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MATERIAL HANDLING
FOR A NON-PROFIT FOOD DISTRIBUTION WAREHOUSE:
CASE STUDY - SHARE-TAMPA BAY

BY

PAUL J. BERNASCONI

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Industrial
Engineering in the Department of Industrial
and Management Systems Engineering at the
University of South Florida

December 1993

Major Professor: Dr. O. Geoffrey Okogbaa

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FOR A NON-PROFIT FOOD DISTRIBUTION WAREHOUSE:

CASE STUDY - SHARE-TAMPA BAY

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An Abstract

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Industrial Engineering in the Department of Industrial and Management Systems Engineering at the University of South Florida

December 1993

Major Professor: Dr. O. Geoffrey Okogbaa

A non-profit organization often has a wide variety of constraints. These include staffing, equipment, or the need to maintain a minimum break even cash flow. This means that such organizations must be effective and must run efficiently.

SHARE-Tampa Bay is a non-profit organization that distributes food packages out of a warehouse facility. This research focuses on improving the effectiveness of material handling in the SHARE warehouse. The major areas of focus included movement of the food pallets for the satellite warehouses, the process flow and associated material handling on Distribution Day, and the layout design of the facility.

In this research, operations process charts were employed as a means to reduce the material handling of the satellite warehouse pallets. The research also examined facility layout software and flow diagrams to reduce material handling on the Distribution Day. Finally, a simulation model was developed and used to evaluate the total flow process time for the different layout alternatives.

The results obtained by this research shows that by proper redesign of the satellite warehouse distribution process and Distribution Day layout, a reduction in material moves by fifty percent was achieved. Qualitative factors such as safety hazards and bottlenecks were also resolved.

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CHAPTER 1
BACKGROUND

1.1 INTRODUCTION

SHARE-Tampa Bay is part of a network of independently incorporated organizations in the United States called SHARE-USA. SHARE-USA began in San Diego, California in 1983 and has since grown into 24 regions of affiliate organizations in the United States. SHARE stands for Self-Help And Resource Exchange. It was designed to enhance community growth by helping people work together to stretch their food budget. In a sense, it is a way of bringing people together to help one another. To begin the process of community development, SHARE uses food, a basic need for all, to foster community participation. SHARE makes food available to communities at a considerable discount in exchange for a commitment of service to the community.

The mission of SHARE-Tampa Bay is to provide quality food and services through volunteerism in ways that enhance the goodness and dignity of all. SHARE-Tampa Bay began in May of 1990 with service to 1300 households and is presently serving up to 27,000 households. The households cover west central Florida (19 counties) from Naples to Lake City. The SHARE-USA network of affiliates operates a self-supporting community development and food program serving over 300,000 families each month. The food is bought directly from the suppliers to distribute over the network by SHARE-USA.

SHARE participants pay $13 and perform two hours of community service to receive the supplemental food package. Community services include bagging food at the warehouse, working in the SHARE office, or at a host site. Community service may also include shopping for shut-ins, letter writing on hunger, or service at shelters and nursing homes. The food packages retail value is between $30 to $35 and contains 4 to 7 fresh vegetables, 2 to 4 fruits, 6 to 10 lbs. of meat, and staples like beans, rice, or cereal. The packages also include a few specialty items and is designed to feed a family of four for one week as well as to raise the nutritional level of the community. The food package serves as a organizational vehicle for involvement and participation in communities.

To aid SHARE-Tampa Bay in their mission, Tampa United Methodist Center (TUMC) is the sponsoring organization which assumes full financial and organizational responsibility. The staffing, medical, and insurance programs are administered through TUMC. Tampa Electric Company (TECO) is SHARE-Tampa Bay's corporate sponsor. TECO assists in areas like training for the staff, supplying computers, company cars, and some advertising. SHARE-Tampa Bay has also received guidance from Dr. Fisher who is the senior partner of an organizations and technologies consulting firm. The organizational structure at SHARE-Tampa Bay is shown in Figure 1. The board of directors at TUMC governs the actions at SHARE-Tampa Bay through the director. World SHARE governs SHARE-USA and its affiliates.

The equipment presently used for material handling purposes include a 3000 pound and a 4000 pound fork lift. There are also two motorized pallet jacks, six hand pallet jacks, and fifteen hand carts. The warehouse layout shows the present areas where these are used.

