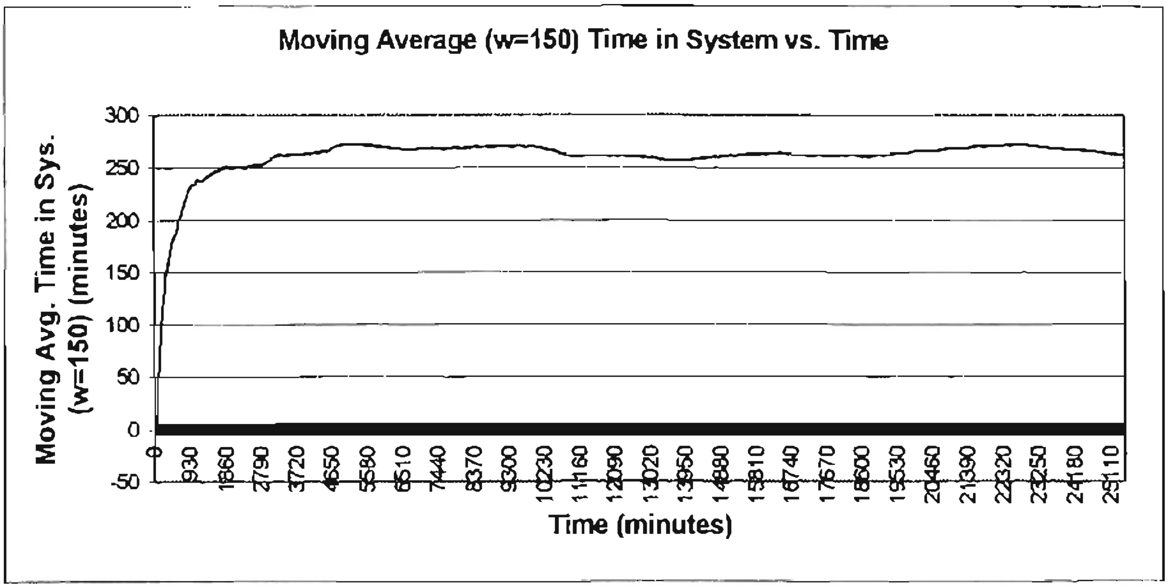


Figure 18 - Warm-up analysis plot of Moving Average Time in System (w=150) vs. Time for the DCM shop with no overlapping.

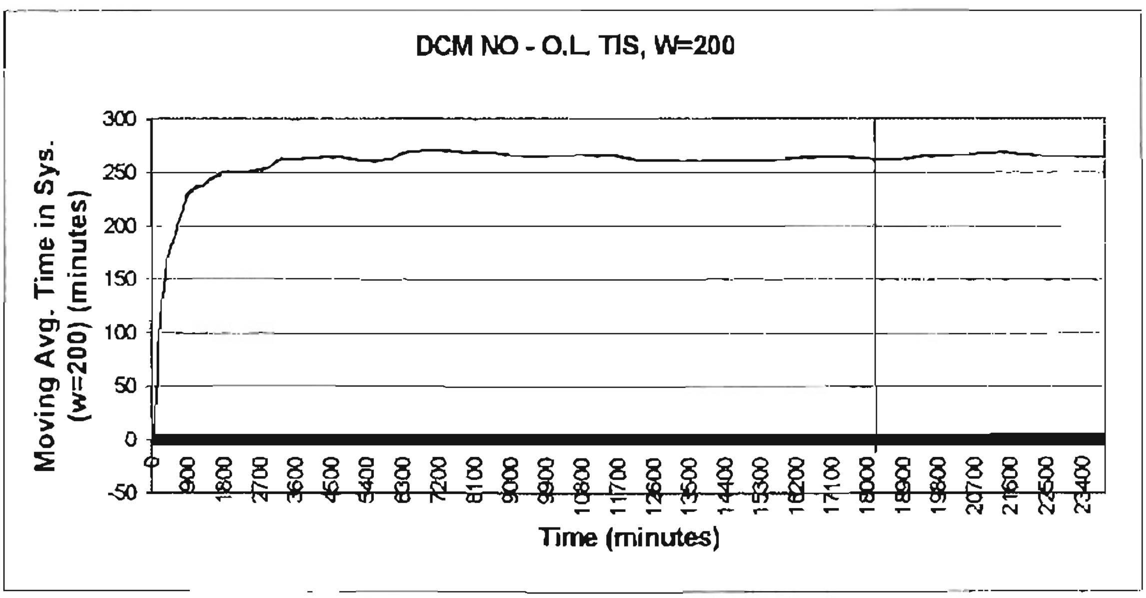


Figure 19 - Warm-up analysis plot of Moving Average Time in System (w=200) vs. Time for the DCM shop with no overlapping.

All minimum warm-up periods are determined using the same procedure. The steady state values and minimum warm-up requirements are shown in Table 41. The values range from 15,000 to 34,000 minutes. For simplicity, all models used a warm-up period of 35,000 minutes.

Table 41 - Minimum warm-up times.

		Est. time req'd for S.S.			
Model	**O.L. Level**	**Time in sys**	**WIP**	**Safety factor**	**Total required warm up time**
PROCESS	100	20000	22000	10000	32000
	50	21000	20000	10000	31000
	25	20500	20000	10000	30500
	10	19000	18000	10000	29000
	1	22000	20000	10000	32000
PR-FAM	100	2000	6000	10000	16000
	50	2000	6000	10000	16000
	25	2500	5000	10000	15000
	10	2500	6000	10000	16000
	1	2500	7500	10000	17500
CM	100	13500	13000	10000	23500
	50	20500	19000	10000	30500
	25	20000	21000	10000	30000
	10	19500	18500	10000	29500
	1	19500	21000	10000	31000
DCM	100	16500	21000	10000	31000
	50	19000	20000	10000	30000
	25	23000	22000	10000	33000
	10	17000	22000	10000	32000
	1	22500	22000	10000	32500
SMALL PROCESS	100	21000	19500	10000	31000
	50	19500	20500	10000	30500
	25	19500	20000	10000	30000
	10	22500	21000	10000	32500
	1	19000	19500	10000	29500
SMALL PR-FAM	100	23500	22000	10000	33500
	50	20000	21500	10000	31500
	25	18000	20000	10000	30000
	10	20000	21500	10000	21500
	1	16500	19500	10000	29500
SMALL CM	100	18500	19000	10000	29000
	50	23000	22500	10000	33000
	25	21500	21000	10000	31500
	10	22500	22000	10000	32500
	1	23000	24000	10000	34000
SMALL DCM	100	19000	19500	10000	29500
	50	18500	16500	10000	28500
	25	23000	21500	10000	33000
	10	23000	22000	10000	33000
	1	20500	17000	10000	30500

Table 42 – Data for warm-up period determination using the large DCM shop with no batch splitting

		RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	AVG	w=5	w=20	w=50	w=100	w=150	w=200
i	TIME	Y1	Y2	Y3	Y4	Y5	Ybar	Ybar(5)	Ybar(20)	Ybar(50)	Ybar(100)	Ybar(150)	Ybar(200)
1	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000
2	30	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000
3	60	0	0	0	0	0	0	3.512	3.512	3.512	3.512	3.512	3.512
4	90	0	0	0	0	0	0	20.640	20.640	20.640	20.640	20.640	20.640
5	120	0	0	0	87.8	0	17.56	47.198	47.198	47.198	47.198	47.198	47.198
6	150	0	0	0	87.8	119	41.36	73.136	73.136	73.136	73.136	73.136	73.136
7	180	104	0	121	87.8	115	85.56	91.118	91.637	91.637	91.637	91.637	91.637
8	210	100	103	97.5	116	191	121.5	108.298	113.619	113.619	113.619	113.619	113.619
9	240	101	103	181	177	232	158.8	133.280	123.946	123.946	123.946	123.946	123.946
10	270	199	219	222	260	124	204.8	154.935	134.615	134.615	134.615	134.615	134.615
11	300	177	170	240	190	97.6	174.9	169.956	141.680	141.680	141.680	141.680	141.680
12	330	103	249	244	201	192	197.8	186.196	152.012	152.012	152.012	152.012	152.012
13	360	150	222	85.9	130	357	189	197.836	156.371	156.371	156.371	156.371	156.371
14	390	312	219	243	230	370	274.8	208.336	166.455	166.455	166.455	166.455	166.455
15	420	191	193	201	282	324	238.2	211.227	171.840	171.840	171.840	171.840	171.840
16	450	199	133	235	184	163	182.8	213.245	176.676	176.676	176.676	176.676	176.676
17	480	151	206	297	166	280	220	225.780	181.168	181.168	181.168	181.168	181.168
18	510	217	180	151	317	203	213.6	226.725	184.182	184.182	184.182	184.182	184.182
19	540	373	180	179	340	113	237	227.109	185.156	185.156	185.156	185.156	185.156
20	570	105	242	239	191	176	190.6	222.109	188.563	188.563	188.563	188.563	188.563
21	600	169	327	312	176	151	227	230.036	191.740	191.740	191.740	191.740	191.740
22	630	331	269	321	318	325	312.8	237.018	198.682	197.571	197.571	197.571	197.571
23	660	120	183	238	310	190	208.2	239.171	207.209	202.799	202.799	202.799	202.799
24	690	219	128	145	149	325	193.2	242.062	215.199	205.352	205.352	205.352	205.352
25	720	207	181	312	283	116	219.8	245.262	222.584	207.869	207.869	207.869	207.869
26	750	390	152	347	372	366	325.4	248.062	227.937	211.701	211.701	211.701	211.701
27	780	142	247	267	327	315	259.6	254.153	233.967	215.388	215.388	215.388	215.388
28	810	203	96.4	181	456	282	243.7	244.589	238.690	219.225	219.225	219.225	219.225
29	840	321	311	161	327	107	245.4	244.389	241.941	222.712	222.712	222.712	222.712
30	870	253	201	287	214	406	272.2	250.625	245.892	225.616	225.616	225.616	225.616
31	900	266	295	102	333	111	221.4	248.771	247.980	229.707	229.707	229.707	229.707
32	930	245	259	304	302	360	294	237.825	252.250	230.735	230.735	230.735	230.735
33	960	272	123	276	222	145	207.6	239.225	253.982	231.873	231.873	231.873	231.873
34	990	267	110	173	175	305	206	237.818	256.168	233.393	233.393	233.393	233.393
35	1020	220	282	103	535	169	261.8	234.782	258.324	233.283	233.283	233.283	233.283
36	1050	162	331	104	151	249	199.4	236.891	259.870	234.171	234.171	234.171	234.171
37	1080	119	166	311	281	148	205	242.636	263.597	236.216	236.216	236.216	236.216
38	1110	150	184	426	236	379	275	247.691	264.358	236.685	236.685	236.685	236.685
39	1140	451	119	285	177	109	228.2	258.600	268.064	238.161	238.161	238.161	238.161
40	1170	181	159	213	348	159	212	267.400	270.279	237.088	237.088	237.088	237.088
41	1200	351	276	217	453	180	295.4	265.145	274.728	236.577	236.577	236.577	236.577
42	1230	413	200	322	306	182	284.6	273.255	276.416	237.238	237.238	237.238	237.238
43	1260	344	114	421	394	475	349.6	280.000	274.347	237.498	237.498	237.498	237.498
44	1290	320	102	444	450	322	327.6	278.164	276.347	238.590	238.590	238.590	238.590
45	1320	320	263	407	202	322	302.8	286.582	277.616	239.701	239.701	239.701	239.701
46	1350	149	134	104	444	354	237	293.709	278.918	240.687	240.687	240.687	240.687
47	1380	324	184	485	254	196	288.6	298.673	278.113	240.972	240.972	240.972	240.972
48	1410	137	401	244	358	256	279.2	297.236	278.245	241.877	241.877	241.877	241.877
49	1440	478	136	118	140	402	254.8	290.782	277.038	243.873	243.873	243.873	243.873
50	1470	241	190	343	409	421	320.8	294.018	277.234	243.888	243.888	243.888	243.888
51	1500	462	270	221	370	129	290.4	293.909	277.332	244.170	244.170	244.170	244.170
52	1530	152	452	320	358	468	350	302.873	279.615	247.320	245.415	245.415	245.415
53	1560	195	377	282	122	368	268.8	299.473	279.824	250.274	245.519	245.519	245.519
54	1590	279	286	181	468	179	278.6	307.324	280.556	252.964	246.756	246.756	246.756
55	1620	197	347	342	525	405	363.2	313.960	282.117	255.243	246.914	246.914	246.914
56	1650	419	115	444	218	312	301.6	318.705	282.244	257.661	246.964	246.964	246.964
57	1680	243	271	483	320	361	335.6	319.233	285.185	260.832	247.354	247.354	247.354
58	1710	281	219	231	301	224	251.2	308.142	284.883	262.783	249.235	249.235	249.235
59	1740	516	97.8	470	323	421	365.6	310.087	283.029	263.839	250.203	250.203	250.203
60	1770	250	328	269	377	415	327.8	307.051	281.751	264.574	249.785	249.785	249.785
61	1800	178	402	189	538	558	373	298.869	282.849	265.182	250.413	250.413	250.413
62	1830	255	203	281	427	315	296.2	298.033	281.941	266.159	250.141	250.141	250.141
63	1860	338	137	302	186	177	228	291.615	281.580	266.819	250.692	250.692	250.692

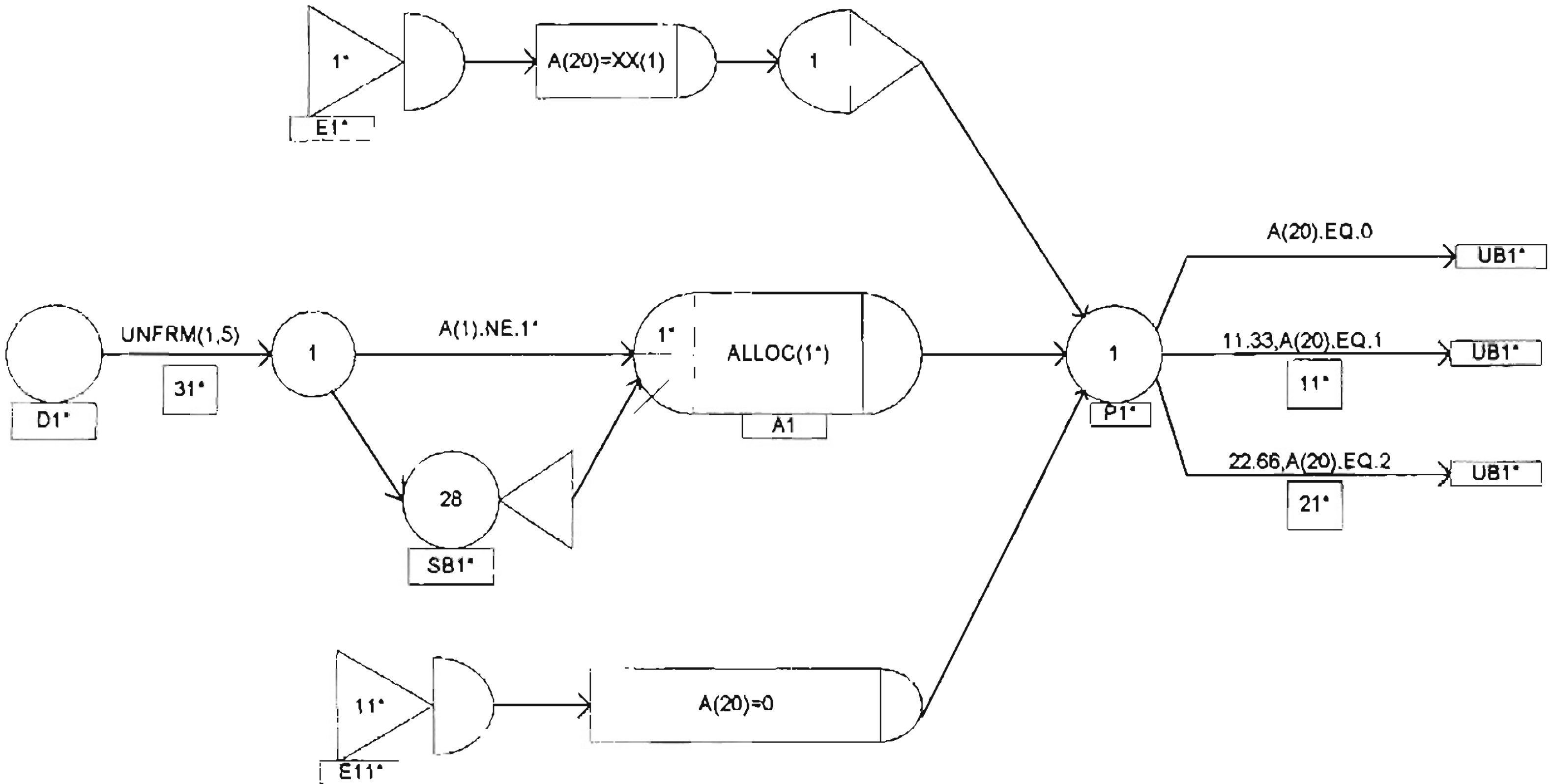
64	1890	206	180	426	340	299	290.2	286.433	279.688	267.979	251.217	251.217	251.217
65	1920	111	437	156	320	202	245.2	276.240	277.176	269.266	250.816	250.816	250.816
66	1950	297	275	282	271	241	273.2	271.549	275.902	270.351	250.077	250.077	250.077
67	1980	337	110	268	210	537	292.4	266.276	277.912	271.155	250.363	250.363	250.363
68	2010	188	325	125	334	353	265	266.858	278.420	271.383	250.590	250.590	250.590
69	2040	122	179	318	242	110	194.2	267.731	278.112	271.324	250.421	250.421	250.421
70	2070	212	306	169	481	99.2	253.4	265.895	279.585	271.601	250.795	250.795	250.795
71	2100	132	222	418	224	385	276.2	267.876	277.956	272.789	250.554	250.554	250.554
72	2130	166	158	419	450	382	315	272.131	276.132	273.086	250.286	250.286	250.286
73	2160	211	207	456	446	193	302.6	263.058	274.722	272.071	250.810	250.810	250.810
74	2190	230	207	178	385	188	237.6	257.058	274.688	272.765	250.798	250.798	250.798
75	2220	292	199	173	426	260	270	255.385	275.224	273.733	250.896	250.896	250.896
76	2250	242	264	279	373	177	267	255.709	275.643	274.703	250.267	250.267	250.267
77	2280	310	445	228	289	328	320	254.073	275.531	273.959	250.455	250.455	250.455
78	2310	145	214	282	131	191	192.6	249.964	274.272	273.390	250.375	250.375	250.375
79	2340	147	167	225	214	242	199	247.182	273.150	273.439	250.660	250.660	250.660
80	2370	189	144	121	217	208	175.8	246.000	270.868	273.134	250.356	250.356	250.356
81	2400	315	249	378	161	182	257	244.236	268.829	272.322	250.608	250.608	250.608
82	2430	181	115	308	350	337	258.2	249.000	267.493	272.498	251.500	251.500	251.500
83	2460	306	251	261	350	181	269.8	248.036	267.546	272.548	251.698	251.698	251.698
84	2490	152	315	337	390	166	272	254.764	268.610	273.041	251.139	251.139	251.139
85	2520	107	324	267	294	131	224.6	265.327	267.146	273.714	250.910	250.910	250.910
86	2550	333	232	332	113	243	250.6	272.436	267.551	273.011	251.782	251.782	251.782
87	2580	381	152	362	230	472	319.4	268.673	269.707	273.881	252.357	252.357	252.357
88	2610	131	330	361	405	320	309.4	271.764	269.468	274.578	253.177	253.177	253.177
89	2640	343	321	196	194	279	266.6	271.545	268.570	274.601	252.949	252.949	252.949
90	2670	267	467	239	269	334	315.2	274.145	269.519	274.698	252.795	252.795	252.795
91	2700	256	295	225	309	185	254	288.305	269.830	274.873	253.016	253.016	253.016
92	2730	330	204	182	147	215	215.6	292.524	269.766	274.463	252.887	252.887	252.887
93	2760	300	424	182	315	240	292.2	289.305	268.532	273.712	252.618	252.618	252.618
94	2790	322	145	193	298	379	267.4	279.833	268.620	273.043	253.555	253.555	253.555
95	2820	205	422	274	314	288	300.6	280.324	272.698	272.716	253.444	253.444	253.444
96	2850	86.8	496	400	455	464	380.4	273.869	274.596	271.617	253.749	253.749	253.749
97	2880	283	248	421	211	322	297	279.705	274.522	272.320	254.403	254.403	254.403
98	2910	368	168	255	413	216	284	287.233	272.644	272.174	255.258	255.258	255.258
99	2940	276	167	193	234	156	205.2	285.360	273.010	271.809	255.952	255.952	255.952
100	2970	327	126	267	407	233	272	281.978	274.620	271.350	256.417	256.417	256.417
101	3000	189	357	269	188	218	244.2	278.451	277.908	270.138	256.845	256.845	256.845
102	3030	401	207	556	134	293	318.2	276.745	277.908	269.449	258.633	257.463	257.463
103	3060	174	204	285	451	378	298.4	275.436	276.740	269.037	260.025	259.043	259.043
104	3090	429	233	232	258	206	271.6	270.360	276.945	269.168	261.588	259.784	259.784
105	3120	146	243	374	174	214	230.2	272.896	277.408	268.455	264.198	260.400	260.400
106	3150	234	277	381	188	229	261.8	272.369	279.681	267.699	265.760	261.001	261.001
107	3180	204	412	361	477	354	361.6	275.042	279.672	267.274	267.245	261.060	261.060
108	3210	166	146	366	369	366	282.6	270.151	276.813	266.325	268.443	261.746	261.746
109	3240	87.8	151	151	424	327	228.2	270.860	275.330	265.949	269.441	262.853	262.853
110	3270	184	251	390	243	97.5	233.1	282.969	274.062	265.005	270.276	262.289	262.289
111	3300	396	177	378	259	121	266.2	293.660	271.013	264.443	270.854	261.704	261.704
112	3330	231	352	161	393	231	273.6	293.860	270.652	263.340	271.060	261.875	261.875
113	3360	296	311	220	293	202	264.4	283.078	272.686	264.219	271.659	261.754	261.754
114	3390	102	291	177	687	274	306.2	276.260	271.838	264.726	272.229	261.670	261.670
115	3420	256	439	203	713	413	404.8	279.609	271.999	264.393	272.683	262.237	262.237
116	3450	355	297	220	481	386	347.8	286.655	269.320	264.112	273.315	262.296	262.296
117	3480	336	119	193	258	414	264	285.818	267.048	263.320	274.388	261.796	261.796
118	3510	280	287	163	320	165	243	280.065	266.521	262.464	274.130	262.353	262.353
119	3540	161	168	272	251	186	207.6	281.320	266.360	262.390	274.232	262.263	262.263
120	3570	101	194	170	533	327	265	279.938	267.160	263.834	274.137	262.556	262.556
121	3600	446	228	194	479	206	310.6	272.029	266.126	264.404	274.071	262.517	262.517
122	3630	238	198	170	333	346	257	263.156	266.365	264.437	274.417	262.577	262.577
123	3660	107	313	93.6	357	181	210.3	257.538	263.697	264.521	274.179	262.494	262.494
124	3690	198	215	233	563	182	278.2	258.047	263.297	264.655	274.525	262.420	262.420
125	3720	230	284	261	378	302	291	258.684	263.858	265.590	274.653	262.556	262.556
126	3750	267	339	247	470	266	317.8	251.884	262.921	265.115	274.668	262.667	262.667
127	3780	350	136	208	197	360	250.2	245.393	264.048	264.887	274.450	262.770	262.770
128	3810	245	244	203	196	123	202.2	249.211	261.907	264.350	275.180	263.069	263.069
129	3840	150	242	225	427	199	248.6	253.491	260.926	264.548	275.196	262.928	262.928
130	3870	281	218	221	156	197	214.6	253.109	260.444	265.071	275.241	262.963	262.963
131	3900	181	154	110	160	346	190.2	244.000	259.599	266.239	275.297	262.938	262.938
132	3930	161	233	265	315	222	239.2	241.218	258.492	265.566	275.319	263.082	263.082

133	3960	407	366	262	208	252	299	243.509	259.340	265.915	274.764	263.183	263.183
134	3990	254	236	194	276	327	257.4	250.345	259.770	265.711	275.506	263.044	263.044
135	4020	227	333	233	123	454	274	249.382	257.340	265.065	275.963	263.285	263.285
136	4050	147	153	170	120	364	190.8	250.745	254.462	266.509	276.298	263.333	263.333
137	4080	242	243	260	274	417	287.2	256.545	252.289	267.097	276.172	263.631	263.631
138	4110	225	438	378	227	109	275.4	253.782	251.699	266.261	276.811	263.425	263.425
139	4140	427	183	198	326	253	277.4	252.236	250.972	265.885	276.742	263.754	263.754
140	4170	349	103	189	388	161	238	255.618	252.499	265.612	276.760	264.018	264.018
141	4200	227	315	202	215	189	229.6	248.145	252.645	265.521	277.117	263.927	263.927
142	4230	232	171	375	365	127	254	258.800	251.450	266.355	277.177	264.158	264.158
143	4260	268	151	132	301	192	208.8	257.582	254.572	267.145	276.917	264.244	264.244
144	4290	252	222	367	358	211	282	254.582	256.252	267.533	276.438	264.183	264.183
145	4320	230	196	341	466	240	294.6	248.309	255.725	268.292	276.059	264.360	264.360
146	4350	135	204	235	130	255	191.8	244.713	253.915	268.860	275.942	264.538	264.538
147	4380	252	381	280	390	237	308	243.913	250.876	267.959	275.894	264.961	264.961
148	4410	233	215	354	339	228	273.8	248.858	249.798	267.601	275.845	264.991	264.991
149	4440	318	267	108	238	281	242.4	255.513	251.147	268.191	275.850	265.181	265.181
150	4470	115	138	302	172	315	208.4	248.658	253.377	268.829	275.741	265.110	265.110
151	4500	232	253	88.2	170	249	198.4	247.949	255.728	269.395	275.737	264.845	264.845
152	4530	114	225	149	339	277	220.8	254.029	257.908	270.536	275.715	265.538	264.659
153	4560	362	199	428	285	268	308.4	247.829	259.962	270.155	275.293	266.418	264.508
154	4590	328	182	185	359	356	282	242.320	260.381	270.312	275.421	267.043	264.413
155	4620	167	339	229	124	174	206.6	244.847	262.201	272.817	275.564	268.023	264.375
156	4650	223	273	183	267	488	286.8	250.538	260.933	273.819	275.088	268.801	264.348
157	4680	91.4	323	265	371	243	258.7	256.260	262.230	274.593	274.694	269.488	264.261
158	4710	119	170	259	359	292	239.8	271.207	261.708	274.245	274.177	270.205	264.380
159	4740	225	237	147	126	331	213.2	268.553	260.177	274.635	274.436	270.518	264.502
160	4770	259	419	264	107	302	270.2	266.244	259.552	275.609	274.060	270.930	264.228
161	4800	242	344	237	287	245	271	267.171	260.913	276.480	273.570	271.039	264.089
162	4830	287	156	393	227	245	261.6	258.662	259.923	275.987	272.895	271.297	263.699
163	4860	343	323	244	487	528	385	253.873	260.884	276.428	273.046	271.466	263.449
164	4890	189	374	269	411	153	279.2	255.484	261.869	276.814	273.267	271.867	263.385
165	4920	167	246	180	333	357	256.6	267.011	260.035	277.408	273.219	271.806	263.301
166	4950	174	182	137	373	218	216.8	270.720	261.884	277.016	273.258	271.913	263.066
167	4980	131	304	132	173	226	193.2	271.502	264.767	277.517	273.074	272.293	262.820
168	5010	137	256	132	361	144	206	277.120	262.986	276.569	273.144	272.286	262.615
169	5040	389	239	304	72.6	283	257.5	270.865	262.435	276.480	273.241	272.319	262.361
170	5070	477	169	254	362	438	340	275.665	262.845	276.583	273.720	272.318	262.112
171	5100	257	276	483	221	318	311	272.520	265.225	275.715	273.697	272.506	261.986
172	5130	273	186	176	226	537	279.6	274.993	268.636	275.575	273.716	272.453	261.888
173	5160	377	277	485	361	117	323.4	281.593	270.456	275.655	273.782	272.049	261.715
174	5190	179	315	427	467	193	316.2	282.193	271.017	276.321	273.516	272.067	261.632
175	5220	241	247	325	449	398	332	281.673	272.529	275.734	273.436	272.198	261.459
176	5250	232	328	223	131	196	222	277.473	276.221	275.059	273.726	272.212	261.540
177	5280	233	267	169	261	290	244	266.382	276.285	274.701	273.838	272.067	261.243
178	5310	108	369	450	231	171	265.8	267.636	276.337	276.247	273.669	272.119	261.414
179	5340	148	198	193	314	210	212.6	260.891	278.868	276.689	274.279	272.053	261.223
180	5370	234	214	389	314	108	251.8	250.945	280.244	276.748	274.540	271.984	261.386
181	5400	403	284	149	293	340	293.8	254.436	281.683	277.430	274.913	271.825	261.359
182	5430	193	251	144	124	233	189	262.436	283.839	277.782	274.971	271.917	261.313
183	5460	266	496	216	275	214	293.4	261.618	284.283	277.219	275.302	271.589	261.218
184	5490	157	294	223	198	374	249.2	260.291	282.556	277.792	275.445	271.824	261.278
185	5520	165	241	130	146	352	206.8	264.527	288.541	278.192	275.358	271.732	261.058
186	5550	452	323	540	276	261	370.4	269.455	290.366	278.738	275.568	271.638	260.979
187	5580	272	295	419	419	145	310	273.498	293.371	278.572	275.535	271.661	260.948
188	5610	250	219	265	128	313	235	283.171	296.620	279.031	275.320	271.700	260.832
189	5640	204	183	275	247	347	251.2	286.625	299.449	278.889	275.290	271.529	261.191
190	5670	226	158	165	186	561	259.2	295.244	301.134	278.437	275.320	271.422	261.337
191	5700	442	223	409	355	101	306	308.989	300.670	278.891	275.283	271.665	261.454
192	5730	380	435	400	385	91.4	338.3	301.625	298.363	279.661	275.762	271.347	261.424
193	5760	364	362	227	315	209	295.4	297.153	299.304	279.447	276.196	271.368	261.637
194	5790	587	278	149	380	263	331.4	307.025	298.817	279.889	276.262	271.036	261.814
195	5820	242	309	502	340	327	344	308.698	300.036	279.586	276.093	270.660	261.784
196	5850	616	187	268	452	267	358	315.062	300.846	279.433	276.191	270.412	261.975
197	5880	155	442	268	397	185	289.4	319.916	305.148	279.786	275.622	270.509	262.297
198	5910	242	275	301	237	249	260.8	314.600	303.300	279.495	275.432	270.313	262.132
199	5940	256	387	464	386	225	343.6	316.309	302.524	279.559	275.265	270.161	262.151
200	5970	451	217	210	280	190	269.6	333.873	302.656	279.466	275.419	270.022	262.070
201	6000	402	372	589	140	143	329.2	332.727	300.841	280.571	275.132	270.081	262.168

202	6030	647	358	207	240	345	359.4	331.091	300.904	281.438	274.954	269.657	262.785
203	6060	382	202	348	303	164	279.8	334.455	302.760	281.877	274.689	269.343	263.440
204	6090	751	272	123	213	212	314.2	340.018	302.375	281.739	274.141	269.297	264.144
205	6120	567	562	555	507	432	524.6	338.473	301.638	281.990	274.256	269.461	264.743
206	6150	644	224	307	262	220	331.4	343.145	302.028	282.594	274.364	268.981	265.616
207	6180	110	529	273	485	303	340	332.891	299.862	281.956	274.296	268.763	266.270
208	6210	302	397	389	293	251	326.4	329.145	302.213	281.688	273.998	268.478	266.785
209	6240	323	274	386	278	349	322	331.291	302.501	282.316	273.663	268.743	267 187
210	6270	312	523	125	261	412	326.6	336.018	302.584	283.076	273.936	268.326	267.571
211	6300	109	488	508	126	374	321	321.527	303.174	282.672	273.957	268.145	267.921
212	6330	168	353	120	205	236	216.4	327.618	301.218	282.338	273.890	267.735	268.356
213	6360	478	472	108	312	221	318.2	312.000	297.416	282.981	273.766	267.603	268.602
214	6390	346	182	220	442	327	303.4	303.600	298.913	281.867	273.992	267.696	268.937
215	6420	486	259	519	179	388	366.2	294.145	298.094	281.880	273.743	267.502	268.971
216	6450	463	365	319	307	372	365.2	280.582	297.733	281.845	273.075	267.456	268.918
217	6480	391	323	634	355	289	398.4	278.345	293.245	282.037	272.823	267.589	268.994
218	6510	176	126	119	101	319	168.2	282.773	294.323	283.160	272.594	267.392	269.336
219	6540	378	161	125	322	184	234	279.082	294.328	283.936	272.498	267.203	269.396
220	6570	331	122	162	209	266	218	271.405	291.601	284.261	272.642	267.483	269.476
221	6600	211	300	133	130	113	177.4	258.369	291.948	283.360	272.553	267.353	269.795
222	6630	283	233	288	182	496	296.4	250.769	291.416	283.053	272.058	267.178	269.987
223	6660	448	233	425	138	81.5	265.1	251 496	288.319	283.535	271.730	267.085	270.092
224	6690	204	290	205	359	330	277.6	258.642	287.675	282.800	271.747	266.868	270.027
225	6720	292	257	140	317	88.8	219	260.515	286.143	281.861	271.520	266.879	270.223
226	6750	187	261	319	125	222	222.8	266.460	280.158	281.826	271.186	267.044	270.446
227	6780	307	346	372	265	118	281.6	270.858	277.622	282.493	271.008	267.278	270.377
228	6810	490	478	205	289	570	406.4	260.495	276 124	282.909	271.133	267.197	270.374
229	6840	114	355	397	237	131	246.8	268.831	274.998	283.398	271 240	267.494	270.372
230	6870	328	159	144	419	223	254.6	270.667	272.827	283.784	271.120	267.820	270.337
231	6900	397	131	353	180	356	283.4	280.689	272.666	283.774	271.169	268.134	270.343
232	6930	305	93.9	281	298	151	225.8	276.253	271.813	283.524	271.462	268.262	270.628
233	6960	204	198	217	171	122	182.4	280.980	273.003	284.869	271.243	268.121	270.399
234	6990	518	281	315	241	429	356.8	267.764	272.422	284.920	271.141	268.193	270.679
235	7020	247	125	485	397	235	297.8	266.400	272.520	284.971	270.747	268.330	270.703
236	7050	373	182	278	530	283	329.2	269.055	270.115	285.587	270.545	268.555	270 651
237	7080	105	115	175	364	111	174	271.236	266.632	284.314	270 623	268.717	270.761
238	7110	324	286	412	370	276	333.6	271.838	262.564	283.979	270 273	268.489	270.809
239	7140	313	121	394	382	95.1	261	278 293	265.857	284.656	270.015	268.329	270.798
240	7170	354	124	170	226	285	231.8	268.711	267.222	284.868	269.609	268.463	270.936
241	7200	246	323	272	131	447	283.8	267.020	267.500	285.349	269.844	268.384	271.023
242	7230	393	208	325	252	359	307 4	257.769	268.959	285.789	269.696	268.658	270.880
243	7260	229	334	174	209	216	232.4	267.278	269.696	285.438	269.879	268.986	270.885
244	7290	465	338	205	102	157	253.4	262.424	269.874	285.537	270.082	268.813	270.709
245	7320	353	205	220	245	234	251.4	259.878	269.947	284.566	269.745	268.653	270.489
246	7350	127	255	354	346	314	279.2	267.896	270.777	284.333	269.416	268.575	270.314
247	7380	226	142	359	98.2	312	227.4	268.096	271.104	283.422	269.786	268.157	270.189
248	7410	353	277	94	405	264	278.6	264.260	271.714	283.119	269.396	268.180	270.182
249	7440	141	199	350	462	249	280.2	269.896	268.738	283.016	269.195	267 861	270.264
250	7470	174	431	288	175	97.1	233	274.805	269.801	281.952	269.049	268 263	270.325

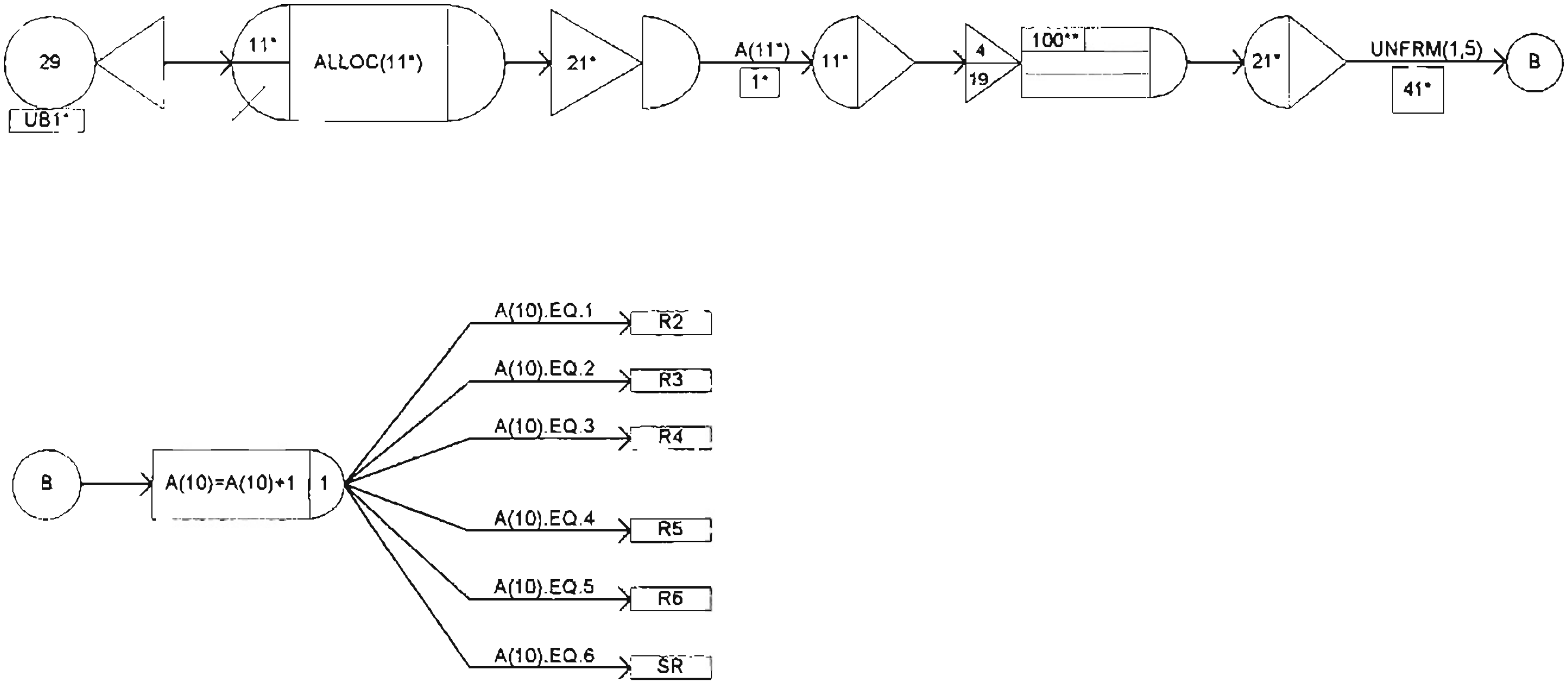
APPENDIX D

Process Shop Network Diagrams, Fortran, and Models



* These numbers will change inother departments.

Figure 20 A - Process shop network diagram for department 1.



* These numbers will change in other departments.

Table 20 B - Process shop network diagram for department 1 (continued)

Table 5 - Attribute descriptions for the process shop models.

ATTRIBUTE(S)	DESCRIPTION
1-7	Defines the routing for the entity (ATRIB(1) is the first machine/dept)
8	Defines the part family of the entity
9	Defines the part number of the entity
10	Counts the number of operations that the entity has finished
11-18	Processing times at departments 1-8
19	Entity identification # - Mark attribute (time that an entity enters the system)
20	Indicates set-up time (0 = no set-up, 1 = short set-up, 2 = long set-up
21-27	Indicates move times between departments (21 is the first move time)
28	Indicates the number of sub-batches per batch
29	Indicates the number of entities per sub-batch

Table 6 - Variable descriptions for the process shop models.

XX	DESCRIPTION
1-8	Set-up time indicators at each department
9	Indicates the number of entities currently in the system

Table 7 - File descriptions for the process shop models.

FILE	DESCRIPTION
1-8	Queue for machines assignments in departments 1-8
11-18	Queue for processing after machine has been assigned to the start-batch

Table 8 - Resource descriptions for the process shop models.

RESOURCES	NUMBERS	CAPACITY	DESCRIPTION
X1 - X6	1-6	4	Start batch resources for departments 1-6
X7 - X8	7-8	3	Start batch resources for departments 7 and 8
D1 - D7	1-7	4	Machine resources for departments 1-6
D7 – D8	7-9	3	Machine resources for departments 7 and 8

Table 9 - Activity descriptions for the process shop models.

ACTIVITIES	DESCRIPTION
1-8	Machine processing in departments 1-8
11-18	Short set-up times in departments 1-8
21-28	Long set-up times in departments 1-8
31-38	Loading times at departments 1-8
41-48	Unloading times at departments 1-8
51-57	Move times from receiving to depts (operations ordered 1-7 on routing)

Table 10 - Array descriptions for the process shop models.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	No. OF ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	4	Machine indicators	Part # of last or current entity on machine
11-18	Department	4	Machine indicators	Entity # of last or current entity on machine
21-28	Department	4	Machine indicators	Number of sub-batches processed
31-38	Department	4	Machine indicators	Part family of entity on machine
41-48	Department	4	Machine indicators	Indicates if machine is idle(0) or busy(1)

Table 11 - Resource descriptions for the small process shop models.

RESOURCE	NUMBER	CAPACITY	DESCRIPTION
X1	1	2	Start batch resources for department 1
X2	2	3	Start batch resources for department 2
X3	3	2	Start batch resources for department 3
X4 - X6	4-6	3	Start batch resources for departments 4 through 6
X7 - X8	7-8	2	Start batch resources for departments 7 and 8
D1	11	2	Machine resources for department 1
D2	12	3	Machine resources for department 2
D3	13	2	Machine resources for department 3
D4 - D6	14-16	3	Machine resources for departments 4 through 6
D7 - D8	17-18	2	Machine resources for departments 7 through 8

D.1 PROC MODEL ALLOC(I) SUBROUTINE

```
SUBROUTINE ALLOC(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
C ALLOC SUBROUTINE FOR PR SHOP B (NO FAMILY CONSIDERATION)
C
      DIMENSION U(32)
      DIMENSION Y(32)
      DIMENSION W(32)
      IFLAG=0
      J=NRUSE(I)+NNRSC(I)
      K=NNRSC(I)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 5
      IF (I.GT.10) GO TO 50
C
C IF ENTITY ALREADY HAS SB THEN SEND THROUGH
```

```
C
5        DO 12 M=1,J
          A=GETARY(I+10,M)
10        N=0
          N=NFIND(1,I,19,0,A,.00001)
          IF (N.GT.0) THEN
            CALL RMOVE(N,I,U)
            CALL ENTER(I+10,U)
            GO TO 10
          ENDIF
12      CONTINUE
C
C IF SB IS FREE FIND NEXT ENTITY TO SEND
C
        N=0
        IF (K.GT.0) THEN
          DO 15 M=1,J
            B=GETARY(I+20,M)
            IF (B.GT.C) THEN
              D=GETARY(I,M)
              N=NFIND(1,I,9,0,D,.00001)
              IF (N.GT.0) GO TO 20
              N=NFIND(1,I,1,I+10,-50,.00001)
              IF (N.GT.0) GO TO 30
            ENDIF
15        CONTINUE
        ENDIF
        RETURN
C
C DETERMINE SET UP TIME FOR NEW BATCH AND SEIZE SB
C
20      XX(I)=0.
        GO TO 35
30      XX(I)=2.
        GO TO 35
35      CALL SEIZE(I,1)
        CALL RMOVE(N,I,Y)
        CALL ENTER(I,Y)
        CALL PUTARY(I+20,M,0.)
        RETURN
C
C DETERMINE APPROPRIATE ENTITY TO SENDIF OP RES. IS FREE
C
50      N=0
        IF (K.GT.0) THEN
          DO 55 M=1,J
            P=GETARY(I+30,M)
            IF (P.EQ.0.) THEN
              A=GETARY(I,M)
              N=NFIND(1,I,19,0,A,.000001)
              IF (N.GT.0) THEN
                CALL PUTARY(I+30,M,1.)
                CALL SEIZE(I,1)
                CALL RMOVE(N,I,W)
                CALL ENTER(I+10,W)
                RETURN
              ENDIF
            ENDIF
55        CONTINUE
        ENDIF
```

```
      RETURN
      END
```

D.2 PROC MODEL EVENT(I) SUBROUTINE

```
SUBROUTINE EVENT(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
C EVENT SUBROUTINE FOR PR SHOP B (NO FAMILY CONSIDERATION)
      F=ATRIB(9)
      G=ATRIB(19)
      H=ATRIB(8)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 5
      IF (I.GT.10.AND.I.LT.20) GO TO 15
      IF (I.GT.20) GO TO 25
C
C SET ARRAYS FOR NEW BATCH
C
5     J=NNRSC(I)+NRUSE(I)
      DO 10 M=1,J
        B=GETARY(I+20,M)
          IF (B.EQ.0.) THEN
            S=GETARY(I+30,M)
            R=GETARY(I,M)
              IF (S.EQ.H.AND.R.NE.F) ATRIB(20)=1.
            CALL PUTARY(I,M,F)
            CALL PUTARY(I+10,M,G)
            CALL PUTARY(I+20,M,1.)
            CALL PUTARY(I+30,M,H)
            CALL PUTARY(I+40,M,0.)
            ENDIF
10    CONTINUE
      RETURN
C
C FREE MACHINE AND SET ARRAY TO AVAILABLE
C
15    J=NNRSC(I)+NRUSE(I)
      DO 20 M=1,J
        A=GETARY(I,M)
        IF (A.EQ.G) THEN
          CALL PUTARY(I+30,M,0.)
          CALL FREE(I,1)
          RETURN
        ENDIF
20    CONTINUE
      RETURN
C
C COUNT SUB-BATCHES AND FREE SB WHEN NECESSARY
C
25    J=NNRSC(I-10)+NRUSE(I-10)
      DO 35 M=1,J
        A=GETARY(I-10,M)
```

```
         IF (A.EQ.G) THEN
           B=GETARY(I,M)
           CALL PUTARY(I,M,B+1.)
           B=GETARY(I,M)
           IF (B.GT.C) THEN
               CALL FREE(I-20,1)
               RETURN
           ENDIF
         ENDIF
35     CONTINUE
       RETURN
       END
```

D.3 PRFAM MODEL ALLOC(I) SUBROUTINE

```
SUBROUTINE ALLOC(I)
       COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
      1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
      1,TNOW,XX(100)
C
C************
C
       DIMENSION U(32)
       DIMENSION Y(32)
       DIMENSION W(32)
       IFLAG=0
       J=NRUSE(I)+NNRSC(I)
       K=NNRSC(I)
       C=ATRIB(28)
C
       IF (I.LT.10) GO TO 5
       IF (I.GT.10) GO TO 50
C
C IF ENTITY ALREADY HAS SB THEN SEND THROUGH
C
5       DO 12 M=1,J
         A=GETARY(I+10,M)
10       N=0
         N=NFIND(1,I,30,0,A,.00001)
         IF (N.GT.0) THEN
           CALL RMOVE(N,I,U)
           CALL ENTER(I+10,U)
           GO TO 10
         ENDIF
12     CONTINUE
C
C IF SB IS FREE FIND NEXT ENTITY TO SEND
C
       N=0
       IF (K.GT.0) THEN
         DO 15 M=1,J
           B=GETARY(I+20,M)
           IF (B.GT.C) THEN
             D=GETARY(I,M)
             N=NFIND(1,I,9,0,D,.00001)
             IF (N.GT.0) GO TO 20
```

```
            E=GETARY(I+30,M)
            N=NFIND(1,I,8,0,E,.00001)
            IF (N.GT.0) GO TO 25
            N=NFIND(1,I,1,I+10,-50,.00001)
            IF (N.GT.0) GO TO 30
          ENDIF
15      CONTINUE
      ENDIF
      RETURN
C
C DETERMINE SET UP TIME FOR NEW BATCH AND SEIZE SB
C
20    XX(I)=0.
      GO TO 35
25    XX(I)=1.
      GO TO 35
30    XX(I)=2.
      GO TO 35
35    CALL SEIZE(I,1)
      CALL RMOVE(N,I,Y)
      CALL ENTER(I,Y)
      CALL PUTARY(I+20,M,0.)
      RETURN
C
C DETERMINE APPROPRIATE ENTITY TO SENDIF OP RES. IS FREE
C
50    N=0
      IF (K.GT.0) THEN
        DO 55 M=1,J
          P=GETARY(I+30,M)
          IF (P.EQ.0.) THEN
            A=GETARY(I,M)
            N=NFIND(1,I,30,0,A,.000001)
            IF (N.GT.0) THEN
              CALL PUTARY(I+30,M,1.)
              CALL SEIZE(I,1)
              CALL RMOVE(N,I,W)
              CALL ENTER(I+10,W)
              RETURN
            ENDIF
          ENDIF
55      CONTINUE
      ENDIF
      RETURN
      END
```

D.4 PRFAM MODEL EVENT(I) SUBROUTINE

```
SUBROUTINE EVENT(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
      F=ATRIB(9)
      G=ATRIB(30)
      H=ATRIB(8)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 5
      IF (I.GT.10.AND.I.LT.20) GO TO 15
      IF (I.GT.20) GO TO 25
C
C SET ARRAYS FOR NEW BATCH
C
5     J=NNRSC(I)+NRUSE(I)
      DO 10 M=1,J
        B=GETARY(I+20,M)
          IF (B.EQ.0.) THEN
            CALL PUTARY(I,M,F)
            CALL PUTARY(I+10,M,G)
            CALL PUTARY(I+20,M,1.)
            CALL PUTARY(I+30,M,H)
            CALL PUTARY(I+40,M,0.)
            ENDIF
10    CONTINUE
      RETURN
C
C FREE MACHINE AND SET ARRAY TO AVAILABLE
C
15    J=NNRSC(I)+NRUSE(I)
      DO 20 M=1,J
        A=GETARY(I,M)
        IF (A.EQ.G) THEN
          CALL PUTARY(I+30,M,0.)
          CALL FREE(I,1)
          RETURN
        ENDIF
20    CONTINUE
      RETURN
C
C COUNT SUB-BATCHES AND FREE SB WHEN NECESSARY
C
25    J=NNRSC(I-10)+NRUSE(I-10)
      DO 35 M=1,J
        A=GETARY(I-10,M)
        IF (A.EQ.G) THEN
          B=GETARY(I,M)
          CALL PUTARY(I,M,B+1.)
          B=GETARY(I,M)
          IF (B.GT.C) THEN
              CALL FREE(I-20,1)
              RETURN
          ENDIF
        ENDIF
35    CONTINUE
```

```
RETURN
END
```

D.5 PROCESS SHOP MODEL – 50% BATCH SPLIT

```
GEN,DAVID BROCK,PROC_50,3/10/97,,NO,NO,,,,72;
LIMITS,18,30,4000;
TIMST,XX(9),WIP;
SEEDS,1586532145(9);
;SET INITIAL VARIABLES
INTLC,XX(1)=0,XX(2)=0,XX(3)=0,XX(4)=0,XX(5)=0,XX(69)=0;
INTLC,XX(6)=0,XX(7)=0,XX(8)=0,XX(9)=0,XX(10)=0;
;SET INITIAL ARRAY VALUES
ARRAY(1,4)/1.,1.,1.,1.;
ARRAY(2,4)/1.,1.,1.,1.;
ARRAY(3,4)/1.,1.,1.,1.;
ARRAY(4,4)/1.,1.,1.,1.;
ARRAY(5,4)/1.,1.,1.,1.;
ARRAY(6,4)/1.,1.,1.,1.;
ARRAY(7,4)/1.,1.,1.,1.;
ARRAY(8,4)/1.,1.,1.,1.;
ARRAY(11,4)/0.,0.,0.,0.;
ARRAY(12,4)/0.,0.,0.,0.;
ARRAY(13,4)/0.,0.,0.,0.;
ARRAY(14,4)/0.,0.,0.,0.;
ARRAY(15,4)/0.,0.,0.,0.;
ARRAY(16,4)/0.,0.,0.,0.;
ARRAY(17,4)/0.,0.,0.,0.;
ARRAY(18,4)/0.,0.,0.,0.;
ARRAY(21,4)/3.,3.,3.,3.;
ARRAY(22,4)/3.,3.,3.,3.;
ARRAY(23,4)/3.,3.,3.,3.;
ARRAY(24,4)/3.,3.,3.,3.;
ARRAY(25,4)/3.,3.,3.,3.;
ARRAY(26,4)/3.,3.,3.,3.;
ARRAY(27,4)/3.,3.,3.,3.;
ARRAY(28,4)/3.,3.,3.,3.;
ARRAY(31,4)/1.,1.,1.,1.;
ARRAY(32,4)/1.,1.,1.,1.;
ARRAY(33,4)/1.,1.,1.,1.;
ARRAY(34,4)/1.,1.,1.,1.;
ARRAY(35,4)/1.,1.,1.,1.;
ARRAY(36,4)/1.,1.,1.,1.;
ARRAY(37,4)/1.,1.,1.,1.;
ARRAY(38,4)/1.,1.,1.,1.;
ARRAY(41,4)/0.,0.,0.,0.;
ARRAY(42,4)/0.,0.,0.,0.;
ARRAY(43,4)/0.,0.,0.,0.;
ARRAY(44,4)/0.,0.,0.,0.;
ARRAY(45,4)/0.,0.,0.,0.;
ARRAY(46,4)/0.,0.,0.,0.;
ARRAY(47,4)/0.,0.,0.,0.;
ARRAY(48,4)/0.,0.,0.,0.;
NETWORK;
;SET RESOURCES
        RESOURCE/1,X1(4),1/2,X2(4),2/3,X3(4),3;
        RESOURCE/4,X4(4),4/5,X5(4),5/6,X6(4),6;
        RESOURCE/7,X7(3),7/8,X8(3),8/11,D1(4),11;
        RESOURCE/12,D2(4),12/13,D3(4),13/14,D4(4),14;
        RESOURCE/15,D5(4),15/16,D6(4),16/17,D7(3),17;
        RESOURCE/18,D8(3),18;
;ARRIVALS
        CREATE,EXPON(8),1,29;
T1      ASSIGN,XX(9)=XX(9)+1,XX(10)=XX(10)+1;
        ASSIGN,XX(69)=XX(69)+1,ATRIB(30)=XX(69);
        ASSIGN,ATRIB(28)=2,ATRIB(29)=50,1;
          ACT,,0.2,F1;
          ACT,,0.25,F2;
          ACT,,0.15,F3;
          ACT,,0.2,F4;
          ACT,,0.2,F5;
```

```
;ASSIGN TO A FAMILY
F1      ASSIGN,ATRIB(8)=1,1;
          ACT,,0.125,PN1;
          ACT,,0.125,PN2;
          ACT,,0.125,PN3;
          ACT,,0.125,PN4;
          ACT,,0.125,PN5;
          ACT,,0.125,PN6;
          ACT,,0.125,PN7;
          ACT,,0.125,PN8;
F2      ASSIGN,ATRIB(8)=2,1;
          ACT,,0.1,PN9;
          ACT,,0.1,PN10;
          ACT,,0.1,PN11;
          ACT,,0.1,PN12;
          ACT,,0.1,PN13;
          ACT,,0.1,PN14;
          ACT,,0.1,PN15;
          ACT,,0.1,PN16;
          ACT,,0.1,PN17;
          ACT,,0.1,PN18;
F3      ASSIGN,ATRIB(8)=3,1;
          ACT,,0.16666,PN27;
          ACT,,0.16666,PN28;
          ACT,,0.16667,PN29;
          ACT,,0.16667,PN30;
          ACT,,0.16667,PN31;
          ACT,,0.16667,PN32;
F4      ASSIGN,ATRIB(8)=4,1;
          ACT,,0.125,PN19;
          ACT,,0.125,PN20;
          ACT,,0.125,PN21;
          ACT,,0.125,PN22;
          ACT,,0.125,PN23;
          ACT,,0.125,PN24;
          ACT,,0.125,PN25;
          ACT,,0.125,PN26;
F5      ASSIGN,ATRIB(8)=5,1;
          ACT,,0.125,PN33;
          ACT,,0.125,PN34;
          ACT,,0.125,PN35;
          ACT,,0.125,PN36;
          ACT,,0.125,PN37;
          ACT,,0.125,PN38;
          ACT,,0.125,PN39;
          ACT,,0.125,PN40;
;ASSIGN PART #s, ROUTINGS, AND PROCESSING TIMES
PN1       ASSIGN,ATRIB(9)=1,ATRIB(1)=5,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
            ACT,,,R1;
PN2       ASSIGN,ATRIB(9)=2,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.153;
            ACT,,,R1;
PN3       ASSIGN,ATRIB(9)=3,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.131;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
            ACT,,,R1;
PN4       ASSIGN,ATRIB(9)=4,ATRIB(1)=3,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.136;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.185;
            ACT,,,R1;
```

```
PN5       ASSIGN,ATRIB(9)=5,ATRIB(1)=5,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
            ACT,,,R1;
PN6       ASSIGN,ATRIB(9)=6,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.136,ATRIB(27)=.185;
            ACT,,,R1;
PN7       ASSIGN,ATRIB(9)=7,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.185;
            ACT,,,R1;
PN8       ASSIGN,ATRIB(9)=8,ATRIB(1)=4,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.131,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.185;
            ACT,,,R1;
PN9       ASSIGN,ATRIB(9)=9,ATRIB(1)=6,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN10      ASSIGN,ATRIB(9)=10,ATRIB(1)=8,ATRIB(2) 1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN11      ASSIGN,ATRIB(9)=11,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.126;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21) .219,ATRIB(22)=.099;
            ACT,,,R1;
PN12      ASSIGN,ATRIB(9)=12,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3) 0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN13      ASSIGN,ATRIB(9)=13,ATRIB(1)=6,ATRIB(2) 1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN14      ASSIGN,ATRIB(9)=14,ATRIB(1)=8,ATRIB(2) 1;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.126;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
            ACT,,,R1;
PN15      ASSIGN,ATRIB(9)=15,ATRIB(1)=6,ATRIB(2) 8;
```

```
          ASSIGN,ATRIB(3)=1,ATRIB(4)=2,ATRIB(5)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.114;
          ASSIGN,ATRIB(23)=.099,ATRIB(24)=.077;
          ASSIGN,ATRIB(27)=.1;
            ACT,,,R1;
PN16      ASSIGN,ATRIB(9)=16,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN17      ASSIGN,ATRIB(9)=17,ATRIB(1)=6,ATRIB(2)=7;
          ASSIGN,ATRIB(3)=8,ATRIB(4)=1,ATRIB(5)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.057,ATRIB(24)=.099;
          ASSIGN,ATRIB(27)=.126;
            ACT,,,R1;
PN18      ASSIGN,ATRIB(9)=18,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN19      ASSIGN,ATRIB(9)=19,ATRIB(1)=1,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=7,ATRIB(4)=8,ATRIB(5)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.205,ATRIB(24)=.057;
          ASSIGN,ATRIB(27)=.219;
            ACT,,,R1;
PN20      ASSIGN,ATRIB(9)=20,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
          ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
            ACT,,,R1;
PN21      ASSIGN,ATRIB(9)=21,ATRIB(1)=2,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=7,ATRIB(5)=8;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.057,ATRIB(27)=.185;
            ACT,,,R1;
PN22      ASSIGN,ATRIB(9)=22,ATRIB(1)=2,ATRIB(2)=3;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=6;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
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          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.185;
            ACT,,,R1;
PN23      ASSIGN,ATRIB(9)=23,ATRIB(1)=1,ATRIB(2)=7;
          ASSIGN,ATRIB(3)=8,ATRIB(4)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.205;
          ASSIGN,ATRIB(23)=.057,ATRIB(27)=.219;
            ACT,,,R1;
PN24      ASSIGN,ATRIB(9)=24,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
          ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
            ACT,,,R1;
PN25      ASSIGN,ATRIB(9)=25,ATRIB(1)=5,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=7,ATRIB(4)=8,ATRIB(5)=0;
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.057;
          ASSIGN,ATRIB(27)=.219;
            ACT,,,R1;
PN26      ASSIGN,ATRIB(9)=26,ATRIB(1)=2,ATRIB(2)=3;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=6;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.185;
            ACT,,,R1;
PN27      ASSIGN,ATRIB(9)=27,ATRIB(1)=8,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.119;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.131;
            ACT,,,R1;
PN28      ASSIGN,ATRIB(9)=28,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.153;
            ACT,,,R1;
PN29      ASSIGN,ATRIB(9)=29,ATRIB(1)=1,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.153;
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          ACT,,,R1;
PN30      ASSIGN,ATRIB(9)=30,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=3,ATRIB(5)=4;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
          ASSIGN,ATRIB(23)=.077,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.131;
          ACT,,,R1;
PN31      ASSIGN,ATRIB(9)=31,ATRIB(1)=8,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.119;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.117;
          ACT,,,R1;
PN32      ASSIGN,ATRIB(9)=32,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=3,ATRIB(5)=4;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
          ASSIGN,ATRIB(23)=.077,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.131;
          ACT,,,R1;
PN33      ASSIGN,ATRIB(9)=33,ATRIB(1)=2,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.136;
          ASSIGN,ATRIB(23)=.136,ATRIB(27)=.185;
          ACT,,,R1;
PN34      ASSIGN,ATRIB(9)=34,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
          ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
          ACT,,,R1;
PN35      ASSIGN,ATRIB(9)=35,ATRIB(1)=3,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.253;
          ACT,,,R1;
PN36      ASSIGN,ATRIB(9)=36,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.253;
          ACT,,,R1;
PN37      ASSIGN,ATRIB(9)=37,ATRIB(1)=3,ATRIB(2)=4;
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          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.253;
            ACT,,,R1;
PN38      ASSIGN,ATRIB(9)=38,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23) .136,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.153;
            ACT,,,R1;
PN39      ASSIGN,ATRIB(9)=39,ATRIB(1)=2,ATRIB(2)=3;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.136,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.185;
            ACT,,,R1;
PN40      ASSIGN,ATRIB(9)=40,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.136,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.136,ATRIB(27)=.253;
            ACT,,,R1;
;ROUTE ENTITY TO APPROPRIATE DEPARTMENT
R1        GOON;
          ACT/51,ATRIB(21);
          GOON,1;
            ACT,,ATRIB(1).EQ.0,SR;
            ACT,,ATRIB(1).EQ.1,D1;
            ACT,,ATRIB(1).EQ.2,D2;
            ACT,,ATRIB(1).EQ.3,D3;
            ACT,,ATRIB(1).EQ.4,D4;
            ACT,,ATRIB(1).EQ.5,D5;
            ACT,,ATRIB(1).EQ.6,D6;
            ACT,,ATRIB(1).EQ.7,D7;
            ACT,,ATRIB(1).EQ.8,D8;
R2        GOON;
          ACT/52,ATRIB(22);
          GOON,1;
            ACT,,ATRIB(2).EQ.0,SR;
            ACT,,ATRIB(2).EQ.1,D1;
            ACT,,ATRIB(2).EQ.2,D2;
            ACT,,ATRIB(2).EQ.3,D3;
            ACT,,ATRIB(2).EQ.4,D4;
            ACT,,ATRIB(2).EQ.5,D5;
            ACT,,ATRIB(2).EQ.6,D6;
            ACT,,ATRIB(2).EQ.7,D7;
            ACT,,ATRIB(2).EQ.8,D8;
R3        GOON;
          ACT/53,ATRIB(23);
          GOON,1;
            ACT,,ATRIB(3).EQ.0,SR;
            ACT,,ATRIB(3).EQ.1,D1;
            ACT,,ATRIB(3).EQ.2,D2;
            ACT,,ATRIB(3).EQ.3,D3;
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          ACT,,ATRIB(3).EQ.4,D4;
          ACT,,ATRIB(3).EQ.5,D5;
          ACT,,ATRIB(3).EQ.6,D6;
          ACT,,ATRIB(3).EQ.7,D7;
          ACT,,ATRIB(3).EQ.8,D8;
R4      GOON;
        ACT/54,ATRIB(24);
        GOON,1;
          ACT,,ATRIB(4).EQ.0,SR;
          ACT,,ATRIB(4).EQ.1,D1;
          ACT,,ATRIB(4).EQ.2,D2;
          ACT,,ATRIB(4).EQ.3,D3;
          ACT,,ATRIB(4).EQ.4,D4;
          ACT,,ATRIB(4).EQ.5,D5;
          ACT,,ATRIB(4).EQ.6,D6;
          ACT,,ATRIB(4).EQ.7,D7;
          ACT,,ATRIB(4).EQ.8,D8;
R5      GOON;
        ACT/55,ATRIB(25);
        GOON,1;
          ACT,,ATRIB(5).EQ.0,SR;
          ACT,,ATRIB(5).EQ.1,D1;
          ACT,,ATRIB(5).EQ.2,D2;
          ACT,,ATRIB(5).EQ.3,D3;
          ACT,,ATRIB(5).EQ.4,D4;
          ACT,,ATRIB(5).EQ.5,D5;
          ACT,,ATRIB(5).EQ.6,D6;
          ACT,,ATRIB(5).EQ.7,D7;
          ACT,,ATRIB(5).EQ.8,D8;
R6      GOON;
        ACT/56,ATRIB(26);
        GOON,1;
          ACT,,ATRIB(6).EQ.0,SR;
          ACT,,ATRIB(6).EQ.1,D1;
          ACT,,ATRIB(6).EQ.2,D2;
          ACT,,ATRIB(6).EQ.3,D3;
          ACT,,ATRIB(6).EQ.4,D4;
          ACT,,ATRIB(6).EQ.5,D5;
          ACT,,ATRIB(6).EQ.6,D6;
          ACT,,ATRIB(6).EQ.7,D7;
          ACT,,ATRIB(6).EQ.8,D8;
D1      GOON;
        ACT/31,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.1,A1;
          ACT,,,SB1;
SB1     UNBATCH,28;
A1      AWAIT(1),ALLOC(1);
E1      ENTER,1;
        ASSIGN,ATRIB(20)=XX(1);
        EVENT,1;
          ACT,,,P1;
E11     ENTER,11;
        ASSIGN,ATRIB(20)=0;
          ACT,,,P1;
P1      GOON,1;
          ACT,,ATRIB(20).EQ.0,UB1;
          ACT/11,11.33,ATRIB(20).EQ.1,UB1;
          ACT/21,22.66,ATRIB(20).EQ.2,UB1;
UB1     UNBATCH,29;
        AWAIT(11),ALLOC(11);
        ENTER,21;
        ACT/1,ATRIB(11);
        EVENT,11;
        BATCH,4/19,50;
        EVENT,21
        ACT/41,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D2      GOON;
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         ACT/32,UNFRM(1,5);
         GOON,1;
           ACT,,ATRIB(1).NE.2,A2;
           ACT,,,SB2;
SB2      UNBATCH,28;
A2       AWAIT(2),ALLOC(2);
E2       ENTER,2;
         ASSIGN,ATRIB(20)=XX(2);
         EVENT,2;
           ACT,,,P2;
E12      ENTER,12;
         ASSIGN,ATRIB(20)=0;
           ACT,,,P2;
P2       GOON,1;
           ACT,,ATRIB(20).EQ.0,UB2;
           ACT/12,11.33,ATRIB(20).EQ.1,UB2;
           ACT/22,22.66,ATRIB(20).EQ.2,UB2;
UB2      UNBATCH,29;
         AWAIT(12),ALLOC(12);
         ENTER,22;
         ACT/2,ATRIB(12);
         EVENT,12;
         BATCH,4/19,50;
         EVENT,22;
         ACT/42,UNFRM(1,5);
         ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
           ACT,,ATRIB(10).EQ.1,R2;
           ACT,,ATRIB(10).EQ.2,R3;
           ACT,,ATRIB(10).EQ.3,R4;
           ACT,,ATRIB(10).EQ.4,R5;
           ACT,,ATRIB(10).EQ.5,R6;
           ACT,,ATRIB(10).EQ.6,SR;
D3       GOON;
         ACT/33,UNFRM(1,5);
         GOON,1;
           ACT,,ATRIB(1).NE.3,A3;
           ACT,,,SB3;
SB3      UNBATCH,28;
A3       AWAIT(3),ALLOC(3);
E3       ENTER,3;
         ASSIGN,ATRIB(20)=XX(3);
         EVENT,3;
           ACT,,,P3;
E13      ENTER,13;
         ASSIGN,ATRIB(20)=0;
           ACT,,,P3;
P3       GOON,1;
           ACT,,ATRIB(20).EQ.0,UB3;
           ACT/13,11.33,ATRIB(20).EQ.1,UB3;
           ACT/23,22.66,ATRIB(20).EQ.2,UB3;
UB3      UNBATCH,29;
         AWAIT(13),ALLOC(13);
         ENTER,23;
         ACT/3,ATRIB(13);
         EVENT,13;
         BATCH,4/19,50;
         EVENT,23;
         ACT/43,UNFRM(1,5);
         ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
           ACT,,ATRIB(10).EQ.1,R2;
           ACT,,ATRIB(10).EQ.2,R3;
           ACT,,ATRIB(10).EQ.3,R4;
           ACT,,ATRIB(10).EQ.4,R5;
           ACT,,ATRIB(10).EQ.5,R6;
           ACT,,ATRIB(10).EQ.6,SR;
D4       GOON;
         ACT/34,UNFRM(1,5);
         GOON,1;
           ACT,,ATRIB(1).NE.4,A4;
           ACT,,,SB4;
SB4      UNBATCH,28;
A4       AWAIT(4),ALLOC(4);
E4       ENTER,4;
         ASSIGN,ATRIB(20)=XX(4);
         EVENT,4;
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              ACT,,,P4;
E14         ENTER,14;
            ASSIGN,ATRIB(20)=0;
              ACT,,,P4;
P4          GOON,1;
              ACT,,ATRIB(20).EQ.0,UB4;
              ACT/14,11.33,ATRIB(20).EQ.1,UB4;
              ACT/24,22.66,ATRIB(20).EQ.2,UB4;
UB4         UNBATCH,29;
            AWAIT(14),ALLOC(14);
            ENTER,24;
            ACT/4,ATRIB(14);
            EVENT,14;
            BATCH,4/19,50;
            EVENT,24;
            ACT/44,UNFRM(1,5);
            ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
              ACT,,ATRIB(10).EQ.1,R2;
              ACT,,ATRIB(10).EQ.2,R3;
              ACT,,ATRIB(10).EQ.3,R4;
              ACT,,ATRIB(10).EQ.4,R5;
              ACT,,ATRIB(10).EQ.5,R6;
              ACT,,ATRIB(10).EQ.6,SR;
D5          GOON;
            ACT/35,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.5,A5;
              ACT,,,SB5;
SB5         UNBATCH,28;
A5          AWAIT(5),ALLOC(5);
E5          ENTER,5;
            ASSIGN,ATRIB(20)=XX(5);
            EVENT,5;
             ACT,,,P5;
E15         ENTER,15;
            ASSIGN,ATRIB(20)=0;
              ACT,,,P5;
P5          GOON,1;
              ACT,,ATRIB(20).EQ.0,UB5;
              ACT/15,11.33,ATRIB(20).EQ.1,UB5;
              ACT/25,22.66,ATRIB(20).EQ.2,UB5;
UB5         UNBATCH,29;
            AWAIT(15),ALLOC(15);
            ENTER,25;
            ACT/5,ATRIB(15);
            EVENT,15;
            BATCH,4/19,50;
            EVENT,25;
            ACT/45,UNFRM(1,5);
            ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
              ACT,,ATRIB(10).EQ.1,R2;
              ACT,,ATRIB(10).EQ.2,R3;
              ACT,,ATRIB(10).EQ.3,R4;
              ACT,,ATRIB(10).EQ.4,R5;
              ACT,,ATRIB(10).EQ.5,R6;
              ACT,,ATRIB(10).EQ.6,SR;
D6          GOON;
            ACT/36,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.6,A6;
              ACT,,,SB6;
SB6         UNBATCH,28;
A6          AWAIT(6),ALLOC(6);
E6          ENTER,6;
            ASSIGN,ATRIB(20)=XX(6);
            EVENT,6;
              ACT,,,P6;
E16         ENTER,16;
            ASSIGN,ATRIB(20)=0;
              ACT,,,P6;
P6          GOON,1;
              ACT,,ATRIB(20).EQ.0,UB6;
              ACT/16,11.33,ATRIB(20).EQ.1,UB6;
              ACT/26,22.66,ATRIB(20).EQ.2,UB6;
UB6         UNBATCH,29;
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          AWAIT(16),ALLOC(16);
          ENTER,26;
          ACT/6,ATRIB(16);
          EVENT,16;
          BATCH,4/19,50;
          EVENT,26;
          ACT/46,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D7        GOON;
          ACT/37,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.7,A7;
            ACT,,,SB7;
SB7       UNBATCH,28;
A7        AWAIT(7),ALLOC(7);
E7        ENTER,7;
          ASSIGN,ATRIB(20)=XX(7);
          EVENT,7;
            ACT,,,P7;
E17       ENTER,17;
          ASSIGN,ATRIB(20)=0;
            ACT,,,P7;
P7        GOON,1;
            ACT,,ATRIB(20).EQ.0,UB7;
            ACT/17,11.33,ATRIB(20).EQ.1,UB7;
            ACT/27,22.66,ATRIB(20).EQ.2,UB7;
UB7       UNBATCH,29;
          AWAIT(17),ALLOC(17);
          ENTER,27;
          ACT/7,ATRIB(17);
          EVENT,17;
          BATCH,4/19,50;
          EVENT,27;
          ACT/47,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D8        GOON;
          ACT/38,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.8,A8;
            ACT,,,SB8;
;UNBATCH INTO SUBBATCHES
SB8       UNBATCH,28;
;WAIT FOR START BATCH RESOURCE
A8        AWAIT(8),ALLOC(8);
E8        ENTER,8;
          ASSIGN,ATRIB(20)=XX(8);
          EVENT,8;
            ACT,,,P8;
E18       ENTER,18;
          ASSIGN,ATRIB(20)=0;
            ACT,,,P8;
P8        GOON,1;
            ACT,,ATRIB(20).EQ.0,UB8;
            ACT/18,11.33,ATRIB(20).EQ.1,UB8;
            ACT/28,22.66,ATRIB(20).EQ.2,UB8;
;UNBATCH INDIVIDUAL PARTS FROM SUB-BATCH
UB8       UNBATCH,29;
          AWAIT(18),ALLOC(18);
          ENTER,28;
;PROCESS THE PARTS
          ACT/8,ATRIB(18);
          EVENT,18;
          BATCH,4/19,50;
```

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          EVENT,28;
          ACT/48,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
;SEND TO NEXT DEPT.
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
;PUT BACK INTO FULL BATCHES GATHER STATS & LEAVE
SR        UNBATCH,29;
          BATCH,50/19,100;
          ACT/57,ATRIB(27);
T2        ASSIGN,XX(9)=XX(9)-1;
          COLCT(1),INT(19),TIME IN SYS;
          TERMINATE;
          ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000;
FIN;
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D.6 SMALL PROCESS SHOP MODEL – 1% BATCH SPLIT

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GEN,DAVID BROCK,SM_PROC_1,3/10/97,,NO,NO,,,,72;
LIMITS,18,30,4000;
TIMST,XX(9),WIP;
SEEDS,6543216323(9);
;SET INITIAL VARIABLES
INTLC,XX(1)=0,XX(2)=0,XX(3)=0,XX(4)=0,XX(5)=0,XX(69)=0;
INTLC,XX(6)=0,XX(7)=0,XX(8)=0,XX(9)=0,XX(10)=0;
;SET INITIAL ARRAY VALUES
ARRAY(1,3)/1.,1.,1.;
ARRAY(2,3)/1.,1.,1.;
ARRAY(3,3)/1.,1.,1.;
ARRAY(4,3)/1.,1.,1.;
ARRAY(5,3)/1.,1.,1.;
ARRAY(6,3)/1.,1.,1.;
ARRAY(7,3)/1.,1.,1.;
ARRAY(8,3)/1.,1.,1.;
ARRAY(11,3)/0.,0.,0.;
ARRAY(12,3)/0.,0.,0.;
ARRAY(13,3)/0.,0.,0.;
ARRAY(14,3)/0.,0.,0.;
ARRAY(15,3)/0.,0.,0.;
ARRAY(16,3)/0.,0.,0.;
ARRAY(17,3)/0.,0.,0.;
ARRAY(18,3)/0.,0.,0.;
ARRAY(21,3)/101.,101.,101.;
ARRAY(22,3)/101.,101.,101.;
ARRAY(23,3)/101.,101.,101.;
ARRAY(24,3)/101.,101.,101.;
ARRAY(25,3)/101.,101.,101.;
ARRAY(26,3)/101.,101.,101.;
ARRAY(27,3)/101.,101.,101.;
ARRAY(28,3)/101.,101.,101.;
ARRAY(31,3)/1.,1.,1.;
ARRAY(32,3)/1.,1.,1.;
ARRAY(33,3)/1.,1.,1.;
ARRAY(34,3)/1.,1.,1.;
ARRAY(35,3)/1.,1.,1.;
ARRAY(36,3)/1.,1.,1.;
ARRAY(37,3)/1.,1.,1.;
ARRAY(38,3)/1.,1.,1.;
ARRAY(41,3)/0.,0.,0.;
ARRAY(42,3)/0.,0.,0.;
ARRAY(43,3)/0.,0.,0.;
ARRAY(44,3)/0.,0.,0.;
ARRAY(45,3)/0.,0.,0.;
ARRAY(46,3)/0.,0.,0.;
ARRAY(47,3)/0.,0.,0.;
ARRAY(48,3)/0.,0.,0.;
NETWORK;
;SET RESOURCES
        RESOURCE/1,X1(2),1/2,X2(3),2/3,X3(2),3;
        RESOURCE/4,X4(3),4/5,X5(3),5/6,X6(3),6;
        RESOURCE/7,X7(2),7/8,X8(2),8/11,D1(2),11;
        RESOURCE/12,D2(3),12/13,D3(2),13/14,D4(3),14;
        RESOURCE/15,D5(3),15/16,D6(3),16/17,D7(2),17;
        RESOURCE/18,D8(2),18;
;ARRIVALS
        CREATE,EXPON(8),1,19;
        ASSIGN,XX(9)=XX(9)+1,XX(10)=XX(10)+1;
        ASSIGN,XX(69)=XX(69)+1,ATRIB(30)=XX(69);
        ASSIGN,ATRIB(28)=100.,ATRIB(29)=1.,1;
          ACT,,0.2,F1;
          ACT,,0.25,F2;
          ACT,,0.15,F3;
          ACT,,0.2,F4;
          ACT,,0.2,F5;
;ASSIGN TO A FAMILY
F1      ASSIGN,ATRIB(8)=1,1;
          ACT,,0.125,PN1;
          ACT,,0.125,PN2;
          ACT,,0.125,PN3;
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          ACT,,0.125,PN4;
          ACT,,0.125,PN5;
          ACT,,0.125,PN6;
          ACT,,0.125,PN7;
          ACT,,0.125,PN8;
F2      ASSIGN,ATRIB(8)=2,1;
          ACT,,0.1,PN9;
          ACT,,0.1,PN10;
          ACT,,0.1,PN11;
          ACT,,0.1,PN12;
          ACT,,0.1,PN13;
          ACT,,0.1,PN14;
          ACT,,0.1,PN15;
          ACT,,0.1,PN16;
          ACT,,0.1,PN17;
          ACT,,0.1,PN18;
F3      ASSIGN,ATRIB(8)=3,1;
          ACT,,0.16666,PN27;
          ACT,,0.16666,PN28;
          ACT,,0.16667,PN29;
          ACT,,0.16667,PN30;
          ACT,,0.16667,PN31;
          ACT,,0.16667,PN32;
F4      ASSIGN,ATRIB(8)=4,1;
          ACT,,0.125,PN19;
          ACT,,0.125,PN20;
          ACT,,0.125,PN21;
          ACT,,0.125,PN22;
          ACT,,0.125,PN23;
          ACT,,0.125,PN24;
          ACT,,0.125,PN25;
          ACT,,0.125,PN26;
F5      ASSIGN,ATRIB(8)=5,1;
          ACT,,0.125,PN33;
          ACT,,0.125,PN34;
          ACT,,0.125,PN35;
          ACT,,0.125,PN36;
          ACT,,0.125,PN37;
          ACT,,0.125,PN38;
          ACT,,0.125,PN39;
          ACT,,0.125,PN40;
;ASSIGN PART #s, ROUTINGS, AND PROCESSING TIMES
PN1       ASSIGN,ATRIB(9)=1,ATRIB(1)=5,ATRIB(2)=0,
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1273,ATRIB(27)=.1273;
            ACT,,,R1;
PN2       ASSIGN,ATRIB(9)=2,ATRIB(1)=3,ATRIB(2)=4,
          ATRIB(3)=5,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
          ATRIB(23)=.0568,ATRIB(27)=.1273;
            ACT,,,R1;
PN3       ASSIGN,ATRIB(9)=3,ATRIB(1)=3,ATRIB(2)=4,
          ATRIB(3)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
          ATRIB(27)=.0705;
            ACT,,,R1;
PN4       ASSIGN,ATRIB(9)=4,ATRIB(1)=3,ATRIB(2    ;
          ASSIGN,ATRIB(3)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0966,
          ATRIB(27)=.1273;
            ACT,,,R1;
PN5       ASSIGN,ATRIB(9)=5,ATRIB(1)=5,ATRIB(2)=  ,
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1273,ATRIB(27)=.1273;
            ACT,,,R1;
PN6       ASSIGN,ATRIB(9)=6,ATRIB(1)=3,ATRIB(2)=4,
          ATRIB(3)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
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        ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
        ATRIB(27)=.0705;
          ACT,,,R1;
PN7     ASSIGN,ATRIB(9)=7,ATRIB(1)=3,ATRIB(2)=4,
        ATRIB(3)=5,ATRIB(4)=0;
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
        ATRIB(14)=RNORM(.3433,.0858),
        ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
        ATRIB(23)=.0568,ATRIB(27)=.1273;
          ACT,,,R1;
PN8     ASSIGN,ATRIB(9)=8,ATRIB(1)=4,ATRIB(2)=5,
        ATRIB(3)=0;
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858),
        ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0705,ATRIB(22)=.0528,
        ATRIB(27)=.0795;
          ACT,,,R1;
PN9     ASSIGN,ATRIB(9)=9,ATRIB(1)=6,ATRIB(2)=0;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(27)=.175;
          ACT,,,R1;
PN10    ASSIGN,ATRIB(9)=10,ATRIB(1)=8,ATRIB(2)=0;
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
          ACT,,,R1;
PN11    ASSIGN,ATRIB(9)=11,ATRIB(1)=8,ATRIB(2)=0;
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
          ACT,,,R1;
PN12    ASSIGN,ATRIB(9)=12,ATRIB(1)=7,ATRIB(2)=0;
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
          ACT,,,R1;
PN13    ASSIGN,ATRIB(9)=13,ATRIB(1)=6,ATRIB(2)=0;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(27)=.175;
          ACT,,,R1;
PN14    ASSIGN,ATRIB(9)=14,ATRIB(1)=8,ATRIB(2)=0;
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
          ACT,,,R1;
PN15    ASSIGN,ATRIB(9)=15,ATRIB(1)=6,ATRIB(2)=8;
        ASSIGN,ATRIB(3)=0;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(22)=.1193;
        ASSIGN,ATRIB(27)=.1466;
          ACT,,,R1;
PN16    ASSIGN,ATRIB(9)=16,ATRIB(1)=7,ATRIB(2)=0;
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
          ACT,,,R1;
PN17    ASSIGN,ATRIB(9)=17,ATRIB(1)=6,ATRIB(2)=7;
        ASSIGN,ATRIB(3)=8,ATRIB(4)=0;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(22)=.0511;
        ASSIGN,ATRIB(23)=.0682;
        ASSIGN,ATRIB(27)=.1466;
          ACT,,,R1;
PN18    ASSIGN,ATRIB(9)=18,ATRIB(1)=7,ATRIB(2)=0;
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
          ACT,,,R1;
PN19    ASSIGN,ATRIB(9)=19,ATRIB(1)=4,ATRIB(2)=8;
        ASSIGN,ATRIB(3)=0;
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0705,ATRIB(22)=.142;
        ASSIGN,ATRIB(27)=.1466;
          ACT,,,R1;
PN20    ASSIGN,ATRIB(9)=20,ATRIB(1)=2,ATRIB(2)=3;
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        ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
        ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN21    ASSIGN,ATRIB(9)=21,ATRIB(1)=2,ATRIB(2)=6;
        ASSIGN,ATRIB(3)=8,ATRIB(4)=0,;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0795;
        ASSIGN,ATRIB(23)=.1193,ATRIB(27)=.185;
          ACT,,,R1;
PN22    ASSIGN,ATRIB(9)=22,ATRIB(1)=2,ATRIB(2)=3;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
        ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN23    ASSIGN,ATRIB(9)=23,ATRIB(1)=8,ATRIB(2)=0;
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
          ACT,,,R1;
PN24    ASSIGN,ATRIB(9)=24,ATRIB(1)=2,ATRIB(2)=3;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
        ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN25    ASSIGN,ATRIB(9)=25,ATRIB(1)=6,ATRIB(2)=8;
        ASSIGN,ATRIB(3)=0,;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(22)=.1193;
        ASSIGN,ATRIB(27)=.1466;
          ACT,,,R1;
PN26    ASSIGN,ATRIB(9)=26,ATRIB(1)=2,ATRIB(2)=3;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
        ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN27    ASSIGN,ATRIB(9)=27,ATRIB(1)=2,ATRIB(2)=4;
        ASSIGN,ATRIB(3)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.1023;
        ASSIGN,ATRIB(27)=.131;
          ACT,,,R1;
PN28    ASSIGN,ATRIB(9)=28,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
        ASSIGN,ATRIB(23)=.1023,ATRIB(24)=.0568;
        ASSIGN,ATRIB(27)=.153;
          ACT,,,R1;
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PN29     ASSIGN,ATRIB(9)=29,ATRIB(1)=1,ATRIB(2)=4;
         ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.1761;
         ASSIGN,ATRIB(23)=.0568,ATRIB(27)=.1273;
           ACT,,,R1;
PN30     ASSIGN,ATRIB(9)=30,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
         ASSIGN,ATRIB(23)=.1023,ATRIB(27)=.0705;
           ACT,,,R1;
PN31     ASSIGN,ATRIB(9)=31,ATRIB(1)=2,ATRIB(2)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(27)=.0955;
           ACT,,,R1;
PN32     ASSIGN,ATRIB(9)=32,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
         ASSIGN,ATRIB(23)=.1023,ATRIB(27)=.0705;
           ACT,,,R1;
PN33     ASSIGN,ATRIB(9)=33,ATRIB(1)=2,ATRIB(2)=6;
         ASSIGN,ATRIB(3)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0795;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN34     ASSIGN,ATRIB(9)=34,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
         ASSIGN,ATRIB(23)=.1591,ATRIB(24)=.0795;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN35     ASSIGN,ATRIB(9)=35,ATRIB(1)=6,ATRIB(2)=7;
         ASSIGN,ATRIB(3)=0;
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.175,ATRIB(22)=.0511;
         ASSIGN,ATRIB(27)=.2148;
           ACT,,,R1;
PN36     ASSIGN,ATRIB(9)=36,ATRIB(1)=5,ATRIB(2)=6;
         ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1273,ATRIB(22)=.0795;
         ASSIGN,ATRIB(23)=.0511,ATRIB(27)=.2148;
           ACT,,,R1;
PN37     ASSIGN,ATRIB(9)=37,ATRIB(1)=5,ATRIB(2)=6;
         ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1273,ATRIB(22)=.0795;
         ASSIGN,ATRIB(23)=.0511,ATRIB(27)=.2148;
           ACT,,,R1;
PN38     ASSIGN,ATRIB(9)=38,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
         ASSIGN,ATRIB(23)=.1591,ATRIB(27)=.1273;
```

```
             ACT,,,R1;
PN39       ASSIGN,ATRIB(9)=39,ATRIB(1)=2,ATRIB(2)=5;
           ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
           ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.1591;
           ASSIGN,ATRIB(23)=.0795,ATRIB(27)=.175;
             ACT,,,R1;
PN40       ASSIGN,ATRIB(9)=40,ATRIB(1)=1,ATRIB(2)=[illegible];
           ASSIGN,ATRIB(3)=5,ATRIB(4)=7,ATRIB(5)=0;
           ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
           ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
           ASSIGN,ATRIB(23)=.1591,ATRIB(24)=.1307;
           ASSIGN,ATRIB(27)=.2148;
             ACT,,,R1;
;ROUTE ENTITY TO APPROPRIATE DEPARTMENT
R1         GOON;
           ACT/51,ATRIB(21);
           GOON,1;
             ACT,,ATRIB(1).EQ.0,SR;
             ACT,,ATRIB(1).EQ.1,D1;
             ACT,,ATRIB(1).EQ.2,D2;
             ACT,,ATRIB(1).EQ.3,D3;
             ACT,,ATRIB(1).EQ.4,D4;
             ACT,,ATRIB(1).EQ.5,D5;
             ACT,,ATRIB(1).EQ.6,D6;
             ACT,,ATRIB(1).EQ.7,D7;
             ACT,,ATRIB(1).EQ.8,D8;
R2         GOON;
           ACT/52,ATRIB(22);
           GOON,1;
             ACT,,ATRIB(2).EQ.0,SR;
             ACT,,ATRIB(2).EQ.1,D1;
             ACT,,ATRIB(2).EQ.2,D2;
             ACT,,ATRIB(2).EQ.3,D3;
             ACT,,ATRIB(2).EQ.4,D4;
             ACT,,ATRIB(2).EQ.5,D5;
             ACT,,ATRIB(2).EQ.6,D6;
             ACT,,ATRIB(2).EQ.7,D7;
             ACT,,ATRIB(2).EQ.8,D8;
R3         GOON;
           ACT/53,ATRIB(23);
           GOON,1;
             ACT,,ATRIB(3).EQ.0,SR;
             ACT,,ATRIB(3).EQ.1,D1;
             ACT,,ATRIB(3).EQ.2,D2;
             ACT,,ATRIB(3).EQ.3,D3;
             ACT,,ATRIB(3).EQ.4,D4;
             ACT,,ATRIB(3).EQ.5,D5;
             ACT,,ATRIB(3).EQ.6,D6;
             ACT,,ATRIB(3).EQ.7,D7;
             ACT,,ATRIB(3).EQ.8,D8;
R4         GOON;
           ACT/54,ATRIB(24);
           GOON,1;
             ACT,,ATRIB(4).EQ.0,SR;
             ACT,,ATRIB(4).EQ.1,D1;
             ACT,,ATRIB(4).EQ.2,D2;
             ACT,,ATRIB(4).EQ.3,D3;
             ACT,,ATRIB(4).EQ.4,D4;
             ACT,,ATRIB(4).EQ.5,D5;
             ACT,,ATRIB(4).EQ.6,D6;
             ACT,,ATRIB(4).EQ.7,D7;
             ACT,,ATRIB(4).EQ.8,D8;
R5         GOON;
           ACT/55,ATRIB(25);
           GOON,1;
             ACT,,ATRIB(5).EQ.0,SR;
             ACT,,ATRIB(5).EQ.1,D1;
             ACT,,ATRIB(5).EQ.2,D2;
             ACT,,ATRIB(5).EQ.3,D3;
```