1.2 THE SHARE CYCLE

The SHARE cycle begins with participants calling SHARE to obtain information on a host site in their neighborhood to pick up a SHARE food package. Host sites are organizations such as churches and civic groups that host the location for package pick-up. Everyone is welcome to participate in the SHARE program. The participant then registers with the host by paying $13 for each food package ordered. Each participant is required to perform 2 hours of volunteer community service for each package ordered. The participants then return to the host site with proof of community service at the end of the month for food pick-up. The host sites place monthly food package orders on 'Order Turn-In Day'. The funds and a volunteer service summary are turned into the SHARE office. The SHARE staff coordinates

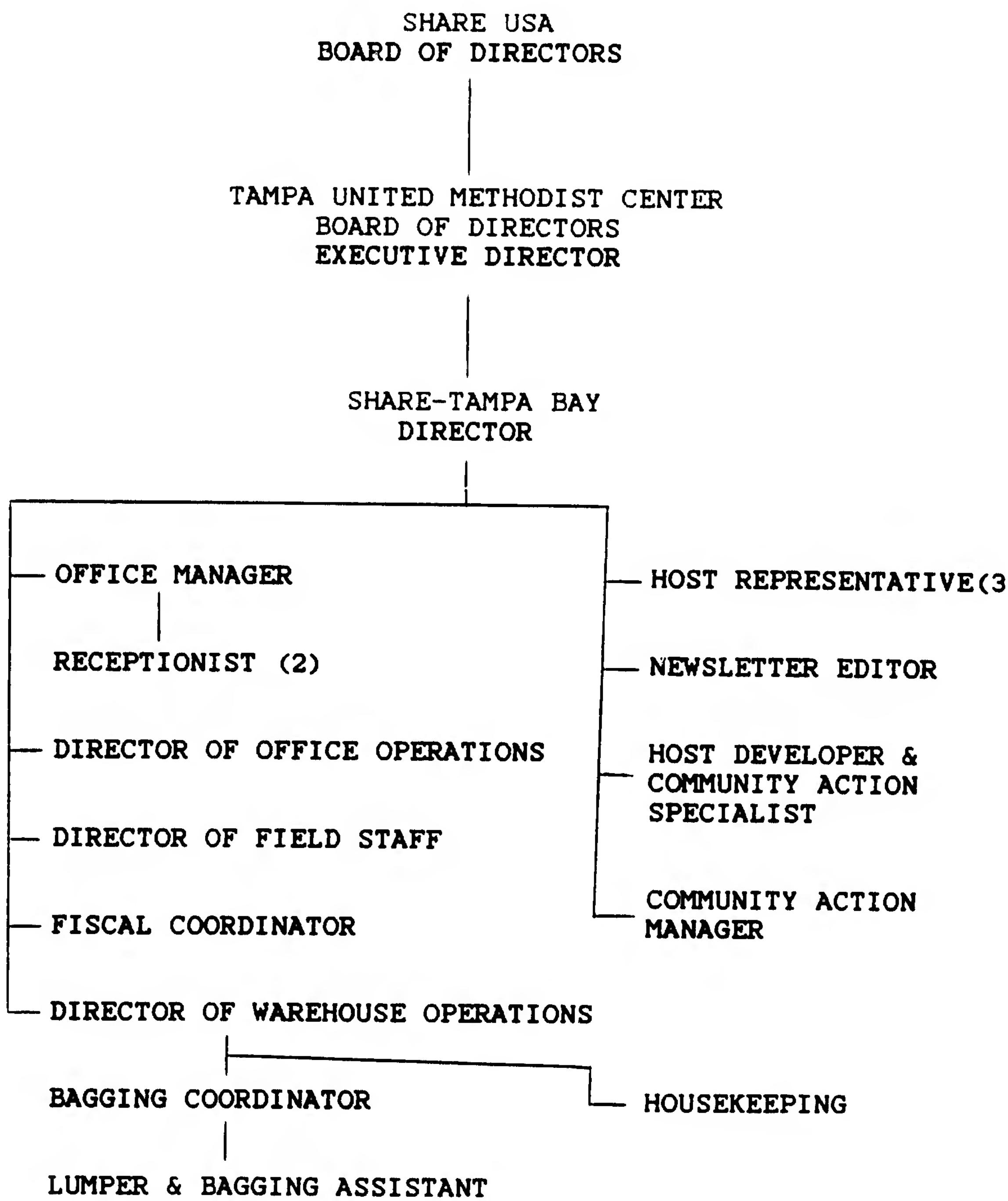

Figure 1. SHARE-Tampa Bay Organizational Structure

the purchase and bagging of the food. The warehouse for SHARE-Tampa Bay is at 1405 E. 2nd Ave in Ybor City. At this location, all of the food arrives during bagging week, prior to Distribution Day. The food arrives in bulk on pallets. During the bagging week the volunteers assisted by the SHARE staff repackage bulk food products into individual packages based on weight. On the day prior to Distribution Day, the three satellite warehouses receive food shipment by pallets. These include individually repacked food products. Distribution Day (D-Day) is generally the third Saturday of every month. On this day, the host sites go to the warehouse at predetermined times to pick up their bulk food packages. Upon return to the host site, the items are put into individual SHARE packages for pick up by the participants. The SHARE cycle ends on distribution day and starts at registration at the beginning of the next month.

1.3 CONSTRAINTS

A non-profit organization usually has a wide variety of constraints. These include personnel staffing, equipment, and space. Most often the critical factor is the need to maintain positive cash flow. Many such organizations rely on sponsors for survival. However, SHARE-Tampa Bay is a self supporting organization and must operate very efficiently to ensure its survival. This means that it cannot afford a negative cash flow situation. Therefore, any changes and investments must be well thought out to ensure success for the organization in terms of growth and return on investment.

For the foreseeable future, SHARE-Tampa Bay will remain in the current warehouse location, since SHARE has a five year lease on the warehouse. There are also financial constraints that limit its ability to modify the present layout of the facility. Other concerns include the present volume and the future growth in volume of participants. At present, the material handling requires improvement in order to enhance productivity. The Distribution Day process flow is hampered with safety hazards, flow problems such as bottlenecks, and excess handling problems. The facilities layout and space utilization are critical in the peak winter months. However, some of the D-Day problems appear to be created by the constraints of the building. These are space constraints and the location of the freezer and loading docks.