```
          ACT,,ATRIB(5).EQ.4,D4;
          ACT,,ATRIB(5).EQ.5,D5;
          ACT,,ATRIB(5).EQ.6,D6;
          ACT,,ATRIB(5).EQ.7,D7;
          ACT,,ATRIB(5).EQ.8,D8;
R6      GOON;
        ACT/56,ATRIB(26);
        GOON,1;
          ACT,,ATRIB(6).EQ.0,SR;
          ACT,,ATRIB(6).EQ.1,D1;
          ACT,,ATRIB(6).EQ.2,D2;
          ACT,,ATRIB(6).EQ.3,D3;
          ACT,,ATRIB(6).EQ.4,D4;
          ACT,,ATRIB(6).EQ.5,D5;
          ACT,,ATRIB(6).EQ.6,D6;
          ACT,,ATRIB(6).EQ.7,D7;
          ACT,,ATRIB(6).EQ.8,D8;
D1      GOON;
        ACT/31,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.1,A1;
          ACT,,,SB1;
SB1     UNBATCH,28;
A1      AWAIT(1),ALLOC(1);
E1      ENTER,1;
        ASSIGN,ATRIB(20)=XX(1);
        EVENT,1;
          ACT,,,P1;
E11     ENTER,11;
        ASSIGN,ATRIB(20)=0;
          ACT,,,P1;
P1      GOON,1;
          ACT,,ATRIB(20).EQ.0,UB1;
          ACT/11,11.33,ATRIB(20).EQ.1,UB1;
          ACT/21,22.66,ATRIB(20).EQ.2,UB1;
UB1     UNBATCH,29;
        AWAIT(11),ALLOC(11);
        ENTER,21;
        ACT/1,ATRIB(11);
        EVENT,11;
        BATCH,3/19,ATRIB(29);
        EVENT,21
        ACT/41,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D2      GOON;
        ACT/32,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.2,A2;
          ACT,,,SB2;
SB2     UNBATCH,28;
A2      AWAIT(2),ALLOC(2);
E2      ENTER,2;
        ASSIGN,ATRIB(20)=XX(2);
        EVENT,2;
          ACT,,,P2;
E12     ENTER,12;
        ASSIGN,ATRIB(20)=0;
          ACT,,,P2;
P2      GOON,1;
          ACT,,ATRIB(20).EQ.0,UB2;
          ACT/12,11.33,ATRIB(20).EQ.1,UB2;
          ACT/22,22.66,ATRIB(20).EQ.2,UB2;
UB2     UNBATCH,29;
        AWAIT(12),ALLOC(12);
        ENTER,22;
        ACT/2,ATRIB(12);
        EVENT,12;
        BATCH,3/19,ATRIB(29);
        EVENT,22;
```

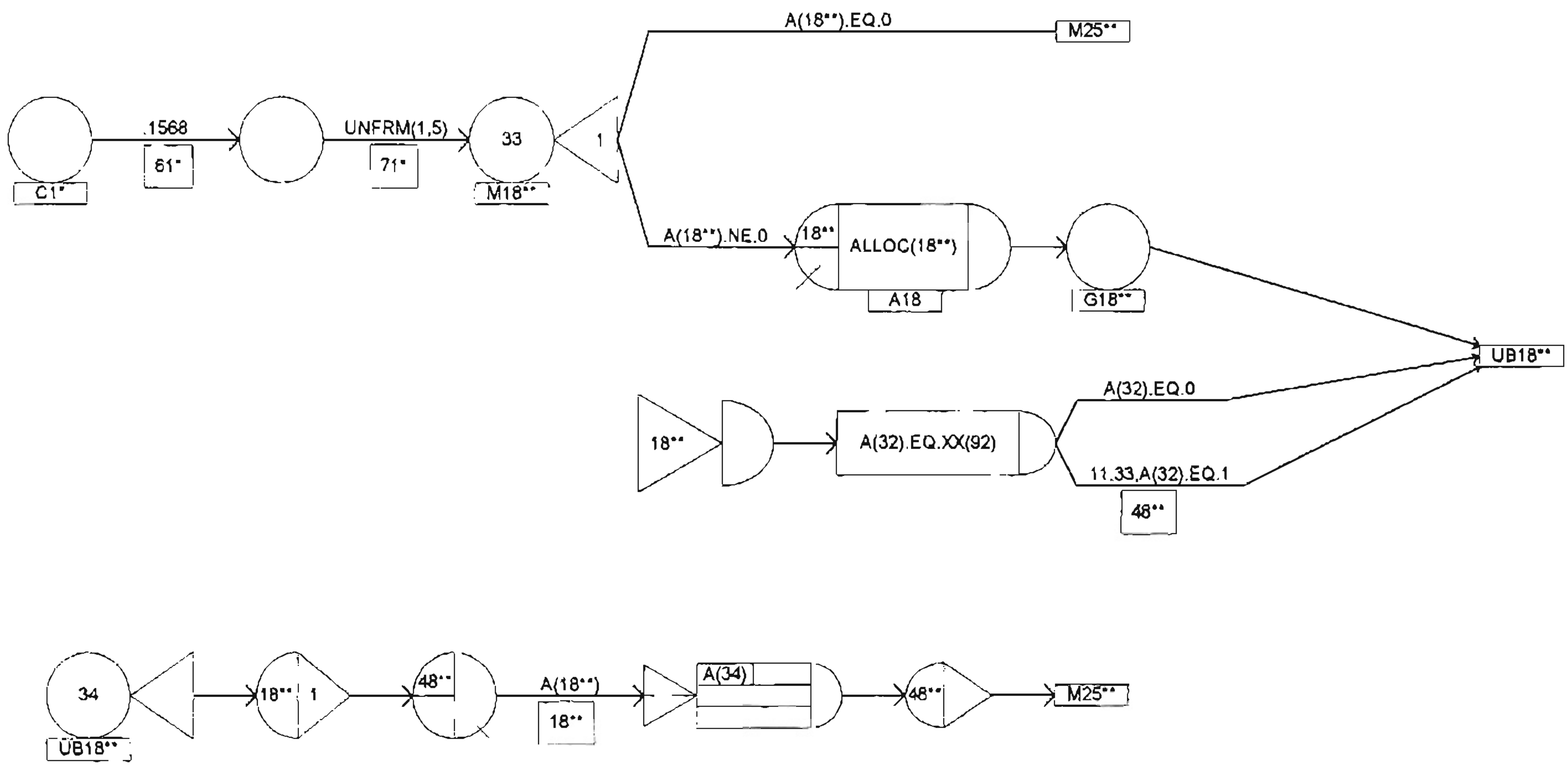
```
          ACT/42,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D3        GOON;
          ACT/33,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.3,A3;
            ACT,,,SB3;
SB3       UNBATCH,28;
A3        AWAIT(3),ALLOC(3);
E3        ENTER,3;
          ASSIGN,ATRIB(20)=XX(3);
          EVENT,3;
            ACT,,,P3;
E13       ENTER,13;
          ASSIGN,ATRIB(20)=0;
            ACT,,,P3;
P3        GOON,1;
            ACT,,ATRIB(20).EQ.0,UB3;
            ACT/13,11.33,ATRIB(20).EQ.1,UB3;
            ACT/23,22.66,ATRIB(20).EQ.2,UB3;
UB3       UNBATCH,29;
          AWAIT(13),ALLOC(13);
          ENTER,23;
          ACT/3,ATRIB(13);
          EVENT,13;
          BATCH,3/19,ATRIB(29);
          EVENT,23;
          ACT/43,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D4        GOON;
          ACT/34,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.4,A4;
            ACT,,,SB4;
SB4       UNBATCH,28;
A4        AWAIT(4),ALLOC(4);
E4        ENTER,4;
          ASSIGN,ATRIB(20)=XX(4);
          EVENT,4;
            ACT,,,P4;
E14       ENTER,14;
          ASSIGN,ATRIB(20)=0;
            ACT,,,P4;
P4        GOON,1;
            ACT,,ATRIB(20).EQ.0,UB4;
            ACT/14,11.33,ATRIB(20).EQ.1,UB4;
            ACT/24,22.66,ATRIB(20).EQ.2,UB4;
UB4       UNBATCH,29;
          AWAIT(14),ALLOC(14);
          ENTER,24;
          ACT/4,ATRIB(14);
          EVENT,14;
          BATCH,3/19,ATRIB(29);
          EVENT,24;
          ACT/44,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D5        GOON;
```

```
        ACT/35,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.5,A5;
          ACT,,,SB5;
SB5     UNBATCH,28;
A5      AWAIT(5),ALLOC(5);
E5      ENTER,5;
        ASSIGN,ATRIB(20)=XX(5);
        EVENT,5;
         ACT,,,P5;
E15     ENTER,15;
        ASSIGN,ATRIB(20)=0;
          ACT,,,P5;
P5      GOON,1;
          ACT,,ATRIB(20).EQ.0,UB5;
          ACT/15,11.33,ATRIB(20).EQ.1,UB5;
          ACT/25,22.66,ATRIB(20).EQ.2,UB5;
UB5     UNBATCH,29;
        AWAIT(15),ALLOC(15);
        ENTER,25;
        ACT/5,ATRIB(15);
        EVENT,15;
        BATCH,3/19,ATRIB(29);
        EVENT,25;
        ACT/45,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D6      GOON;
        ACT/36,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.6,A6;
          ACT,,,SB6;
SB6     UNBATCH,28;
A6      AWAIT(6),ALLOC(6);
E6      ENTER,6;
        ASSIGN,ATRIB(20)=XX(6);
        EVENT,6;
          ACT,,,P6;
E16     ENTER,16;
        ASSIGN,ATRIB(20)=0;
          ACT,,,P6;
P6      GOON,1;
          ACT,,ATRIB(20).EQ.0,UB6;
          ACT/16,11.33,ATRIB(20).EQ.1,UB6;
          ACT/26,22.66,ATRIB(20).EQ.2,UB6;
UB6     UNBATCH,29;
        AWAIT(16),ALLOC(16);
        ENTER,26;
        ACT/6,ATRIB(16);
        EVENT,16;
        BATCH,3/19,ATRIB(29);
        EVENT,26;
        ACT/46,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D7      GOON;
        ACT/37,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.7,A7;
          ACT,,,SB7;
SB7     UNBATCH,28;
A7      AWAIT(7),ALLOC(7);
E7      ENTER,7;
        ASSIGN,ATRIB(20)=XX(7);
        EVENT,7;
```

```
                ACT,,,P7;
E17           ENTER,17;
              ASSIGN,ATRIB(20)=0;
                ACT,,,P7;
P7            GOON,1;
                ACT,,ATRIB(20).EQ.0,UB7;
                ACT/17,11.33,ATRIB(20).EQ.1,UB7;
                ACT/27,22.66,ATRIB(20).EQ.2,UB7;
UB7           UNBATCH,29;
              AWAIT(17),ALLOC(17);
              ENTER,27;
              ACT/7,ATRIB(17);
              EVENT,17;
              BATCH,3/19,ATRIB(29);
              EVENT,27;
              ACT/47,UNFRM(1,5);
              ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
                ACT,,ATRIB(10).EQ.1,R2;
                ACT,,ATRIB(10).EQ.2,R3;
                ACT,,ATRIB(10).EQ.3,R4;
                ACT,,ATRIB(10).EQ.4,R5;
                ACT,,ATRIB(10).EQ.5,R6;
                ACT,,ATRIB(10).EQ.6,SR;
D8            GOON;
              ACT/38,UNFRM(1,5);
              GOON,1;
                ACT,,ATRIB(1).NE.8,A8;
                ACT,,,SB8;
;UNBATCH INTO SUBBATCHES
SB8           UNBATCH,28;
;WAIT FOR START BATCH RESOURCE
A8            AWAIT(8),ALLOC(8);
E8            ENTER,8;
              ASSIGN,ATRIB(20)=XX(8);
              EVENT,8;
                ACT,,,P8;
E18           ENTER,18;
              ASSIGN,ATRIB(20)=0;
                ACT,,,P8;
P8            GOON,1;
                ACT,,ATRIB(20).EQ.0,UB8;
                ACT/18,11.33,ATRIB(20).EQ.1,UB8;
                ACT/28,22.66,ATRIB(20).EQ.2,UB8;
;UNBATCH INDIVIDUAL PARTS FROM SUB-BATCH
UB8           UNBATCH,29;
              AWAIT(18),ALLOC(18);
              ENTER,28;
;PROCESS THE PARTS
              ACT/8,ATRIB(18);
              EVENT,18;
              BATCH,3/19,ATRIB(29);
              EVENT,28;
              ACT/48,UNFRM(1,5);
              ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
;SEND TO NEXT DEPT.
                ACT,,ATRIB(10).EQ.1,R2;
                ACT,,ATRIB(10).EQ.2,R3;
                ACT,,ATRIB(10).EQ.3,R4;
                ACT,,ATRIB(10).EQ.4,R5;
                ACT,,ATRIB(10).EQ.5,R6;
                ACT,,ATRIB(10).EQ.6,SR;
;PUT BACK INTO FULL BATCHES GATHER STATS & LEAVE
SR            UNBATCH,29;
              BATCH,50/19,100;
              ACT/57,ATRIB(27);
              ASSIGN,XX(9)=XX(9)-1;
              COLCT(1),INT(19),TIME IN SYS;
              TERMINATE;
              ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000;
FIN;
```

APPENDIX E

CM Shop Network Diagrams, Fortran, and Models



* These numbers are different for each cell.

** These numbers are different for each machine work center.

Figure 21 A - Cellular manufacturing shop network diagram - Cell 1, Machine 18

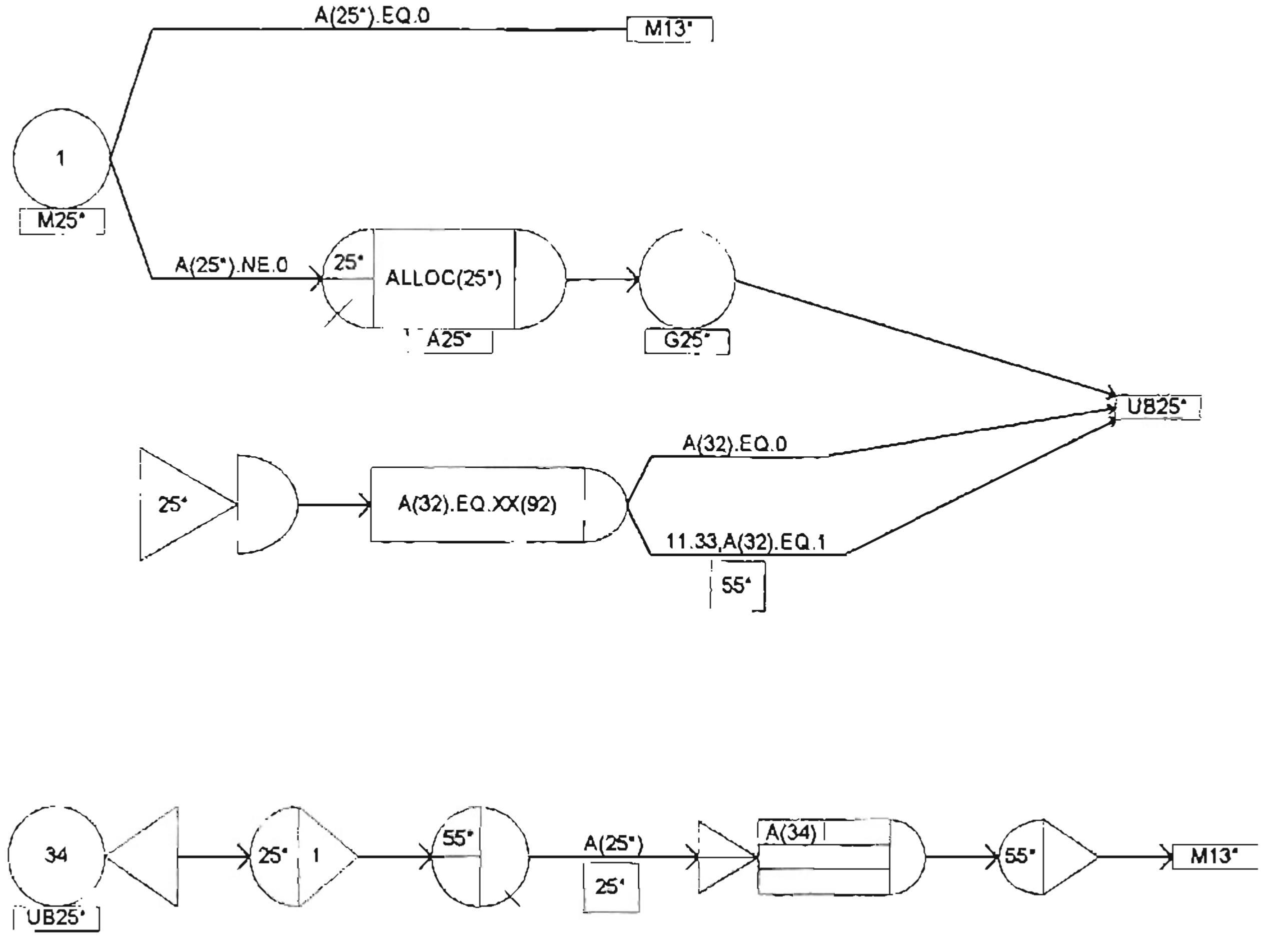


Figure 21 B - Cellular manufacturing shop network diagram - Cell 1, Machine 25.

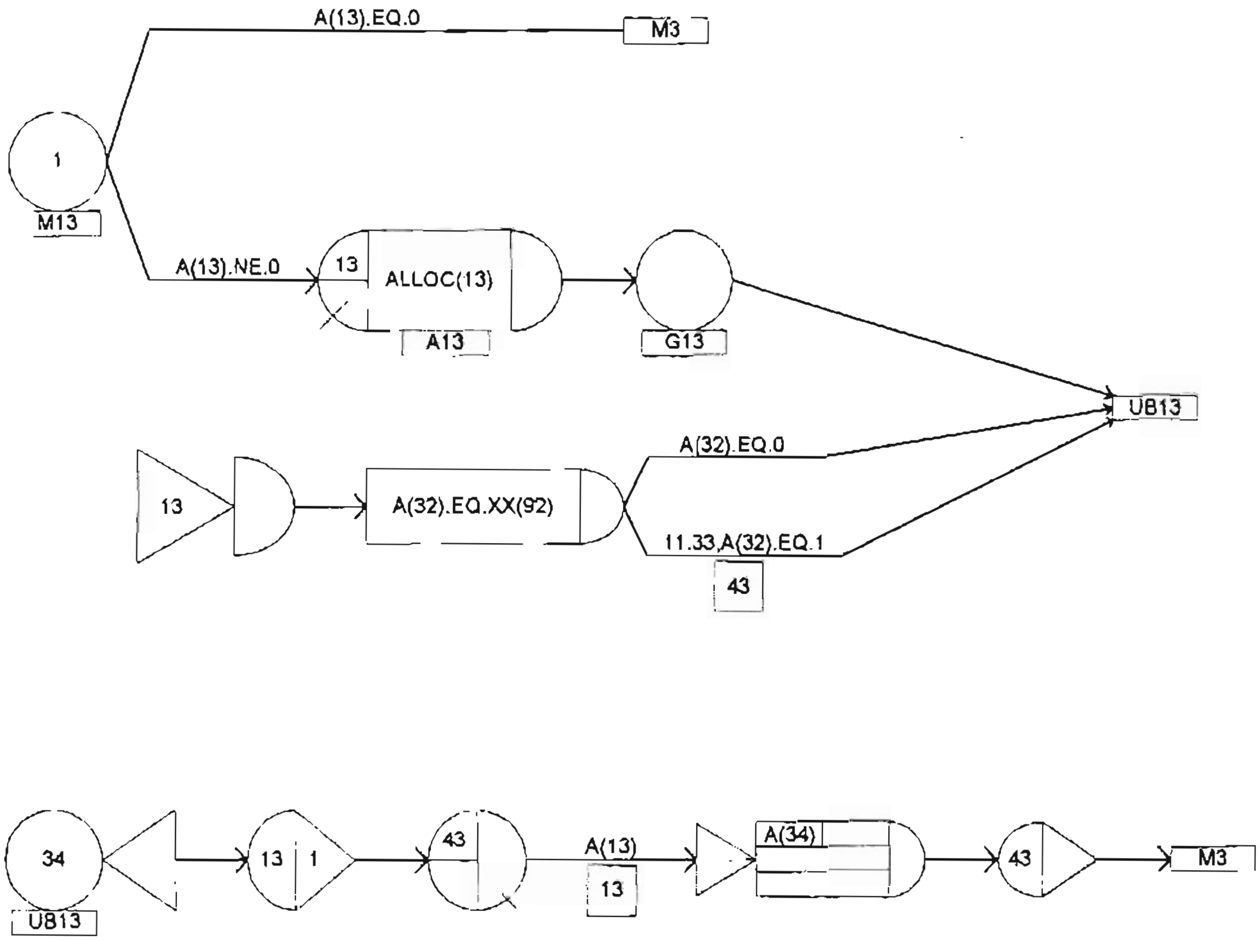


Figure 21 C - Cellular manufacturing shop network diagram - Cell 1, Machine 13

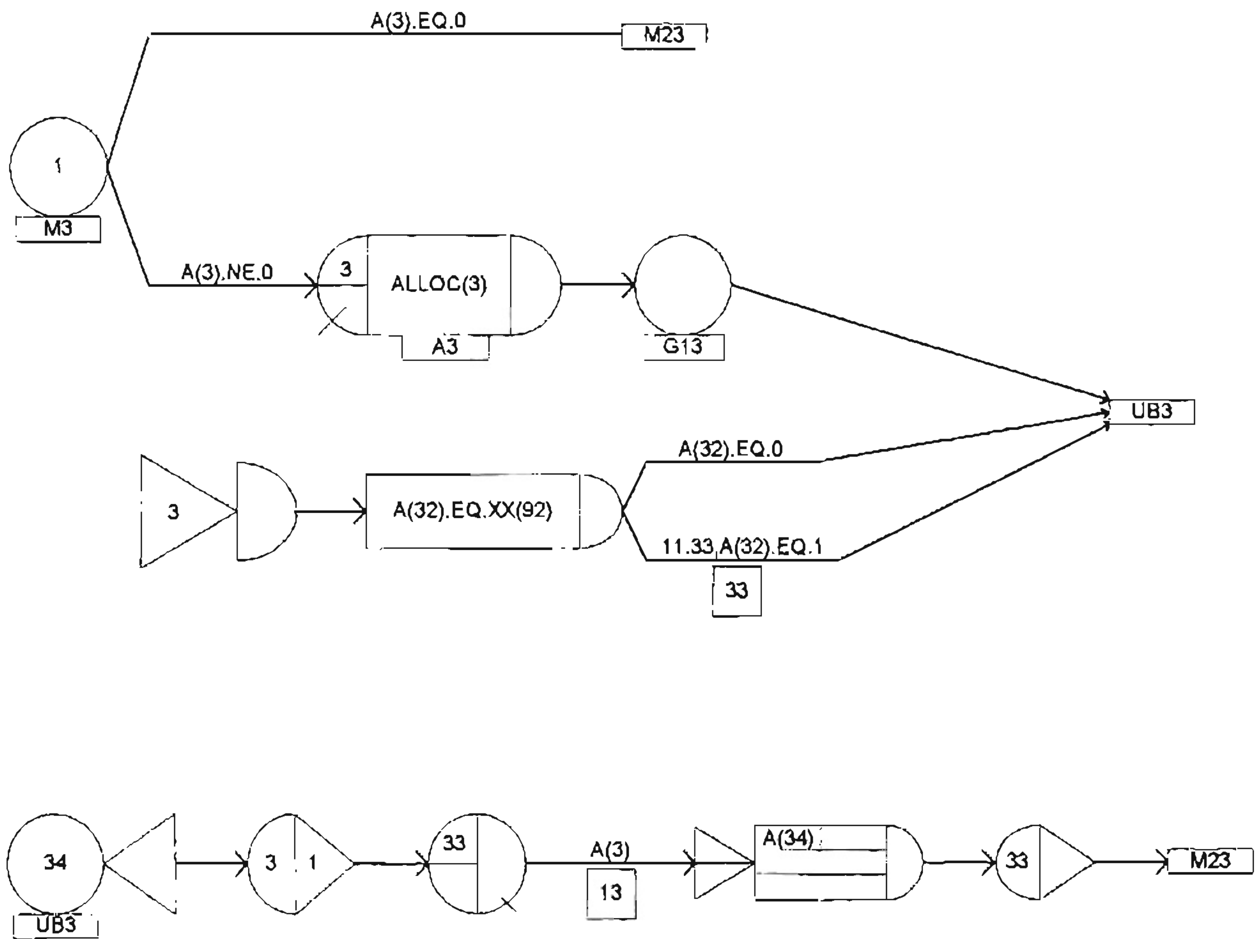


Figure 21 D - Cellular manufacturing shop network diagram - Cell 1, Machine 3

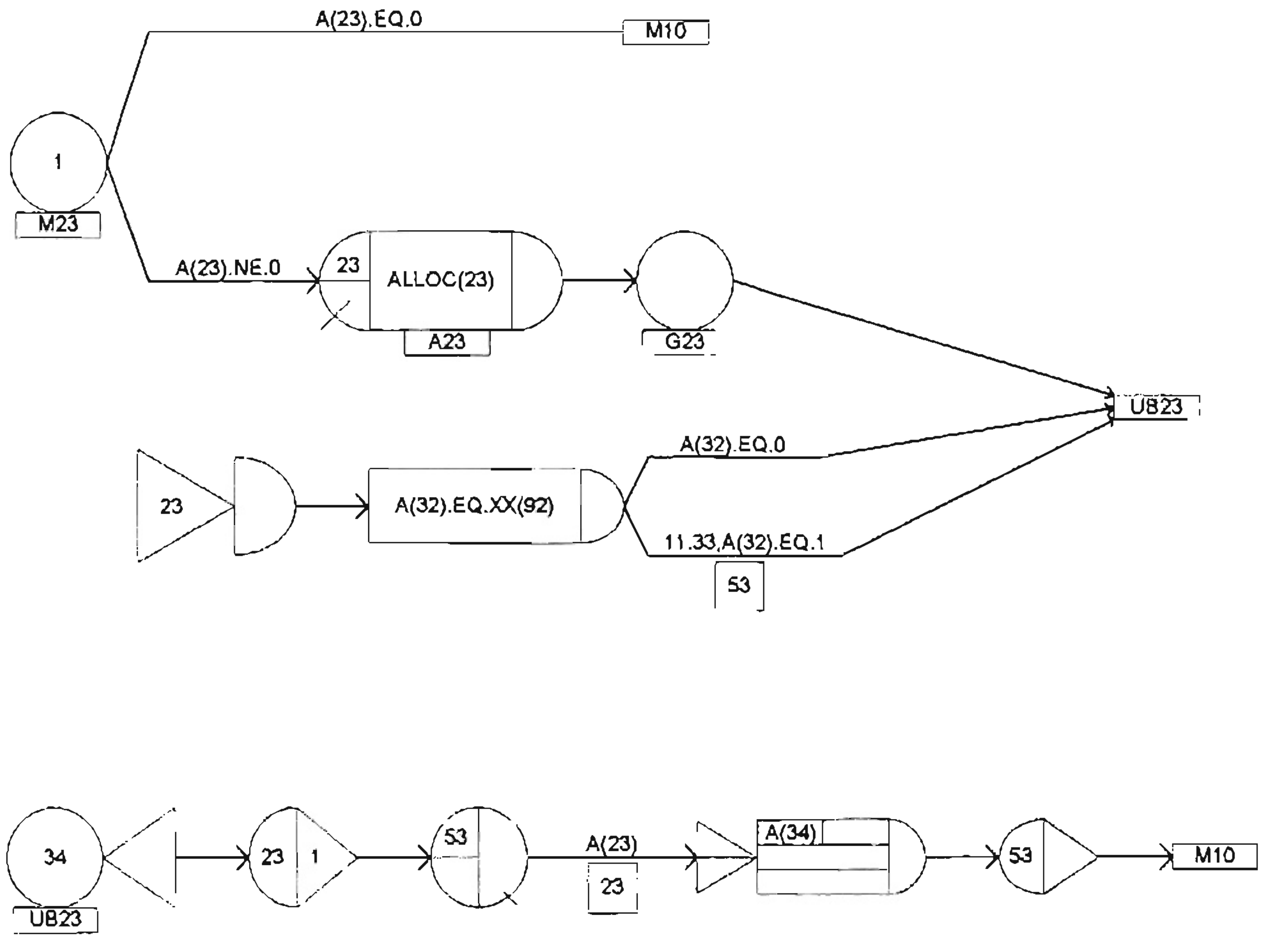


Figure 21 E - Cellular manufacturing shop network diagram - Cell 1, Machine 23

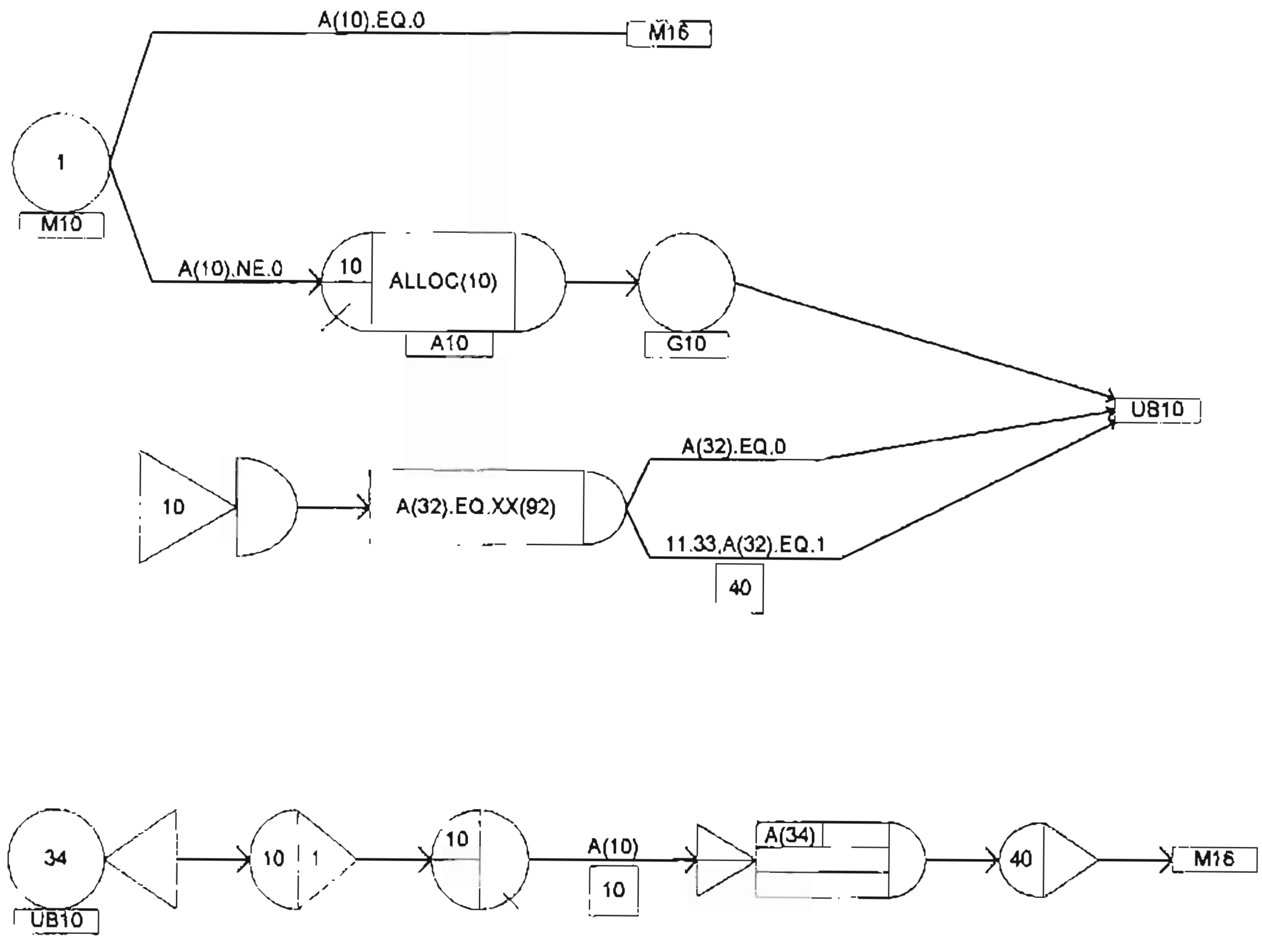


Figure 21 F - Cellular manufacturing shop network diagram - Cell 1, Machine 10

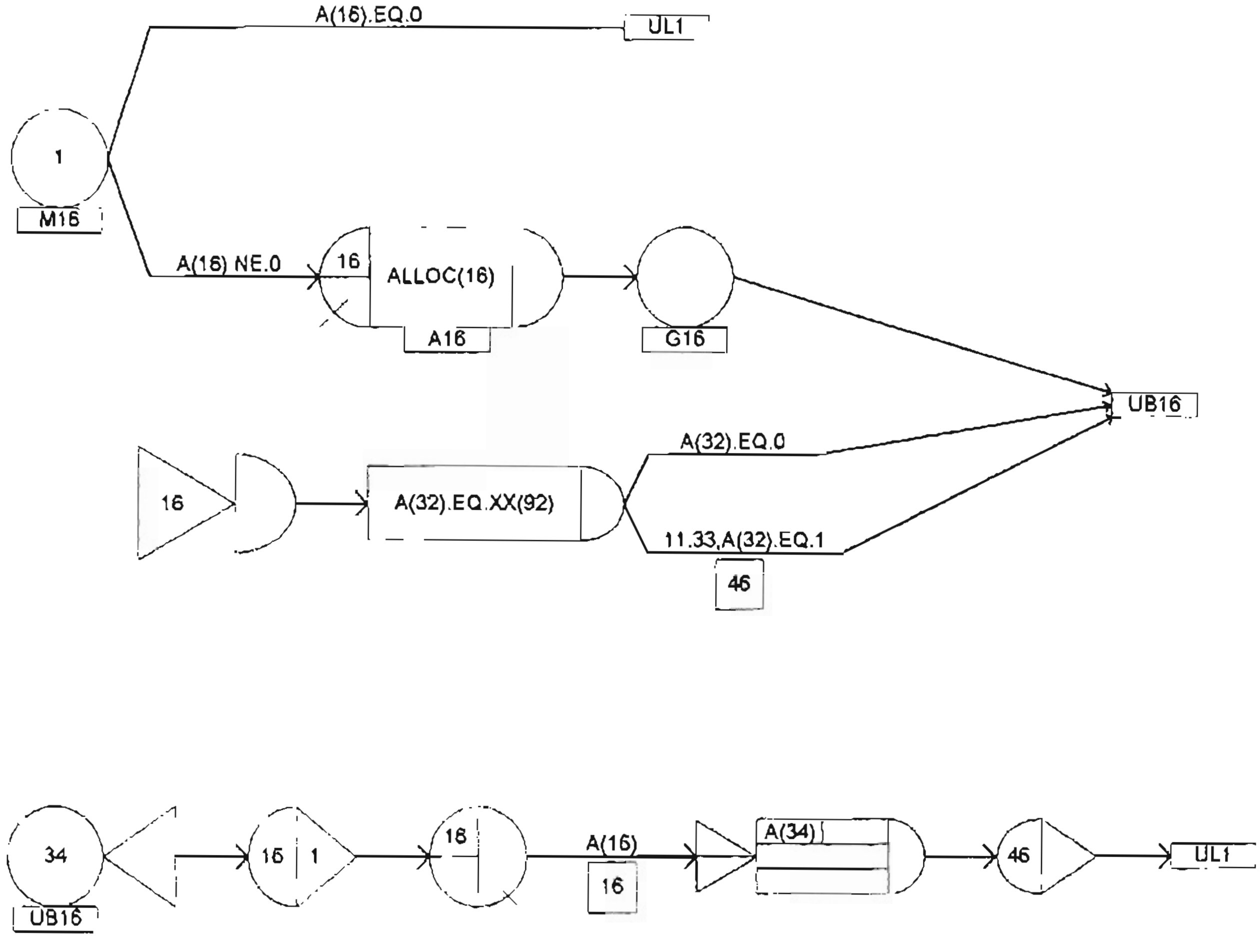


Figure 21 G - Cellular manufacturing shop network diagram - Cell 1, Machine 16

Table 12 - Attribute descriptions for the cellular manufacturing (CM) model.

ATTRIBUTE	DESCRIPTION
1-30	Processing times at machines 1-40
31	Entity identification # - Mark attribute (time that an entity enters the system)
32	Indicates set-up time (0 = no set-up, 1 = short set-up, 2 = long set-up
33	Indicates the number of sub-batches per batch
34	Indicates the number of entities per sub-batch
35	Indicates part number
36	Counts entities that enter system (entity number)

Table 13 - Variable descriptions for the cellular manufacturing (CM) model.

XX	DESCRIPTION
1-30	Entity number of entity that was last or is currently on a machine
31-60	part number of entity that was last or is currently on a machine
61-90	counts sub-batches that have been completed at station 1-30
91	Number of entities in the system
92	Set up indicator
93	Routes sub-batches to appropriate machine from event node

Table 14 - File descriptions for the cellular manufacturing (CM) model.

FILE	DESCRIPTION
1-30	Queue for start batch resource at machine 1-30
31-60	Queue for processing after machine has been assigned to the start-batch

Table 15 - Resource descriptions for the cellular manufacturing (CM) model.

RESOURCE	NUMBER	CAPACITY	DESCRIPTION
M1 - M30	1-30	1	Start batch resources for departments 1-30

Table 16 - Activity descriptions for the cellular manufacturing (CM) model.

ACTIVITIES	DESCRIPTION
1-30	Processing at machines 1-40
31-60	Set-up times in departments 1-40
61-65	Move times from receiving to cells 1-5
66-70	Move times from cells 1-5 to shipping
71-75	Loading times at cells 1-5
76-80	Unloading times at cells 1-5

E.1 CM MODEL ALLOC(I) SUBROUTINE

```
SUBROUTINE ALLOC(I)
       COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
      1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
      1,TNOW,XX(100)
C
C************
C
       DIMENSION Z(38)
       M=NNRSC(I)
       IFLAG=0
C
C IF ENTITY ALREADY HAS S.B. THEN SEND THROUGH
C
       N=0
       N=NFIND(1,I,31,0,XX(I),.00001)
       IF (N.GT.0) THEN
         XX(94)=I
         CALL RMOVE(N,I,Z)
         CALL ENTER(31,Z)
         RETURN
       ENDIF
C
C IF S.B. RESOURCE IS FREE, FIND NEXT ENTITY TO SEND
C
       N=0
       IF (M.GT.0) THEN
         N=NFIND(1,I,35,0,XX(I+30),.000001)
         IF (N.GT.0) GO TO 10
         N=NFIND(1,I,I,1,-50,.001)
         IF (N.GT.0) GO TO 15
       ENDIF
       RETURN
C
C INDICATE SET UP TIME AND SEIZE START BATCH
C
10     XX(92)=0.
       GO TO 20
15     XX(92)=1.
       GO TO 20
20     XX(I)=0
       XX(I+30)=0
       CALL SEIZE(I,1)
       CALL RMOVE(N,I,Z)
       CALL ENTER(I,Z)
       RETURN
       END
```

E.2 CM MODEL EVENT(I) SUBROUTINE

```
SUBROUTINE EVENT(I)
       COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
      1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
      1,TNOW,XX(100)
C
C DETERMINE WHICH EVENT NODE IS ACTIVE
C
       IF (I.LE.30) GO TO 10
       IF (I.GT.30) GO TO 20
C
C SET XX VARIABLES FOR NEW BATCH
C
10     B=ATRIB(31)
       C=ATRIB(35)
       XX(I)=B
       XX(I+30)=C
C
C SEE IF SUB-BATCHES SHOULD BE SENT
C
15     N=0
       N=NFIND(1,I,31,0,XX(I),.000001)
       IF (N.GT.0) THEN
         XX(94)=I
         CALL RMOVE(N,I,ATRIB)
         CALL ENTER(31,ATRIB)
         GO TO 15
       ENDIF
       RETURN
C
C COUNT SUB-BATCHES & FREE S.B. RESOURCES IF NEEDED
C
20     XX(I+30)=XX(I+30)+1
       D=ATRIB(33)
       IF (D.EQ.XX(I+30)) THEN
         XX(I+30)=0.
         CALL FREE(I-30,1)
         RETURN
       ENDIF
       RETURN
       END
```

E.3 CM SHOP MODEL – 25% BATCH SPLIT

```
GEN,DAVID BROCK,CM_25,4/25/97,,NO,NO,,,,72;
LIMITS,60,35,4000;
SEEDS,86324951(9);
TIMST,XX(91),WIP;
;SET INITIAL VARIABLES
INTLC,XX(1)=0.,XX(2)=0.,XX(3)=0.,XX(4)=0.,
XX(5)=0.,XX(6)=0.,XX(7)=0.,XX(8)=0.,XX(9)=0.,
XX(10)=0.;
INTLC,XX(11)=0.,XX(12)=0.,XX(13)=0.,XX(14)=0.,
XX(15)=0.,XX(16)=0.,XX(17)=0.,XX(18)=0.,XX(19)=0.,
XX(20)=0.;
INTLC,XX(21)=0.,XX(22)=0.,XX(23)=0.,XX(24)=0.,
XX(25)=0.,XX(26)=0.,XX(27)=0.,XX(28)=0.,XX(29)=0.,
```

```
XX(30)=0.;
INTLC,XX(31)=0.,XX(32)=0.,XX(33)=0.,XX(34)=0.,
XX(35)=0.,XX(36)=0.,XX(37)=0.,XX(38)=0.,XX(39)=0.,
XX(40)=0.;
INTLC,XX(41)=0.,XX(42)=0.,XX(43)=0.,XX(44)=0.,
XX(45)=0.,XX(46)=0.,XX(47)=0.,XX(48)=0.,XX(49)=0.,
XX(50)=0.;
INTLC,XX(51)=0.,XX(52)=0.,XX(53)=0.,XX(54)=0.,
XX(55)=0.,XX(56)=0.,XX(57)=0.,XX(58)=0.,XX(59)=0.,
XX(60)=0.;
INTLC,XX(61)=0.,XX(62)=0.,XX(63)=0.,XX(64)=0.,
XX(65)=0.,XX(66)=0.,XX(67)=0.,XX(68)=0.,XX(69)=0.,
XX(70)=0.;
INTLC,XX(71)=0.,XX(72)=0.,XX(73)=0.,XX(74)=0.,
XX(75)=0.,XX(76)=0.,XX(77)=0.,XX(78)=0.,XX(79)=0.,
XX(80)=0.;
INTLC,XX(81)=0.,XX(82)=0.,XX(83)=0.,XX(84)=0.,
XX(85)=0.,XX(86)=0.,XX(87)=0.,XX(88)=0.,XX(89)=0.,
XX(90)=0.;
INTLC,XX(91)=0.,XX(92)=0.;
NETWORK;
;SET RESOURCES
       RESOURCE/1,M1,1/2,M2,2/3,M3,3/
       4,M4,4/5,M5,5/6,M6,6/7,M7,7/
       8,M8,8/9,M9,9/10,M10,10;
       RESOURCE/11,M11,11/12,M12,12/13,M13,13/
       14,M14,14/15,M15,15/16,M16,16/17,M17,17/
       18,M18,18/19,M19,19/20,M20,20;
       RESOURCE/21,M21,21/22,M22,22/23,M23,23/
       24,M24,24/25,M25,25/26,M26,26/27,M27,27/
       28,M28,28/29,M29,29/30,M30,30;
;ARRIVALS
       CREATE,EXPON(8),1,31;
       ASSIGN,XX(91)=XX(91)+1,ATRIB(33)=4,
       ATRIB(34)=25,1;
;ASSIGN TO A PART #
         ACT,,.025,P1;
         ACT,,.025,P2;
         ACT,,.025,P3;
         ACT,,.025,P4;
         ACT,,.025,P5;
         ACT,,.025,P6;
         ACT,,.025,P7;
         ACT,,.025,P8;
         ACT,,.025,P9;
         ACT,,.025,P10;
         ACT,,.025,P11;
         ACT,,.025,P12;
         ACT,,.025,P13;
         ACT,,.025,P14;
         ACT,,.025,P15;
         ACT,,.025,P16;
         ACT,,.025,P17;
         ACT,,.025,P18;
         ACT,,.025,P19;
         ACT,,.025,P20;
         ACT,,.025,P21;
         ACT,,.025,P22;
         ACT,,.025,P23;
         ACT,,.025,P24;
         ACT,,.025,P25;
         ACT,,.025,P26;
         ACT,,.025,P27;
         ACT,,.025,P28;
         ACT,,.025,P29;
         ACT,,.025,P30;
         ACT,,.025,P31;
         ACT,,.025,P32;
         ACT,,.025,P33;
         ACT,,.025,P34;
         ACT,,.025,P35;
         ACT,,.025,P36;
         ACT,,.025,P37;
         ACT,,.025,P38;
         ACT,,.025,P39;
```

```
        ACT,,.025,P40;
;SET PART ROUTINGS
P1      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=1.;
            ACT,,,C5;
P2      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=0.,
          ATRIB(35)=2.;
            ACT,,,C5;
P3      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=0.,
          ATRIB(5)=0.,
          ATRIB(35)=3.;
            ACT,,,C5;
P4      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=4.;
            ACT,,,C5;
P5      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=5.;
            ACT,,,C5;
P6      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=0.,
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=6.;
            ACT,,,C5;
P7      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=7.;
            ACT,,,C5;
P8      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(5)=RNORM(.3433,.0858),
          ATRIB(35)=8.;
            ACT,,,C5;
P9      ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
          ATRIB(14)=0.,
          ATRIB(6)=0.,
          ATRIB(19)=RNORM(.3433,.0858),
          ATRIB(27)=RNORM(.3433,.0858),
          ATRIB(35)=9.;
            ACT,,,C4;
P10     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(19)=RNORM(.3433,.0858),
          ATRIB(27)=RNORM(.3433,.0858),
          ATRIB(35)=10.;
            ACT,,,C4;
P11     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(19)=RNORM(.3433,.0858),
          ATRIB(27)=0.,
          ATRIB(35)=11.;
            ACT,,,C4;
P12     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(6)=0.,
          ATRIB(19)=0.,
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        ATRIB(27)=RNORM(.3433,.0858),
        ATRIB(35)=12.;
          ACT,,,C4;
P13   ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
        ATRIB(14)=0.,
        ATRIB(6)=0.,
        ATRIB(19)=RNORM(.3433,.0858),
        ATRIB(27)=RNORM(.3433,.0858),
        ATRIB(35)=13.;
          ACT,,,C4;
P14   ASSIGN,ATRIB(29)=0.,
        ATRIB(14)=0.,
        ATRIB(6)=RNORM(.3433,.0858),
        ATRIB(19)=RNORM(.3433,.0858),
        ATRIB(27)=0.,
        ATRIB(35)=14.;
          ACT,,,C4;
P15   ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
        ATRIB(14)=0.,
        ATRIB(6)=RNORM(.3433,.0858),
        ATRIB(19)=RNORM(.3433,.0858),
        ATRIB(27)=RNORM(.3433,.0858),
        ATRIB(35)=15.;
          ACT,,,C4;
P16   ASSIGN,ATRIB(29)=0.,
        ATRIB(14)=RNORM(.3433,.0858),
        ATRIB(6)=0.,
        ATRIB(19)=0.,
        ATRIB(27)=RNORM(.3433,.0858),
        ATRIB(35)=16.;
          ACT,,,C4;
P17   ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
        ATRIB(14)=RNORM(.3433,.0858),
        ATRIB(6)=RNORM(.3433,.0858),
        ATRIB(19)=RNORM(.3433,.0858),
        ATRIB(27)=0.,
        ATRIB(35)=17.;
          ACT,,,C4;
P18   ASSIGN,ATRIB(29)=0.,
        ATRIB(14)=RNORM(.3433,.0858),
        ATRIB(6)=0.,
        ATRIB(19)=0.,
        ATRIB(27)=RNORM(.3433,.0858),
        ATRIB(35)=18.;
          ACT,,,C4;
P19   ASSIGN,ATRIB(26)=RNORM(.3433,.0858),
        ATRIB(2)=0.,
        ATRIB(15)=0.,
        ATRIB(7)=RNORM(.3433,.0858),
        ATRIB(17)=0.;
        ASSIGN,ATRIB(4)=0.,
        ATRIB(20)=RNORM(.3433,.0858),
        ATRIB(12)=RNORM(.3433,.0858),
        ATRIB(35)=19.;
          ACT,,,C2;
P20   ASSIGN,ATRIB(26)=RNORM(.3433,.0858),
        ATRIB(2)=RNORM(.3433,.0858),
        ATRIB(15)=RNORM(.3433,.0858),
        ATRIB(7)=RNORM(.3433,.0858),
        ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
        ATRIB(20)=0.,
        ATRIB(12)=0.,
        ATRIB(35)=20.;
          ACT,,,C2;
P21   ASSIGN,ATRIB(26)=0.,
        ATRIB(2)=RNORM(.3433,.0858),
        ATRIB(15)=0.,
        ATRIB(7)=0.,
        ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
        ATRIB(20)=RNORM(.3433,.0858),
        ATRIB(12)=RNORM(.3433,.0858),
        ATRIB(35)=21.;
          ACT,,,C2;
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P22    ASSIGN,ATRIB(26)=0.,
         ATRIB(2)=RNORM(.3433,.0858),
         ATRIB(15)=RNORM(.3433,.0858),
         ATRIB(7)=RNORM(.3433,.0858),
         ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
         ATRIB(20)=0.,
         ATRIB(12)=0.,
         ATRIB(35)=22.;
           ACT,,,C2;
P23    ASSIGN,ATRIB(26)=RNORM(.3433,.0858),
         ATRIB(2)=0.,
         ATRIB(15)=0.,
         ATRIB(7)=0.,
         ATRIB(17)=0.;
         ASSIGN,ATRIB(4)=0.,
         ATRIB(20) RNORM(.3433,.0858),
         ATRIB(12)=RNORM(.3433,.0858),
         ATRIB(35)=23.;
           ACT,,,C2;
P24    ASSIGN,ATRIB(26)=RNORM(.3433,.0858),
         ATRIB(2)=RNORM(.3433,.0858),
         ATRIB(15)=RNORM(.3433,.0858),
         ATRIB(7)=RNORM(.3433,.0858),
         ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
         ATRIB(20)=0.,
         ATRIB(12)=0.,
         ATRIB(35)=24.;
           ACT,,,C2;
P25    ASSIGN,ATRIB(26)=0.,
         ATRIB(2)=0.,
         ATRIB(15)=0.,
         ATRIB(7)=0.,
         ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
         ATRIB(20)=RNORM(.3433,.0858),
         ATRIB(12)=RNORM(.3433,.0858),
         ATRIB(35)=25.;
           ACT,,,C2;
P26    ASSIGN,ATRIB(26)=0.,
         ATRIB(2)=RNORM(.3433,.0858),
         ATRIB(15)=RNORM(.3433,.0858),
         ATRIB(7)=RNORM(.3433,.0858),
         ATRIB(17)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
         ATRIB(20)=0.,
         ATRIB(12)=0.,
         ATRIB(35)=26.;
           ACT,,,C2;
P27    ASSIGN,ATRIB(22)=RNORM(.3433,.0858),
         ATRIB(8)=0.,
         ATRIB(28)=RNORM(.3433,.0858),
         ATRIB(24) RNORM(.3433,.0858),
         ATRIB(9)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=0.,
         ATRIB(35)=27.;
           ACT,,,C3;
P28    ASSIGN,ATRIB(22)=0.,
         ATRIB(8)=RNORM(.3433,.0858),
         ATRIB(28)=RNORM(.3433,.0858),
         ATRIB(24)=RNORM(.3433,.0858),
         ATRIB(9)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=RNORM(.3433,.0858),
         ATRIB(35)=28.;
           ACT,,,C3;
P29    ASSIGN,ATRIB(22)=0.,
         ATRIB(8)=RNORM(.3433,.0858),
         ATRIB(28)=0.,
         ATRIB(24)=0.,
         ATRIB(9)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=RNORM(.3433,.0858),
         ATRIB(35)=29.;
           ACT,,,C3;
P30    ASSIGN,ATRIB(22) RNORM(.3433,.0858),
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```
          ATRIB(8)=RNORM(.3433,.0858),
          ATRIB(28)=RNORM(.3433,.0858),
          ATRIB(24)=RNORM(.3433,.0858),
          ATRIB(9)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=0.,
          ATRIB(35)=30.;
            ACT,,,C3;
P31     ASSIGN,ATRIB(22)=RNORM(.3433,.0858),
          ATRIB(8)=0.,
          ATRIB(28)=RNORM(.3433,.0858),
          ATRIB(24)=RNORM(.3433,.0858),
          ATRIB(9)=0.;
          ASSIGN,ATRIB(21)=0.,
          ATRIB(35)=31.;
            ACT,,,C3;
P32     ASSIGN,ATRIB(22)=RNORM(.3433,.0858),
          ATRIB(8)=RNORM(.3433,.0858),
          ATRIB(28)=RNORM(.3433,.0858),
          ATRIB(24)=RNORM(.3433,.0858),
          ATRIB(9)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=0.,
          ATRIB(35)=32.;
            ACT,,,C3;
P33     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(13)=0.,
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=0.;
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=0.,
          ATRIB(35)=33.;
            ACT,,,C1;
P34     ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=0.,
          ATRIB(35)=34.;
            ACT,,,C1;
P35     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(3)=0.,
          ATRIB(23)=0.;
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=35;
            ACT,,,C1;
P36     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=36;
            ACT,,,C1;
P37     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=37;
           ACT,,,C1;
P38     ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(13)=0.,
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858):
          ASSIGN,ATRIB(10)=0.,
          ATRIB(16)=0.,
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          ATRIB(35)=38;
            ACT,,,C1;
P39     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(3)=0.,
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=0.,
          ATRIB(35)=39;
            ACT,,,C1;
P40     ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(13)=0.,
          ATRIB(3)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=0.,
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=40;
            ACT,,,C1;
;CELL 1
C1      GOON;
        ACT/61,.2086;
        GOON;
        ACT/71,UNFRM(1,5);
;MACHINE 18
M18     UNBATCH,33,1;
          ACT,,ATRIB(18).EQ.0.,M25;
          ACT,,ATRIB(18).NE.0,A18;
A18     AWAIT(18),ALLOC(18);
G18     GOON;
          ACT,,,UB18;
        ENTER,18;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB18;
          ACT/48,11.33,ATRIB(32).EQ.1.,UB18;
UB18    UNBATCH,34;
        EVENT,18,1;
        QUEUE(48);
        ACT/18,ATRIB(18);
        BATCH,,ATRIB(34);
        EVENT,48;
          ACT,,,M25;
;MACHINE 25
M25     GOON,1;
          ACT,,ATRIB(25).EQ.0.,M13;
          ACT,,ATRIB(25).NE.0,A25;
A25     AWAIT(25),ALLOC(25);
G25     GOON;
          ACT,,,UB25;
        ENTER,25;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB25;
          ACT/55,11.33,ATRIB(32).EQ.1.,UB25;
UB25    UNBATCH,34;
        EVENT,25,1;
        QUEUE(55);
        ACT/25,ATRIB(25);
        BATCH,,ATRIB(34);
        EVENT,55;
          ACT,,,M13;
;MACHINE 13
M13     GOON,1;
          ACT,,ATRIB(13).EQ.0.,M3;
          ACT,,ATRIB(13).NE.0,A13;
A13     AWAIT(13),ALLOC(13);
G13     GOON;
          ACT,,,UB13;
        ENTER,13;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB13;
          ACT/43,11.33,ATRIB(32).EQ.1.,UB13;
UB13    UNBATCH,34;
        EVENT,13,1;
        QUEUE(43);
```

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        ACT/13,ATRIB(13);
        BATCH,,ATRIB(34);
        EVENT,43;
          ACT,,,M3;
;MACHINE 3
M3      GOON,1;
          ACT,,ATRIB(3).EQ.0.,M23;
          ACT,,ATRIB(3).NE.0,A3;
A3      AWAIT(3),ALLOC(3);
G3      GOON;
          ACT,,,UB3;
        ENTER,3;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB3;
          ACT/33,11.33,ATRIB(32).EQ.1.,UB3;
UB3     UNBATCH,34;
        EVENT,3,1;
        QUEUE(33);
        ACT/3,ATRIB(3);
        BATCH,,ATRIB(34);
        EVENT,33;
          ACT,,,M23;
;MACHINE 23
M23     GOON,1;
          ACT,,ATRIB(23).EQ.0.,M10;
          ACT,,ATRIB(23).NE.0,A23;
A23     AWAIT(23),ALLOC(23);
G23     GOON;
          ACT,,,UB23;
        ENTER,23;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB23;
          ACT/53,11.33,ATRIB(32).EQ.1.,UB23;
UB23    UNBATCH,34;
        EVENT,23,1;
        QUEUE(53);
        ACT/23,ATRIB(23);
        BATCH,,ATRIB(34);
        EVENT,53;
          ACT,,,M10;
;MACHINE 10
M10     GOON,1;
          ACT,,ATRIB(10).EQ.0.,M16;
          ACT,,ATRIB(10).NE.0,A10;
A10     AWAIT(10),ALLOC(10);
G10     GOON;
          ACT,,,UB10;
        ENTER,10;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB10;
          ACT/40,11.33,ATRIB(32).EQ.1.,UB10;
UB10    UNBATCH,34;
        EVENT,10,1;
        QUEUE(40);
        ACT/10,ATRIB(10);
        BATCH,,ATRIB(34);
        EVENT,40;
          ACT,,,M16;
;MACHINE 16
M16     GOON,1;
          ACT,,ATRIB(16).EQ.0.,UL1;
          ACT,,ATRIB(16).NE.0,A16;
A16     AWAIT(16),ALLOC(16);
G16     GOON;
          ACT,,,UB16;
        ENTER,16;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB16;
          ACT/46,11.33,ATRIB(32).EQ.1.,UB16;
UB16    UNBATCH,34;
        EVENT,16,1;
        QUEUE(46);
        ACT/16,ATRIB(16);
        BATCH,,ATRIB(34);
        EVENT,46;
```

```
         ACT,,,UL1;
;UNLOAD AND MOVE FROM CELL 1
UL1    GOON;
       ACT/76,UNFRM(1,5);
       GOON;
       ACT/66,.2086,,SR;
;CELL 2
C2     GOON;
       ACT/62,.1989;
       GOON;
       ACT/72,UNFRM(1,5);
;MACHINE 26
M26    UNBATCH,33,1;
         ACT,,ATRIB(26).EQ.0.,M2;
         ACT,,ATRIB(26).NE.0,A26;
A26    AWAIT(26),ALLOC(26);
G26    GOON;
         ACT,,,UB26;
       ENTER,26;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB26;
         ACT/56,11.33,ATRIB(32).EQ.1.,UB26;
UB26   UNBATCH,34;
       EVENT,26,1;
       QUEUE(56);
       ACT/26,ATRIB(26);
       BATCH,,ATRIB(34);
       EVENT,56;
         ACT,,,M2;
;MACHINE 2
M2     GOON,1;
          ACT,,ATRIB(2).EQ.0.,M15;
         ACT,,ATRIB(2).NE.0,A2;
A2     AWAIT(2),ALLOC(2);
G2      GOON;
         ACT,,,UB2;
       ENTER,2;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB2;
         ACT/32,11.33,ATRIB(32).EQ.1.,UB2;
UB2    UNBATCH,34;
       EVENT,2,1;
       QUEUE(32);
       ACT/2,ATRIB(2);
       BATCH,,ATRIB(34);
       EVENT,32;
         ACT,,,M15;
;MACHINE 15
M15    GOON,1;
         ACT,,ATRIB(15).EQ.0.,M7;
         ACT,,ATRIB(15).NE.0,A15;
A15    AWAIT(15),ALLOC(15);
G15    GOON;
         ACT,,,UB15;
       ENTER,15;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB15;
         ACT/45,11.33,ATRIB(32).EQ.1.,UB15;
UB15   UNBATCH,34;
       EVENT,15,1;
       QUEUE(45);
       ACT/15,ATRIB(15);
       BATCH,,ATRIB(34);
       EVENT,45;
         ACT,,,M7;
;MACHINE 7
M7     GOON,1;
         ACT,,ATRIB(7).EQ.0.,M17;
         ACT,,ATRIB(7).NE.0,A7;
A7     AWAIT(7),ALLOC(7);
G7     GOON;
         ACT,,,UB7;
       ENTER,7;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB7;
```

```
          ACT/37,11.33,ATRIB(32).EQ.1.,UB7;
UB7     UNBATCH,34;
        EVENT,7,1;
        QUEUE(37);
        ACT/7,ATRIB(7);
        BATCH,,ATRIB(34);
        EVENT,37;
          ACT,,,M17;
;MACHINE 17
M17      GOON,1;
          ACT,,ATRIB(17).EQ.0.,M4;
          ACT,,ATRIB(17).NE.0,A17;
A17      AWAIT(17),ALLOC(17);
G17     GOON;
          ACT,,,UB17;
        ENTER,17;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB17;
          ACT/47,11.33,ATRIB(32).EQ.1.,UB17;
UB17    UNBATCH,34;
        EVENT,17,1;
        QUEUE(47);
        ACT/17,ATRIB(17);
        BATCH,,ATRIB(34);
        EVENT,47;
          ACT,,,M4;
;MACHINE 4
M4      GOON,1;
          ACT,,ATRIB(4).EQ.0.,M20;
          ACT,,ATRIB(4).NE.0,A4;
A4      AWAIT(4),ALLOC(4);
G4      GOON;
          ACT,,,UB4;
        ENTER,4;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB4;
          ACT/34,11.33,ATRIB(32).EQ.1.,UB4;
UB4     UNBATCH,34;
        EVENT,4,1;
        QUEUE(34);
        ACT/4,ATRIB(4);
        BATCH,,ATRIB(34);
        EVENT,34;
          ACT,,,M20;
;MACHINE 20
M20      GOON,1;
          ACT,,ATRIB(20).EQ.0.,M12;
          ACT,,ATRIB(20).NE.0,A20;
A20      AWAIT(20),ALLOC(20);
G20     GOON;
          ACT,,,UB20;
        ENTER,20;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB20;
          ACT/50,11.33,ATRIB(32).EQ.1.,UB20;
UB20     UNBATCH,34;
        EVENT,20,1;
        QUEUE(50);
        ACT/20,ATRIB(20);
        BATCH,,ATRIB(34);
        EVENT,50;
          ACT,,,M12;
;MACHINE 12
M12     GOON,1;
          ACT,,ATRIB(12).EQ.0.,UB12;
          ACT,,ATRIB(12).NE.0,A12;
A12     AWAIT(12),ALLOC(12);
G12     GOON;
          ACT,,,UB12;
        ENTER,12;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB12;
          ACT/42,11.33,ATRIB(32).EQ.1.,UB12;
UB12    UNBATCH,34;
        EVENT,12,1;
```

```
       QUEUE(42);
       ACT/12,ATRIB(12);
       BATCH,,ATRIB(34);
       EVENT,42;
         ACT,,,UL2;
;UNLOAD AND MOVE FROM CELL 2
UL2    GOON;
       ACT/77,UNFRM(1,5);
       GOON;
       ACT/67,.1989,,SR;
;CELL 3
C3     GOON;
       ACT/63,.1477;
       GOON;
       ACT/73,UNFRM(1,5);
;MACHINE 22
M22    UNBATCH,33,1;
         ACT,,ATRIB(22).EQ.0.,M8;
         ACT,,ATRIB(22).NE.0,A22;
A22    AWAIT(22),ALLOC(22);
G22    GOON;
         ACT,,,UB22;
       ENTER,22;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB22;
         ACT/52,11.33,ATRIB(32).EQ.1.,UB22;
UB22   UNBATCH,34;
       EVENT,22,1;
       QUEUE(57);
       ACT/22,ATRIB(22);
       BATCH,,ATRIB(34);
       EVENT,52;
         ACT,,,M8;
;MACHINE 8
M8     GOON,1;
         ACT,,ATRIB(8).EQ.0.,M28;
         ACT,,ATRIB(8).NE.0,A8;
A8     AWAIT(8),ALLOC(8);
G8     GOON;
         ACT,,,UB8;
       ENTER,8;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB8;
         ACT/38,11.33,ATRIB(32).EQ.1.,UB8;
UB8    UNBATCH,34;
       EVENT,8,1;
       QUEUE(38);
       ACT/8,ATRIB(8);
       BATCH,,ATRIB(34);
       EVENT,38;
         ACT,,,M28;
;MACHINE 28
M28     GOON,1;
         ACT,,ATRIB(28).EQ.0.,M24;
         ACT,,ATRIB(28).NE.0,A28;
A28     AWAIT(28),ALLOC(28);
G28    GOON;
         ACT,,,UB28;
       ENTER,28;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB28;
         ACT/58,11.33,ATRIB(32).EQ.1.,UB28;
UB28    UNBATCH,34;
       EVENT,28,1;
       QUEUE(58);
       ACT/28,ATRIB(28);
       BATCH,,ATRIB(34);
       EVENT,58;
         ACT,,,M24;
;MACHINE 24
M24     GOON,1;
         ACT,,ATRIB(24).EQ.0.,M9;
         ACT,,ATRIB(24).NE.0,A24;
A24     AWAIT(24),ALLOC(24);
G24    GOON;
```

```
          ACT,,,UB24;
        ENTER,24;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB24;
          ACT/54,11.33,ATRIB(32).EQ.1.,UB24;
UB24     UNBATCH,34;
        EVENT,24,1;
        QUEUE(54);
        ACT/24,ATRIB(24);
        BATCH,,ATRIB(34);
        EVENT,54;
          ACT,,,M9;
;MACHINE 9
M9      GOON,1;
          ACT,,ATRIB(9).EQ.0.,M21;
          ACT,,ATRIB(9).NE.0,A9;
A9      AWAIT(9),ALLOC(9);
G9      GOON;
          ACT,,,UB9;
        ENTER,9;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB9;
          ACT/39,11.33,ATRIB(32).EQ.1.,UB9;
UB9     UNBATCH,34;
        EVENT,9,1;
        QUEUE(39);
        ACT/9,ATRIB(9);
        BATCH,,ATRIB(34);
        EVENT,39;
          ACT,,,M21;
;MACHINE 21
M21     GOON,1;
          ACT,,ATRIB(21).EQ.0.,UL3;
          ACT,,ATRIB(21).NE.0,A21;
A21     AWAIT(21),ALLOC(21);
G21     GOON;
          ACT,,,UB21;
        ENTER,21;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB21;
          ACT/51,11.33,ATRIB(32).EQ.1.,UB21;
UB21    UNBATCH,34;
        EVENT,21,1;
        QUEUE(51);
        ACT/21,ATRIB(21);
        BATCH,,ATRIB(34);
        EVENT,51;
          ACT,,,UL3;
;UNLOAD AND MOVE FROM CELL 3
UL3     GOON;
        ACT/78,UNFRM(1,[illegible]);
        GOON;
        ACT/68,.1477,,SR;
;CELL 4
C4      GOON;
        ACT/64,.0761;
        GOON;
        ACT/74,UNFRM(1,[illegible]);
;MACHINE 29
M29     UNBATCH,33,1;
          ACT,,ATRIB(29).EQ.0.,M14;
          ACT,,ATRIB(29).NE.0,A29;
A29     AWAIT(29),ALLOC(29);
G29     GOON;
          ACT,,,UB29;
        ENTER,29;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB29;
          ACT/59,11.33,ATRIB(32).EQ.1.,UB29;
UB29    UNBATCH,34;
        EVENT,29,1;
        QUEUE(59);
        ACT/29,ATRIB(29);
        BATCH,,ATRIB(34);
        EVENT,59;
```

```
          ACT,,,M14;
;MACHINE 14
M14      GOON,1;
          ACT,,ATRIB(14).EQ.0.,M6;
          ACT,,ATRIB(14).NE.0,A14;
A14      AWAIT(14),ALLOC(14);
G14     GOON;
          ACT,,,UB14;
        ENTER,14;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB14;
          ACT/44,11.33,ATRIB(32).EQ.1.,UB14;
UB14     UNBATCH,34;
        EVENT,14,1;
        QUEUE(44);
        ACT/14,ATRIB(14);
        BATCH,,ATRIB(34);
        EVENT,44;
          ACT,,,M6;
;MACHINE 6
M6      GOON,1;
          ACT,,ATRIB(6).EQ.0.,M19;
          ACT,,ATRIB(6).NE.0,A6;
A6      AWAIT(6),ALLOC(6);
G6      GOON;
          ACT,,,UB6;
        ENTER,6;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB6;
          ACT/36,11.33,ATRIB(32).EQ.1.,UB6;
UB6     UNBATCH,34;
        EVENT,6,1;
        QUEUE(36);
        ACT/6,ATRIB(6);
        BATCH,,ATRIB(34);
        EVENT,36;
          ACT,,,M19;
;MACHINE 19
M19      GOON,1;
          ACT,,ATRIB(19).EQ.0.,M27;
          ACT,,ATRIB(19).NE.0,A19;
A19      AWAIT(19),ALLOC(19);
G19     GOON;
          ACT,,,UB19;
        ENTER,19;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB19;
          ACT/49,11.33,ATRIB(32).EQ.1.,UB19;
UB19     UNBATCH,34;
        EVENT,19,1;
        QUEUE(49);
        ACT/19,ATRIB(19);
        BATCH,,ATRIB(34);
        EVENT,49;
          ACT,,,M27;
;MACHINE 27
M27     GOON,1;
          ACT,,ATRIB(27).EQ.0.,UL4;
          ACT,,ATRIB(27).NE.0,A27;
A27     AWAIT(27),ALLOC(27);
G27     GOON;
          ACT,,,UB27;
        ENTER,27;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB27;
          ACT/57,11.33,ATRIB(32).EQ.1.,UB27;
UB27    UNBATCH,34;
        EVENT,27,1;
        QUEUE(57);
        ACT/27,ATRIB(27);
        BATCH,,ATRIB(34);
        EVENT,57;
          ACT,,,UL4;
;UNLOAD AND MOVE FROM CELL 4
UL4     GOON;
```

```
        ACT/79,UNFRM(1,5);
        GOON;
        ACT/69,.0761,,SR;
;CELL 5
C5      GOON;
        ACT/65,.1307;
        GOON;
        ACT/75,UNFRM(1,5);
;MACHINE 11
M11     UNBATCH,33,1;
          ACT,,ATRIB(11).EQ.0.,M1;
          ACT,,ATRIB(11).NE.0,A11;
A11     AWAIT(11),ALLOC(11);
G11     GOON;
          ACT,,,UB11;
        ENTER,11;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB11;
          ACT/41,11.33,ATRIB(32).EQ.1.,UB11;
UB11    UNBATCH,34;
        EVENT,11,1;
        QUEUE(41);
        ACT/11,ATRIB(11);
        BATCH,,ATRIB(34);
        EVENT,41;
          ACT,,,M1;
;MACHINE 1
M1      GOON,1;
          ACT,,ATRIB(1).EQ.0.,M30;
          ACT,,ATRIB(1).NE.0,A1;
A1      AWAIT(1),ALLOC(1);
G1      GOON;
          ACT,,,UB1;
        ENTER,1;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB1;
          ACT/31,11.33,ATRIB(32).EQ.1.,UB1;
UB1     UNBATCH,34;
        EVENT,1,1;
        QUEUE(31);
        ACT/1,ATRIB(1);
        BATCH,,ATRIB(34);
        EVENT,31;
          ACT,,,M30;
;MACHINE 30
M30      GOON,30;
          ACT,,ATRIB(30).EQ.0.,M5;
          ACT,,ATRIB(30).NE.0,A30;
A30      AWAIT(30),ALLOC(30);
G30     GOON;
          ACT,,,UB30;
        ENTER,30;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB30;
          ACT/60,11.33,ATRIB(32).EQ.1.,UB30;
UB30     UNBATCH,34;
        EVENT,30,1;
        QUEUE(60);
        ACT/30,ATRIB(30);
        BATCH,,ATRIB(34);
        EVENT,60;
          ACT,,,M5;
;MACHINE 5
M5      GOON,1;
          ACT,,ATRIB(5).EQ.0.,UL5;
          ACT,,ATRIB(5).NE.0,A5;
A5      AWAIT(5),ALLOC(5);
G5      GOON;
          ACT,,,UB5;
        ENTER,5;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB5;
          ACT/35,11.33,ATRIB(32).EQ.1.,UB5;
UB5     UNBATCH,34;
        EVENT,5,1;
```

```
       QUEUE(35);
       ACT/5,ATRIB(5);
       BATCH,,ATRIB(34);
       EVENT,35;
         ACT,,,UL5;
;UNLOAD AND MOVE FROM CELL 5
UL5    GOON;
       ACT/80,UNFRM(1,5);
       GOON;
       ACT/70,.1307,,SR;
;ROUTE SUB-BATCHES AFTER EVENT
       ENTER,31,1;
       ACT,,XX(94).EQ.1,G1;
       ACT,,XX(94).EQ.2,G2;
       ACT,,XX(94).EQ.3,G3;
       ACT,,XX(94).EQ.4,G4;
       ACT,,XX(94).EQ.5,G5;
       ACT,,XX(94).EQ.6,G6;
       ACT,,XX(94).EQ.7,G7;
       ACT,,XX(94).EQ.8,G8;
       ACT,,XX(94).EQ.9,G9;
       ACT,,XX(94).EQ.10,G10;
       ACT,,XX(94).EQ.11,G11;
       ACT,,XX(94).EQ.12,G12;
       ACT,,XX(94).EQ.13,G13;
       ACT,,XX(94).EQ.14,G14;
       ACT,,XX(94).EQ.15,G15;
       ACT,,XX(94).EQ.16,G16;
       ACT,,XX(94).EQ.17,G17;
       ACT,,XX(94).EQ.18,G18;
       ACT,,XX(94).EQ.19,G19;
       ACT,,XX(94).EQ.20,G20;
       ACT,,XX(94).EQ.21,G21;
       ACT,,XX(94).EQ.22,G22;
       ACT,,XX(94).EQ.23,G23;
       ACT,,XX(94).EQ.24,G24;
       ACT,,XX(94).EQ.25,G25;
       ACT,,XX(94).EQ.26,G26;
       ACT,,XX(94).EQ.27,G27;
       ACT,,XX(94).EQ.28,G28;
       ACT,,XX(94).EQ.29,G29;
       ACT,,XX(94).EQ.30,G30;
;BATCH PARTS, COLLECT DATA, AND TERMINATE
SR     UNBATCH,34;
       BATCH,50/31,100;
       ASSIGN,XX(91)=XX(91)-1;
       COLCT(1),INT(31),TIME IN SYS;
       TERMINATE;
       ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000;
FIN;
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E.4 SMALL CM SHOP MODEL – 10% BATCH SPLIT

```
GEN,DAVID BROCK,SM_CM_10,4/20/97,,NO,NO,,,,72;
LIMITS,60,35,4000;
SEEDS,865254147(9);
TIMST,XX(91),WIP;
;SET INITIAL VARIABLES
INTLC,XX(1)=0.,XX(2)=0.,XX(3)=0.,XX(4)=0.,
XX(5)=0.,XX(6)=0.,XX(7)=0.,XX(8)=0.,XX(9)=0.,
XX(10)=0.;
INTLC,XX(11)=0.,XX(12)=0.,XX(13)=0.,XX(14)=0.,
XX(15)=0.,XX(16)=0.,XX(17)=0.,XX(18)=0.,XX(19)=0.,
XX(20)=0.;
INTLC,XX(21)=0.,XX(22)=0.,XX(23)=0.,XX(24)=0.,
XX(25)=0.,XX(26)=0.,XX(27)=0.,XX(28)=0.,XX(29)=0.,
XX(30)=0.;
INTLC,XX(31)=0.,XX(32)=0.,XX(33)=0.,XX(34)=0.,
XX(35)=0.,XX(36)=0.,XX(37)=0.,XX(38)=0.,XX(39)=0.,
XX(40)=0.;
INTLC,XX(41)=0.,XX(42)=0.,XX(43)=0.,XX(44)=0.,
XX(45)=0.,XX(46)=0.,XX(47)=0.,XX(48)=0.,XX(49)=0.,
XX(50)=0.;
INTLC,XX(51)=0.,XX(52)=0.,XX(53)=0.,XX(54)=0.,
XX(55)=0.,XX(56)=0.,XX(57)=0.,XX(58)=0.,XX(59)=0.,
XX(60)=0.;
INTLC,XX(61)=0.,XX(62)=0.,XX(63)=0.,XX(64)=0.,
XX(65)=0.,XX(66)=0.,XX(67)=0.,XX(68)=0.,XX(69)=0.,
XX(70)=0.;
INTLC,XX(71)=0.,XX(72)=0.,XX(73)=0.,XX(74)=0.,
XX(75)=0.,XX(76)=0.,XX(77)=0.,XX(78)=0.,XX(79)=0.,
XX(80)=0.;
INTLC,XX(81)=0.,XX(82)=0.,XX(83)=0.,XX(84)=0.,
XX(85)=0.,XX(86)=0.,XX(87)=0.,XX(88)=0.,XX(89)=0.,
XX(90)=0.;
INTLC,XX(91)=0.,XX(92)=0.;
NETWORK;
;SET RESOURCES
       RESOURCE/1,M1,1/2,M2,2/3,M3,3/
       4,M4,4/5,M5,5/6,M6,6/7,M7,7/
       8,M8,8/9,M9,9/10,M10,10;
       RESOURCE/11,M11,11/12,M12,12/13,M13,13/
       14,M14,14/15,M15,15/16,M16,16/17,M17,17/
       18,M18,18/19,M19,19/20,M20,20;
       RESOURCE/21,M21,21/22,M22,22/23,M23,23/
       24,M24,24/25,M25,25/26,M26,26/27,M27,27/
       28,M28,28/29,M29,29/30,M30,30;
;ARRIVALS
       CREATE,EXPON(8),1,33;
       ASSIGN,XX(91)=XX(91)+1,ATRIB(33)=10.,
       ATRIB(34)=10.,1;
;ASSIGN TO A PART #
         ACT,,.025,P1;
         ACT,,.025,P2;
         ACT,,.025,P3;
         ACT,,.025,P4;
         ACT,,.025,P5;
         ACT,,.025,P6;
         ACT,,.025,P7;
         ACT,,.025,P8;
         ACT,,.025,P9;
         ACT,,.025,P10;
         ACT,,.025,P11;
         ACT,,.025,P12;
         ACT,,.025,P13;
         ACT,,.025,P14;
         ACT,,.025,P15;
         ACT,,.025,P16;
         ACT,,.025,P17;
         ACT,,.025,P18;
         ACT,,.025,P19;
         ACT,,.025,P20;
         ACT,,.025,P21;
         ACT,,.025,P22;
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          ACT,,.025,P23;
          ACT,,.025,P24;
          ACT,,.025,P25;
          ACT,,.025,P26;
          ACT,,.025,P27;
          ACT,,.025,P28;
          ACT,,.025,P29;
          ACT,,.025,P30;
          ACT,,.025,P31;
          ACT,,.025,P32;
          ACT,,.025,P33;
          ACT,,.025,P34;
          ACT,,.025,P35;
          ACT,,.025,P36;
          ACT,,.025,P37;
          ACT,,.025,P38;
          ACT,,.025,P39;
          ACT,,.025,P40;
;SET PART ROUTINGS
P1      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=1.;
            ACT,,,C5;
P2      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=2.;
            ACT,,,C5;
P3      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=0.,
          ATRIB(35)=3.;
            ACT,,,C5;
P4      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=4.;
            ACT,,,C5;
P5      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=0.,
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=5.;
            ACT,,,C5;
P6      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=0.,
          ATRIB(35)=6.;
            ACT,,,C5;
P7      ASSIGN,ATRIB(11)=RNORM(.3433,.0858),
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=7.;
            ACT,,,C5;
P8      ASSIGN,ATRIB(11)=0.,
          ATRIB(1)=RNORM(.3433,.0858),
          ATRIB(30)=RNORM(.3433,.0858),
          ATRIB(35)=8.;
            ACT,,,C5;
P9      ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
          ATRIB(14)=0.,
          ATRIB(6)=0.,
          ATRIB(35)=9.;
            ACT,,,C4;
P10     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(35)=10.;
            ACT,,,C4;
P11     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(35)=11.;
            ACT,,,C4;
P12     ASSIGN,ATRIB(29)=0.,
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          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(6)=0.,
          ATRIB(35)=12.;
            ACT,,,C4;
P13     ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
          ATRIB(14)=0.,
          ATRIB(6)=0.,
          ATRIB(35)=13.;
            ACT,,,C4;
P14     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(35)=14.;
            ACT,,,C4;
P15     ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
          ATRIB(14)=0.,
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(35)=15.;
            ACT,,,C4;
P16     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(6)=0.,
          ATRIB(35)=16.;
            ACT,,,C4;
P17     ASSIGN,ATRIB(29)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(6)=RNORM(.3433,.0858),
          ATRIB(35)=17.;
            ACT,,,C4;
P18     ASSIGN,ATRIB(29)=0.,
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(6)=0.,
          ATRIB(35)=18.;
            ACT,,,C4;
P19     ASSIGN,
          ATRIB(2)=0.,
          ATRIB(15)=0.,
          ATRIB(7)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(4)=0.,
          ATRIB(12)=RNORM(.3433,.0858),
          ATRIB(35)=19.;
            ACT,,,C2;
P20     ASSIGN,
          ATRIB(2)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858),
          ATRIB(7)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
          ATRIB(12)=0.,
          ATRIB(35)=20.;
            ACT,,,C2;
P21     ASSIGN,
          ATRIB(2)=RNORM(.3433,.0858),
          ATRIB(15)=0.,
          ATRIB(7)=0.;
          ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
          ATRIB(12)=RNORM(.3433,.0858),
          ATRIB(35)=21.;
            ACT,,,C2;
P22     ASSIGN,
          ATRIB(2)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858),
          ATRIB(7)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
          ATRIB(12)=0.,
          ATRIB(35)=22.;
            ACT,,,C2;
P23     ASSIGN,
          ATRIB(2)=0.,
          ATRIB(15)=0.,
          ATRIB(7)=0.;
          ASSIGN,ATRIB(4)=0.,
          ATRIB(12)=RNORM(.3433,.0858),
          ATRIB(35)=23.;
            ACT,,,C2;
P24     ASSIGN,
```

```
        ATRIB(2)=RNORM(.3433,.0858),
        ATRIB(15)=RNORM(.3433,.0858),
        ATRIB(7)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
        ATRIB(12)=0.,
        ATRIB(35)=24.;
          ACT,,,C2;
P25   ASSIGN,
        ATRIB(2)=0.,
        ATRIB(15)=0.,
        ATRIB(7)=0.;
        ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
        ATRIB(12)=RNORM(.3433,.0858),
        ATRIB(35)=25.;
          ACT,,,C2;
P26   ASSIGN,
        ATRIB(2)=RNORM(.3433,.0858),
        ATRIB(15)=RNORM(.3433,.0858),
        ATRIB(7)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(4)=RNORM(.3433,.0858),
        ATRIB(12)=0.,
        ATRIB(35)=26.;
          ACT,,,C2;
P27   ASSIGN,
        ATRIB(8)=0.,
        ATRIB(28)=RNORM(.3433,.0858),
        ATRIB(9)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=0.,
        ATRIB(35)=27.;
          ACT,,,C3;
P28   ASSIGN,
        ATRIB(8)=RNORM(.3433,.0858),
        ATRIB(28)=RNORM(.3433,.0858),
        ATRIB(9)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=RNORM(.3433,.0858),
        ATRIB(35)=28.;
          ACT,,,C3;
P29   ASSIGN,
        ATRIB(8)=RNORM(.3433,.0858),
        ATRIB(28)=0.,
        ATRIB(9)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=RNORM(.3433,.0858),
        ATRIB(35)=29.;
          ACT,,,C3;
P30   ASSIGN,
        ATRIB(8)=RNORM(.3433,.0858),
        ATRIB(28)=RNORM(.3433,.0858),
        ATRIB(9)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=0.,
        ATRIB(35)=30.;
          ACT,,,C3;
P31   ASSIGN,
        ATRIB(8)=0.,
        ATRIB(28)=RNORM(.3433,.0858),
        ATRIB(9)=0.;
        ASSIGN,ATRIB(21)=0.,
        ATRIB(35)=31.;
          ACT,,,C3;
P32   ASSIGN,
        ATRIB(8)=RNORM(.3433,.0858),
        ATRIB(28)=RNORM(.3433,.0858),
        ATRIB(9)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=0.,
        ATRIB(35)=32.;
          ACT,,,C3;
P33   ASSIGN,ATRIB(18)=0.,
        ATRIB(25)=RNORM(.3433,.0858),
        ATRIB(23)=0.;
        ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
        ATRIB(16)=0.,
        ATRIB(35)=33.;
          ACT,,,C1;
P34   ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
        ATRIB(25)=RNORM(.3433,.0858),
        ATRIB(23)=RNORM(.3433,.0858);
```

```
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=0.,
          ATRIB(35)=34.;
            ACT,,,C1;
P35     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(23)=0.;
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=35;
            ACT,,,C1;
P36     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=36;
            ACT,,,C1;
P37     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=0.,
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=37;
           ACT,,,C1;
P38     ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=0.,
          ATRIB(16)=0.,
          ATRIB(35)=38;
            ACT,,,C1;
P39     ASSIGN,ATRIB(18)=0.,
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=RNORM(.3433,.0858),
          ATRIB(16)=0.,
          ATRIB(35)=39;
            ACT,,,C1;
P40     ASSIGN,ATRIB(18)=RNORM(.3433,.0858),
          ATRIB(25)=RNORM(.3433,.0858),
          ATRIB(23)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(10)=0.,
          ATRIB(16)=RNORM(.3433,.0858),
          ATRIB(35)=40;
            ACT,,,C1;
;CELL 1
C1      GOON;
        ACT/61,.1568;
        GOON;
        ACT/71,UNFRM(1,5);
;MACHINE 18
M18     UNBATCH,33,1;
          ACT,,ATRIB(18).EQ.0.,M25;
          ACT,,ATRIB(18).NE.0,A18;
A18     AWAIT(18),ALLOC(18);
G18     GOON;
          ACT,,,UB18;
        ENTER,18;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB18;
          ACT/48,11.33,ATRIB(32).EQ.1.,UB18;
UB18    UNBATCH,34;
        EVENT,18,1;
        QUEUE(48);
        ACT/18,ATRIB(18);
        BATCH,,ATRIB(34);
        EVENT,48;
          ACT,,,M25;
;MACHINE 25
M25     GOON,1;
          ACT,,ATRIB(25).EQ.0.,M23;
          ACT,,ATRIB(25).NE.0,A25;
A25     AWAIT(25),ALLOC(25);
G25     GOON;
```

```
          ACT,,,UB25;
        ENTER,25;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB25;
          ACT/55,11.33,ATRIB(32).EQ.1.,UB25;
UB25    UNBATCH,34;
        EVENT,25,1;
        QUEUE(55);
        ACT/25,ATRIB(25);
        BATCH,,ATRIB(34);
        EVENT,55;
          ACT,,,M23;
;MACHINE 23
M23     GOON,1;
          ACT,,ATRIB(23).EQ.0.,M10;
          ACT,,ATRIB(23).NE.0,A23;
A23     AWAIT(23),ALLOC(23);
G23     GOON;
          ACT,,,UB23;
        ENTER,23;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB23;
          ACT/53,11.33,ATRIB(32).EQ.1.,UB23;
UB23    UNBATCH,34;
        EVENT,23,1;
        QUEUE(53);
        ACT/23,ATRIB(23);
        BATCH,,ATRIB(34);
        EVENT,53;
          ACT,,,M10;
;MACHINE 10
M10     GOON,1;
          ACT,,ATRIB(10).EQ.0.,M16;
          ACT,,ATRIB(10).NE.0,A10;
A10     AWAIT(10),ALLOC(10);
G10     GOON;
          ACT,,,UB10;
        ENTER,10;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB10;
          ACT/40,11.33,ATRIB(32).EQ.1.,UB10;
UB10    UNBATCH,34;
        EVENT,10,1;
        QUEUE(40);
        ACT/10,ATRIB(10);
        BATCH,,ATRIB(34);
        EVENT,40;
          ACT,,,M16;
;MACHINE 16
M16     GOON,1;
          ACT,,ATRIB(16).EQ.0.,UL1;
          ACT,,ATRIB(16).NE.0,A16;
A16     AWAIT(16),ALLOC(16);
G16     GOON;
          ACT,,,UB16;
        ENTER,16;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB16;
          ACT/46,11.33,ATRIB(32).EQ.1.,UB16;
UB16    UNBATCH,34;
        EVENT,16,1;
        QUEUE(46);
        ACT/16,ATRIB(16);
        BATCH,,ATRIB(34);
        EVENT,46;
          ACT,,,UL1;
;UNLOAD AND MOVE FROM CELL 1
UL1     GOON;
        ACT/76,UNFRM(1,5);
        GOON;
        ACT/66,.1568,,SR;
;CELL 2
C2      GOON;
        ACT/62,.1636;
        GOON;
```

```
       ACT/72,UNFRM(1,5);
;MACHINE 2
M2     UNBATCH,33,1;
         ACT,,ATRIB(2).EQ.0.,M15;
         ACT,,ATRIB(2).NE.0,A2;
A2     AWAIT(2),ALLOC(2);
G2      GOON;
         ACT,,,UB2;
       ENTER,2;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB2;
         ACT/32,11.33,ATRIB(32).EQ.1.,UB2;
UB2    UNBATCH,34;
       EVENT,2,1;
       QUEUE(32);
       ACT/2,ATRIB(2);
       BATCH,,ATRIB(34);
       EVENT,32;
         ACT,,,M15;
;MACHINE 15
M15    GOON,1;
         ACT,,ATRIB(15).EQ.0.,M7;
         ACT,,ATRIB(15).NE.0,A15;
A15    AWAIT(15),ALLOC(15);
G15    GOON;
         ACT,,,UB15;
       ENTER,15;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB15;
         ACT/45,11.33,ATRIB(32).EQ.1.,UB15;
UB15   UNBATCH,34;
       EVENT,15,1;
       QUEUE(45);
       ACT/15,ATRIB(15);
       BATCH,,ATRIB(34);
       EVENT,45;
         ACT,,,M7;
;MACHINE 7
M7     GOON,1;
         ACT,,ATRIB(7).EQ.0.,M4;
         ACT,,ATRIB(7).NE.0,A7;
A7     AWAIT(7),ALLOC(7);
G7     GOON;
         ACT,,,UB7;
       ENTER,7;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB7;
         ACT/37,11.33,ATRIB(32).EQ.1.,UB7;
UB7    UNBATCH,34;
       EVENT,7,1;
       QUEUE(37);
       ACT/7,ATRIB(7);
       BATCH,,ATRIB(34);
       EVENT,37;
         ACT,,,M4;
;MACHINE 4
M4     GOON,1;
         ACT,,ATRIB(4).EQ.0.,M12;
         ACT,,ATRIB(4).NE.0,A4;
A4     AWAIT(4),ALLOC(4);
G4     GOON;
         ACT,,,UB4;
       ENTER,4;
       ASSIGN,ATRIB(32)=XX(92);
         ACT,,ATRIB(32).EQ.0.,UB4;
         ACT/34,11.33,ATRIB(32).EQ.1.,UB4;
UB4    UNBATCH,34;
       EVENT,4,1;
       QUEUE(34);
       ACT/4,ATRIB(4);
       BATCH,,ATRIB(34);
       EVENT,34;
         ACT,,,M12;
;MACHINE 12
M12    GOON,1;
```