CHAPTER 2

LITERATURE REVIEW

The three fundamental areas of research to be presented in this review are material handling, simulation, and facility layout. These three areas cover the extent of this thesis.

2.1 MATERIAL HANDLING

Some basic questions should be asked whenever designing or analyzing an existing material handling system. These questions are why, what, where, when, how, who, and which in reference to the material to be handled [Tompkins, etal 1984]. It is also essential to remember the best materials handling system is no materials handling at all [Sims 1975].

Matson [1992] described a knowledged-based approach for determining the major factors that influence equipment selection. He did this by compiling the traditional checklists and published literature on equipment selection. From this he developed a prototype expert system for material handling equipment selection.

Apple [1972] discussed the necessity to ensure the total system is being looked at while trying to optimize the material handling system. This involved three steps:

1. Involve the entire enterprise.
2. Provide for handling material, and relevant data.
3. Include all phases of movement from incoming raw materials to outgoing finished goods.

Apple's steps in a material handling system development covers five phases.

Phases I - Definition: Identifying the problem(s), determining the cause(s), and defining the problem(s).
Phase II - Investigation: Determine the information needed, collect, verify, and analyze the data.
Phase III - Synthesis: Conceptualize system possibilities and alternatives. Simulate potential systems and select.
Phase IV - Design: Define proposed system, develop components and budget.
Phase V - Implementation: Procure equipment, install, train operators. Start-up the system and debug while continuing to audit the performance.

Velury [1992] and Elliott [1988] discussed the same general phases used by Apple [1972], but used a mathematical model and a database respectively to assist the selection process. Velury concentrated more on bulk material handling selection. Other considerations include the degree to which protection from weather is needed and the capability to move different materials with the same equipment.

Like Apple, Condit [1971] also discussed the basic steps to choosing the proper material handling system. He also discussed the basic types and means to choose pallets and racking. In order to select equipment, there must be a thorough understanding of management objectives along with storage and material handling problems. Application and cost are the major determinants in deciding between wood, steel, and plastic pallets. There are four different pallet applications:

1. Captive - Pallet does not leave the plant
2. Expendable - The shipped pallet doesn't return to the plant
3. Pooled - The shipped pallet is replaced with one of equal value by the receiver
4. Returnable - the shipped pallet is returned to sender when empty

The three major classifications of racks are regular, drive-in and/or drive-thru, and cantilever. Drive-thru racks are the most popular because they use fewer aisles.