```
          ACT,,ATRIB(12).EQ.0.,UL2;
          ACT,,ATRIB(12).NE.0,A12;
A12     AWAIT(12),ALLOC(12);
G12     GOON;
          ACT,,,UB12;
        ENTER,12;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB12;
          ACT/42,11.33,ATRIB(32).EQ.1.,UB12;
UB12    UNBATCH,34;
        EVENT,12,1;
        QUEUE(42);
        ACT/12,ATRIB(12);
        BATCH,,ATRIB(34);
        EVENT,42;
          ACT,,,UL2;
;UNLOAD AND MOVE FROM CELL 2
UL2     GOON;
        ACT/72,UNFRM(1,5);
        GOON;
        ACT/67,.1636,,SR;
;CELL 3
C3      GOON;
        ACT/63,.1023;
        GOON;
        ACT/73,UNFRM(1,5);
;MACHINE 8
M8      UNBATCH,33,1;
          ACT,,ATRIB(8).EQ.0.,M28;
          ACT,,ATRIB(8).NE.0,A8;
A8      AWAIT(8),ALLOC(8);
G8      GOON;
          ACT,,,UB8;
        ENTER,8;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB8;
          ACT/38,11.33,ATRIB(32).EQ.1.,UB8;
UB8     UNBATCH,34;
        EVENT,8,1;
        QUEUE(38);
        ACT/8,ATRIB(8);
        BATCH,,ATRIB(34);
        EVENT,38;
          ACT,,,M28;
;MACHINE 28
M28      GOON,1;
          ACT,,ATRIB(28).EQ.0.,M9;
          ACT,,ATRIB(28).NE.0,A28;
A28      AWAIT(28),ALLOC(28);
G28     GOON;
          ACT,,,UB28;
        ENTER,28;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB28;
          ACT/58,11.33,ATRIB(32).EQ.1.,UB28;
UB28     UNBATCH,34;
        EVENT,28,1;
        QUEUE(58);
        ACT/28,ATRIB(28);
        BATCH,,ATRIB(34);
        EVENT,58;
          ACT,,,M9;
;MACHINE 9
M9      GOON,1;
          ACT,,ATRIB(9).EQ.0.,M21;
          ACT,,ATRIB(9).NE.0,A9;
A9      AWAIT(9),ALLOC(9);
G9      GOON;
          ACT,,,UB9;
        ENTER,9;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB9;
          ACT/39,11.33,ATRIB(32).EQ.1.,UB9;
UB9     UNBATCH,34;
        EVENT,9,1;
```

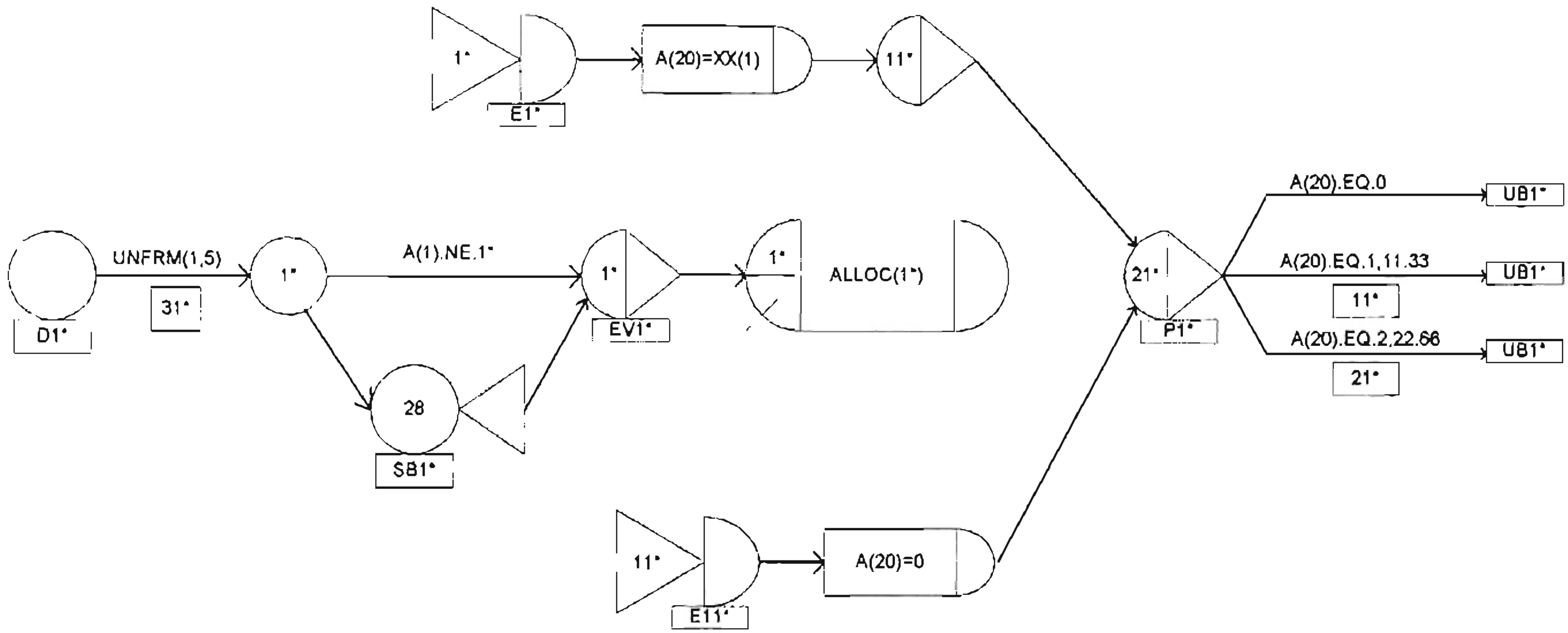
```
        QUEUE(39);
        ACT/9,ATRIB(9);
        BATCH,,ATRIB(34);
        EVENT,39;
          ACT,,,M21;
;MACHINE 21
M21     GOON,1;
          ACT,,ATRIB(21).EQ.0.,UL3;
          ACT,,ATRIB(21).NE.0,A21;
A21     AWAIT(21),ALLOC(21);
G21     GOON;
          ACT,,,UB21;
        ENTER,21;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB21;
          ACT/51,11.33,ATRIB(32).EQ.1.,UB21;
UB21    UNBATCH,34;
        EVENT,21,1;
        QUEUE(51);
        ACT/21,ATRIB(21);
        BATCH,,ATRIB(34);
        EVENT,51;
          ACT,,,UL3;
;UNLOAD AND MOVE FROM CELL 3
UL3     GOON;
        ACT/78,UNFRM(1,5);
        GOON;
        ACT/68,.1023,,SR;
;CELL 4
C4      GOON;
        ACT/64,.0682;
        GOON;
        ACT/74,UNFRM(1,5);
;MACHINE 29
M29     UNBATCH,33,1;
          ACT,,ATRIB(29).EQ.0.,M14;
          ACT,,ATRIB(29).NE.0,A29;
A29     AWAIT(29),ALLOC(29);
G29     GOON;
          ACT,,,UB29;
        ENTER,29;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB29;
          ACT/59,11.33,ATRIB(32).EQ.1.,UB29;
UB29    UNBATCH,34;
        EVENT,29,1;
        QUEUE(59);
        ACT/29,ATRIB(29);
        BATCH,,ATRIB(34);
        EVENT,59;
          ACT,,,M14;
;MACHINE 14
M14      GOON,1;
          ACT,,ATRIB(14).EQ.0.,M6;
          ACT,,ATRIB(14).NE.0,A14;
A14      AWAIT(14),ALLOC(14);
G14     GOON;
          ACT,,,UB14;
        ENTER,14;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB14;
          ACT/44,11.33,ATRIB(32).EQ.1.,UB14;
UB14     UNBATCH,34;
        EVENT,14,1;
        QUEUE(44);
        ACT/14,ATRIB(14);
        BATCH,,ATRIB(34);
        EVENT,44;
          ACT,,,M6;
;MACHINE 6
M6      GOON,1;
          ACT,,ATRIB(6).EQ.0.,UL4;
          ACT,,ATRIB(6).NE.0,A6;
A6      AWAIT(6),ALLOC(6);
G6      GOON;
```

```
          ACT,,,UB6;
        ENTER,6;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB6;
          ACT/36,11.33,ATRIB(32).EQ.1.,UB6;
UB6     UNBATCH,34;
        EVENT,6,1;
        QUEUE(36);
        ACT/6,ATRIB(6);
        BATCH,,ATRIB(34);
        EVENT,36;
          ACT,,,UL4;
;UNLOAD AND MOVE FROM CELL 4
UL4     GOON;
        ACT/79,UNFRM(1,5);
        GOON;
        ACT/69,.0682,,SR;
;CELL 5
C5      GOON;
        ACT/65,.1023;
        GOON;
        ACT/75,UNFRM(1,5);
;MACHINE 11
M11     UNBATCH,33,1;
          ACT,,ATRIB(11).EQ.0.,M1;
          ACT,,ATRIB(11).NE.0,A11;
A11     AWAIT(11),ALLOC(11);
G11     GOON;
          ACT,,,UB11;
        ENTER,11;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB11;
          ACT/41,11.33,ATRIB(32).EQ.1.,UB11;
UB11    UNBATCH,34;
        EVENT,11,1;
        QUEUE(41);
        ACT/11,ATRIB(11);
        BATCH,,ATRIB(34);
        EVENT,41;
          ACT,,,M1;
;MACHINE 1
M1      GOON,1;
          ACT,,ATRIB(1).EQ.0.,M30;
          ACT,,ATRIB(1).NE.0,A1;
A1      AWAIT(1),ALLOC(1);
G1      GOON;
          ACT,,,UB1;
        ENTER,1;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB1;
          ACT/31,11.33,ATRIB(32).EQ.1.,UB1;
UB1     UNBATCH,34;
        EVENT,1,1;
        QUEUE(31);
        ACT/1,ATRIB(1);
        BATCH,,ATRIB(34);
        EVENT,31;
          ACT,,,M30;
;MACHINE 30
M30     GOON,30;
          ACT,,ATRIB(30).EQ.0.,UL5;
          ACT,,ATRIB(30).NE.0,A30;
A30     AWAIT(30),ALLOC(30);
G30     GOON;
          ACT,,,UB30;
        ENTER,30;
        ASSIGN,ATRIB(32)=XX(92);
          ACT,,ATRIB(32).EQ.0.,UB30;
          ACT/60,11.33,ATRIB(32).EQ.1.,UB30;
UB30    UNBATCH,34;
        EVENT,30,1;
        QUEUE(60);
        ACT/30,ATRIB(30);
        BATCH,,ATRIB(34);
        EVENT,60;
```

```
         ACT,,,UL5;
;UNLOAD AND MOVE FROM CELL 5
UL5     GOON;
        ACT/80,UNFRM(1,5);
        GOON;
        ACT/70,.1023,,SR;
;ROUTE SUB-BATCHES AFTER EVENT
        ENTER,31,1;
        ACT,,XX(94).EQ.1,G1;
        ACT,,XX(94).EQ.2,G2;
        ACT,,XX(94).EQ.4,G4;
        ACT,,XX(94).EQ.6,G6;
        ACT,,XX(94).EQ.7,G7;
        ACT,,XX(94).EQ.8,G8;
        ACT,,XX(94).EQ.9,G9;
        ACT,,XX(94).EQ.10,G10;
        ACT,,XX(94).EQ.11,G11;
        ACT,,XX(94).EQ.12,G12;
        ACT,,XX(94).EQ.14,G14;
        ACT,,XX(94).EQ.15,G15;
        ACT,,XX(94).EQ.16,G16;
        ACT,,XX(94).EQ.18,G18;
        ACT,,XX(94).EQ.21,G21;
        ACT,,XX(94).EQ.23,G23;
        ACT,,XX(94).EQ.25,G25;
        ACT,,XX(94).EQ.28,G28;
        ACT,,XX(94).EQ.29,G29;
        ACT,,XX(94).EQ.30,G30;
;BATCH PARTS, COLLECT DATA, AND TERMINATE
SR      UNBATCH,34;
        BATCH,50/31,100;
        ASSIGN,XX(91)=XX(91)-1;
        COLCT(1),INT(31),TIME IN SYS;
        TERMINATE;
        ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000,,;
FIN;
```

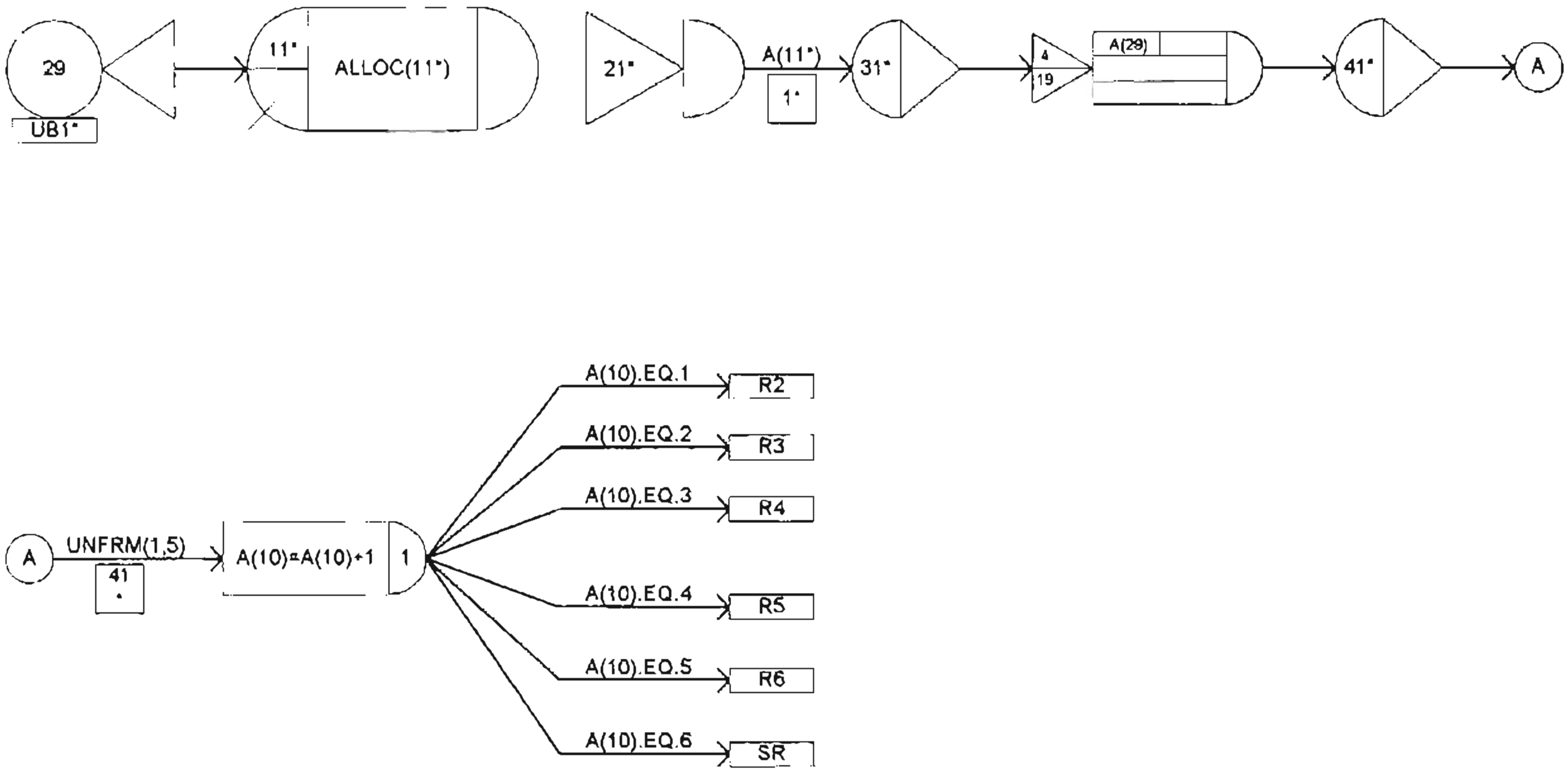
APPENDIX F

DCM Shop Network Diagrams, Fortran, and Models



* These numbers will change inother departments.

- DCM shop network diagram for department 1.



* These numbers will change in other departments.

- DCM shop network diagram for department 1 (continued).

NOTE: The activities, attributes, variables, resources, and files for the DCM shop model are the same as the process shop model. The DCM arrays are described below.

Table 17 - Array descriptions for the dynamic cellular manufacturing (DCM) model.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	1-4	Machine indicators	Part No. of last or current entity on machine
		2-8	Machine indicators	Part family of entity on machine
11-18	Department	1-4	Machine indicators	Entity No. of last or current entity on machine
		2-8	Machine indicators	Indicates if machine is idle(0) or busy(1)
21-28	Department	1-4	Machine indicators	No. of sub-batches processed
31-38	Department	1-5	Family indicators	No. of sub-batches from families 1-5 in the queue
41-48	Department	1-5	Family indicators	No. of machines possessed by families 1-5

Table 18 - Array descriptions for the small dynamic cellular manufacturing (DCM) model.

ARRAY No. (COLUMN No.)	COLUMN DESCRIPTION	ROWS	ROW DESCRIPTION	DATA DESCRIPTION
1-8	Department	1-3	Machine indicators	Part # of last or current entity on machine
		4-6	Machine indicators	Part family of entity on machine
11-18	Department	1-3	Machine indicators	Entity # of last or current entity on machine
		4-6	Machine indicators	Indicates if machine is idle(0) or busy(1)
21-28	Department	1-3	Machine indicators	Number of sub-batches processed
31-38	Department	1-5	Family indicators	Number of sub-batches from families 1-5 in the queue
41-48	Department	1-5	Family indicators	Machine number possessed by families 1-5

F.1 DCM MODEL ALLOC(I) SUBROUTINE

```
SUBROUTINE ALLOC(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
C ALLOCATE SUBROUTINE FOR DCM SHOP
C

      DIMENSION U(32)
      DIMENSION Y(32)
      DIMENSION W(32)
      IFLAG=0
      J=NRUSE(I)+NNRSC(I)
      K=NNRSC(I)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 10
      IF (I.GT.10) GO TO 90
C
C IF ENTITY ALREADY HAS SB THEN SEND THROUGH
C
10    DO 15 M=1,J
        A=GETARY(I+10,M)
12      N=0
        N=NFIND(1,I,19,0,A,.00001)
        IF (N.GT.0) THEN
          CALL RMOVE(N,I,U)
          CALL ENTER(I+10,U)
          GO TO 12
        ENDIF
15    CONTINUE
C
C IF SB IS FREE FIND NEXT ENTITY TO SEND
C
C IF FAMILY HAS 1 M/C & THERE ARE FAM MEMBERS IN Q
      N=0
      IF (K.GT.0) THEN
        DO 16 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+4)
            FL=GETARY(I,M+4)
            N=NFIND(1,I,8,0,FL,.0001)
            G=GETARY(I+40,L)
            IF (N.GT.0.AND.G.EQ.1) THEN
              P=GETARY(I,M)
              N=NFIND(1,I,9,0,P,.00001)
              IF (N.GT.0) GO TO 70
              N=NFIND(1,I,8,0,FL,.00001)
              IF (N.GT.0) GO TO 80
            ENDIF
          ENDIF
16      CONTINUE
C IF FAMILY HAS >1 M/C AND ANOTHER FAMILY NEEDS A M/C
        DO 17 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
```

```
            L=GETARY(I,M+4)
            FL=GETARY(I,M+4)
            G=GETARY(I+40,L)
            IF (G.GT.1) GO TO 20
          ENDIF
17      CONTINUE
C A FAMILY IN Q HAS NO M/C
        DO 18 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+4)
            FL=GETARY(I,M+4)
            N=NFIND(1,I,8,0,FL,.0001)
            G=GETARY(I+40,L)
            IF (N.GT.0.AND.G.EQ.0) GO TO 20
          ENDIF
18      CONTINUE
C A FAMILY W/ A M/C HAS ZERO IN Q SO REASSIGN M/C
        DO 19 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+4)
            FL=GETARY(I,M+4)
            N=NFIND(1,I,8,0,FL,.0001)
            G=GETARY(I+40,L)
            IF (G.EQ.1.AND.N.EQ.0) GO TO 20
          ENDIF
19      CONTINUE
        RETURN
      ENDIF
      RETURN
C
C COMPETITION FOR MACHINE
C
20          DO 36 MM=0,4
              FM1=GETARY(I+40,1)
              IF (FM1.EQ.MM) THEN
                F1=GETARY(I+30,1)
              ELSE
                F1=0
              ENDIF
              FM2=GETARY(I+40,2)
              IF (FM2.EQ.MM) THEN
                F2=GETARY(I+30,2)
              ELSE
                F2=0
              ENDIF
              FM3=GETARY(I+40,3)
              IF (FM3.EQ.MM) THEN
                F3=GETARY(I+30,3)
              ELSE
                F3=0
              ENDIF
              FM4=GETARY(I+40,4)
              IF (FM4.EQ.MM) THEN
              F4=GETARY(I+30,4)
              ELSE
                F4=0
              ENDIF
              FM5=GETARY(I+40,5)
```

```
               IF (FM5.EQ.MM) THEN
                 F5=GETARY(I+30,5)
               ELSE
                 F5=0
               ENDIF
C
C FIND FAMILY W/ MOST IN Q
C
               IF (F1.GE.F2) THEN
                 GO TO 21
               ELSE
                 GO TO 24
               ENDIF
21             IF (F1.GE.F3) THEN
                 GO TO 22
               ELSE
                 GO TO 27
               ENDIF
22             IF (F1.GE.F4) THEN
                 GO TO 23
               ELSE
                 GO TO 29
               ENDIF
23             IF (F1.GE.F5) THEN
                 GO TO 30
               ELSE
                 GO TO 34
               ENDIF
24             IF (F2.GE.F3) THEN
                 GO TO 25
               ELSE
                 GO TO 27
               ENDIF
25             IF (F2.GE.F4) THEN
                 GO TO 26
               ELSE
                 GO TO 29
               ENDIF
26             IF (F2.GE.F5) THEN
                 GO TO 31
               ELSE
                 GO TO 34
               ENDIF
27             IF (F3.GE.F4) THEN
                 GO TO 28
               ELSE
                 GO TO 29
               ENDIF
28             IF (F3.GE.F5) THEN
                 GO TO 32
               ELSE
                 GO TO 34
               ENDIF
29             IF (F4.GE.F5) THEN
                 GO TO 33
               ELSE
                GO TO 34
               ENDIF
C
C CHANGE # OF M/C FOR FAMILY AND FIND GET ENTITY F/ Q
```

```
C
30              IF (F1.GT.0.) THEN
                  N=NFIND(1,I,8,0,1.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,1)+1
                  CALL PUTARY(I+40,1,Q)
                  IF (L.EQ.1) GO TO 80
                  GO TO 60
                ELSE
                  GO TO 36
                ENDIF
C
31                N=NFIND(1,I,8,0,2.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,2)+1
                  CALL PUTARY(I+40,2,Q)
                  IF (L.EQ.2) GO TO 80
                  GO TO 60
C
32                N=NFIND(1,I,8,0,3.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,3)+1
                  CALL PUTARY(I+40,3,Q)
                  IF (L.EQ.3) GO TO 80
                  GO TO 60
C
33                N=NFIND(1,I,8,0,4.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,4)+1
                  CALL PUTARY(I+40,4,Q)
                  IF (L.EQ.4) GO TO 80
                  GO TO 60
C
34                N=NFIND(1,I,8,0,5.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,5)+1
                  CALL PUTARY(I+40,5,Q)
                  IF (L.EQ.5) GO TO 80
                  GO TO 60
C
36            CONTINUE
              RETURN
C
C DETERMINE SU TIMES AND SEIZE SB RESOURCE
C
60      XX(I)=2.
        GO TO 85
70      XX(I)=0.
        GO TO 85
80      XX(I)=1.
        GO TO 85
85      CALL SEIZE(I,1)
        CALL RMOVE(N,I,Y)
        CALL ENTER(I,Y)
        CALL PUTARY(I+20,M,0.)
```

```
      RETURN
C
C DETERMINE APPROPRIATE ENTITY TO SEND IF OP.RES. IS FREE
C
90    N=0
      IF (K.GT.0) THEN
        DO 95 M=1,J
          R=GETARY(I,M+4)
          IF (R.EQ.0.) THEN
            A=GETARY(I,M)
            N=NFIND(1,I,19,0,A,.00001)
            IF (N.GT.0) THEN
              CALL PUTARY(I,M+4,1.)
              CALL SEIZE(I,1)
              CALL RMOVE(N,I,W)
              CALL ENTER(I+10,W)
              RETURN
            ENDIF
          ENDIF
95      CONTINUE
      ENDIF
      RETURN
      END
```

F.2 DCM MODEL EVENT(I) SUBROUTINE

```
SUBROUTINE EVENT(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
      F=ATRIB(9)
      G=ATRIB(19)
      L=ATRIB(8)
      S=ATRIB(8)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 5
      IF (I.GT.10.AND.I.LT.20) GO TO 10
      IF (I.GT.20.AND.I.LT.30) GO TO 20
      IF (I.GT.30.AND.I.LT.40) GO TO 30
      IF (I.GT.40) GO TO 40
C
C COUNT # OF SUB-BATCHES IN Q FOR EACH FAMILY
C
5     A=GETARY(I+30,L)
      B=A+1
      CALL PUTARY(I+30,L,B)
      RETURN
C
C SET ARRAYS FOR NEW BATCH
C
10    J=NNRSC(I)+NRUSE(I)
      DO 15 M=1,J
        B=GETARY(I+10,M)
          IF (B.EQ.0.) THEN
            CALL PUTARY(I-10,M,F)
```

```
            CALL PUTARY(I,M,G)
            CALL PUTARY(I+10,M,1.)
            CALL PUTARY(I-10,M+4,S)
            CALL PUTARY(I,M+4,0.)
          ENDIF
15    CONTINUE
      RETURN
C
C REMOVE ONE SUB-BATCH FROM Q COUNT ARRAY
C
20    A=GETARY(I+10,L)
      B=A-1
      CALL PUTARY(I+10,L,B)
      RETURN
C
C FREE MACHINE AND SET ARRAY TO AVAILABLE
C
30    J=NNRSC(I-30)+NRUSE(I-30)
      DO 35 M=1,J
        A=GETARY(I-20,M)
        IF (A.EQ.G) THEN
          CALL PUTARY(I-20,M+4,0.)
          CALL FREE(I-20,1)
          RETURN
        ENDIF
35    CONTINUE
      RETURN
C
C COUNT SUB-BATCHES AND FREE SB WHEN NECESSARY
C
40    J=NNRSC(I-40)+NRUSE(I-40)
      DO 45 M=1,J
        A=GETARY(I-30,M)
        IF (A.EQ.G) THEN
          B=GETARY(I-20,M)
          CALL PUTARY(I-20,M,B+1.)
          B=GETARY(I-20,M)
          IF (B.GT.C) THEN
              CALL FREE(I-40,1)
              RETURN
          ENDIF
        ENDIF
45    CONTINUE
      RETURN
      END
```

F.3 SMALL DCM MODEL ALLOC(I) SUBROUTINE

```
SUBROUTINE ALLOC(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
C ALLOCATE SUBROUTINE FOR SMALL DCM SHOP
C

      DIMENSION U(32)
      DIMENSION Y(32)
```

```
      DIMENSION W(32)
      IFLAG=0
      J=NRUSE(I)+NNRSC(I)
      K=NNRSC(I)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 10
      IF (I.GT.10) GO TO 90
C
C IF ENTITY ALREADY HAS SB THEN SEND THROUGH
C
10    DO 15 M=1,J
        A=GETARY(I+10,M)
12      N=0
        N=NFIND(1,I,19,0,A,.00001)
        IF (N.GT.0) THEN
          CALL RMOVE(N,I,U)
          CALL ENTER(I+10,U)
          GO TO 12
        ENDIF
15    CONTINUE
C
C IF SB IS FREE FIND NEXT ENTITY TO SEND
C
C IF FAMILY HAS 1 M/C & THERE ARE FAM MEMBERS IN Q
      N=0
      IF (K.GT.0) THEN
        DO 16 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+3)
            FL=GETARY(I,M+3)
            N=NFIND(1,I,8,0,FL,.0001)
            G=GETARY(I+40,L)
            IF (N.GT.0.AND.G.EQ.1) THEN
              P=GETARY(I,M)
              N=NFIND(1,I,9,0,P,.00001)
              IF (N.GT.0) GO TO 70
              N=NFIND(1,I,8,0,FL,.00001)
              IF (N.GT.0) GO TO 80
            ENDIF
          ENDIF
16      CONTINUE
C IF FAMILY HAS >1 M/C AND ANOTHER FAMILY NEEDS A M/C
        DO 17 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+3)
            FL=GETARY(I,M+3)
            G=GETARY(I+40,L)
            IF (G.GT.1) GO TO 20
          ENDIF
17      CONTINUE
C A FAMILY IN Q HAS NO M/C
        DO 18 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+3)
            FL=GETARY(I,M+3)
            N=NFIND(1,I,8,0,FL,.0001)
```

```
            G=GETARY(I+40,L)
            IF (N.GT.0.AND.G.EQ.0) GO TO 20
          ENDIF
18      CONTINUE
C A FAMILY W/ A M/C HAS ZERO IN Q SO REASSIGN M/C
        DO 19 M=1,J
          B=GETARY(I+20,M)
          IF (B.GT.C) THEN
            L=GETARY(I,M+3)
            FL=GETARY(I,M+3)
            N=NFIND(1,I,8,0,FL,.0001)
            G=GETARY(I+40,L)
            IF (G.EQ.1.AND.N.EQ.0) GO TO 20
          ENDIF
19      CONTINUE
        RETURN
      ENDIF
      RETURN
C
C COMPETITION FOR MACHINE
C
20          DO 36 MM=0,4
              FM1=GETARY(I+40,1)
              IF (FM1.EQ.MM) THEN
                F1=GETARY(I+30,1)
              ELSE
                F1=0
              ENDIF
              FM2=GETARY(I+40,2)
              IF (FM2.EQ.MM) THEN
                F2=GETARY(I+30,2)
              ELSE
                F2=0
              ENDIF
              FM3=GETARY(I+40,3)
              IF (FM3.EQ.MM) THEN
                F3=GETARY(I+30,3)
              ELSE
                F3=0
              ENDIF
              FM4=GETARY(I+40,4)
              IF (FM4.EQ.MM) THEN
              F4=GETARY(I+30,4)
              ELSE
                F4=0
              ENDIF
              FM5=GETARY(I+40,5)
              IF (FM5.EQ.MM) THEN
                F5=GETARY(I+30,5)
              ELSE
                F5=0
              ENDIF
C
C FIND FAMILY W/ MOST IN Q
C
              IF (F1.GE.F2) THEN
                GO TO 21
              ELSE
                GO TO 24
              ENDIF
```

```
21              IF (F1.GE.F3) THEN
                  GO TO 22
                ELSE
                  GO TO 27
                ENDIF
22              IF (F1.GE.F4) THEN
                  GO TO 23
                ELSE
                  GO TO 29
                ENDIF
23              IF (F1.GE.F5) THEN
                  GO TO 30
                ELSE
                  GO TO 34
                ENDIF
24              IF (F2.GE.F3) THEN
                  GO TO 25
                ELSE
                  GO TO 27
                ENDIF
25              IF (F2.GE.F4) THEN
                  GO TO 26
                ELSE
                  GO TO 29
                ENDIF
26              IF (F2.GE.F5) THEN
                  GO TO 31
                ELSE
                  GO TO 34
                ENDIF
27              IF (F3.GE.F4) THEN
                  GO TO 28
                ELSE
                  GO TO 29
                ENDIF
28              IF (F3.GE.F5) THEN
                  GO TO 32
                ELSE
                  GO TO 34
                ENDIF
29              IF (F4.GE.F5) THEN
                  GO TO 33
                ELSE
                 GO TO 34
                ENDIF
C
C CHANGE # OF M/C FOR FAMILY AND FIND GET ENTITY F/ Q
C
30              IF (F1.GT.0.) THEN
                  N=NFIND(1,I,8,0,1.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,1)+1
                  CALL PUTARY(I+40,1,Q)
                  IF (L.EQ.1) GO TO 80
                  GO TO 60
                ELSE
                  GO TO 36
                ENDIF
C
```

```
31                N=NFIND(1,I,8,0,2.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,2)+1
                  CALL PUTARY(I+40,2,Q)
                  IF (L.EQ.2) GO TO 80
                  GO TO 60
C
32                N=NFIND(1,I,8,0,3.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,3)+1
                  CALL PUTARY(I+40,3,Q)
                  IF (L.EQ.3) GO TO 80
                  GO TO 60
C
33                N=NFIND(1,I,8,0,4.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,4)+1
                  CALL PUTARY(I+40,4,Q)
                  IF (L.EQ.4) GO TO 80
                  GO TO 60
C
34                N=NFIND(1,I,8,0,5.,.00001)
                  IF (N.EQ.0) GO TO 36
                  CALL PUTARY(I+40,L,G-1.)
                  Q=GETARY(I+40,5)+1
                  CALL PUTARY(I+40,5,Q)
                  IF (L.EQ.5) GO TO 80
                  GO TO 60
C
36            CONTINUE
              RETURN
C
C DETERMINE SU TIMES AND SEIZE SB RESOURCE
C
60      XX(I)=2.
        GO TO 85
70      XX(I)=0.
        GO TO 85
80      XX(I)=1.
        GO TO 85
85      CALL SEIZE(I,1)
        CALL RMOVE(N,I,Y)
        CALL ENTER(I,Y)
        CALL PUTARY(I+20,M,0.)
        RETURN
C
C DETERMINE APPROPRIATE ENTITY TO SEND IF OP.RES. IS FREE
C
90      N=0
        IF (K.GT.0) THEN
          DO 95 M=1,J
            R=GETARY(I,M+3)
            IF (R.EQ.0.) THEN
              A=GETARY(I,M)
              N=NFIND(1,I,19,0,A,.00001)
              IF (N.GT.0) THEN
                CALL PUTARY(I,M+3,1.)
```

```
              CALL SEIZE(I,1)
              CALL RMOVE(N,I,W)
              CALL ENTER(I+10,W)
              RETURN
            ENDIF
          ENDIF
95      CONTINUE
      ENDIF
      RETURN
      END
```

F.4 SMALL DCM MODEL EVENT(I) SUBROUTINE

```
SUBROUTINE EVENT(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT
     1,TNOW,XX(100)
C
C EVENT SUBROUTINE FOR SMALL DCM SHOP
C
      F=ATRIB(9)
      G=ATRIB(19)
      L=ATRIB(8)
      S=ATRIB(8)
      C=ATRIB(28)
C
      IF (I.LT.10) GO TO 5
      IF (I.GT.10.AND.I.LT.20) GO TO 10
      IF (I.GT.20.AND.I.LT.30) GO TO 20
      IF (I.GT.30.AND.I.LT.40) GO TO 30
      IF (I.GT.40) GO TO 40
C
C COUNT # OF SUB-BATCHES IN Q FOR EACH FAMILY
C
5     A=GETARY(I+30,L)
      B=A+1
      CALL PUTARY(I+30,L,B)
      RETURN
C
C SET ARRAYS FOR NEW BATCH
C
10    J=NNRSC(I)+NRUSE(I)
      DO 15 M=1,J
        B=GETARY(I+10,M)
          IF (B.EQ.0.) THEN
            CALL PUTARY(I-10,M,F)
            CALL PUTARY(I,M,G)
            CALL PUTARY(I+10,M,1.)
            CALL PUTARY(I-10,M+3,S)
            CALL PUTARY(I,M+3,0.)
          ENDIF
15    CONTINUE
      RETURN
C
C REMOVE ONE SUB-BATCH FROM Q COUNT ARRAY
C
20    A=GETARY(I+10,L)
```

```
      B=A-1
      CALL PUTARY(I+10,L,B)
      RETURN
C
C FREE MACHINE AND SET ARRAY TO AVAILABLE
C
30    J=NNRSC(I-30)+NRUSE(I-30)
      DO 35 M=1,J
        A=GETARY(I-20,M)
        IF (A.EQ.G) THEN
          CALL PUTARY(I-20,M+3,0.)
          CALL FREE(I-20,1)
          RETURN
        ENDIF
35    CONTINUE
      RETURN
C
C COUNT SUB-BATCHES AND FREE SB WHEN NECESSARY
C
40    J=NNRSC(I-40)+NRUSE(I-40)
      DO 45 M=1,J
        A=GETARY(I-30,M)
        IF (A.EQ.G) THEN
          B=GETARY(I-20,M)
          CALL PUTARY(I-20,M,B+1.)
          B=GETARY(I-20,M)
          IF (B.GT.C) THEN
              CALL FREE(I-40,1)
              RETURN
          ENDIF
        ENDIF
45    CONTINUE
      RETURN
      END
```

F.5 DCM SHOP MODEL – NO BATCH SPLIT

```
GEN,DAVID BROCK,DCM_NO,3/10/97,,NO,NO,,,,72;
LIMITS,18,29,4000;
TIMST,XX(9),WIP;
SEEDS,125653201(9);
;SET INITIAL VARIABLES
INTLC,XX(1)=0,XX(2)=0,XX(3)=0,XX(4)=0,XX(5)=0;
INTLC,XX(6)=0,XX(7)=0,XX(8)=0,XX(9)=0;
;SET INITIAL ARRAY VALUES
ARRAY(1,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(2,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(3,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(4,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(5,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(6,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(7,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(8,8)/1.,1.,1.,1.,1.,1.,1.,1.;
ARRAY(11,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(12,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(13,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(14,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(15,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(16,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(17,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(18,8)/0.,0.,0.,0.,0.,0.,0.,0.;
ARRAY(21,4)/2.,2.,2.,2.;
ARRAY(22,4)/2.,2.,2.,2.;
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ARRAY(23,4)/2.,2.,2.,2.;
ARRAY(24,4)/2.,2.,2.,2.;
ARRAY(25,4)/2.,2.,2.,2.;
ARRAY(26,4)/2.,2.,2.,2.;
ARRAY(27,4)/2.,2.,2.,2.;
ARRAY(28,4)/2.,2.,2.,2.;
ARRAY(31,5)/0.,0.,0.,0.,0.;
ARRAY(32,5)/0.,0.,0.,0.,0.;
ARRAY(33,5)/0.,0.,0.,0.,0.;
ARRAY(34,5)/0.,0.,0.,0.,0.;
ARRAY(35,5)/0.,0.,0.,0.,0.;
ARRAY(36,5)/0.,0.,0.,0.,0.;
ARRAY(37,5)/0.,0.,0.,0.,0.;
ARRAY(38,5)/0.,0.,0.,0.,0.;
ARRAY(41,5)/4.,0.,0.,0.,0.;
ARRAY(42,5)/4.,0.,0.,0.,0.;
ARRAY(43,5)/4.,0.,0.,0.,0.;
ARRAY(44,5)/4.,0.,0.,0.,0.;
ARRAY(45,5)/4.,0.,0.,0.,0.;
ARRAY(46,5)/4.,0.,0.,0.,0.;
ARRAY(47,5)/3.,0.,0.,0.,0.;
ARRAY(48,5)/3.,0.,0.,0.,0.;
NETWORK;
;SET RESOURCES
        RESOURCE/1,X1(4),1/2,X2(4),2/3,X3(4),3;
        RESOURCE/4,X4(4),4/5,X5(4),5/6,X6(4),6;
        RESOURCE/7,X7(3),7/8,X8(3),8/11,D1(4),11;
        RESOURCE/12,D2(4),12/13,D3(4),13/14,D4(4),14;
        RESOURCE/15,D5(4),15/16,D6(4),16/17,D7(3),17;
        RESOURCE/18,D8(3),18;
;ARRIVALS
        CREATE,EXPON(8),1,19;
        ASSIGN,XX(9)=XX(9)+1;
        ASSIGN,ATRIB(28)=1,ATRIB(29)=100,1;
          ACT,,0.2,F1;
          ACT,,0.25,F2;
          ACT,,0.15,F3;
          ACT,,0.2,F4;
          ACT,,0.2,F5;
;ASSIGN TO A FAMILY
F1      ASSIGN,ATRIB(8)=1,1;
          ACT,,0.125,PN1;
          ACT,,0.125,PN2;
          ACT,,0.125,PN3;
          ACT,,0.125,PN4;
          ACT,,0.125,PN5;
          ACT,,0.125,PN6;
          ACT,,0.125,PN7;
          ACT,,0.125,PN8;
F2      ASSIGN,ATRIB(8)=2,1;
          ACT,,0.1,PN9;
          ACT,,0.1,PN10;
          ACT,,0.1,PN11;
          ACT,,0.1,PN12;
          ACT,,0.1,PN13;
          ACT,,0.1,PN14;
          ACT,,0.1,PN15;
          ACT,,0.1,PN16;
          ACT,,0.1,PN17;
          ACT,,0.1,PN18;
F3      ASSIGN,ATRIB(8)=3,1;
          ACT,,0.16666,PN27;
          ACT,,0.16666,PN28;
          ACT,,0.16667,PN29;
          ACT,,0.16667,PN30;
          ACT,,0.16667,PN31;
          ACT,,0.16667,PN32;
F4      ASSIGN,ATRIB(8)=4,1;
          ACT,,0.125,PN19;
          ACT,,0.125,PN20;
          ACT,,0.125,PN21;
          ACT,,0.125,PN22;
          ACT,,0.125,PN23;
          ACT,,0.125,PN24;
          ACT,,0.125,PN25;
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          ACT,,0.125,PN26;
FS      ASSIGN,ATRIB(8)=5,1;
          ACT,,0.125,PN33;
          ACT,,0.125,PN34;
          ACT,,0.125,PN35;
          ACT,,0.125,PN36;
          ACT,,0.125,PN37;
          ACT,,0.125,PN38;
          ACT,,0.125,PN39;
          ACT,,0.125,PN40;
;ASSIGN PART #s, ROUTINGS, AND PROCESSING TIMES
PN1       ASSIGN,ATRIB(9)=1,ATRIB(1)=5,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
            ACT,,,R1;
PN2       ASSIGN,ATRIB(9)=2,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)-.153;
            ACT,,,R1;
PN3       ASSIGN,ATRIB(9)=3,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.131;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
            ACT,,,R1;
PN4       ASSIGN,ATRIB(9)=4,ATRIB(1)=3,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.136;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.185;
            ACT,,,R1;
PN5       ASSIGN,ATRIB(9)=5,ATRIB(1)=5,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
            ACT,,,R1;
PN6       ASSIGN,ATRIB(9)=6,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.136,ATRIB(27)=.185;
            ACT,,,R1;
PN7       ASSIGN,ATRIB(9)=7,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.185;
            ACT,,,R1;
PN8       ASSIGN,ATRIB(9)=8,ATRIB(1)=4,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.131,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.185;
            ACT,,,R1;
PN9       ASSIGN,ATRIB(9)=9,ATRIB(1)=6,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
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          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN10      ASSIGN,ATRIB(9)=10,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN11      ASSIGN,ATRIB(9)=11,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.126;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
            ACT,,,R1;
PN12      ASSIGN,ATRIB(9)=12,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN13      ASSIGN,ATRIB(9)=13,ATRIB(1)=6,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=2,ATRIB(4)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.213;
          ASSIGN,ATRIB(23)=.077,ATRIB(27)=.1;
            ACT,,,R1;
PN14      ASSIGN,ATRIB(9)=14,ATRIB(1)=8,ATRIB(2)=1;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.126;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
            ACT,,,R1;
PN15      ASSIGN,ATRIB(9)=15,ATRIB(1)=6,ATRIB(2)=8;
          ASSIGN,ATRIB(3)=1,ATRIB(4)=2,ATRIB(5)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.114;
          ASSIGN,ATRIB(23)=.099,ATRIB(24)=.077;
          ASSIGN,ATRIB(27)=.1;
            ACT,,,R1;
PN16      ASSIGN,ATRIB(9)=16,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN17      ASSIGN,ATRIB(9)=17,ATRIB(1)=6,ATRIB(2)=7;
          ASSIGN,ATRIB(3)=8,ATRIB(4)=1,ATRIB(5)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.185,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.057,ATRIB(24)=.099;
          ASSIGN,ATRIB(27)=.126;
            ACT,,,R1;
PN18      ASSIGN,ATRIB(9)=18,ATRIB(1)=7,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=0,ATRIB(27)=.1;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.253,ATRIB(22)=.153;
            ACT,,,R1;
PN19      ASSIGN,ATRIB(9)=19,ATRIB(1)=1,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=7,ATRIB(4)=8,ATRIB(5)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
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        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.126,ATRIB(22)=.213;
        ASSIGN,ATRIB(23)=.205,ATRIB(24)=.057;
        ASSIGN,ATRIB(27)=.219;
          ACT,,,R1;
PN20    ASSIGN,ATRIB(9)=20,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
        ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
        ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
        ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
          ACT,,,R1;
PN21    ASSIGN,ATRIB(9)=21,ATRIB(1)=2,ATRIB(2)=5;
        ASSIGN,ATRIB(3)=6,ATRIB(4)=7,ATRIB(5)=8;
        ASSIGN,ATRIB(6)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
        ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
        ASSIGN,ATRIB(25)=.057,ATRIB(27)=.185;
          ACT,,,R1;
PN22    ASSIGN,ATRIB(9)=22,ATRIB(1)=2,ATRIB(2)=3;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=6;
        ASSIGN,ATRIB(6)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
        ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
        ASSIGN,ATRIB(25)=.068,ATRIB(27)=.185;
          ACT,,,R1;
PN23    ASSIGN,ATRIB(9)=23,ATRIB(1)=1,ATRIB(2)=7;
        ASSIGN,ATRIB(3)=8,ATRIB(4)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.126,ATRIB(22)=.205;
        ASSIGN,ATRIB(23)=.057,ATRIB(27)=.219;
          ACT,,,R1;
PN24    ASSIGN,ATRIB(9)=24,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
        ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
        ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
        ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
          ACT,,,R1;
PN25    ASSIGN,ATRIB(9)=25,ATRIB(1)=5,ATRIB(2)=6;
        ASSIGN,ATRIB(3)=7,ATRIB(4)=8,ATRIB(5)=0;
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.153,ATRIB(22)=.068;
        ASSIGN,ATRIB(23)=.068,ATRIB(24)=.057;
        ASSIGN,ATRIB(27)=.219;
          ACT,,,R1;
PN26    ASSIGN,ATRIB(9)=26,ATRIB(1)=2,ATRIB(2)=3;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=6;
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         ASSIGN,ATRIB(6)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
         ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
         ASSIGN,ATRIB(25)=.068,ATRIB(27)=.185;
           ACT,,,R1;
PN27     ASSIGN,ATRIB(9)=27,ATRIB(1)=8,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=0;
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.219,ATRIB(22)=.119;
         ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
         ASSIGN,ATRIB(27)=.131;
           ACT,,,R1;
PN28     ASSIGN,ATRIB(9)=28,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
         ASSIGN,ATRIB(6)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
         ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
         ASSIGN,ATRIB(25)=.068,ATRIB(27)=.153;
           ACT,,,R1;
PN29     ASSIGN,ATRIB(9)=29,ATRIB(1)=1,ATRIB(2)=4;
         ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.126,ATRIB(22)=.213;
         ASSIGN,ATRIB(23)=.068,ATRIB(27)=.153;
           ACT,,,R1;
PN30     ASSIGN,ATRIB(9)=30,ATRIB(1)=8,ATRIB(2)=1;
         ASSIGN,ATRIB(3)=2,ATRIB(4)=3,ATRIB(5)=4;
         ASSIGN,ATRIB(6)=0;
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
         ASSIGN,ATRIB(23)=.077,ATRIB(24)=.068;
         ASSIGN,ATRIB(25)=.068,ATRIB(27)=.131;
           ACT,,,R1;
PN31     ASSIGN,ATRIB(9)=31,ATRIB(1)=8,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=3,ATRIB(4)=0;
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.219,ATRIB(22)=.119;
         ASSIGN,ATRIB(23)=.068,ATRIB(27)=.117;
           ACT,,,R1;
PN32     ASSIGN,ATRIB(9)=32,ATRIB(1)=8,ATRIB(2)=1;
         ASSIGN,ATRIB(3)=2,ATRIB(4)=3,ATRIB(5)=4;
         ASSIGN,ATRIB(6)=0;
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.219,ATRIB(22)=.099;
         ASSIGN,ATRIB(23)=.077,ATRIB(24)=.068;
         ASSIGN,ATRIB(25)=.068,ATRIB(27)=.131;
           ACT,,,R1;
PN33     ASSIGN,ATRIB(9)=33,ATRIB(1)=2,ATRIB(2)=4;
         ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
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          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.136;
          ASSIGN,ATRIB(23)=.136,ATRIB(27)=.185;
            ACT,,,R1;
PN34      ASSIGN,ATRIB(9)=34,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=3,ATRIB(4)=4,ATRIB(5)=5;
          ASSIGN,ATRIB(6)=6,ATRIB(7)=0,ATRIB(27)=.185;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(26)=.068;
            ACT,,,R1;
PN35      ASSIGN,ATRIB(9)=35,ATRIB(1)=3,ATRIB(2)=6;
          ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(27)=.253;
            ACT,,,R1;
PN36      ASSIGN,ATRIB(9)=36,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.253;
            ACT,,,R1;
PN37      ASSIGN,ATRIB(9)=37,ATRIB(1)=3,ATRIB(2)=4;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.117,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.068,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.068,ATRIB(27)=.253;
            ACT,,,R1;
PN38      ASSIGN,ATRIB(9)=38,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.136,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.153;
            ACT,,,R1;
PN39      ASSIGN,ATRIB(9)=39,ATRIB(1)=2,ATRIB(2)=3;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1,ATRIB(22)=.068;
          ASSIGN,ATRIB(23)=.136,ATRIB(24)=.068;
          ASSIGN,ATRIB(27)=.185;
            ACT,,,R1;
PN40      ASSIGN,ATRIB(9)=40,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=7;
          ASSIGN,ATRIB(6)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
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          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.126,ATRIB(22)=.077;
          ASSIGN,ATRIB(23)=.136,ATRIB(24)=.068;
          ASSIGN,ATRIB(25)=.136,ATRIB(27)=.253;
            ACT,,,R1;
;ROUTE ENTITY TO APPROPRIATE DEPARTMENT
R1        GOON;
          ACT/51,ATRIB(21);
          GOON,1;
            ACT,,ATRIB(1).EQ.0,SR;
            ACT,,ATRIB(1).EQ.1,D1;
            ACT,,ATRIB(1).EQ.2,D2;
            ACT,,ATRIB(1).EQ.3,D3;
            ACT,,ATRIB(1).EQ.4,D4;
            ACT,,ATRIB(1).EQ.5,D5;
            ACT,,ATRIB(1).EQ.6,D6;
            ACT,,ATRIB(1).EQ.7,D7;
            ACT,,ATRIB(1).EQ.8,D8;
R2        GOON;
          ACT/52,ATRIB(22);
          GOON,1;
            ACT,,ATRIB(2).EQ.0,SR;
            ACT,,ATRIB(2).EQ.1,D1;
            ACT,,ATRIB(2).EQ.2,D2;
            ACT,,ATRIB(2).EQ.3,D3;
            ACT,,ATRIB(2).EQ.4,D4;
            ACT,,ATRIB(2).EQ.5,D5;
            ACT,,ATRIB(2).EQ.6,D6;
            ACT,,ATRIB(2).EQ.7,D7;
            ACT,,ATRIB(2).EQ.8,D8;
R3        GOON;
          ACT/53,ATRIB(23);
          GOON,1;
            ACT,,ATRIB(3).EQ.0,SR;
            ACT,,ATRIB(3).EQ.1,D1;
            ACT,,ATRIB(3).EQ.2,D2;
            ACT,,ATRIB(3).EQ.3,D3;
            ACT,,ATRIB(3).EQ.4,D4;
            ACT,,ATRIB(3).EQ.5,D5;
            ACT,,ATRIB(3).EQ.6,D6;
            ACT,,ATRIB(3).EQ.7,D7;
            ACT,,ATRIB(3).EQ.8,D8;
R4        GOON;
          ACT/54,ATRIB(24);
          GOON,1;
            ACT,,ATRIB(4).EQ.0,SR;
            ACT,,ATRIB(4).EQ.1,D1;
            ACT,,ATRIB(4).EQ.2,D2;
            ACT,,ATRIB(4).EQ.3,D3;
            ACT,,ATRIB(4).EQ.4,D4;
            ACT,,ATRIB(4).EQ.5,D5;
            ACT,,ATRIB(4).EQ.6,D6;
            ACT,,ATRIB(4).EQ.7,D7;
            ACT,,ATRIB(4).EQ.8,D8;
R5        GOON;
          ACT/55,ATRIB(25);
          GOON,1;
            ACT,,ATRIB(5).EQ.0,SR;
            ACT,,ATRIB(5).EQ.1,D1;
            ACT,,ATRIB(5).EQ.2,D2;
            ACT,,ATRIB(5).EQ.3,D3;
            ACT,,ATRIB(5).EQ.4,D4;
            ACT,,ATRIB(5).EQ.5,D5;
            ACT,,ATRIB(5).EQ.6,D6;
            ACT,,ATRIB(5).EQ.7,D7;
            ACT,,ATRIB(5).EQ.8,D8;
R6        GOON;
          ACT/56,ATRIB(26);
          GOON,1;
            ACT,,ATRIB(6).EQ.0,SR;
            ACT,,ATRIB(6).EQ.1,D1;
            ACT,,ATRIB(6).EQ.2,D2;
            ACT,,ATRIB(6).EQ.3,D3;
```

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             ACT,,ATRIB(6).EQ.4,D4;
             ACT,,ATRIB(6).EQ.5,D5;
             ACT,,ATRIB(6).EQ.6,D6;
             ACT,,ATRIB(6).EQ.7,D7;
             ACT,,ATRIB(6).EQ.8,D8;
D1         GOON;
           ACT/31,UNFRM(1,5);
           GOON,1;
             ACT,,ATRIB(1).NE.1,EV1;
             ACT,,,SB1;
SB1        UNBATCH,28;
EV1        EVENT,1;
           AWAIT(1),ALLOC(1);
E1         ENTER,1;
           ASSIGN,ATRIB(20)=XX(1);
           EVENT,11;
             ACT,,,P1;
E11        ENTER,11;
           ASSIGN,ATRIB(20)=0.;
             ACT,,,P1;
P1         EVENT,21;
             ACT,,ATRIB(20).EQ.0.,UB1;
             ACT/11,11.33,ATRIB(20).EQ.1.,UB1;
             ACT/21,22.66,ATRIB(20).EQ.2.,UB1;
UB1        UNBATCH,29;
           AWAIT(11),ALLOC(11);
           ENTER,21;
           ACT/1,ATRIB(11);
           EVENT,31;
           BATCH,4/19,ATRIB(29);
           EVENT,41
           ACT/41,UNFRM(1,5);
           ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
             ACT,,ATRIB(10).EQ.1,R2;
             ACT,,ATRIB(10).EQ.2,R3;
             ACT,,ATRIB(10).EQ.3,R4;
             ACT,,ATRIB(10).EQ.4,R5;
             ACT,,ATRIB(10).EQ.5,R6;
             ACT,,ATRIB(10).EQ.6,SR;
D2         GOON;
           ACT/32,UNFRM(1,5);
           GOON,1;
             ACT,,ATRIB(1).NE.2,EV2;
             ACT,,,SB2;
SB2        UNBATCH,28;
EV2        EVENT,2;
           AWAIT(2),ALLOC(2);
E2         ENTER,2;
           ASSIGN,ATRIB(20)=XX(2);
           EVENT,12;
             ACT,,,P2;
E12        ENTER,12;
           ASSIGN,ATRIB(20)=0.;
             ACT,,,P2;
P2         EVENT,22;
             ACT,,ATRIB(20).EQ.0.,UB2;
             ACT/12,11.33,ATRIB(20).EQ.1.,UB2;
             ACT/22,22.66,ATRIB(20).EQ.2.,UB2;
UB2        UNBATCH,29;
           AWAIT(12),ALLOC(12);
           ENTER,22;
           ACT/2,ATRIB(12);
           EVENT,32;
           BATCH,4/19,ATRIB(29);
           EVENT,42
           ACT/42,UNFRM(1,5);
           ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
             ACT,,ATRIB(10).EQ.1,R2;
             ACT,,ATRIB(10).EQ.2,R3;
             ACT,,ATRIB(10).EQ.3,R4;
             ACT,,ATRIB(10).EQ.4,R5;
             ACT,,ATRIB(10).EQ.5,R6;
             ACT,,ATRIB(10).EQ.6,SR;
D3         GOON;
           ACT/33,UNFRM(1,5);
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          GOON,1;
            ACT,,ATRIB(1).NE.3,EV3;
            ACT,,,SB3;
SB3       UNBATCH,28;
EV3       EVENT,3;
          AWAIT(3),ALLOC(3);
E3        ENTER,3;
          ASSIGN,ATRIB(20)=XX(3);
          EVENT,13;
            ACT,,,P3;
E13       ENTER,13;
          ASSIGN,ATRIB(20)=0.;
            ACT,,,P3;
P3        EVENT,23;
            ACT,,ATRIB(20).EQ.0.,UB3;
            ACT/13,11.33,ATRIB(20).EQ.1.,UB3;
            ACT/23,22.66,ATRIB(20).EQ.2.,UB3;
UB3       UNBATCH,29;
          AWAIT(13),ALLOC(13);
          ENTER,23;
          ACT/3,ATRIB(13);
          EVENT,33;
          BATCH,4/19,ATRIB(29);
          EVENT,43
          ACT/43,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D4        GOON;
          ACT/34,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.4,EV4;
            ACT,,,SB4;
SB4       UNBATCH,28;
EV4       EVENT,4;
          AWAIT(4),ALLOC(4);
E4        ENTER,4;
          ASSIGN,ATRIB(20)=XX(4);
          EVENT,14;
            ACT,,,P4;
E14       ENTER,14;
          ASSIGN,ATRIB(20)=0.;
            ACT,,,P4;
P4        EVENT,24;
            ACT,,ATRIB(20).EQ.0.,UB4;
            ACT/14,11.33,ATRIB(20).EQ.1.,UB4;
            ACT/24,22.66,ATRIB(20).EQ.2.,UB4;
UB4       UNBATCH,29;
          AWAIT(14),ALLOC(14);
          ENTER,24;
          ACT/4,ATRIB(14);
          EVENT,34;
          BATCH,4/19,ATRIB(29);
          EVENT,44
          ACT/44,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D5        GOON;
          ACT/35,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.5,EV5;
            ACT,,,SB5;
SB5       UNBATCH,28;
EV5       EVENT,5;
          AWAIT(5),ALLOC(5);
E5        ENTER,5;
```

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            ASSIGN,ATRIB(20)=XX(5);
            EVENT,15;
              ACT,,,P5;
E15         ENTER,15;
            ASSIGN,ATRIB(20)=0.;
              ACT,,,P5;
P5          EVENT,25;
              ACT,,ATRIB(20).EQ.0.,UB5;
              ACT/15,11.33,ATRIB(20).EQ.1.,UB5;
              ACT/25,22.66,ATRIB(20).EQ.2.,UB5;
UB5         UNBATCH,29;
            AWAIT(15),ALLOC(15);
            ENTER,25;
            ACT/5,ATRIB(15);
            EVENT,35;
            BATCH,4/19,ATRIB(29);
            EVENT,45
            ACT/45,UNFRM(1,5);
            ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
              ACT,,ATRIB(10).EQ.1,R2;
              ACT,,ATRIB(10).EQ.2,R3;
              ACT,,ATRIB(10).EQ.3,R4;
              ACT,,ATRIB(10).EQ.4,R5;
              ACT,,ATRIB(10).EQ.5,R6;
              ACT,,ATRIB(10).EQ.6,SR;
D6          GOON;
            ACT/36,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.6,EV6;
              ACT,,,SB6;
SB6         UNBATCH,28;
EV6         EVENT,6;
            AWAIT(6),ALLOC(6);
E6          ENTER,6;
            ASSIGN,ATRIB(20)=XX(6);
            EVENT,16;
              ACT,,,P6:
E16         ENTER,16;
            ASSIGN,ATRIB(20)=0.;
              ACT,,,P6;
P6          EVENT,26;
              ACT,,ATRIB(20).EQ.0.,UB6;
              ACT/16,11.33,ATRIB(20).EQ.1.,UB6;
              ACT/26,22.66,ATRIB(20).EQ.2.,UB6;
UB6         UNBATCH,29;
            AWAIT(16),ALLOC(16);
            ENTER,26;
            ACT/6,ATRIB(16);
            EVENT,36;
            BATCH,4/19,ATRIB(29);
            EVENT,46
            ACT/46,UNFRM(1,5);
            ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
              ACT,,ATRIB(10).EQ.1,R2;
              ACT,,ATRIB(10).EQ.2,R3;
              ACT,,ATRIB(10).EQ.3,R4;
              ACT,,ATRIB(10).EQ.4,R5;
              ACT,,ATRIB(10).EQ.5,R6;
              ACT,,ATRIB(10).EQ.6,SR;
D7          GOON;
            ACT/37,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.7,EV7;
              ACT,,,SB7;
SB7         UNBATCH,28;
EV7         EVENT,7;
            AWAIT(7),ALLOC(7);
E7          ENTER,7;
            ASSIGN,ATRIB(20)=XX(7);
            EVENT,17;
              ACT,,,P7;
E17         ENTER,17;
            ASSIGN,ATRIB(20)=0.;
              ACT,,,P7;
P7          EVENT,27;
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            ACT,,ATRIB(20).EQ.0.,UB7;
            ACT/17,11.33,ATRIB(20).EQ.1.,UB7;
            ACT/27,22.66,ATRIB(20).EQ.2.,UB7;
UB7       UNBATCH,29;
          AWAIT(17),ALLOC(17);
          ENTER,27;
          ACT/7,ATRIB(17);
          EVENT,37;
          BATCH,4/19,ATRIB(29);
          EVENT,47
          ACT/47,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D8        GOON;
          ACT/38,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.8,EV8;
            ACT,,,SB8;
SB8       UNBATCH,28;
EV8       EVENT,8;
          AWAIT(8),ALLOC(8);
E8        ENTER,8;
          ASSIGN,ATRIB(20)=XX(8);
          EVENT,18;
            ACT,,,P8;
E18       ENTER,18;
          ASSIGN,ATRIB(20)=0.;
            ACT,,,P8;
P8        EVENT,28;
            ACT,,ATRIB(20).EQ.0.,UB8;
            ACT/18,11.33,ATRIB(20).EQ.1.,UB8;
            ACT/28,22.66,ATRIB(20).EQ.2.,UB8;
UB8       UNBATCH,29;
          AWAIT(18),ALLOC(18);
          ENTER,28;
          ACT/8,ATRIB(18);
          EVENT,38;
          BATCH,4/19,ATRIB(29);
          EVENT,48
          ACT/48,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
;PUT BACK INTO FULL BATCHES GATHER STATS & LEAVE
SR        UNBATCH,29;
          BATCH,50/19,100;
          ACT/57,ATRIB(27);
          ASSIGN,XX(9)=XX(9)-1;
          COLCT(1),INT(19),TIME IN SYS;
          TERMINATE;
          ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000;
FIN;
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F.6 SMALL DCM SHOP MODEL – 1% BATCH SPLIT

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GEN,DAVID BROCK,SM_DCM_1,3/10/97,,NO,NO,,,,72;
LIMITS,18,29,4000;
TIMST,XX(9),WIP;
SEEDS,1236548965l(9);
;SET INITIAL VARIABLES
INTLC,XX(1)=0,XX(2)=0,XX(3)=0,XX(4)=0,XX(5)=0;
INTLC,XX(6)=0,XX(7)=0,XX(8)=0,XX(9)=0;
;SET INITIAL ARRAY VALUES
ARRAY(1,8)/1.,1.,1.,1.,1.,1.;
ARRAY(2,8)/1.,1.,1.,1.,1.,1.;
ARRAY(3,8)/1.,1.,1.,1.,1.,1.;
ARRAY(4,8)/1.,1.,1.,1.,1.,1.;
ARRAY(5,8)/1.,1.,1.,1.,1.,1.;
ARRAY(6,8)/1.,1.,1.,1.,1.,1.;
ARRAY(7,8)/1.,1.,1.,1.,1.,1.;
ARRAY(8,8)/1.,1.,1.,1.,1.,1.;
ARRAY(11,8)/0.,0.,0.,0.,0.,0.;
ARRAY(12,8)/0.,0.,0.,0.,0.,0.;
ARRAY(13,8)/0.,0.,0.,0.,0.,0.;
ARRAY(14,8)/0.,0.,0.,0.,0.,0.;
ARRAY(15,8)/0.,0.,0.,0.,0.,0.;
ARRAY(16,8)/0.,0.,0.,0.,0.,0.;
ARRAY(17,8)/0.,0.,0.,0.,0.,0.;
ARRAY(18,8)/0.,0.,0.,0.,0.,0.;
ARRAY(21,4)/101.,101.,101.;
ARRAY(22,4)/101.,101.,101.;
ARRAY(23,4)/101.,101.,101.;
ARRAY(24,4)/101.,101.,101.;
ARRAY(25,4)/101.,101.,101.;
ARRAY(26,4)/101.,101.,101.;
ARRAY(27,4)/101.,101.,101.;
ARRAY(28,4)/101.,101.,101.;
ARRAY(31,5)/0.,0.,0.,0.,0.;
ARRAY(32,5)/0.,0.,0.,0.,0.;
ARRAY(33,5)/0.,0.,0.,0.,0.;
ARRAY(34,5)/0.,0.,0.,0.,0.;
ARRAY(35,5)/0.,0.,0.,0.,0.;
ARRAY(36,5)/0.,0.,0.,0.,0.;
ARRAY(37,5)/0.,0.,0.,0.,0.;
ARRAY(38,5)/0.,0.,0.,0.,0.;
ARRAY(41,5)/2.,0.,0.,0.,0.;
ARRAY(42,5)/3.,0.,0.,0.,0.;
ARRAY(43,5)/2.,0.,0.,0.,0.;
ARRAY(44,5)/3.,0.,0.,0.,0.;
ARRAY(45,5)/3.,0.,0.,0.,0.;
ARRAY(46,5)/3.,0.,0.,0.,0.;
ARRAY(47,5)/2.,0.,0.,0.,0.;
ARRAY(48,5)/2.,0.,0.,0.,0.;
NETWORK;
;SET RESOURCES
        RESOURCE/1,X1(2),1/2,X2(3),2/3,X3(2),3;
        RESOURCE/4,X4(3),4/5,X5(3),5/6,X6(3),6;
        RESOURCE/7,X7(2),7/8,X8(2),8/11,D1(2),11;
        RESOURCE/12,D2(3),12/13,D3(2),13/14,D4(3),14;
        RESOURCE/15,D5(3),15/16,D6(3),16/17,D7(2),17;
        RESOURCE/18,D8(2),18;
;ARRIVALS
        CREATE,EXPON(8),1,19;
        ASSIGN,XX(9)=XX(9)+1;
        ASSIGN,ATRIB(28)=100,ATRIB(29)=1,1;
          ACT,,0.2,F1;
          ACT,,0.25,F2;
          ACT,,0.15,F3;
          ACT,,0.2,F4;
          ACT,,0.2,F5;
;ASSIGN TO A FAMILY
F1      ASSIGN,ATRIB(8)=1,1;
          ACT,,0.125,PN1;
          ACT,,0.125,PN2;
          ACT,,0.125,PN3;
          ACT,,0.125,PN4;
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            ACT,,0.125,PN5;
            ACT,,0.125,PN6;
            ACT,,0.125,PN7;
            ACT,,0.125,PN8;
F2         ASSIGN,ATRIB(8)=2,1;
            ACT,,0.1,PN9;
            ACT,,0.1,PN10;
            ACT,,0.1,PN11;
            ACT,,0.1,PN12;
            ACT,,0.1,PN13;
            ACT,,0.1,PN14;
            ACT,,0.1,PN15;
            ACT,,0.1,PN16;
            ACT,,0.1,PN17;
            ACT,,0.1,PN18;
F3         ASSIGN,ATRIB(8)=3,1;
            ACT,,0.16666,PN27;
            ACT,,0.16666,PN28;
            ACT,,0.16667,PN29;
            ACT,,0.16667,PN30;
            ACT,,0.16667,PN31;
            ACT,,0.16667,PN32;
F4         ASSIGN,ATRIB(8)=4,1;
            ACT,,0.125,PN19;
            ACT,,0.125,PN20;
            ACT,,0.125,PN21;
            ACT,,0.125,PN22;
            ACT,,0.125,PN23;
            ACT,,0.125,PN24;
            ACT,,0.125,PN25;
            ACT,,0.125,PN26;
F5         ASSIGN,ATRIB(8)=5,1;
            ACT,,0.125,PN33;
            ACT,,0.125,PN34;
            ACT,,0.125,PN35;
            ACT,,0.125,PN36;
            ACT,,0.125,PN37;
            ACT,,0.125,PN38;
            ACT,,0.125,PN39;
            ACT,,0.125,PN40;
;ASSIGN PART #s, ROUTINGS, AND PROCESSING TIMES
PN1         ASSIGN,ATRIB(9)=1,ATRIB(1)=5,ATRIB(2)=0,
            ATRIB(15)=RNORM(.3433,.0858);
            ASSIGN,ATRIB(21)=.1273,ATRIB(27)=.1273;
              ACT,,,R1;
PN2         ASSIGN,ATRIB(9)=2,ATRIB(1)=3,ATRIB(2)=4,
            ATRIB(3)=5,ATRIB(4)=0;
            ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
            ATRIB(14)=RNORM(.3433,.0858),
            ATRIB(15)=RNORM(.3433,.0858);
            ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
            ATRIB(23)=.0568,ATRIB(27)=.1273;
              ACT,,,R1;
PN3         ASSIGN,ATRIB(9)=3,ATRIB(1)=3,ATRIB(2)=4,
            ATRIB(3)=0;
            ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
            ATRIB(14)=RNORM(.3433,.0858);
            ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
            ATRIB(27)=.0705;
              ACT,,,R1;
PN4         ASSIGN,ATRIB(9)=4,ATRIB(1)=3,ATRIB(2)=5;
            ASSIGN,ATRIB(3)=0;
            ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
            ATRIB(15)=RNORM(.3433,.0858);
            ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0966,
            ATRIB(27)=.1273;
              ACT,,,R1;
PN5         ASSIGN,ATRIB(9)=5,ATRIB(1)=5,ATRIB(2)=0,
            ATRIB(15)=RNORM(.3433,.0858);
            ASSIGN,ATRIB(21)=.1273,ATRIB(27)=.1273;
              ACT,,,R1;
PN6         ASSIGN,ATRIB(9)=6,ATRIB(1)=3,ATRIB(2)=4,
            ATRIB(3)=0;
            ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
            ATRIB(14)=RNORM(.3433,.0858);
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          ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
          ATRIB(27)=.0705;
            ACT,,,R1;
PN7       ASSIGN,ATRIB(9)=7,ATRIB(1)=3,ATRIB(2)=4,
          ATRIB(3)=5,ATRIB(4)=0;
          ASSIGN,ATRIB(13)=RNORM(.3433,.0858),
          ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1125,ATRIB(22)=.0511,
          ATRIB(23)=.0568,ATRIB(27)=.1273;
            ACT,,,R1;
PN8       ASSIGN,ATRIB(9)=8,ATRIB(1)=4,ATRIB(2)=5,
          ATRIB(3)=0;
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858),
          ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.0705,ATRIB(22)=.0528,
          ATRIB(27)=.0795;
            ACT,,,R1;
PN9       ASSIGN,ATRIB(9)=9,ATRIB(1)=6,ATRIB(2)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.175,ATRIB(27)=.175;
            ACT,,,R1;
PN10      ASSIGN,ATRIB(9)=10,ATRIB(1)=8,ATRIB(2)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
            ACT,,,R1;
PN11      ASSIGN,ATRIB(9)=11,ATRIB(1)=8,ATRIB(2)=0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
            ACT,,,R1;
PN12      ASSIGN,ATRIB(9)=12,ATRIB(1)=7,ATRIB(2)=0;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
            ACT,,,R1;
PN13      ASSIGN,ATRIB(9)=13,ATRIB(1)=6,ATRIB(2)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.175,ATRIB(27)=.175;
            ACT,,,R1;
PN14      ASSIGN,ATRIB(9)=14,ATRIB(1)=8,ATRIB(2) 0;
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
            ACT,,,R1;
PN15      ASSIGN,ATRIB(9)=15,ATRIB(1)=6,ATRIB(2)=8;
          ASSIGN,ATRIB(3)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.175,ATRIB(22)=.1193;
          ASSIGN,ATRIB(27)=.1466;
            ACT,,,R1;
PN16      ASSIGN,ATRIB(9)=16,ATRIB(1)=7,ATRIB(2)=0;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
            ACT,,,R1;
PN17      ASSIGN,ATRIB(9)=17,ATRIB(1)=6,ATRIB(2)=7;
          ASSIGN,ATRIB(3)=8,ATRIB(4)=0;
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.175,ATRIB(22)=.0511;
          ASSIGN,ATRIB(23)=.0682;
          ASSIGN,ATRIB(27)=.1466;
            ACT,,,R1;
PN18      ASSIGN,ATRIB(9)=18,ATRIB(1)=7,ATRIB(2)=0;
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.2148,ATRIB(27)=.2148;
            ACT,,,R1;
PN19      ASSIGN,ATRIB(9)=19,ATRIB(1)=4,ATRIB(2)=8;
          ASSIGN,ATRIB(3)=0;
          ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.0705,ATRIB(22)=.142;
          ASSIGN,ATRIB(27)=.1466;
            ACT,,,R1;
PN20      ASSIGN,ATRIB(9)=20,ATRIB(1)=2,ATRIB(2)=3;
          ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
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         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
         ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN21     ASSIGN,ATRIB(9)=21,ATRIB(1)=2,ATRIB(2)=6;
         ASSIGN,ATRIB(3)=8,ATRIB(4)=0,;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0795;
         ASSIGN,ATRIB(23)=.1193,ATRIB(27)=.185;
           ACT,,,R1;
PN22     ASSIGN,ATRIB(9)=22,ATRIB(1)=2,ATRIB(2)=3;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
         ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN23     ASSIGN,ATRIB(9)=23,ATRIB(1)=8,ATRIB(2)=0;
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1466,ATRIB(27)=.1466;
           ACT,,,R1;
PN24     ASSIGN,ATRIB(9)=24,ATRIB(1)=2,ATRIB(2)=3;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
         ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN25     ASSIGN,ATRIB(9)=25,ATRIB(1)=6,ATRIB(2)=8;
         ASSIGN,ATRIB(3)=0,;
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(18)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.175,ATRIB(22)=.1193;
         ASSIGN,ATRIB(27)=.1466;
           ACT,,,R1;
PN26     ASSIGN,ATRIB(9)=26,ATRIB(1)=2,ATRIB(2)=3;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=6,ATRIB(5)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(13)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0625;
         ASSIGN,ATRIB(23)=.0511,ATRIB(24)=.1136;
         ASSIGN,ATRIB(27)=.175;
           ACT,,,R1;
PN27     ASSIGN,ATRIB(9)=27,ATRIB(1)=2,ATRIB(2)=4;
         ASSIGN,ATRIB(3)=0;
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.1023;
         ASSIGN,ATRIB(27)=.131;
           ACT,,,R1;
PN28     ASSIGN,ATRIB(9)=28,ATRIB(1)=1,ATRIB(2)=2;
         ASSIGN,ATRIB(3)=4,ATRIB(4)=5,ATRIB(5)=0;
         ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
         ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
         ASSIGN,ATRIB(23)=.1023,ATRIB(24)=.0568;
         ASSIGN,ATRIB(27)=.153;
           ACT,,,R1;
PN29     ASSIGN,ATRIB(9)=29,ATRIB(1)=1,ATRIB(2)=4;
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        ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.1761;
        ASSIGN,ATRIB(23)=.0568,ATRIB(27)=.1273;
          ACT,,,R1;
PN30    ASSIGN,ATRIB(9)=30,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
        ASSIGN,ATRIB(23)=.1023,ATRIB(27)=.0705;
          ACT,,,R1;
PN31    ASSIGN,ATRIB(9)=31,ATRIB(1)=2,ATRIB(2)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(27)=.0955;
          ACT,,,R1;
PN32    ASSIGN,ATRIB(9)=32,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=4,ATRIB(4)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(14)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
        ASSIGN,ATRIB(23)=.1023,ATRIB(27)=.0705;
          ACT,,,R1;
PN33    ASSIGN,ATRIB(9)=33,ATRIB(1)=2,ATRIB(2)=6;
        ASSIGN,ATRIB(3)=0;
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.0795;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN34    ASSIGN,ATRIB(9)=34,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=5,ATRIB(4)=6,ATRIB(5)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
        ASSIGN,ATRIB(23)=.1591,ATRIB(24)=.0795;
        ASSIGN,ATRIB(27)=.175;
          ACT,,,R1;
PN35    ASSIGN,ATRIB(9)=35,ATRIB(1)=6,ATRIB(2)=7;
        ASSIGN,ATRIB(3)=0;
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.175,ATRIB(22)=.0511;
        ASSIGN,ATRIB(27)=.2148;
          ACT,,,R1;
PN36    ASSIGN,ATRIB(9)=36,ATRIB(1)=5,ATRIB(2)=6;
        ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1273,ATRIB(22)=.0795;
        ASSIGN,ATRIB(23)=.0511,ATRIB(27)=.2148;
          ACT,,,R1;
PN37    ASSIGN,ATRIB(9)=37,ATRIB(1)=5,ATRIB(2)=6;
        ASSIGN,ATRIB(3)=7,ATRIB(4)=0;
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1273,ATRIB(22)=.0795;
        ASSIGN,ATRIB(23)=.0511,ATRIB(27)=.2148;
          ACT,,,R1;
PN38    ASSIGN,ATRIB(9)=38,ATRIB(1)=1,ATRIB(2)=2;
        ASSIGN,ATRIB(3)=5,ATRIB(4)=0;
        ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
        ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
        ASSIGN,ATRIB(23)=.1591,ATRIB(27)=.1273;
          ACT,,,R1;
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PN39      ASSIGN,ATRIB(9)=39,ATRIB(1)=2,ATRIB(2)=5;
          ASSIGN,ATRIB(3)=6,ATRIB(4)=0;
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(16)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.0955,ATRIB(22)=.1591;
          ASSIGN,ATRIB(23)=.0795,ATRIB(27)=.175;
            ACT,,,R1;
PN40      ASSIGN,ATRIB(9)=40,ATRIB(1)=1,ATRIB(2)=2;
          ASSIGN,ATRIB(3)=5,ATRIB(4)=7,ATRIB(5)=0;
          ASSIGN,ATRIB(11)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(12)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(15)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(17)=RNORM(.3433,.0858);
          ASSIGN,ATRIB(21)=.1057,ATRIB(22)=.0739;
          ASSIGN,ATRIB(23)=.1591,ATRIB(24)=.1307;
          ASSIGN,ATRIB(27)=.2148;
            ACT,,,R1;
;ROUTE ENTITY TO APPROPRIATE DEPARTMENT
R1        GOON;
          ACT/51,ATRIB(21);
          GOON,1;
            ACT,,ATRIB(1).EQ.0,SR;
            ACT,,ATRIB(1).EQ.1,D1;
            ACT,,ATRIB(1).EQ.2,D2;
            ACT,,ATRIB(1).EQ.3,D3;
            ACT,,ATRIB(1).EQ.4,D4;
            ACT,,ATRIB(1).EQ.5,D5;
            ACT,,ATRIB(1).EQ.6,D6;
            ACT,,ATRIB(1).EQ.7,D7;
            ACT,,ATRIB(1).EQ.8,D8;
R2        GOON;
          ACT/52,ATRIB(22);
          GOON,1;
            ACT,,ATRIB(2).EQ.0,SR;
            ACT,,ATRIB(2).EQ.1,D1;
            ACT,,ATRIB(2).EQ.2,D2;
            ACT,,ATRIB(2).EQ.3,D3;
            ACT,,ATRIB(2).EQ.4,D4;
            ACT,,ATRIB(2).EQ.5,D5;
            ACT,,ATRIB(2).EQ.6,D6;
            ACT,,ATRIB(2).EQ.7,D7;
            ACT,,ATRIB(2).EQ.8,D8;
R3        GOON;
          ACT/53,ATRIB(23);
          GOON,1;
            ACT,,ATRIB(3).EQ.0,SR;
            ACT,,ATRIB(3).EQ.1,D1;
            ACT,,ATRIB(3).EQ.2,D2;
            ACT,,ATRIB(3).EQ.3,D3;
            ACT,,ATRIB(3).EQ.4,D4;
            ACT,,ATRIB(3).EQ.5,D5;
            ACT,,ATRIB(3).EQ.6,D6;
            ACT,,ATRIB(3).EQ.7,D7;
            ACT,,ATRIB(3).EQ.8,D8;
R4        GOON;
          ACT/54,ATRIB(24);
          GOON,1;
            ACT,,ATRIB(4).EQ.0,SR;
            ACT,,ATRIB(4).EQ.1,D1;
            ACT,,ATRIB(4).EQ.2,D2;
            ACT,,ATRIB(4).EQ.3,D3;
            ACT,,ATRIB(4).EQ.4,D4;
            ACT,,ATRIB(4).EQ.5,D5;
            ACT,,ATRIB(4).EQ.6,D6;
            ACT,,ATRIB(4).EQ.7,D7;
            ACT,,ATRIB(4).EQ.8,D8;
R5        GOON;
          ACT/55,ATRIB(25);
          GOON,1;
            ACT,,ATRIB(5).EQ.0,SR;
            ACT,,ATRIB(5).EQ.1,D1;
            ACT,,ATRIB(5).EQ.2,D2;
            ACT,,ATRIB(5).EQ.3,D3;
            ACT,,ATRIB(5).EQ.4,D4;
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              ACT,,ATRIB(5).EQ.5,D5;
              ACT,,ATRIB(5).EQ.6,D6;
              ACT,,ATRIB(5).EQ.7,D7;
              ACT,,ATRIB(5).EQ.8,D8;
R6          GOON;
            ACT/56,ATRIB(26);
            GOON,1;
              ACT,,ATRIB(6).EQ.0,SR;
              ACT,,ATRIB(6).EQ.1,D1;
              ACT,,ATRIB(6).EQ.2,D2;
              ACT,,ATRIB(6).EQ.3,D3;
              ACT,,ATRIB(6).EQ.4,D4;
              ACT,,ATRIB(6).EQ.5,D5;
              ACT,,ATRIB(6).EQ.6,D6;
              ACT,,ATRIB(6).EQ.7,D7;
              ACT,,ATRIB(6).EQ.8,D8;
D1          GOON;
            ACT/31,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.1,EV1;
              ACT,,,SB1;
SB1         UNBATCH,28;
EV1         EVENT,1;
            AWAIT(1),ALLOC(1);
E1          ENTER,1;
            ASSIGN,ATRIB(20)=XX(1);
            EVENT,11;
              ACT,,,P1;
E11         ENTER,11;
            ASSIGN,ATRIB(20)=0.;
              ACT,,,P1;
P1          EVENT,21;
              ACT,,ATRIB(20).EQ.0.,UB1;
              ACT/11,11.33,ATRIB(20).EQ.1.,UB1;
              ACT/21,22.66,ATRIB(20).EQ.2.,UB1;
UB1         UNBATCH,29;
            AWAIT(11),ALLOC(11);
            ENTER,21;
            ACT/1,ATRIB(11);
            EVENT,31;
            BATCH,4/19,ATRIB(29);
            EVENT,41
            ACT/41,UNFRM(1,5);
            ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
              ACT,,ATRIB(10).EQ.1,R2;
              ACT,,ATRIB(10).EQ.2,R3;
              ACT,,ATRIB(10).EQ.3,R4;
              ACT,,ATRIB(10).EQ.4,R5;
              ACT,,ATRIB(10).EQ.5,R6;
              ACT,,ATRIB(10).EQ.6,SR;
D2          GOON;
            ACT/32,UNFRM(1,5);
            GOON,1;
              ACT,,ATRIB(1).NE.2,EV2;
              ACT,,,SB2;
SB2         UNBATCH,28;
EV2         EVENT,2;
            AWAIT(2),ALLOC(2);
E2          ENTER,2;
            ASSIGN,ATRIB(20)=XX(2);
            EVENT,12;
              ACT,,,P2;
E12         ENTER,12;
            ASSIGN,ATRIB(20)=0.;
              ACT,,,P2;
P2          EVENT,22;
              ACT,,ATRIB(20).EQ.0.,UB2;
              ACT/12,11.33,ATRIB(20).EQ.1.,UB2;
              ACT/22,22.66,ATRIB(20).EQ.2.,UB2;
UB2         UNBATCH,29;
            AWAIT(12),ALLOC(12);
            ENTER,22;
            ACT/2,ATRIB(12);
            EVENT,32;
            BATCH,4/19,ATRIB(29);
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         EVENT,42
         ACT/42,UNFRM(1,5);
         ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
           ACT,,ATRIB(10).EQ.1,R2;
           ACT,,ATRIB(10).EQ.2,R3;
           ACT,,ATRIB(10).EQ.3,R4;
           ACT,,ATRIB(10).EQ.4,R5;
           ACT,,ATRIB(10).EQ.5,R6;
           ACT,,ATRIB(10).EQ.6,SR;
D3       GOON;
         ACT/33,UNFRM(1,5);
         GOON,1;
           ACT,,ATRIB(1).NE.3,EV3;
           ACT,,,SB3;
SB3      UNBATCH,28;
EV3      EVENT,3;
         AWAIT(3),ALLOC(3);
E3       ENTER,3;
         ASSIGN,ATRIB(20)=XX(3);
         EVENT,13;
           ACT,,,P3;
E13      ENTER,13;
         ASSIGN,ATRIB(20)=0.;
           ACT,,,P3;
P3       EVENT,23;
           ACT,,ATRIB(20).EQ.0.,UB3;
           ACT/13,11.33,ATRIB(20).EQ.1.,UB3;
           ACT/23,22.66,ATRIB(20).EQ.2.,UB3;
UB3      UNBATCH,29;
         AWAIT(13),ALLOC(13);
         ENTER,23;
         ACT/3,ATRIB(13);
         EVENT,33;
         BATCH,4/19,ATRIB(29);
         EVENT,43
         ACT/43,UNFRM(1,5);
         ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
           ACT,,ATRIB(10).EQ.1,R2;
           ACT,,ATRIB(10).EQ.2,R3;
           ACT,,ATRIB(10).EQ.3,R4;
           ACT,,ATRIB(10).EQ.4,R5;
           ACT,,ATRIB(10).EQ.5,R6;
           ACT,,ATRIB(10).EQ.6,SR;
D4       GOON;
         ACT/34,UNFRM(1,5);
         GOON,1;
           ACT,,ATRIB(1).NE.4,EV4;
           ACT,,,SB4;
SB4      UNBATCH,28;
EV4      EVENT,4;
         AWAIT(4),ALLOC(4);
E4       ENTER,4;
         ASSIGN,ATRIB(20)=XX(4);
         EVENT,14;
           ACT,,,P4;
E14      ENTER,14;
         ASSIGN,ATRIB(20)=0.;
           ACT,,,P4;
P4       EVENT,24;
           ACT,,ATRIB(20).EQ.0.,UB4;
           ACT/14,11.33,ATRIB(20).EQ.1.,UB4;
           ACT/24,22.66,ATRIB(20).EQ.2.,UB4;
UB4      UNBATCH,29;
         AWAIT(14),ALLOC(14);
         ENTER,24;
         ACT/4,ATRIB(14);
         EVENT,34;
         BATCH,4/19,ATRIB(29);
         EVENT,44
         ACT/44,UNFRM(1,5);
         ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
           ACT,,ATRIB(10).EQ.1,R2;
           ACT,,ATRIB(10).EQ.2,R3;
           ACT,,ATRIB(10).EQ.3,R4;
           ACT,,ATRIB(10).EQ.4,R5;
```

```
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D5      GOON;
        ACT/35,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.5,EV5;
          ACT,,,SB5;
SB5     UNBATCH,28;
EV5     EVENT,5;
        AWAIT(5),ALLOC(5);
E5      ENTER,5;
        ASSIGN,ATRIB(20)=XX(5);
        EVENT,15;
          ACT,,,P5;
E15     ENTER,15;
        ASSIGN,ATRIB(20)=0.;
          ACT,,,P5;
P5      EVENT,25;
          ACT,,ATRIB(20).EQ.0.,UB5;
          ACT/15,11.33,ATRIB(20).EQ.1.,UB5;
          ACT/25,22.66,ATRIB(20).EQ.2.,UB5;
UB5     UNBATCH,29;
        AWAIT(15),ALLOC(15);
        ENTER,25;
        ACT/5,ATRIB(15);
        EVENT,35;
        BATCH,4/19,ATRIB(29);
        EVENT,45
        ACT/45,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D6      GOON;
        ACT/36,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.6,EV6;
          ACT,,,SB6;
SB6     UNBATCH,28;
EV6     EVENT,6;
        AWAIT(6),ALLOC(6);
E6      ENTER,6;
        ASSIGN,ATRIB(20)=XX(6);
        EVENT,16;
          ACT,,,P6;
E16     ENTER,16;
        ASSIGN,ATRIB(20)=0.;
          ACT,,,P6;
P6      EVENT,26;
          ACT,,ATRIB(20).EQ.0.,UB6;
          ACT/16,11.33,ATRIB(20).EQ.1.,UB6;
          ACT/26,22.66,ATRIB(20).EQ.2.,UB6;
UB6     UNBATCH,29;
        AWAIT(16),ALLOC(16);
        ENTER,26;
        ACT/6,ATRIB(16);
        EVENT,36;
        BATCH,4/19,ATRIB(29);
        EVENT,46
        ACT/46,UNFRM(1,5);
        ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
          ACT,,ATRIB(10).EQ.1,R2;
          ACT,,ATRIB(10).EQ.2,R3;
          ACT,,ATRIB(10).EQ.3,R4;
          ACT,,ATRIB(10).EQ.4,R5;
          ACT,,ATRIB(10).EQ.5,R6;
          ACT,,ATRIB(10).EQ.6,SR;
D7      GOON;
        ACT/37,UNFRM(1,5);
        GOON,1;
          ACT,,ATRIB(1).NE.7,EV7;
          ACT,,,SB7;
```