Moore [1972] discussed the same subject, but had different criteria for an overall material handling selection process. His factors started with the traditional criteria such as return on investment, payback period, reduced labor costs, and safety improvement. Included in his list are commonly accepted qualitative criteria such as flexibility, expandability, amount of damage caused by system, promotional value, ease of maintenance, installation disruption, and disruption of working conditions. He also examined additional quantitative criteria such as:

- Volume and Distance Moved
- Work-In-Process Inventory Level
- Number of Moves
- Ratios - Materials, automatic, direct labor, number of handlings ratios
- Equipment Utilization Ratio
- Movement Operation Ratio

Moore suggested examining these criteria and their advantages and disadvantages with the plans for material handling devices. Then by looking at the pros and cons make comparisons and decide. This can also include a weightedfactor method if all criteria are not equally important.

Markell [1972] discussed different equipment selection criteria for different types of trucks. These included gas or electric, tractors, narrow aisle, walkies, and attachments. He pointed out that 80% of the cost to own and operate an industrial truck is the cost of the operator. His point was that higher basic equipment cost for a better and newer truck will reduce the out-of-service time and will not waste the more expensive operator investment. From Markell's criteria, the use of electric trucks is still ideal for indoor manufacturing, truck loading, and more adaptable for short runs. Their fume-free, quiet and clean running characteristics make them ideal for use with food, coolers, freezers, and indoor environments. Markell study also pointed out that gas and electric are approximately equal to operate from a financial aspect. This is true even though there is a lower initial cost and higher trade-in value for a gas truck.

Markell also discussed powered hand trucks, or more commonly called "walkies". Accordingly, the walkies should be considered supplemental equipment to the regular riding trucks. They should not be used for distances over 50 to 100 feet. The operator spends too much time walking due to the slow speed for longer distances. If the scope of operation falls into this, then a walkie is suitable for application.

Fasold [1971] discussed the "Twenty Principles of

Material Handling" to aid in solving material handling problems. These principles included simplifying, utilizing gravity, and "reducing the ratio of dead weight of mobile handling equipment to load carried." His principles also included capacity, space utilization, control of materials, standardization, performance, and safety.

In line with Fasold, Sims [1975] explains that in many situations, a change can be made in the sequence of operations or the level of completion of a product in inventory. This can reduce the material handling costs.

Niebel [1988] listed specific check questions that an analyst should use to shorten the distances travelled and reduce material handling time. These include:

1. Is product group technology being practiced to reduce the number of setups and to allow for larger production runs?
2. Can a facility be economically relocated to reduce the distances traveled?
3. What can be done to reduce handling of materials?
4. What is the correct equipment for handling materials?
5. How much time is lost in getting materials to and from the workstation?
6. Should product grouping be considered rather than process grouping?
7. How can the size of the unit of material handled be increased to reduce handling, scrap, and downtime?
8. What can be done about runways and roadways to speed up transportation?
9. What is the proper position in which to place material to reduce handling by the operator?
10. What use can be made of gravity delivery?

Automation plays a role in many plants today. The factors that may determine the use of automation systems are the complexity of the processes, the quality and safety aspects for the products produced, and the need for efficient use of the production facility [Jarnebrant 1992].

Backart [1975] reviews various conveyor systems by their operating conditions and areas of application. The package handling, towline, power and free, trolley, and monorail conveyor systems are discussed. He also discusses the factors to be considered when planning for a major conveyor system [Backart].

Frazier [1976] discussed the small plant material handling improvement opportunities through planning, tools, thru-put, unitizing, and fast equipment payout. Some of his ideas ranged from floor lines for organization and traffic flow to using a standard pallet for all possible uses. Of course, he included simply reducing material handling, but also studying sophisticated ideas for relieving material handling problems [Frazier].

2.2 SIMULATION

Simulation is designing a model od a system of interest and experimenting with the model to study a problem [Pegden 1990]. The model mimics the response of the actual system. The various types of simulation models are classified as iconic or symbolic. The iconic simulation models are usually referred to as simulators such as flight or driving simulators. Symbolic simulation models take the properties and characteristics of the real system and are put into mathematical and/or symbolic form. Analog, digital, and hybrid computers are used to execute different types of symbolic simulation models [Pegden].