```
SB7       UNBATCH,28;
EV7       EVENT,7;
          AWAIT(7),ALLOC(7);
E7        ENTER,7;
          ASSIGN,ATRIB(20)=XX(7);
          EVENT,17;
            ACT,,,P7;
E17       ENTER,17;
          ASSIGN,ATRIB(20)=0.;
            ACT,,,P7;
P7        EVENT,27;
            ACT,,ATRIB(20).EQ.0.,UB7;
            ACT/17,11.33,ATRIB(20).EQ.1.,UB7;
            ACT/27,22.66,ATRIB(20).EQ.2.,UB7;
UB7       UNBATCH,29;
          AWAIT(17),ALLOC(17);
          ENTER,27;
          ACT/7,ATRIB(17);
          EVENT,37;
          BATCH,4/19,ATRIB(29);
          EVENT,47
          ACT/47,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
D8        GOON;
          ACT/38,UNFRM(1,5);
          GOON,1;
            ACT,,ATRIB(1).NE.8,EV8;
            ACT,,,SB8;
SB8       UNBATCH,28;
EV8       EVENT,8;
          AWAIT(8),ALLOC(8);
E8        ENTER,8;
          ASSIGN,ATRIB(20)=XX(8);
          EVENT,18;
            ACT,,,P8;
E18       ENTER,18;
          ASSIGN,ATRIB(20) 0.;
            ACT,,,P8;
P8        EVENT,28;
            ACT,,ATRIB(20).EQ.0.,UB8;
            ACT/18,11.33,ATRIB(20).EQ.1.,UB8;
            ACT/28,22.66,ATRIB(20).EQ.2.,UB8;
UB8       UNBATCH,29;
          AWAIT(18),ALLOC(18);
          ENTER,28;
          ACT/8,ATRIB(18);
          EVENT,38;
          BATCH,4/19,ATRIB(29);
          EVENT,48
          ACT/48,UNFRM(1,5);
          ASSIGN,ATRIB(10)=ATRIB(10)+1,1;
            ACT,,ATRIB(10).EQ.1,R2;
            ACT,,ATRIB(10).EQ.2,R3;
            ACT,,ATRIB(10).EQ.3,R4;
            ACT,,ATRIB(10).EQ.4,R5;
            ACT,,ATRIB(10).EQ.5,R6;
            ACT,,ATRIB(10).EQ.6,SR;
;PUT BACK INTO FULL BATCHES GATHER STATS & LEAVE
SR        UNBATCH,29;
          BATCH,50/19,100;
          ACT/57,ATRIB(27);
          ASSIGN,XX(9)=XX(9)-1;
          COLCT(1),INT(19),TIME IN SYS;
          TERMINATE;
          ENDNETWORK;
INITIALIZE,,45000;
MONTR,CLEAR,35000;
FIN;
```

APPENDIX G

SAMPLE VERIFICATION OUTPUT

G.1 CM MODEL WITH 25% BATCH SPLITTING – ONE ENTITY

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SLAM II VERSION 4.03
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1
1 **INTERMEDIATE RESULTS**

1

S L A M I I S U M M A R Y R E P O R T

SIMULATION PROJECT CM_25 BY DAVID BROCK

DATE 4/20/1997 RUN NUMBER 1 OF 1

CURRENT TIME 0.1031E+03
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
TIME IN SYS	0.102E+03	0.000E+00	0.000E+00	0.102E+03	0.102E+03	1

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	0.990	0.098	0.00	1.00	103.144	0.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE		AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	0.000	0.000	0	0	0.000
2	A2	AWAIT	0.000	0.000	0	0	0.000
3	A3	AWAIT	0.000	0.000	0	0	0.000
4	A4	AWAIT	0.021	0.144	1	0	0.546
5	A5	AWAIT	0.000	0.000	0	0	0.000
6	A6	AWAIT	0.000	0.000	0	0	0.000
7	A7	AWAIT	0.000	0.000	0	0	0.000
8	A8	AWAIT	0.000	0.000	0	0	0.000
9	A9	AWAIT	0.000	0.000	0	0	0.000
10	A10	AWAIT	0.000	0.000	0	0	0.000
11	A11	AWAIT	0.000	0.000	0	0	0.000
12	A12	AWAIT	0.033	0.178	1	0	0.848
13	A13	AWAIT	0.000	0.000	0	0	0.000
14	A14	AWAIT	0.000	0.000	0	0	0.000
15	A15	AWAIT	0.000	0.000	0	0	0.000
16	A16	AWAIT	0.000	0.000	0	0	0.000
17	A17	AWAIT	0.330	0.938	3	0	8.498
18	A18	AWAIT	0.000	0.000	0	0	0.000
19	A19	AWAIT	0.000	0.000	0	0	0.000
20	A20	AWAIT	0.046	0.209	1	0	1.175
21	A21	AWAIT	0.000	0.000	0	0	0.000
22	A22	AWAIT	0.000	0.000	0	0	0.000
23	A23	AWAIT	0.000	0.000	0	0	0.000
24	A24	AWAIT	0.000	0.000	0	0	0.000
25	A25	AWAIT	0.000	0.000	0	0	0.000
26	A26	AWAIT	0.000	0.000	0	0	0.000
27	A27	AWAIT	0.000	0.000	0	0	0.000
28	A28	AWAIT	0.000	0.000	0	0	0.000
29	A29	AWAIT	0.000	0.000	0	0	0.000
30	A30	AWAIT	0.000	0.000	0	0	0.000
31		QUEUE	0.000	0.000	0	0	0.000
32		QUEUE	0.000	0.000	0	0	0.000
33		QUEUE	0.000	0.000	0	0	0.000
34		QUEUE	7.139	13.648	49	0	7.362
35		QUEUE	0.000	0.000	0	0	0.000
36		QUEUE	0.000	0.000	0	0	0.000
37		QUEUE	0.000	0.000	0	0	0.000
38		QUEUE	0.000	0.000	0	0	0.000
39		QUEUE	0.000	0.000	0	0	0.000
40		QUEUE	0.000	0.000	0	0	0.000
41		QUEUE	0.000	0.000	0	0	0.000
42		QUEUE	7.519	15.142	56	0	7.755
43		QUEUE	0.000	0.000	0	0	0.000
44		QUEUE	0.000	0.000	0	0	0.000
45		QUEUE	0.000	0.000	0	0	0.000
46		QUEUE	0.000	0.000	0	0	0.000
47		QUEUE	17.558	29.264	99	0	18.110
48		QUEUE	0.000	0.000	0	0	0.000
49		QUEUE	0.000	0.000	0	0	0.000
50		QUEUE	12.690	22.116	73	0	13.089
51		QUEUE	0.000	0.000	0	0	0.000
52		QUEUE	0.000	0.000	0	0	0.000
53		QUEUE	0.000	0.000	0	0	0.000
54		QUEUE	0.000	0.000	0	0	0.000
55		QUEUE	0.000	0.000	0	0	0.000
56		QUEUE	0.000	0.000	0	0	0.000
57		QUEUE	0.000	0.000	0	0	0.000
58		QUEUE	0.000	0.000	0	0	0.000
59		QUEUE	0.000	0.000	0	0	0.000
60		QUEUE	0.000	0.000	0	0	0.000

61	CALENDAR	1.749	0.645	52	0	0.098

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
31	0.0000	0.0000	0	0	0
32	0.0000	0.0000	0	0	0
33	0.0000	0.0000	0	0	0
34	0.1098	0.3127	1	0	1
35	0.0000	0.0000	0	0	0
36	0.0000	0.0000	0	0	0
37	0.0000	0.0000	0	0	0
38	0.0000	0.0000	0	0	0
39	0.0000	0.0000	0	0	0
40	0.0000	0.0000	0	0	0
41	0.0000	0.0000	0	0	0
42	0.1098	0.3127	1	0	1
43	0.0000	0.0000	0	0	0
44	0.0000	0.0000	0	0	0
45	0.0000	0.0000	0	0	0
46	0.0000	0.0000	0	0	0
47	0.1098	0.3127	1	0	1
48	0.0000	0.0000	0	0	0
49	0.0000	0.0000	0	0	0
50	0.1098	0.3127	1	0	1
51	0.0000	0.0000	0	0	0
52	0.0000	0.0000	0	0	0
53	0.0000	0.0000	0	0	0
54	0.0000	0.0000	0	0	0
55	0.0000	0.0000	0	0	0
56	0.0000	0.0000	0	0	0
57	0.0000	0.0000	0	0	0
58	0.0000	0.0000	0	0	0
59	0.0000	0.0000	0	0	0
60	0.0000	0.0000	0	0	0
61	0.0000	0.0000	0	0	0
62	0.0019	0.0439	1	0	1
63	0.0000	0.0000	0	0	0
64	0.0000	0.0000	0	0	0
65	0.0000	0.0000	0	0	0
66	0.0000	0.0000	0	0	0
67	0.0077	0.0875	1	0	4
68	0.0000	0.0000	0	0	0
69	0.0000	0.0000	0	0	0
70	0.0000	0.0000	0	0	0
71	0.0000	0.0000	0	0	0
72	0.0354	0.1849	1	0	1
73	0.0000	0.0000	0	0	0
74	0.0000	0.0000	0	0	0
75	0.0000	0.0000	0	0	0
76	0.0000	0.0000	0	0	0
77	0.1004	0.3005	1	0	4
78	0.0000	0.0000	0	0	0
79	0.0000	0.0000	0	0	0
80	0.0000	0.0000	0	0	0

SERVICE ACTIVITY STATISTICS

ACT NUM	ACT LABEL OR START NODE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
18	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
25	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
13	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
3	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
23	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
10	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
16	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
26	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0

2	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
15	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
7	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
17	QUEUE	1	0.355	0.48	0	0.00	50.37	36.59	100
4	QUEUE	1	0.257	0.44	0	0.00	39.96	26.53	100
20	QUEUE	1	0.308	0.46	0	0.00	54.62	31.74	100
5	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
30	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
1	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
11	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
27	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
19	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
6	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
14	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
29	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
21	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
9	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
24	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
28	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
8	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
22	QUEUE	1	0.000	0.00	0	0.00	103.14	0.00	0
12	QUEUE	1	0.235	0.42	0	0.00	73.89	24.26	100

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	M1	1	0.00	0.000	0	0
2	M2	1	0.00	0.000	0	0
3	M3	1	0.00	0.000	0	0
4	M4	1	0.37	0.482	1	0
5	M5	1	0.00	0.000	0	0
6	M6	1	0.00	0.000	0	0
7	M7	1	0.00	0.000	0	0
8	M8	1	0.00	0.000	0	0
9	M9	1	0.00	0.000	0	0
10	M10	1	0.00	0.000	0	0
11	M11	1	0.00	0.000	0	0
12	M12	1	0.35	0.475	1	0
13	M13	1	0.00	0.000	0	0
14	M14	1	0.00	0.000	0	0
15	M15	1	0.00	0.000	0	0
16	M16	1	0.00	0.000	0	0
17	M17	1	0.46	0.499	1	0
18	M18	1	0.00	0.000	0	0
19	M19	1	0.00	0.000	0	0
20	M20	1	0.42	0.493	1	0
21	M21	1	0.00	0.000	0	0
22	M22	1	0.00	0.000	0	0
23	M23	1	0.00	0.000	0	0
24	M24	1	0.00	0.000	0	0
25	M25	1	0.00	0.000	0	0
26	M26	1	0.00	0.000	0	0
27	M27	1	0.00	0.000	0	0
28	M28	1	0.00	0.000	0	0
29	M29	1	0.00	0.000	0	0
30	M30	1	0.00	0.000	0	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	M1	1	1.0000	1	1
2	M2	1	1.0000	1	1
3	M3	1	1.0000	1	1
4	M4	1	0.6330	0	1
5	M5	1	1.0000	1	1
6	M6	1	1.0000	1	1
7	M7	1	1.0000	1	1
8	M8	1	1.0000	1	1
9	M9	1	1.0000	1	1

10	M10	1	1.0000	1	1
11	M11	1	1.0000	1	1
12	M12	1	0.6549	0	1
13	M13	1	1.0000	1	1
14	M14	1	1.0000	1	1
15	M15	1	1.0000	1	1
16	M16	1	1.0000	1	1
17	M17	1	0.5354	0	1
18	M18	1	1.0000	1	1
19	M19	1	1.0000	1	1
20	M20	1	0.5824	0	1
21	M21	1	1.0000	1	1
22	M22	1	1.0000	1	1
23	M23	1	1.0000	1	1
24	M24	1	1.0000	1	1
25	M25	1	1.0000	1	1
26	M26	1	1.0000	1	1
27	M27	1	1.0000	1	1
28	M28	1	1.0000	1	1
29	M29	1	1.0000	1	1
30	M30	1	1.0000	1	1

G.2 CM MODEL WITH 25% BATCH SPLITTING – 100 ENTITIES

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SLAM II VERSION 4.03
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1
1 **INTERMEDIATE RESULTS**

1

S L A M I I S U M M A R Y R E P O R T

SIMULATION PROJECT CM_25 BY DAVID BROCK

DATE 4/20/1997 RUN NUMBER 1 OF 1

CURRENT TIME 0.1028E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
TIME IN SYS	0.168E+03	0.806E+02	0.481E+00	0.523E+02	0.472E+03	100

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	16.316	6.846	0.00	27.00	1027.977	0.00

FILE STATISTICS

FILE NUMBER	LABEL	TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	0.874	1.857	8	0	20.429
2	A2	AWAIT	0.174	0.660	3	0	5.589
3	A3	AWAIT	1.508	1.696	6	0	20.394
4	A4	AWAIT	0.140	0.512	3	0	3.606
5	A5	AWAIT	1.084	1.682	7	0	17.418
6	A6	AWAIT	0.347	1.093	6	0	12.757
7	A7	AWAIT	0.021	0.145	2	0	0.686
8	A8	AWAIT	0.662	1.454	5	0	12.155
9	A9	AWAIT	0.802	1.486	6	0	11.443
10	A10	AWAIT	2.378	2.943	11	0	30.555
11	A11	AWAIT	1.584	2.717	11	0	37.013
12	A12	AWAIT	0.053	0.262	2	0	1.953
13	A13	AWAIT	3.290	4.161	16	0	52.850
14	A14	AWAIT	0.586	1.457	8	0	16.728
15	A15	AWAIT	0.019	0.143	2	0	0.702
16	A16	AWAIT	0.284	0.874	4	0	6.626
17	A17	AWAIT	0.140	0.579	3	0	3.586
18	A18	AWAIT	1.019	1.781	8	0	23.800
19	A19	AWAIT	2.241	3.534	13	0	44.309
20	A20	AWAIT	0.018	0.132	1	0	0.654
21	A21	AWAIT	0.025	0.169	2	0	2.124
22	A22	AWAIT	2.083	2.444	8	0	33.456
23	A23	AWAIT	0.234	0.641	3	0	3.752
24	A24	AWAIT	0.414	1.043	5	0	5.906
25	A25	AWAIT	0.912	1.637	8	0	14.648
26	A26	AWAIT	0.414	1.120	4	0	11.825
27	A27	AWAIT	1.551	2.366	8	0	26.567
28	A28	AWAIT	2.105	2.067	8	0	30.050
29	A29	AWAIT	0.645	1.502	7	0	20.732
30	A30	AWAIT	2.754	3.514	12	0	41.637
31		QUEUE	16.204	24.755	99	0	15.143
32		QUEUE	10.059	21.276	99	0	12.926
33		QUEUE	31.481	30.494	99	0	17.033
34		QUEUE	13.143	22.505	99	0	13.511
35		QUEUE	22.061	28.653	99	0	14.174
36		QUEUE	8.388	21.111	99	0	12.317
37		QUEUE	6.771	15.613	77	0	8.701
38		QUEUE	14.682	23.814	99	0	10.781
39		QUEUE	18.461	24.920	99	0	10.543
40		QUEUE	26.501	28.479	99	0	13.621
41		QUEUE	17.945	29.467	99	0	16.770
42		QUEUE	8.986	19.516	80	0	13.196
43		QUEUE	25.592	31.444	99	0	16.443
44		QUEUE	13.607	26.104	99	0	15.541
45		QUEUE	6.297	15.675	81	0	9.248
46		QUEUE	11.931	20.266	99	0	11.057
47		QUEUE	10.817	21.268	99	0	11.119
48		QUEUE	21.614	31.089	99	0	20.198
49		QUEUE	18.528	27.366	99	0	14.651
50		QUEUE	4.995	12.342	56	0	7.336
51		QUEUE	3.581	13.421	87	0	12.[illegible]72
52		QUEUE	27.113	32.610	99	0	17.420
53		QUEUE	16.336	22.022	99	0	10.495
54		QUEUE	20.252	23.731	99	0	11.566
55		QUEUE	24.487	28.581	99	0	15.732
56		QUEUE	15.232	27.900	99	0	17.398
57		QUEUE	19.274	27.628	99	0	13.209
58		QUEUE	27.469	30.269	99	0	15.687
59		QUEUE	13.125	26.423	99	0	16.859
60		QUEUE	26.620	32.249	99	0	16.097
61		CALENDAR	17.449	7.024	81	0	0.106

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
31	0.0772	0.2668	1	0	7
32	0.0772	0.2668	1	0	7
33	0.1433	0.3504	1	0	13
34	0.0992	0.2989	1	0	9
35	0.1212	0.3264	1	0	11
36	0.0551	0.2282	1	0	5
37	0.0661	0.2485	1	0	6
38	0.0772	0.2668	1	0	7
39	0.1323	0.3388	1	0	12
40	0.1323	0.3388	1	0	12
41	0.0772	0.2668	1	0	7
42	0.0661	0.2485	1	0	6
43	0.0992	0.2989	1	0	9
44	0.0551	0.2282	1	0	5
45	0.0551	0.2282	1	0	5
46	0.0772	0.2668	1	0	7
47	0.0992	0.2989	1	0	9
48	0.0882	0.2835	1	0	8
49	0.1102	0.3132	1	0	10
50	0.0661	0.2485	1	0	6
51	0.0331	0.1788	1	0	3
52	0.1102	0.3132	1	0	10
53	0.1323	0.3388	1	0	12
54	0.1433	0.3504	1	0	13
55	0.1323	0.3388	1	0	12
56	0.0772	0.2668	1	0	7
57	0.1323	0.3388	1	0	12
58	0.1433	0.3504	1	0	13
59	0.0772	0.2668	1	0	7
60	0.1212	0.3264	1	0	11
61	0.0051	0.0710	1	0	25
62	0.0027	0.0520	1	0	14
63	0.0027	0.0522	1	0	19
64	0.0015	0.0385	1	0	20
65	0.0028	0.0528	1	0	22
66	0.0203	0.1440	2	0	100
67	0.0108	0.1041	2	0	56
68	0.0109	0.1039	1	0	76
69	0.0059	0.0767	1	0	80
70	0.0112	0.1063	2	0	88
71	0.0793	0.2724	2	0	25
72	0.0425	0.2037	2	0	14
73	0.0605	0.2409	2	0	19
74	0.0554	0.2327	2	0	20
75	0.0701	0.2626	2	0	22
76	0.3000	0.5025	2	0	100
77	0.1570	0.3934	3	0	56
78	0.2402	0.4359	2	0	76
79	0.2471	0.4732	2	0	80
80	0.2629	0.4714	2	0	88

SERVICE ACTIVITY STATISTICS

ACT NUM	ACT LABEL OR START NODE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
18	QUEUE	1	0.437	0.50	0	0.00	234.64	51.72	1100
25	QUEUE	1	0.591	0.49	0	0.00	117.04	56.97	1600
13	QUEUE	1	0.568	0.50	0	0.00	107.64	54.14	1600
3	QUEUE	1	0.716	0.45	0	0.00	61.83	53.96	1900
23	QUEUE	1	0.499	0.50	0	0.00	145.37	50.29	1600
10	QUEUE	1	0.679	0.47	0	0.00	64.48	57.19	2000
16	QUEUE	1	0.395	0.49	0	0.00	129.67	51.88	1100
26	QUEUE	1	0.308	0.46	0	0.00	258.97	40.37	900
2	QUEUE	1	0.263	0.44	0	0.00	239.50	49.29	800
15	QUEUE	1	0.208	0.41	0	0.00	229.07	48.14	700

7	QUEUE	1	0.234	0.42	0	0.00	244.26	41.76	800
17	QUEUE	1	0.280	0.45	0	0.00	224.51	46.17	1000
4	QUEUE	1	0.352	0.48	0	0.00	220.59	40.83	1000
20	QUEUE	1	0.178	0.38	0	0.00	297.96	28.85	700
5	QUEUE	1	0.514	0.50	0	0.00	235.60	45.56	1600
30	QUEUE	1	0.544	0.50	0	0.00	295.42	47.77	1700
1	QUEUE	1	0.408	0.49	0	0.00	335.01	60.91	1100
11	QUEUE	1	0.363	0.48	0	0.00	401.80	47.89	1100
27	QUEUE	1	0.457	0.50	0	0.00	196.26	43.25	1500
19	QUEUE	1	0.441	0.50	0	0.00	171.79	52.57	1300
6	QUEUE	1	0.187	0.39	0	0.00	229.10	38.42	700
14	QUEUE	1	0.292	0.45	0	0.00	375.84	44.62	900
29	QUEUE	1	0.265	0.44	0	0.00	226.38	45.95	800
21	QUEUE	1	0.086	0.28	0	0.00	470.98	35.53	300
9	QUEUE	1	0.535	0.50	0	0.00	128.32	47.79	1800
24	QUEUE	1	0.614	0.49	0	0.00	108.91	49.06	1800
28	QUEUE	1	0.622	0.48	0	0.00	120.80	51.98	1800
8	QUEUE	1	0.430	0.50	0	0.00	181.58	44.27	1400
22	QUEUE	1	0.548	0.50	0	0.00	191.81	48.28	1600
12	QUEUE	1	0.219	0.41	0	0.00	267.22	44.46	700

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	M1	1	0.49	0.500	1	0
2	M2	1	0.34	0.474	1	0
3	M3	1	0.86	0.348	1	0
4	M4	1	0.45	0.498	1	0
5	M5	1	0.65	0.476	1	0
6	M6	1	0.24	0.428	1	0
7	M7	1	0.31	0.462	1	0
8	M8	1	0.55	0.497	1	0
9	M9	1	0.69	0.463	1	0
10	M10	1	0.83	0.373	1	0
11	M11	1	0.44	0.496	1	0
12	M12	1	0.29	0.451	1	0
13	M13	1	0.69	0.463	1	0
14	M14	1	0.35	0.476	1	0
15	M15	1	0.28	0.448	1	0
16	M16	1	0.48	0.499	1	0
17	M17	1	0.40	0.491	1	0
18	M18	1	0.52	0.499	1	0
19	M19	1	0.56	0.496	1	0
20	M20	1	0.26	0.436	1	0
21	M21	1	0.12	0.324	1	0
22	M22	1	0.66	0.474	1	0
23	M23	1	0.65	0.476	1	0
24	M24	1	0.77	0.423	1	0
25	M25	1	0.72	0.447	1	0
26	M26	1	0.38	0.487	1	0
27	M27	1	0.62	0.486	1	0
28	M28	1	0.77	0.424	1	0
29	M29	1	0.34	0.474	1	0
30	M30	1	0.67	0.472	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	M1	1	0.5128	0	1
2	M2	1	0.6600	0	1
3	M3	1	0.1407	0	1
4	M4	1	0.5485	0	1
5	M5	1	0.3479	0	1
6	M6	1	0.7580	0	1
7	M7	1	0.6913	0	1
8	M8	1	0.4485	0	1
9	M9	1	0.3109	0	1
10	M10	1	0.1670	0	1
11	M11	1	0.5603	0	1

12	M12	1	0.7150	0	1
13	M13	1	0.3107	0	1
14	M14	1	0.6530	0	1
15	M15	1	0.7224	0	1
16	M16	1	0.5242	0	1
17	M17	1	0.5963	0	1
18	M18	1	0.4752	0	1
19	M19	1	0.4401	0	1
20	M20	1	0.7449	0	1
21	M21	1	0.8806	0	1
22	M22	1	0.3420	0	1
23	M23	1	0.3457	0	1
24	M24	1	0.2328	0	1
25	M25	1	0.2764	0	1
26	M26	1	0.6151	0	1
27	M27	1	0.3811	0	1
28	M28	1	0.2345	0	1
29	M29	1	0.6578	0	1
30	M30	1	0.3344	0	1

G.3 CM MODEL WITH 25% BATCH SPLITTING – 10,000 MINUTES

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SLAM II VERSION 4.03

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1
1                    **INTERMEDIATE RESULTS**

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          S L A M   I I   S U M M A R Y   R E P O R T

 SIMULATION PROJECT CM_25                    BY DAVID BROCK

 DATE  4/20/1997                             RUN NUMBER    1 OF    1

 CURRENT TIME   0.1000E+05
 STATISTICAL ARRAYS CLEARED AT TIME  0.0000E+00

        **STATISTICS FOR VARIABLES BASED ON OBSERVATION**

                 MEAN     STANDARD  COEFF. OF  MINIMUM   MAXIMUM   NO.OF
                 VALUE    DEVIATION VARIATION   VALUE     VALUE     OBS

TIME IN SYS    0.216E+03 0.139E+03 0.644E+00 0.364E+02 0.153E+04  1247
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STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	27.257	7.364	0.00	47.00	10000.000	17.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE		AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	1.572	3.008	16	0	25.197
2	A2	AWAIT	2.393	3.775	18	0	38.342
3	A3	AWAIT	3.386	4.127	17	0	44.783
4	A4	AWAIT	1.046	1.819	8	0	13.989
5	A5	AWAIT	1.764	3.315	19	0	23.584
6	A6	AWAIT	3.096	4.744	26	0	48.989
7	A7	AWAIT	1.902	4.119	24	0	30.876
8	A8	AWAIT	0.950	1.836	10	0	18.416
9	A9	AWAIT	0.860	1.646	8	0	13.586
10	A10	AWAIT	1.834	2.830	16	0	25.657
11	A11	AWAIT	2.181	3.297	19	0	33.872
12	A12	AWAIT	0.147	0.503	4	0	3.122
13	A13	AWAIT	2.592	3.943	19	3	42.352
14	A14	AWAIT	1.575	2.625	15	0	28.952
15	A15	AWAIT	0.551	1.301	8	0	10.670
16	A16	AWAIT	0.456	1.661	16	1	9.957
17	A17	AWAIT	3.635	5.218	28	0	48.462
18	A18	AWAIT	1.011	2.247	16	0	25.036
19	A19	AWAIT	7.701	7.653	31	13	87.813
20	A20	AWAIT	1.167	3.566	26	0	24.733
21	A21	AWAIT	0.026	0.199	3	0	1.135
22	A22	AWAIT	1.761	2.869	16	0	33.106
23	A23	AWAIT	1.542	2.760	15	15	20.649
24	A24	AWAIT	0.433	1.032	8	0	6.815
25	A25	AWAIT	2.199	3.420	16	0	34.582
26	A26	AWAIT	1.430	2.558	16	0	28.144
27	A27	AWAIT	7.001	6.454	31	1	79.106
28	A28	AWAIT	0.874	1.618	8	0	13.749
29	A29	AWAIT	1.436	2.989	20	0	29.669
30	A30	AWAIT	4.127	4.444	19	[illegible]	49.843
31		QUEUE	21.823	28.056	99	0	13.989
32		QUEUE	24.200	30.745	99	43	15.513
33		QUEUE	28.613	30.048	99	5	15.139
34		QUEUE	24.332	26.889	99	0	13.012
35		QUEUE	24.510	27.655	99	0	13.107
36		QUEUE	25.721	31.353	99	35	16.279
37		QUEUE	21.352	27.655	99	0	13.865
38		QUEUE	18.642	27.776	99	54	14.451
39		QUEUE	20.527	26.320	99	0	12.992
40		QUEUE	24.074	28.135	99	16	13.469
41		QUEUE	27.254	32.635	99	0	16.928
42		QUEUE	14.511	22.278	99	31	12.350
43		QUEUE	24.645	30.639	99	0	16.214
44		QUEUE	21.884	30.362	99	0	16.091
45		QUEUE	16.997	24.763	99	[illegible]	13.176
46		QUEUE	12.637	21.223	99	0	11.085
47		QUEUE	28.693	29.901	99	37	15.303
48		QUEUE	18.155	29.575	99	0	17.975
49		QUEUE	32.864	30.851	99	65	15.215
50		QUEUE	15.063	24.065	99	34	12.766
51		QUEUE	5.120	13.598	99	0	8.983
52		QUEUE	23.423	31.711	99	85	17.611
53		QUEUE	24.023	27.487	99	4	13.128
54		QUEUE	20.043	25.536	99	0	12.606
55		QUEUE	25.452	30.141	99	0	16.008
56		QUEUE	21.158	30.933	99	77	16.660
57		QUEUE	34.944	31.456	99	57	15.812
58		QUEUE	20.590	26.307	99	0	12.949
59		QUEUE	20.566	30.682	99	11	16.997

60	QUEUE	31.412	31.245	99	0	15.175
61	CALENDAR	22.352	4.049	88	18	0.105

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
31	0.1269	0.3329	1	0	112
32	0.1269	0.3329	1	0	112
33	0.1496	0.3566	1	0	132
34	0.1428	0.3498	1	0	126
35	0.1416	0.3487	1	0	125
36	0.1314	0.3379	1	0	116
37	0.1167	0.3211	1	0	103
38	0.1054	0.3070	1	0	93
39	0.1297	0.3360	1	1	114
40	0.1462	0.3533	1	0	129
41	0.1326	0.3391	1	0	117
42	0.0872	0.2822	1	0	77
43	0.1251	0.3309	1	1	110
44	0.1110	0.3142	1	0	98
45	0.0986	0.2981	1	0	87
46	0.0869	0.2817	1	1	76
47	0.1439	0.3510	1	0	127
48	0.0736	0.2612	1	0	65
49	0.1575	0.3643	1	0	139
50	0.0872	0.2822	1	0	77
51	0.0329	0.1783	1	0	29
52	0.1031	0.3041	1	0	91
53	0.1473	0.3544	1	0	130
54	0.1314	0.3379	1	0	116
55	0.1280	0.3341	1	0	113
56	0.1088	0.3113	1	0	96
57	0.1484	0.3555	1	0	131
58	0.1314	0.3379	1	0	116
59	0.0986	0.2981	1	0	87
60	0.1598	0.3664	1	0	141
61	0.0052	0.0718	2	0	247
62	0.0050	0.0702	2	0	249
63	0.0028	0.0530	1	0	191
64	0.0025	0.0495	1	0	322
65	0.0033	0.0578	2	0	255
66	0.0201	0.1408	2	0	964
67	0.0196	0.1392	2	0	984
68	0.0112	0.1051	2	0	756
69	0.0096	0.0978	2	0	1265
70	0.0133	0.1153	2	0	1020
71	0.0743	0.2731	2	0	247
72	0.0743	0.2720	2	0	249
73	0.0580	0.2391	2	0	191
74	0.0982	0.3119	3	0	322
75	0.0752	0.2743	3	0	255
76	0.2909	0.4866	3	0	964
77	0.2959	0.4968	3	0	984
78	0.2280	0.4337	2	0	756
79	0.3896	0.5431	3	0	1265
80	0.3054	0.4967	3	0	1020

SERVICE ACTIVITY STATISTICS

ACT NUM	ACT LABEL OR START NODE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
18	QUEUE	1	0.367	0.48	0	0.00	439.05	55.66	****
25	QUEUE	1	0.576	0.49	0	0.00	215.94	61.21	****
13	QUEUE	1	0.540	0.50	0	0.00	222.79	60.96	****
3	QUEUE	1	0.658	0.47	1	0.00	173.86	54.15	****
23	QUEUE	1	0.602	0.49	1	0.00	185.73	52.54	****
10	QUEUE	1	0.595	0.49	1	0.00	194.92	57.19	****
16	QUEUE	1	0.372	0.48	0	0.00	424.33	55.47	****

26	QUEUE	1	0.427	0.49	1	0.00	401.08	61.08	****
2	QUEUE	1	0.522	0.50	1	0.00	369.77	64.70	****
15	QUEUE	1	0.449	0.50	0	0.00	352.59	57.32	****
7	QUEUE	1	0.537	0.50	0	0.00	362.76	64.11	****
17	QUEUE	1	0.656	0.48	1	0.00	351.16	68.21	****
4	QUEUE	1	0.632	0.48	0	0.00	364.28	54.10	****
20	QUEUE	1	0.404	0.49	1	0.00	459.58	51.98	****
5	QUEUE	1	0.629	0.48	0	0.00	171.67	53.88	****
30	QUEUE	1	0.694	0.46	0	0.00	155.03	54.70	****
1	QUEUE	1	0.530	0.50	0	0.00	408.29	60.91	****
11	QUEUE	1	0.551	0.50	0	0.00	256.28	59.52	****
27	QUEUE	1	0.751	0.43	1	0.00	196.26	56.79	****
19	QUEUE	1	0.732	0.44	1	0.00	171.79	53.91	****
6	QUEUE	1	0.542	0.50	1	0.00	245.89	54.39	****
14	QUEUE	1	0.464	0.50	0	0.00	375.84	58.84	****
29	QUEUE	1	0.415	0.49	1	0.00	337.42	57.03	****
21	QUEUE	1	0.189	0.39	0	0.00	544.01	50.56	5700
9	QUEUE	1	0.531	0.50	0	0.00	385.67	55.86	****
24	QUEUE	1	0.535	0.50	0	0.00	384.03	54.98	****
28	QUEUE	1	0.536	0.50	0	0.00	398.79	54.69	****
8	QUEUE	1	0.440	0.50	1	0.00	454.94	62.72	****
22	QUEUE	1	0.473	0.50	1	0.00	568.18	51.92	****
12	QUEUE	1	0.411	0.49	1	0.00	438.53	51.77	****

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	M1	1	0.67	0.471	1	0
2	M2	1	0.65	0.477	1	1
3	M3	1	0.81	0.391	1	1
4	M4	1	0.79	0.406	1	0
5	M5	1	0.78	0.411	1	0
6	M6	1	0.67	0.468	1	1
7	M7	1	0.67	0.471	1	0
8	M8	1	0.55	0.497	1	1
9	M9	1	0.67	0.470	1	1
10	M10	1	0.75	0.434	1	1
11	M11	1	0.68	0.465	1	0
12	M12	1	0.51	0.500	1	1
13	M13	1	0.67	0.470	1	1
14	M14	1	0.58	0.494	1	0
15	M15	1	0.56	0.497	1	0
16	M16	1	0.47	0.499	1	1
17	M17	1	0.81	0.394	1	1
18	M18	1	0.44	0.496	1	0
19	M19	1	0.90	0.306	1	1
20	M20	1	0.50	0.500	1	1
21	M21	1	0.23	0.422	1	0
22	M22	1	0.58	0.494	1	1
23	M23	1	0.76	0.427	1	1
24	M24	1	0.68	0.465	1	0
25	M25	1	0.71	0.455	1	0
26	M26	1	0.54	0.499	1	1
27	M27	1	0.91	0.290	1	1
28	M28	1	0.68	0.467	1	0
29	M29	1	0.51	0.500	1	1
30	M30	1	0.86	0.343	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	M1	1	0.3325	0	1
2	M2	0	0.3506	0	1
3	M3	0	0.1881	0	1
4	M4	1	0.2075	0	1
5	M5	1	0.2153	0	1
6	M6	0	0.3250	0	1
7	M7	1	0.3335	0	1
8	M8	0	0.4485	0	1

9	M9	0	0.3286	0	1
10	M10	0	0.2514	0	1
11	M11	1	0.3168	0	1
12	M12	0	0.4930	0	1
13	M13	0	0.3306	0	1
14	M14	1	0.4246	0	1
15	M15	1	0.4415	0	1
16	M16	0	0.5311	0	1
17	M17	0	0.1917	0	1
18	M18	1	0.5596	0	1
19	M19	0	0.1049	0	1
20	M20	0	0.4978	0	1
21	M21	1	0.7682	0	1
22	M22	0	0.4239	0	1
23	M23	0	0.2396	0	1
24	M24	1	0.3152	0	1
25	M25	1	0.2927	0	1
26	M26	0	0.4642	0	1
27	M27	0	0.0925	0	1
28	M28	1	0.3226	0	1
29	M29	0	0.4863	0	1
30	M30	1	0.1363	0	1

APPENDIX H

SAMPLE TRACE OUTPUT

H.1 PROC MODEL WITH 10% BATCH SPLITTING - TRACE OUTPUT

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                         SLAM II VERSION 4.03

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1
1                         **INTERMEDIATE RESULTS**


1


           SLAM II TRACE BEGINNING AT TNOW=   0.0000E+00

--------------------------------------------------------------------------
                 NODE ARRIVAL                               ACTIVITY SUMMARY
  TNOW    JEVNT  ------------    CUR ATRIB BUFFER    --------------------
                 LABEL  TYPE     ----------------    IND DURATION END ND
--------------------------------------------------------------------------

 0.100E+01      CR    CREATE     0.000E+00
                                                       0 NO RELEASE   F1
                                                       0 NO RELEASE   F2
                                                       0 NO RELEASE   F3
                                                       0       0.000  F4
                F4    ASSIGN     0.000E+00
                                                       0 NO RELEASE   PN19
                                                       0 NO RELEASE   PN20
                                                       0 NO RELEASE   PN21
                                                       0 NO RELEASE   PN22
```

```
                                                        0 NO RELEASE   PN23
                                                        0 NO RELEASE   PN24
                                                        0 NO RELEASE   PN25
                                                        0       0.000  PN26
0.110E+01                                               0 NO RELEASE   SR
                                                        0       0.000  D2
           D2   GOON       0.260E+02
                                                       32       2.517
0.362E+01                                               0 NO RELEASE   A2
                                                        0       0.000  SB2
           SB2  UNBATCH    0.260E+02
           A2   AWAIT      0.260E+02
           E2   ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0 NO RELEASE   UB2
                                                       12 NO RELEASE   UB2
                                                       22      22.660  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
           A2   AWAIT      0.260E+02
           E12  ENTER      0.260E+02
                                                        0       0.000  P2
           P2   GOON       0.260E+02
                                                        0       0.000  UB2
0.535E+01  CR   CREATE     0.000E+00
                                                        0       0.000  F1
           F1   ASSIGN     0.000E+00
                                                        0 NO RELEASE   PN1
                                                        0 NO RELEASE   PN2
                                                        0 NO RELEASE   PN3
                                                        0 NO RELEASE   PN4
                                                        0 NO RELEASE   PN5
                                                        0 NO RELEASE   PN6
                                                        0       0.000  PN7
0.547E+01                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
```

				0	0.000	D3
	D3	GOON	0.700E+01			
				33	2.177	
0.765E+01				0	NO RELEASE	A3
				0	0.000	SB3
	SB3	UNBATCH	0.700E+01			
	A3	AWAIT	0.700E+01			
	E3	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	NO RELEASE	UB3
				13	11.330	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
	A3	AWAIT	0.700E+01			
	E13	ENTER	0.700E+01			
				0	0.000	P3
	P3	GOON	0.700E+01			
				0	0.000	UB3
0.855E+01				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	0.000	D3
	D3	GOON	0.260E+02			
				33	2.330	
0.966E+01				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	0.000	D3
	D3	GOON	0.260E+02			
				33	2.262	
0.109E+02				0	0.000	A3
	A3	AWAIT	0.260E+02			
	E3	ENTER	0.260E+02			
				0	0.000	P3
	P3	GOON	0.260E+02			
				0	NO RELEASE	UB3
				13	NO RELEASE	UB3
				23	22.660	UB3

0.119E+02				0	0.000	A3
	A3	AWAIT	0.260E+02			
	E13	ENTER	0.260E+02			
				0	0.000	P3
	P3	GOON	0.260E+02			
				0	0.000	UB3
0.119E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	0.000	D3
	D3	GOON	0.260E+02			
				33	2.794	
0.138E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.700E+01			
				34	2.240	
0.147E+02				0	0.000	A3
	A3	AWAIT	0.260E+02			
	E13	ENTER	0.260E+02			
				0	0.000	P3
	P3	GOON	0.260E+02			
				0	0.000	UB3
0.153E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.700E+01			
				34	3.980	
0.159E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.260E+02			
				34	1.715	
0.159E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	0.000	D3
	D3	GOON	0.260E+02			
				33	4.859	
0.161E+02				0	0.000	A4
	A4	AWAIT	0.700E+01			
	E4	ENTER	0.700E+01			
				0	0.000	P4
	P4	GOON	0.700E+01			
				0	NO RELEASE	UB4
				14	11.330	UB4
0.169E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.700E+01			
				34	3.777	
0.173E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	0.000	D3
	D3	GOON	0.260E+02			
				33	4.189	
0.176E+02				0	0.000	A4
	A4	AWAIT	0.260E+02			
	E4	ENTER	0.260E+02			
				0	0.000	P4
	P4	GOON	0.260E+02			
				0	NO RELEASE	UB4
				14	NO RELEASE	UB4
				24	22.660	UB4
0.193E+02				0	0.000	A4
	A4	AWAIT	0.700E+01			
	E14	ENTER	0.700E+01			
				0	0.000	P4
	P4	GOON	0.700E+01			
				0	0.000	UB4
0.206E+02				0	0.000	A4
	A4	AWAIT	0.700E+01			
	E14	ENTER	0.700E+01			

```
                                                   0       0.000  P4
             P4   GOON        0.700E+01
                                                   0       0.000  UB4
0.208E+02                                          0       0.000  A3
             A3   AWAIT       0.260E+02
             E13  ENTER       0.260E+02
                                                   0       0.000  P3
             P3   GOON        0.260E+02
                                                   0       0.000  UB3
0.212E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0       0.000  D3
             D3   GOON        0.260E+02
                                                  33       1.542
0.214E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0 NO RELEASE   D3
                                                   0       0.000  D4
             D4   GOON        0.260E+02
                                                  34       4.493
0.215E+02                                          0       0.000  A3
             A3   AWAIT       0.260E+02
             E13  ENTER       0.260E+02
                                                   0       0.000  P3
             P3   GOON        0.260E+02
                                                   0       0.000  UB3
0.219E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0 NO RELEASE   D3
                                                   0       0.000  D4
             D4   GOON        0.700E+01
                                                  34       1.494
0.228E+02                                          0       0.000  A3
             A3   AWAIT       0.260E+02
             E13  ENTER       0.260E+02
                                                   0       0.000  P3
             P3   GOON        0.260E+02
                                                   0       0.000  UB3
0.233E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0       0.000  D3
             D3   GOON        0.260E+02
                                                  33       2.634
0.234E+02                                          0       0.000  A4
             A4   AWAIT       0.700E+01
             E14  ENTER       0.700E+01
                                                   0       0.000  P4
             P4   GOON        0.700E+01
                                                   0       0.000  UB4
0.235E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0       0.000  D3
             D3   GOON        0.260E+02
                                                  33       3.935
0.235E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0 NO RELEASE   D3
                                                   0       0.000  D4
             D4   GOON        0.700E+01
                                                  34       4.973
0.239E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0 NO RELEASE   D3
                                                   0 NO RELEASE   D4
                                                   0       0.000  D5
             D5   GOON        0.700E+01
                                                  35       4.615
0.248E+02                                          0 NO RELEASE   SR
                                                   0 NO RELEASE   D2
                                                   0       0.000  D3
             D3   GOON        0.260E+02
                                                  33       1.305
0.259E+02                                          0       0.000  A4
             A4   AWAIT       0.260E+02
             E14  ENTER       0.260E+02
```

```
                                                        0       0.000  P4
                P4   GOON     0.260E+02
                                                        0       0.000  UB4
0.260E+02                                               0       0.000  A3
                A3   AWAIT    0.260E+02
                E13  ENTER    0.260E+02
                                                        0       0.000  P3
                P3   GOON     0.260E+02
                                                        0       0.000  UB3
0.260E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0       0.000  D5
                D5   GOON     0.700E+01
                                                       35       1.184
0.261E+02                                               0       0.000  A3
                A3   AWAIT    0.260E+02
                E13  ENTER    0.260E+02
                                                        0       0.000  P3
                P3   GOON     0.260E+02
                                                        0       0.000  UB3
0.264E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0       0.000  D4
                D4   GOON     0.260E+02
                                                       34       2.785
0.265E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0       0.000  D4
                D4   GOON     0.700E+01
                                                       34       2.890
0.269E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0       0.000  D4
                D4   GOON     0.700E+01
                                                       34       2.234
0.272E+02                                               0       0.000  A5
                A5   AWAIT    0.700E+01
                E5   ENTER    0.700E+01
                                                        0       0.000  P5
                P5   GOON     0.700E+01
                                                        0 NO RELEASE   UB5
                                                       15      11.330  UB5
0.274E+02                                               0       0.000  A3
                A3   AWAIT    0.260E+02
                E13  ENTER    0.260E+02
                                                        0       0.000  P3
                P3   GOON     0.260E+02
                                                        0       0.000  UB3
0.285E+02                                               0       0.000  A4
                A4   AWAIT    0.700E+01
                E14  ENTER    0.700E+01
                                                        0       0.000  P4
                P4   GOON     0.700E+01
                                                        0       0.000  UB4
0.285E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0       0.000  D5
                D5   GOON     0.700E+01
                                                       35       1.565
0.286E+02                                               0       0.000  A5
                A5   AWAIT    0.700E+01
                E15  ENTER    0.700E+01
                                                        0       0.000  P5
                P5   GOON     0.700E+01
                                                        0       0.000  UB5
0.291E+02                                               0       0.000  A4
                A4   AWAIT    0.700E+01
                E14  ENTER    0.700E+01
```

```
                                                    0     0.000  P4
               P4    GOON      0.700E+01
                                                    0     0.000  UB4
0.292E+02                                           0     0.000  A4
               A4    AWAIT     0.260E+02
               E14   ENTER     0.260E+02
                                                    0     0.000  P4
               P4    GOON      0.260E+02
                                                    0     0.000  UB4
0.294E+02                                           0     0.000  A4
               A4    AWAIT     0.700E+01
               E14   ENTER     0.700E+01
                                                    0     0.000  P4
               P4    GOON      0.700E+01
                                                    0     0.000  UB4
0.297E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0     0.000  D4
               D4    GOON      0.260E+02
                                                   34     1.060
0.299E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0     0.000  D3
               D3    GOON      0.260E+02
                                                   33     2.764
0.301E+02                                           0     0.000  A5
               A5    AWAIT     0.700E+01
               E15   ENTER     0.700E+01
                                                    0     0.000  P5
               P5    GOON      0.700E+01
                                                    0     0.000  UB5
0.307E+02                                           0     0.000  A4
               A4    AWAIT     0.260E+02
               E14   ENTER     0.260E+02
                                                    0     0.000  P4
               P4    GOON      0.260E+02
                                                    0     0.000  UB4
0.309E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0     0.000  D4
               D4    GOON      0.700E+01
                                                   34     2.675
0.311E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0 NO RELEASE D4
                                                    0     0.000  D5
               D5    GOON      0.700E+01
                                                   35     2.634
0.319E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0     0.000  D4
               D4    GOON      0.700E+01
                                                   34     2.463
0.327E+02                                           0     0.000  A3
               A3    AWAIT     0.260E+02
               E13   ENTER     0.260E+02
                                                    0     0.000  P3
               P3    GOON      0.260E+02
                                                    0     0.000  UB3
0.328E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0 NO RELEASE D4
                                                    0 NO RELEASE D5
0.329E+02                                           0 NO RELEASE SR
                                                    0 NO RELEASE D2
                                                    0 NO RELEASE D3
                                                    0 NO RELEASE D4
                                                    0     0.000  D5
               D5    GOON      0.260E+02
                                                   35     2.978
```

```
0.330E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0      0.000  D4
           D4   GOON       0.260E+02
                                                  34      4.643
0.336E+02                                          0      0.000  A4
           A4   AWAIT      0.700E+01
           E14  ENTER      0.700E+01
                                                   0      0.000  P4
           P4   GOON       0.700E+01
                                                   0      0.000  UB4
0.338E+02                                          0      0.000  A5
           A5   AWAIT      0.700E+01
           E15  ENTER      0.700E+01
                                                   0      0.000  P5
           P5   GOON       0.700E+01
                                                   0      0.000  UB5
0.343E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0 NO RELEASE  D4
                                                   0      0.000  D5
           D5   GOON       0.700E+01
                                                  35      4.269
0.344E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0      0.000  D4
           D4   GOON       0.700E+01
                                                  34      4.601
0.344E+02                                          0      0.000  A4
           A4   AWAIT      0.700E+01
           E14  ENTER      0.700E+01
                                                   0      0.000  P4
           P4   GOON       0.700E+01
                                                   0      0.000  UB4
0.358E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0      0.000  D4
           D4   GOON       0.260E+02
                                                  34      1.137
0.359E+02                                          0      0.000  A5
           A5   AWAIT      0.260E+02
           E5   ENTER      0.260E+02
                                                   0      0.000  P5
           P5   GOON       0.260E+02
                                                   0 NO RELEASE  UB5
                                                  15 NO RELEASE  UB5
                                                  25     22.660  UB5
0.360E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0 NO RELEASE  D4
                                                   0      0.000  D5
           D5   GOON       0.260E+02
                                                  35      2.258
0.368E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0 NO RELEASE  D4
                                                   0      0.000  D5
           D5   GOON       0.700E+01
                                                  35      3.141
0.369E+02                                          0      0.000  A4
           A4   AWAIT      0.260E+02
           E14  ENTER      0.260E+02
                                                   0      0.000  P4
           P4   GOON       0.260E+02
                                                   0      0.000  UB4
0.373E+02                                          0 NO RELEASE  SR
                                                   0 NO RELEASE  D2
                                                   0 NO RELEASE  D3
                                                   0 NO RELEASE  D4
```

				0	NO RELEASE	D5
0.373E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.260E+02			
				34	1.189	
0.376E+02				0	0.000	A4
	A4	AWAIT	0.260E+02			
	E14	ENTER	0.260E+02			
				0	0.000	P4
	P4	GOON	0.260E+02			
				0	0.000	UB4
0.382E+02				0	0.000	A5
	A5	AWAIT	0.260E+02			
	E15	ENTER	0.260E+02			
				0	0.000	P5
	P5	GOON	0.260E+02			
				0	0.000	UB5
0.385E+02				0	0.000	A4
	A4	AWAIT	0.260E+02			
	E14	ENTER	0.260E+02			
				0	0.000	P4
	P4	GOON	0.260E+02			
				0	0.000	UB4
0.386E+02				0	0.000	A5
	A5	AWAIT	0.700E+01			
	E15	ENTER	0.700E+01			
				0	0.000	P5
	P5	GOON	0.700E+01			
				0	0.000	UB5
0.389E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	NO RELEASE	D5
0.390E+02				0	0.000	A4
	A4	AWAIT	0.700E+01			
	E14	ENTER	0.700E+01			
				0	0.000	P4
	P4	GOON	0.700E+01			
				0	0.000	UB4
0.400E+02				0	0.000	A5
	A5	AWAIT	0.700E+01			
	E15	ENTER	0.700E+01			
				0	0.000	P5
	P5	GOON	0.700E+01			
				0	0.000	UB5
0.410E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.700E+01			
				35	4.406	
0.411E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.260E+02			
				35	1.807	
0.423E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.260E+02			
				34	3.975	
0.429E+02				0	0.000	A5
	A5	AWAIT	0.260E+02			
	E15	ENTER	0.260E+02			
				0	0.000	P5
	P5	GOON	0.260E+02			
				0	0.000	UB5
0.434E+02				0	NO RELEASE	SR

				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.700E+01			
				35	2.570	
0.439E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	NO RELEASE	D5
0.444E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.700E+01			
				35	3.318	
0.445E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.260E+02			
				34	3.833	
0.446E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	0.000	D4
	D4	GOON	0.260E+02			
				34	1.513	
0.449E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	NO RELEASE	D5
0.454E+02				0	0.000	A5
	A5	AWAIT	0.700E+01			
	E15	ENTER	0.700E+01			
				0	0.000	P5
	P5	GOON	0.700E+01			
				0	0.000	UB5
0.456E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.260E+02			
				35	3.676	
0.460E+02				0	0.000	A5
	A5	AWAIT	0.700E+01			
	E15	ENTER	0.700E+01			
				0	0.000	P5
	P5	GOON	0.700E+01			
				0	0.000	UB5
0.461E+02				0	0.000	A4
	A4	AWAIT	0.260E+02			
	E14	ENTER	0.260E+02			
				0	0.000	P4
	P4	GOON	0.260E+02			
				0	0.000	UB4
0.463E-02				0	0.000	A4
	A4	AWAIT	0.260E+02			
	E14	ENTER	0.260E+02			
				0	0.000	P4
	P4	GOON	0.260E+02			
				0	0.000	UB4
0.464E+02				0	0.000	SR
	SR	UNBATCH	0.700E+01			
0.464E+02				0	NO RELEASE	SR
				0	NO RELEASE	D2
				0	NO RELEASE	D3
				0	NO RELEASE	D4
				0	0.000	D5
	D5	GOON	0.700E+01			
				35	4.804	

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0.477E+02                                                   0        0.000  A5
                A5   AWAIT      0.700E+01
                E15  ENTER      0.700E+01
                                                            0        0.000  P5
                P5   GOON       0.700E+01
                                                            0        0.000  UB5
0.478E+02                                                   0        0.000  SR
                SR   UNBATCH    0.700E+01
0.479E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0 NO RELEASE    D5
0.484E+02                                                   0        0.000  A4
                A4   AWAIT      0.260E+02
                E14  ENTER      0.260E+02
                                                            0        0.000  P4
                P4   GOON       0.260E+02
                                                            0        0.000  UB4
0.489E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0 NO RELEASE    D5
0.493E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0        0.000  D5
                D5   GOON       0.260E+02
                                                           35        2.401
0.493E+02                                                   0        0.000  A5
                A5   AWAIT      0.260E+02
                E15  ENTER      0.260E+02
                                                            0        0.000  P5
                P5   GOON       0.260E+02
                                                            0        0.000  UB5
0.500E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0 NO RELEASE    D5
0.512E+02                                                   0        0.000  A5
                A5   AWAIT      0.700E+01
                E15  ENTER      0.700E+01
                                                            0        0.000  P5
                P5   GOON       0.700E+01
                                                            0        0.000  UB5
0.517E+02                                                   0        0.000  A5
                A5   AWAIT      0.260E+02
                E15  ENTER      0.260E+02
                                                            0        0.000  P5
                P5   GOON       0.260E+02
                                                            0        0.000  UB5
0.521E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0        0.000  D5
                D5   GOON       0.260E+02
                                                           35        1.363
0.530E+02                                                   0 NO RELEASE    SR
                                                            0 NO RELEASE    D2
                                                            0 NO RELEASE    D3
                                                            0 NO RELEASE    D4
                                                            0 NO RELEASE    D5
0.530E+02                                                   0        0.000  SR
                SR   UNBATCH    0.700E+01
0.534E+02                                                   0        0.000  A5
                A5   AWAIT      0.260E+02
                E15  ENTER      0.260E+02
                                                            0        0.000  P5
                P5   GOON       0.260E+02
                                                            0        0.000  UB5
0.543E+02                                                   0 NO RELEASE    SR
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                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.545E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0       0.000  D5
             D5    GOON       0.260E+02
                                                       35       2.992
0.551E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.558E+02                                               0       0.000  SR
             SR    UNBATCH    0.700E+01
0.573E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.575E+02                                               0       0.000  A5
             A5    AWAIT      0.260E+02
             E15   ENTER      0.260E+02
                                                        0       0.000  P5
             P5    GOON       0.260E+02
                                                        0       0.000  UB5
0.582E+02                                               0       0.000  SR
             SR    UNBATCH    0.700E+01
0.584E+02                                               0       0.000  SR
             SR    UNBATCH    0.700E+01
0.585E+02                                               0       0.000  SR
             SR    UNBATCH    0.260E+02
0.569E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.607E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.613E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0       0.000  D5
             D5    GOON       0.260E+02
                                                       35       3.986
0.627E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0 NO RELEASE   D5
0.629E+02                                               0       0.000  SR
             SR    UNBATCH    0.700E+01
0.652E+02                                               0       0.000  A5
             A5    AWAIT      0.260E+02
             E15   ENTER      0.260E+02
                                                        0       0.000  P5
             P5    GOON       0.260E+02
                                                        0       0.000  UB5
0.653E+02                                               0 NO RELEASE   SR
                                                        0 NO RELEASE   D2
                                                        0 NO RELEASE   D3
                                                        0 NO RELEASE   D4
                                                        0       0.000  D5
             D5    GOON       0.260E+02
                                                       35       2.062
0.659E+02                                               0       0.000  SR
             SR    UNBATCH    0.700E+01
0.661E+02                                               0 NO RELEASE   SR
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                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0      0.000   D5
              D5    GOON        0.260E+02
                                                                35      4.475
0.662E+02                                                        0 NO RELEASE   SR
                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0 NO RELEASE   D5
0.664E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.670E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.674E+02                                                        0      0.000   A5
              A5    AWAIT       0.260E+02
              E15   ENTER       0.260E+02
                                                                 0      0.000   P5
              P5    GOON        0.260E+02
                                                                 0      0.000   UB5
0.676E+02                                                        0      0.000   SR
              SR    UNBATCH     0.700E+01
0.702E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.704E+02                                                        0 NO RELEASE   SR
                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0 NO RELEASE   D5
0.705E+02                                                        0      0.000   A5
              A5    AWAIT       0.260E+02
              E15   ENTER       0.260E+02
                                                                 0      0.000   P5
              P5    GOON        0.260E+02
                                                                 0      0.000   UB5
0.709E+02                                                        0      0.000   SR
              SR    UNBATCH     0.700E+01
0.738E+02                                                        0 NO RELEASE   SR
                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0 NO RELEASE   D5
0.766E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.785E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.800E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.805E+02                                                        0 NO RELEASE   SR
                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0 NO RELEASE   D5
0.837E+02                                                        0 NO RELEASE   SR
                                                                 0 NO RELEASE   D2
                                                                 0 NO RELEASE   D3
                                                                 0 NO RELEASE   D4
                                                                 0 NO RELEASE   D5
0.865E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.897E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
0.924E+02                                                        0      0.000   SR
              SR    UNBATCH     0.260E+02
1

              S L A M   I I   S U M M A R Y   R E P O R T

 SIMULATION PROJECT PROC_LO                          BY DAVID BROCK

 DATE  3/10/1997                                     RUN NUMBER    1 OF    1
```

CURRENT TIME 0.9256E+02
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
TIME IN SYS	0.787E+02	0.182E+02	0.232E+00	0.658E+02	0.916E+02	2

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	1.700	0.481	0.00	2.00	92.560	0.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE		AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	0.000	0.000	0	0	0.000
2	A2	AWAIT	0.000	0.000	1	0	0.000
3	A3	AWAIT	0.000	0.000	1	0	0.000
4	A4	AWAIT	0.000	0.000	1	0	0.000
5	A5	AWAIT	0.000	0.000	1	0	0.000
6	A6	AWAIT	0.000	0.000	1	0	0.000
7	A7	AWAIT	0.000	0.000	0	0	0.000
8	A8	AWAIT	0.000	0.000	0	0	0.000
9			0.000	0.000	0	0	0.000
10			0.000	0.000	0	0	0.000
11		AWAIT	0.000	0.000	0	0	0.000
12		AWAIT	9.566	21.762	89	0	8.854
13		AWAIT	16.612	25.529	89	0	7.688
14		AWAIT	10.721	13.881	45	0	4.962
15		AWAIT	8.354	9.425	33	0	3.866
16		AWAIT	4.964	6.769	29	0	2.297
17		AWAIT	0.000	0.000	0	0	0.000
18		AWAIT	0.000	0.000	0	0	0.000
19		CALENDAR	9.741	[illegible].474	28	0	0.188

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	0.0000	0.0000	0	0	0
2	0.2362	0.4247	1	0	100
3	0.5603	0.7784	2	0	200
4	0.6588	0.7487	2	0	200
5	0.7031	0.7313	2	0	200
6	0.6141	0.6975	2	0	200
7	0.0000	0.0000	0	0	0
8	0.0000	0.0000	0	0	0
11	0.0000	0.0000	0	0	0
12	0.0000	0.0000	0	0	[illegible]
13	0.1224	0.3278	1	0	1
14	0.1224	0.3278	1	0	1
15	0.1224	0.3278	1	0	1
16	0.1224	0.3278	1	0	1
17	0.0000	0.0000	0	0	0
18	0.0000	0.0000	0	0	0
21	0.0000	0.0000	0	0	0
22	0.2448	0.4300	1	0	1
23	0.7448	0.4300	1	0	1
24	0.2448	0.4300	1	0	1

25	0.2448	0.4300	1	0	1
26	0.2448	0.4300	1	0	1
27	0.0000	0.0000	0	0	0
28	0.0000	0.0000	0	0	0
31	0.0000	0.0000	0	0	0
32	0.0272	0.1626	1	0	1
33	0.3327	0.6599	3	0	11
34	0.6230	1.0280	4	0	20
35	0.6537	0.8811	3	0	20
36	0.6074	0.7690	3	0	20
37	0.0000	0.0000	0	0	0
38	0.0000	0.0000	0	0	0
41	0.0000	0.0000	0	0	0
42	0.2804	0.5917	3	0	10
43	0.6930	1.0092	4	0	20
44	0.6628	0.9210	4	0	20
45	0.5654	0.7488	3	0	20
46	0.6940	0.8811	4	0	20
47	0.0000	0.0000	0	0	0
48	0.0000	0.0000	0	0	0
51	0.0023	0.0484	1	0	2
52	0.0147	0.1234	2	0	20
53	0.0147	0.1203	1	0	20
54	0.0147	0.1210	2	0	20
55	0.0073	0.0854	1	0	20
56	0.0000	0.0000	1	0	10
57	0.0040	0.0631	1	0	2

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	X1	4	0.00	0.000	0	0
2	X2	4	0.27	0.443	1	0
3	X3	4	0.61	0.832	2	0
4	X4	4	0.80	0.841	2	0
5	X5	4	0.80	0.784	2	0
6	X6	4	0.80	0.774	2	0
7	X7	3	0.00	0.000	0	0
8	X8	3	0.00	0.000	0	0
11	D1	4	0.00	0.000	0	0
12	D2	4	0.24	0.425	1	0
13	D3	4	0.56	0.778	2	0
14	D4	4	0.66	0.749	2	0
15	D5	4	0.70	0.731	2	0
16	D6	4	0.61	0.698	2	0
17	D7	3	0.00	0.000	0	0
18	D8	3	0.00	0.000	0	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	X1	4	4.0000	4	4
2	X2	4	3.7316	3	4
3	X3	4	3.3927	2	4
4	X4	4	3.2009	2	4
5	X5	4	3.1984	2	4
6	X6	4	3.1983	2	4
7	X7	3	3.0000	3	3
8	X8	3	3.0000	3	3
11	D1	4	4.0000	4	4
12	D2	4	3.7638	3	4
13	D3	4	3.4397	2	4
14	D4	4	3.3412	2	4
15	D5	4	3.2969	2	4
16	D6	4	3.3859	2	4
17	D7	3	3.0000	3	3
18	D8	3	3.0000	3	3

APPENDIX I

SAMPLE SIMULATION RUN OUTPUT

I.1 SAMPLE OUTPUT FROM PROC MODEL - NO BATCH SPLITTING

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SLAM II VERSION 4.03

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1
1                    **INTERMEDIATE RESULTS**

1

           S L A M   I I   S U M M A R Y   R E P O R T

 SIMULATION PROJECT PROC_NO                   BY DAVID BROCK

 DATE  3/10/1997                              RUN NUMBER     1 OF     1

 CURRENT TIME   0.4500E+05
 STATISTICAL ARRAYS CLEARED AT TIME   0.3500E+05

          **STATISTICS FOR VARIABLES BASED ON OBSERVATION**

                  MEAN     STANDARD  COEFF. OF  MINIMUM    MAXIMUM   NO.OF
                  VALUE    DEVIATION VARIATION   VALUE      VALUE     OBS

TIME IN SYS     0.280E+03 0.136E+03 0.485E+00 0.920E+02 0.105E+04  1202

          **STATISTICS FOR TIME-PERSISTENT VARIABLES**
```

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	33.796	6.975	15.00	50.00	10000.000	32.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE		AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	0.520	1.089	7	0	9.557
2	A2	AWAIT	2.133	2.457	12	1	31.185
3	A3	AWAIT	0.611	1.214	8	0	10.366
4	A4	AWAIT	1.535	2.149	12	0	24.211
5	A5	AWAIT	0.788	1.493	11	1	13.422
6	A6	AWAIT	1.250	1.898	10	3	20.030
7	A7	AWAIT	0.317	0.760	5	0	8.695
8	A8	AWAIT	0.584	1.140	8	0	13.730
9			0.000	0.000	0	0	0.000
10			0.000	0.000	0	0	0.000
11		AWAIT	91.377	68.355	362	53	16.762
12		AWAIT	117.657	66.787	369	68	17.203
13		AWAIT	99.182	65.994	353	0	16.841
14		AWAIT	108.296	66.583	393	56	17.040
15		AWAIT	99.569	67.102	364	203	16.991
16		AWAIT	105.084	70.314	365	62	16.905
17		AWAIT	60.602	55.899	284	30	16.590
18		AWAIT	73.542	57.034	283	0	17.365
19		CALENDAR	27.056	3.798	136	28	0.139

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	1.8467	1.1502	4	1	54464
2	2.3761	1.0426	4	3	68372
3	2.0041	1.0841	4	0	58896
4	2.1884	1.0724	4	1	63498
5	2.0099	1.125[illegible]	4	3	58394
6	2.1247	1.1287	4	3	62102
7	1.2240	0.9358	3	1	36499
8	1.4871	0.9276	3	0	42353
11	0.1314	0.3605	2	0	116
12	0.1643	0.4035	3	0	145
13	0.1185	0.3378	2	1	104
14	0.1473	0.3736	2	0	130
15	0.1495	0.3767	2	0	132
16	0.1089	0.3264	3	1	96
17	0.1050	0.3226	3	1	92
18	0.1325	0.3586	2	0	117
21	0.8837	0.8510	4	0	390
22	1.0672	0.9033	4	1	471
23	0.9665	0.8684	4	1	426
24	1.0022	0.8456	4	1	443
25	0.8987	0.8083	4	1	397
26	1.0492	0.8956	4	0	463
27	0.5417	0.6768	3	0	240
28	0.5947	0.671[illegible]	3	3	262
31	0.1619	0.3963	3	0	539
32	0.2056	0.4505	3	0	684
33	0.1741	0.4186	3	0	585
34	0.1936	0.4372	4	0	634
35	0.1735	0.4097	3	0	587
36	0.1856	0.4305	3	0	623
37	0.1118	0.3326	3	0	365
38	0.1273	0.3593	3	0	42[illegible]
41	0.1648	0.4002	3	1	546
42	0.2069	0.4437	3	0	682
43	0.1720	0.4058	3	1	590

44	0.1871	0.4159	3	1	634
45	0.1753	0.4066	3	1	582
46	0.1870	0.4189	3	1	620
47	0.1124	0.3310	3	0	366
48	0.1310	0.3532	2	0	425
51	0.0187	0.1363	2	0	1198
52	0.0126	0.1123	2	0	1208
53	0.0081	0.0900	2	0	1202
54	0.0042	0.0644	2	0	971
55	0.0026	0.0509	2	0	618
56	0.0005	0.0230	1	0	367
57	0.0197	0.1399	2	0	1202

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	X1	4	2.86	1.248	4	1
2	X2	4	3.61	0.824	4	4
3	X3	4	3.09	1.097	4	2
4	X4	4	3.34	1.025	4	2
5	X5	4	3.06	1.184	4	4
6	X6	4	3.28	1.076	4	4
7	X7	3	1.87	1.037	3	2
8	X8	3	2.21	0.969	3	3
11	D1	4	1.85	1.150	4	1
12	D2	4	2.38	1.043	4	3
13	D3	4	2.00	1.084	4	0
14	D4	4	2.19	1.072	4	1
15	D5	4	2.01	1.125	4	3
16	D6	4	2.12	1.129	4	3
17	D7	3	1.22	0.936	3	1
18	D8	3	1.49	0.928	3	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	X1	3	1.1382	0	4
2	X2	0	0.3924	0	4
3	X3	2	0.9110	0	4
4	X4	2	0.6621	0	4
5	X5	0	0.9419	0	4
6	X6	0	0.7173	0	4
7	X7	1	1.1293	0	3
8	X8	0	0.7856	0	3
11	D1	3	2.1533	0	4
12	D2	1	1.6238	0	4
13	D3	4	1.9959	0	4
14	D4	3	1.8117	0	4
15	D5	1	1.9901	0	4
16	D6	1	1.8753	0	4
17	D7	2	1.7760	0	3
18	D8	3	1.5129	0	3

I.2 SAMPLE OUTPUT FROM SMALL PRFAM MODEL - 25% BATCH SPLITTING

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SLAM II VERSION 4.03
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INTERMEDIATE RESULTS

S L A M I I S U M M A R Y R E P O R T

SIMULATION PROJECT SM_PROC_25 BY DAVID BROCK

DATE 3/10/1997 RUN NUMBER 1 OF 1

CURRENT TIME 0.4500E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.3500E+05

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
TIME IN SYS	0.852E+02	0.387E+02	0.454E+00	0.206E+02	0.329E+03	1199

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	10.212	3.591	2.00	23.00	10000.000	6.00

FILE STATISTICS

FILE NUMBER	LABEL	TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	0.576	1.675	12	0	6.491
2	A2	AWAIT	0.962	2.422	24	0	5.049
3	A3	AWAIT	0.529	1.484	10	0	5.330
4	A4	AWAIT	1.040	2.895	22	0	5.526
5	A5	AWAIT	0.482	1.577	14	0	3.009
6	A6	AWAIT	1.195	3.217	24	0	6.356
7	A7	AWAIT	0.404	1.286	12	0	4.296
8	A8	AWAIT	0.529	1.423	13	0	4.861
9			0.000	0.000	0	0	0.000
10			0.000	0.000	0	0	0.000
11		AWAIT	29.774	34.422	170	0	13.420
12		AWAIT	54.041	41.331	225	0	11.315
13		AWAIT	27.956	31.242	188	1	11.242
14		AWAIT	47.592	38.926	228	92	10.101
15		AWAIT	40.773	37.782	207	21	10.157
16		AWAIT	51.708	41.772	213	17	11.002
17		AWAIT	25.336	30.960	170	0	10.775
18		AWAIT	28.560	30.426	169	0	10.500
19		CALENDAR	20.905	5.712	67	16	0.152

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	0.7596	0.7306	2	0	22188
2	1.6338	0.9687	3	0	47763
3	0.8510	0.7310	2	1	24866
4	1.6397	1.0007	3	3	47023
5	1.3895	0.9973	3	1	40124
6	1.6326	1.0185	3	1	46982
7	0.8014	0.7678	2	0	23515
8	0.9016	0.7676	2	0	27200
11	0.0918	0.2997	2	0	81
12	0.1473	0.3809	3	0	130
13	0.1088	0.3157	2	0	96
14	0.1801	0.4114	2	0	159
15	0.1393	0.3624	2	0	123
16	0.1484	0.3729	2	0	131
17	0.1088	0.3250	2	0	96
18	0.1291	0.3474	2	0	114
21	0.2198	0.4432	2	0	97
22	0.6955	0.7390	3	0	308
23	0.2583	0.4733	2	0	114
24	0.6073	0.6853	3	0	269
25	0.5498	0.6686	3	1	243
26	0.6571	0.7241	3	1	290
27	0.2493	0.4760	2	0	110
28	0.2651	0.4868	2	0	117
31	0.0679	0.2640	3	0	221
32	0.3097	0.5374	4	0	1047
33	0.1785	0.4156	3	0	599
34	0.5129	0.6845	5	0	1705
35	0.3802	0.6034	4	0	1270
36	0.4014	0.6208	4	1	1325
37	0.2059	0.4566	4	0	682
38	0.2268	0.4770	4	0	743
41	0.2671	0.4901	2	0	889

42	0.5791	0.6979	3	0	1912
43	0.2943	0.5053	3	1	993
44	0.5538	0.6981	4	3	1878
45	0.4869	0.6535	3	0	1608
46	0.5725	0.7056	3	1	1878
47	0.2865	0.5090	2	0	941
48	0.3287	0.5414	3	0	1088
51	0.0152	0.1230	2	1	1195
52	0.0280	0.1666	3	0	4790
53	0.0185	0.1361	2	0	3375
54	0.0086	0.0926	2	0	2166
55	0.0000	0.0000	1	0	856
56	0.0000	0.0000	0	0	0
57	0.0182	0.1352	2	0	1199

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	X1	2	0.83	0.794	2	0
2	X2	3	1.87	0.993	3	0
3	X3	2	0.99	0.769	2	1
4	X4	3	1.97	1.004	3	3
5	X5	3	1.66	1.022	3	1
6	X6	3	1.89	1.040	3	2
7	X7	2	0.95	0.806	2	0
8	X8	2	1.06	0.811	2	0
11	D1	2	0.76	0.731	2	0
12	D2	3	1.63	0.969	3	0
13	D3	2	0.85	0.731	2	1
14	D4	3	1.64	1.001	3	3
15	D5	3	1.39	0.997	3	1
16	D6	3	1.63	1.018	3	1
17	D7	2	0.80	0.768	2	0
18	D8	2	0.90	0.768	2	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	X1	2	1.1656	0	2
2	X2	3	1.1260	0	3
3	X3	1	1.0143	0	2
4	X4	0	1.0331	0	3
5	X5	2	1.3385	0	3
6	X6	1	1.1109	0	3
7	X7	2	1.0508	0	2
8	X8	2	0.9366	0	2
11	D1	2	1.2404	0	2
12	D2	3	1.3662	0	3
13	D3	1	1.1490	0	2
14	D4	0	1.3603	0	3
15	D5	2	1.6105	0	3
16	D6	2	1.3674	0	3
17	D7	2	1.1986	0	2
18	D8	2	1.0984	0	2

I.3 SAMPLE OUTPUT FROM CM MODEL - 10% BATCH SPLITTING

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1
1                       **INTERMEDIATE RESULTS**

1

            S L A M   I I   S U M M A R Y   R E P O R T

 SIMULATION PROJECT CM_10                     BY DAVID BROCK

 DATE  4/20/1997                              RUN NUMBER     1 OF     1

 CURRENT TIME   0.4500E+05
 STATISTICAL ARRAYS CLEARED AT TIME   0.3500E+05

          **STATISTICS FOR VARIABLES BASED ON OBSERVATION**

                  MEAN     STANDARD  COEFF. OF  MINIMUM    MAXIMUM   NO.OF
                  VALUE    DEVIATION VARIATION   VALUE      VALUE     OBS

TIME IN SYS     0.211E+03 0.165E+03 0.782E+00 0.360E+02 0.209E+04  1261

          **STATISTICS FOR TIME-PERSISTENT VARIABLES**
```

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	26.583	5.861	13.00	43.00	10000.000	22.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE		AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	A1	AWAIT	3.754	7.279	39	0	25.193
2	A2	AWAIT	7.518	9.156	45	0	43.409
3	A3	AWAIT	8.041	10.575	49	10	40.206
4	A4	AWAIT	3.839	4.778	20	7	18.135
5	A5	AWAIT	5.967	8.889	51	0	31.076
6	A6	AWAIT	5.089	7.568	40	23	31.358
7	A7	AWAIT	3.981	6.189	29	0	22.242
8	A8	AWAIT	2.779	5.902	31	0	22.409
9	A9	AWAIT	2.416	4.755	31	0	15.802
10	A10	AWAIT	5.906	8.484	50	0	31.770
11	A11	AWAIT	6.667	10.562	60	0	42.199
12	A12	AWAIT	0.704	2.041	18	0	5.100
13	A13	AWAIT	5.836	9.894	51	0	39.976
14	A14	AWAIT	3.901	9.406	60	0	31.207
15	A15	AWAIT	0.596	1.649	11	0	4.194
16	A16	AWAIT	2.299	6.222	41	5	17.083
17	A17	AWAIT	17.693	17.390	71	10	83.106
18	A18	AWAIT	1.477	3.979	30	0	15.731
19	A19	AWAIT	24.879	21.369	79	9	113.087
20	A20	AWAIT	2.882	5.619	35	19	20.589
21	A21	AWAIT	0.182	0.939	10	0	2.721
22	A22	AWAIT	2.109	4.753	40	0	20.084
23	A23	AWAIT	3.814	6.646	36	16	20.651
24	A24	AWAIT	0.510	1.478	12	0	3.668
25	A25	AWAIT	4.247	6.890	40	10	27.382
26	A26	AWAIT	4.471	8.542	50	9	34.131
27	A27	AWAIT	16.277	22.470	100	0	79.398
28	A28	AWAIT	1.980	4.059	21	0	14.344
29	A29	AWAIT	3.071	5.565	30	9	24.989
30	A30	AWAIT	7.092	9.584	50	0	37.927
31		QUEUE	18.734	26.095	99	0	12.549
32		QUEUE	28.125	31.696	99	39	16.204
33		QUEUE	27.847	29.200	99	37	13.991
34		QUEUE	28.699	28.211	99	36	13.599
35		QUEUE	25.437	28.262	99	0	13.248
36		QUEUE	23.563	30.241	99	93	14.720
37		QUEUE	23.442	27.233	99	0	13.078
38		QUEUE	17.995	27.304	99	0	14.508
39		QUEUE	20.308	26.360	99	0	13.259
40		QUEUE	25.242	28.088	99	30	13.571
41		QUEUE	26.813	32.552	99	0	16.970
42		QUEUE	15.429	22.187	99	48	11.180
43		QUEUE	22.125	30.295	99	0	15.089
44		QUEUE	19.343	29.065	99	62	15.475
45		QUEUE	15.296	21.870	99	50	10.735
46		QUEUE	15.309	23.724	99	0	11.424
47		QUEUE	33.856	31.259	99	26	15.970
48		QUEUE	15.292	27.957	99	87	16.269
49		QUEUE	34.268	31.274	99	0	15.577
50		QUEUE	17.070	25.642	99	0	12.370
51		QUEUE	5.710	14.125	99	0	8.522
52		QUEUE	17.700	29.333	99	0	16.822
53		QUEUE	24.242	27.071	99	28	13.198
54		QUEUE	13.995	20.747	99	0	10.066
55		QUEUE	22.954	29.260	99	0	14.856
56		QUEUE	22.091	31.261	99	0	16.980
57		QUEUE	31.141	30.811	99	70	15.152
58		QUEUE	18.168	25.353	99	0	13.086
59		QUEUE	20.972	30.843	99	0	17.190
60		QUEUE	26.052	29.688	99	0	13.932
61		CALENDAR	24.836	3.510	64	23	0.104

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
31	0.1178	0.3224	1	0	104
32	0.1427	0.3498	1	0	126
33	0.1461	0.3532	1	0	129
34	0.1427	0.3498	1	0	126
35	0.1427	0.3498	1	0	126
36	0.1269	0.3328	1	0	112
37	0.1427	0.3498	1	0	126
38	0.0918	0.2887	1	0	81
39	0.1178	0.3224	1	0	104
40	0.1438	0.3509	1	0	127
41	0.1348	0.3415	1	0	119
42	0.0952	0.2934	1	0	84
43	0.1201	0.3251	1	0	106
44	0.0940	0.2919	1	0	83
45	0.1133	0.3169	1	0	100
46	0.0856	0.2798	1	1	75
47	0.1452	0.3523	1	0	129
48	0.0626	0.2422	1	0	56
49	0.1529	0.3599	1	1	135
50	0.0961	0.2947	1	1	84
51	0.0363	0.1869	1	0	32
52	0.0804	0.2720	1	0	71
53	0.1393	0.3463	1	0	123
54	0.1133	0.3169	1	0	100
55	0.1257	0.3315	1	1	110
56	0.0959	0.2944	1	1	84
57	0.1371	0.3439	1	0	121
58	0.1121	0.3155	1	0	99
59	0.1002	0.3002	1	1	89
60	0.1473	0.3544	1	0	130
61	0.0052	0.0722	2	0	252
62	0.0056	0.0750	2	0	283
63	0.0025	0.0500	1	0	169
64	0.0023	0.0478	2	0	308
65	0.0031	0.0558	2	0	242
66	0.0521	0.2259	3	0	2517
67	0.0554	0.2334	3	0	2780
68	0.0262	0.1609	2	0	1762
69	0.0230	0.1512	3	0	3098
70	0.0313	0.1758	3	0	2426
71	0.0777	0.2788	2	0	252
72	0.0860	0.2897	3	0	283
73	0.048[illegible]	0.2215	3	0	169
74	0.0929	0.3053	3	0	308
75	0.0721	0.2661	2	0	242
76	0.7540	0.7315	6	1	2517
77	0.8336	0.7681	[illegible]	3	2780
78	0.5255	0.6521	5	0	1762
79	0.9376	0.8059	12	0	3098
80	0.7264	0.7076	6	0	2426

SERVICE ACTIVITY STATISTICS

ACT NUM	ACT LABEL OR START NODE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
18	QUEUE	1	0.309	0.46	1	0.00	586.12	50.78	931[illegible]
25	QUEUE	1	0.544	0.50	0	0.00	245.48	65.63	****
13	QUEUE	1	0.483	0.50	0	0.00	286.43	63.67	****
3	QUEUE	1	0.687	0.46	1	0.00	175.86	62.1[illegible]	****
23	QUEUE		0.634	0.48	1	0.00	[illegible].99	57.42	****
10	QUEUE	1	0.637	0.48	1	0.00	232.20	59.39	****
16	QUEUE	1	0.455	0.50	0	0.00	251.56	57.81	****
26	QUEUE	1	0.447	0.50	0	0.00	303.44	56.64	****
2	QUEUE	1	0.6[illegible]2	0.49	1	0.00	277.93	58.59	****
15	QUEUE	1	0.466	0.50	1	0.00	648.61	57.03	****

7	QUEUE	1	0.610	0.49	0	0.00	245.10	57.81	****
17	QUEUE	1	0.741	0.44	1	0.00	265.15	55.47	****
4	QUEUE	1	0.726	0.45	1	0.00	275.97	60.16	****
20	QUEUE	1	0.462	0.50	0	0.00	584.19	54.30	****
5	QUEUE	1	0.644	0.48	0	0.00	216.64	66.80	****
30	QUEUE	1	0.631	0.48	0	0.00	228.20	56.25	****
1	QUEUE	1	0.515	0.50	0	0.00	299.70	57.81	****
11	QUEUE	1	0.542	0.50	0	0.00	204.27	57.42	****
27	QUEUE	1	0.704	0.46	1	0.00	149.69	60.16	****
19	QUEUE	1	0.760	0.43	0	0.00	179.57	58.20	****
6	QUEUE	1	0.540	0.50	1	0.00	186.60	56.25	****
14	QUEUE	1	0.424	0.49	1	0.00	293.66	55.08	****
29	QUEUE	1	0.424	0.49	0	0.00	368.18	57.03	****
21	QUEUE	1	0.227	0.42	0	0.00	944.34	54.30	6700
9	QUEUE	1	0.524	0.50	0	0.00	218.28	56.25	****
24	QUEUE	1	0.468	0.50	0	0.00	348.40	51.17	****
28	QUEUE	1	0.488	0.50	0	0.00	358.44	58.20	****
8	QUEUE	1	0.422	0.49	0	0.00	455.44	52.73	****
22	QUEUE	1	0.358	0.48	0	0.00	366.25	54.30	****
12	QUEUE	1	0.480	0.50	1	0.00	594.27	60.55	****

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	M1	1	0.65	0.478	1	0
2	M2	1	0.75	0.434	1	1
3	M3	1	0.84	0.366	1	1
4	M4	1	0.88	0.322	1	1
5	M5	1	0.80	0.401	1	0
6	M6	1	0.67	0.469	1	1
7	M7	1	0.77	0.421	1	0
8	M8	1	0.52	0.500	1	0
9	M9	1	0.65	0.476	1	0
10	M10	1	0.79	0.407	1	1
11	M11	1	0.68	0.468	1	0
12	M12	1	0.59	0.492	1	1
13	M13	1	0.61	0.489	1	0
14	M14	1	0.52	0.500	1	1
15	M15	1	0.61	0.487	1	1
16	M16	1	0.56	0.497	1	1
17	M17	1	0.89	0.310	1	1
18	M18	1	0.37	0.483	1	1
19	M19	1	0.92	0.274	1	1
20	M20	1	0.57	0.495	1	1
21	M21	1	0.27	0.446	1	0
22	M22	1	0.44	0.496	1	0
23	M23	1	0.78	0.415	1	1
24	M24	1	0.60	0.490	1	0
25	M25	1	0.68	0.467	1	1
26	M26	1	0.54	0.498	1	1
27	M27	1	0.85	0.358	1	1
28	M28	1	0.61	0.488	1	0
29	M29	1	0.52	0.499	1	1
30	M30	1	0.79	0.407	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	M1	1	0.3539	0	1
2	M2	0	0.2524	0	1
3	M3	0	0.1595	0	1
4	M4	0	0.1175	0	1
5	M5	1	0.2018	0	1
6	M6	0	0.3273	0	1
7	M7	1	0.2299	0	1
8	M8	1	0.4819	0	1
9	M9	1	0.3465	0	1
10	M10	0	0.2[illegible]92	0	1
11	M11	1	0.3235	0	1

12	M12	0	0.4105	0	1
13	M13	1	0.3934	0	1
14	M14	0	0.4795	0	1
15	M15	0	0.3851	0	1
16	M16	0	0.4433	0	1
17	M17	0	0.1081	0	1
18	M18	0	0.6289	0	1
19	M19	0	0.0819	0	1
20	M20	0	0.4269	0	1
21	M21	1	0.7258	0	1
22	M22	1	0.5615	0	1
23	M23	0	0.2204	0	1
24	M24	1	0.4008	0	1
25	M25	0	0.3222	0	1
26	M26	0	0.4575	0	1
27	M27	0	0.1508	0	1
28	M28	1	0.3891	0	1
29	M29	0	0.4762	0	1
30	M30	1	0.2101	0	1

I.4 SAMPLE OUTPUT FROM DCM MODEL - 1% BATCH SPLITTING

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SLAM II VERSION 4.03
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INTERMEDIATE RESULTS

S L A M I I S U M M A R Y R E P O R T

SIMULATION PROJECT DCM_1 BY DAVID BROCK

DATE 3/10/1997 RUN NUMBER 1 OF 1

CURRENT TIME 0.4500E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.3500E+05

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
TIME IN SYS	0.785E+02	0.207E+02	0.264E+00	0.349E+02	0.192E+03	1193

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	9.319	3.454	1.00	21.00	10000.000	5.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	AWAIT	4.731	26.443	420	0	0.899
2	AWAIT	12.927	40.558	373	0	1.930
3	AWAIT	9.412	36.257	336	0	1.623
4	AWAIT	6.605	21.822	230	0	1.069
5	AWAIT	6.161	25.202	286	0	1.048
6	AWAIT	8.272	28.600	263	0	1.335
7	AWAIT	8.501	34.961	357	0	2.296
8	AWAIT	15.439	53.873	553	0	3.678
9		0.000	0.000	0	0	0.000
10		0.000	0.000	0	0	0.000
11	AWAIT	53.160	52.093	306	0	10.100
12	AWAIT	47.027	51.512	285	11	7.013
13	AWAIT	49.510	51.419	279	11	8.535
14	AWAIT	25.254	34.342	240	0	4.083
15	AWAIT	28.856	37.574	248	9	4.895
16	AWAIT	34.933	41.020	254	2	5.628
17	AWAIT	25.151	37.724	247	37	6.775
18	AWAIT	44.959	49.488	286	63	10.691
19	CALENDAR	254.732	88.980	608	170	0.341

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	1.8458	1.1965	4	0	52634
2	2.3185	1.2311	4	2	67050
3	2.0260	1.2114	4	[illegible]	57999
4	2.1318	1.2399	4	0	61851
5	2.0231	1.2004	4	1	58937
6	2.1317	1.2099	4	1	62072
7	1.2926	1.0225	3	1	37088
8	1.4337	1.0214	3	3	41988
11	0.2526	0.4921	3	0	223
12	0.2648	0.4989	3	1	233
13	0.2583	0.4801	3	0	228
14	0.2549	0.4770	3	0	226
15	0.2669	0.4891	3	0	236
16	0.2656	0.4957	4	0	235
17	0.1906	0.4204	2	0	169
18	0.1971	0.4382	3	0	174
21	0.5950	0.8093	4	0	263
22	0.9014	0.8763	4	0	398
23	0.6915	0.8068	4	1	305
24	0.7954	0.8389	4	0	351
25	0.7232	0.8072	4	0	320
26	0.7877	0.8573	4	0	349
27	0.3698	0.6236	3	0	172
28	0.4721	0.6704	3	1	208
31	8.0314	7.90[illegible]	43	0	26763
32	15.7388	10.7555	62	23	52318
33	10.6441	8.3069	56	13	35627
34	17.7527	11.1189	67	1	59198
35	15.0327	9.6569	63	5	50103
36	15.2953	9.8657	63	6	50965
37	8.4168	8.2451	50	10	28097
38	5.6240	6.4061	38	8	18806
41	15.8245	10.4060	65	0	52657
42	20.1470	10.1787	61	25	67054
43	17.3688	9.9455	52	11	58004

44	18.5669	9.8919	49	1	61874
45	17.6557	9.6811	62	7	58958
46	18.6112	9.9976	61	7	62092
47	11.1152	8.3332	39	8	37101
48	12.6050	8.7955	48	30	42005
51	0.0185	0.1357	3	1	1183
52	1.2400	1.2575	12	0	118613
53	0.8007	0.9646	10	1	118823
54	0.4181	0.6866	8	0	96287
55	0.2624	0.5491	7	0	62049
56	0.0497	0.2360	4	0	36513
57	0.0196	0.1399	3	0	1193

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	X1	4	2.03	1.248	4	0
2	X2	4	2.66	1.203	4	2
3	X3	4	2.30	1.222	4	2
4	X4	4	2.61	1.229	4	0
5	X5	4	2.47	1.225	4	1
6	X6	4	2.60	1.227	4	1
7	X7	3	1.55	1.066	3	1
8	X8	3	1.64	1.066	3	3
11	D1	4	1.85	1.197	4	0
12	D2	4	2.32	1.231	4	2
13	D3	4	2.03	1.211	4	1
14	D4	4	2.13	1.240	4	0
15	D5	4	2.02	1.200	4	1
16	D6	4	2.13	1.210	4	1
17	D7	3	1.29	1.022	3	1
18	D8	3	1.43	1.021	3	3

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	X1	4	1.9749	0	4
2	X2	2	1.3361	0	4
3	X3	2	1.6987	0	4
4	X4	4	1.3914	0	4
5	X5	3	1.5290	0	4
6	X6	3	1.3995	0	4
7	X7	2	1.4537	0	3
8	X8	0	1.3612	0	3
11	D1	4	2.1542	0	4
12	D2	2	1.6815	0	4
13	D3	3	1.9741	0	4
14	D4	4	1.8682	0	4
15	D5	3	1.9769	0	4
16	D6	3	1.8684	0	4
17	D7	2	1.7074	0	3
18	D8	0	1.5663	0	3

I.5 SAMPLE OUTPUT FROM SMALL DCM MODEL - 50% BATCH SPLITTING

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                    SLAM II VERSION 4.03
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                 PRITSKER AND ASSOCIATES, INC.
                        P.O. BOX 2413
                 WEST LAFAYETTE, INDIANA 47906
                        (317)463-5557
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1                        **INTERMEDIATE RESULTS**

1
              S L A M   I I   S U M M A R Y   R E P O R T

  SIMULATION PROJECT SM_DCM_50               BY DAVID BROCK

  DATE  3/10/1997                            RUN NUMBER    1 OF    1

  CURRENT TIME   0.4500E+05
  STATISTICAL ARRAYS CLEARED AT TIME   0.3500E+05

          **STATISTICS FOR VARIABLES BASED ON OBSERVATION**

                  MEAN     STANDARD  COEFF. OF  MINIMUM    MAXIMUM   NO.OF
                  VALUE    DEVIATION VARIATION   VALUE      VALUE     OBS

 TIME IN SYS    0.110E+03 0.540E+02 0.489E+00 0.223E+02 0.341E+03  1250
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STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	TIME INTERVAL	CURRENT VALUE
WIP	13.778	4.210	4.00	26.00	10000.000	11.00

FILE STATISTICS

FILE NUMBER	LABEL/TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	AWAIT	0.372	1.007	8	0	8.059
2	AWAIT	0.835	1.602	10	0	8.462
3	AWAIT	0.337	0.844	6	0	6.639
4	AWAIT	0.843	1.654	10	1	8.515
5	AWAIT	0.522	1.312	8	0	6.291
6	AWAIT	0.980	1.913	12	1	9.858
7	AWAIT	0.429	1.071	7	0	8.776
8	AWAIT	0.534	1.028	6	0	9.182
9		0.000	0.000	0	0	0.000
10		0.000	0.000	0	0	0.000
11	AWAIT	26.738	31.147	171	0	11.519
12	AWAIT	59.327	42.525	244	67	11.989
13	AWAIT	30.659	32.610	190	0	12.044
14	AWAIT	62.152	44.492	237	22	12.573
15	AWAIT	53.383	42.801	238	64	12.865
16	AWAIT	60.424	42.608	233	52	12.182
17	AWAIT	30.562	34.287	188	43	12.468
18	AWAIT	35.860	34.246	179	0	12.307
19	CALENDAR	18.756	4.487	82	18	0.136

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	0.7943	0.7524	2	0	23214
2	1.7188	0.9552	3	1	49420
3	0.8591	0.7214	2	0	25456
4	1.6723	0.9466	3	2	49410
5	1.4495	0.9584	3	1	41430
6	1.7140	0.9333	3	2	49546
7	0.8386	0.7644	2	1	24470
8	0.9856	0.7443	2	1	29139
11	0.1421	0.3663	2	0	126
12	0.2141	0.4454	2	0	189
13	0.1348	0.3603	2	0	119
14	0.2447	0.4708	3	0	216
15	0.2084	0.4332	3	0	184
16	0.2436	0.4766	3	0	215
17	0.1359	0.3518	2	0	120
18	0.1869	0.4195	2	0	165
21	0.1790	0.4156	2	0	79
22	0.6225	0.7250	3	0	275
23	0.2153	0.4438	2	0	95
24	0.5078	0.6382	3	2	223
25	0.4649	0.6272	3	1	205
26	0.5684	0.6936	3	1	250
27	0.2266	0.4522	2	0	100
28	0.2358	0.4653	2	1	104
31	0.0681	0.2641	2	0	230
32	0.2085	0.4511	3	1	689
33	0.1124	0.3288	3	0	373
34	0.2776	0.5081	3	0	922
35	0.2132	0.4509	4	1	716
36	0.2394	0.4878	3	0	800
37	0.1165	0.3459	3	0	399
38	0.1404	0.3699	3	1	458
41	0.1387	0.3607	2	0	465

42	0.2956	0.5168	3	0	989
43	0.1562	0.3806	2	0	510
44	0.3003	0.5328	3	0	989
45	0.2472	0.4830	3	0	828
46	0.2957	0.5202	3	1	990
47	0.1448	0.3731	2	0	490
48	0.1763	0.4028	2	0	582
51	0.0158	0.1255	2	0	1243
52	0.0147	0.1212	2	0	2500
53	0.0096	0.0978	2	0	1767
54	0.0045	0.0674	2	0	1121
55	0.0000	0.0000	1	0	453
56	0.0000	0.0000	0	0	0
57	0.0190	0.1384	2	0	1250

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	X1	2	0.89	0.817	2	0
2	X2	3	2.11	1.004	3	2
3	X3	2	1.07	0.766	2	0
4	X4	3	2.16	0.936	3	3
5	X5	3	1.85	1.014	3	2
6	X6	3	2.14	0.950	3	3
7	X7	2	1.06	0.824	2	1
8	X8	2	1.24	0.784	2	2
11	D1	2	0.79	0.752	2	0
12	D2	3	1.72	0.955	3	1
13	D3	2	0.86	0.721	2	0
14	D4	3	1.67	0.947	3	2
15	D5	3	1.45	0.958	3	1
16	D6	3	1.71	0.933	3	2
17	D7	2	0.84	0.764	2	1
18	D8	2	0.99	0.744	2	1

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	X1	2	1.1059	0	2
2	X2	1	0.8915	0	3
3	X3	2	0.9298	0	2
4	X4	0	0.8363	0	3
5	X5	1	1.1495	0	3
6	X6	0	0.8597	0	3
7	X7	1	0.9399	0	2
8	X8	0	0.7580	0	2
11	D1	2	1.2057	0	2
12	D2	2	1.2812	0	3
13	D3	2	1.1409	0	2
14	D4	1	1.3277	0	3
15	D5	2	1.5505	0	3
16	D6	1	1.2860	0	3
17	D7	1	1.1614	0	2
18	D8	1	1.0144	0	2

VITA

David Allan Brock

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF OPERATIONS OVERLAPPING ON DYNAMIC CELLULAR, PROCESS, AND CELLULAR MANUFACTURING SHOPS

Major Field: Industrial Engineering and Management

Biographical:

Education: Graduated from Stillwater High School, Stillwater, Oklahoma in 1990. Received Bachelor of Science degree in Industrial Engineering and Management from Oklahoma State University in December, 1995. Completed the requirements for the Master of Science degree with a major in Industrial Engineering and Management at Oklahoma State University in December, 1997.

Experience: Employed by General Motors, Kansas City, Kansas during the summer of 1995 and Smith International, Ponca City, Oklahoma during the summer of 1996. Employed by Oklahoma State University, College of Engineering, Architecture, and Technology as a graduate teaching assistant from August, 1995 to May 1997. Employed by Webco Industries, Sand Springs, Oklahoma from May, 1997 to present.

Professional Memberships: Institute of Industrial Engineers, Alpha Pi Mu, APICS.