The advantages of simulation includes exploring new policies, procedures, and rules without disrupting the present operations. Also different hypotheses can be tested for feasibility along with learning which variables may be most important with respect to system performance. Some drawbacks of simulation are its time consuming nature and potential expense. However, better the quality of the model the better the quality of the analysis. Other drawbacks include the fact that it can be difficult to determine whether an observation during the run is due to randomness or is significant [Pegden 1990].

Seevers [1988] discussed the growing number of complex applications which make the traditional methods of planning more difficult and less exact. However, with the use of simulation, the risk of costly surprises are reduced before an investment is made. Once a project is decided on, the simulation results can also help in successfully implementing the project. Additional simulation runs can be made to test the system if additional changes need to be made in the installation and actual running of the system [Seevers].

Carrie [1988] explained the basic steps when building a simulation model. The steps are:

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Carrie [1988] explained the basic steps when building a simulation model. The steps are:

1. Define the system to be modelled
2. Build the model
3. Collect the data
4. Validate the model
5. Run experiments using the model
6. Revise the model and repeat experiments

The model should consist of only the area of the system that is necessary to be modeled. The larger the system, the harder and more expensive the simulation modeling. More data will also be required to fulfill the accuracy and detail needed. After these things are decided and the model is run, the model must be validated to debug the program and make sure the results are reliable. The next step is to assess the performance of the system. The initial questions may be answered with the first runs of the simulation, but more information may be needed and the model revised. This last step may require more detail and accurate data [Carrie].

Phillips [1991] examined a packaged food distribution warehouse through detailed micro models to examine different equipment and operational procedures. Once the best alternatives were identified for the entire facility, a macro model was used to encompass the whole distribution facility. The macro simulation model examined throughput, material flow, material handling equipment utilization, and resource allocation. This was an effective tool in handling a very large and complex simulation. Siman/Cinema were used so the models could run on a PC and a SUN workstation, logic functions coded in Fortran could be used, and for its high-resolution animation [Phillips 1991].

Corish [1988] discussed using simulation to find out the capacity of an Automated Guided Vehicle (AGV) system in a printing plant. Once it was determined what elements to include in the model, the logic of the model was designed. He also collected data such as frequency of scrap bin movement or movement speeds/times for the AGVs. The simulation model used was HOCUS due to its simplicity in model formulation and data input. The model was used in two stages. Namely, validation and debugging, and experimentation. In the experimental phase, the simulation model collected statistics like AGV, press, and strip operator utilization. From working with the model, it was found that the AGV system needed to be expanded and the model was used to test various design changes [Corish].

Falagan [1988] explained the use of simulation relating to a project for a machine tool manufacturer, Robotiker. The project attempted to achieve the integration of all the technologies involved: CAD/CAM, production planning and control, robotics, communications, automatic transport, and quality control. Looking only at the material handling proposals, they had to make a decision as to the system. Two initial solutions were turned down through simulation models which showed the system inadequacies. The team could then form a better design from the knowledge gained from the previous model runs. The team was able to calculate the number of vehicles required, buffer sizes, and change the traffic layout [Falagan].

2.3 FACILITY LAYOUT

Tompkins [etal 1984] explained the four basic types of layout. They are fixed material location, production line, product family, and process. There is a hybrid layout when a company's products fits each type of layout. To design the best facility, Rogers [1992] recommends including the following aspects in the planning process.

- Create the right team
- Plan world-class
- Seek breakthrough improvements
- Define perfect process
- Eliminate non-value added activities
- Attack the inventories
- Leverage information and control systems
- Design for logistics
- Don't be the guinea pig
- Preclude conflicts of interest

Tompkins [etal 1984] believed no matter what method you plan to use the following basic layout planning steps should be followed:

1. Define the objective of the facility
2. Specify the primary and support activities to be performed in accomplishing the objective
3. Determine interrelationships among all activities
4. Determine the space requirements for all activities
5. Generate alternative facility layouts
6. Evaluate alternative facility layouts
7. Select a facility layout
8. Implement the facility layout
9. Maintain and adapt the facility layout

Tompkins also discussed Immer's and Nadlers approaches. Immer's [1950] three basic steps are to put the problem on paper, show the lines of flow, and finally to convert the flow lines to machine lines. Nadler's [1965] ideal systems approach is more of a philosophy through a top-down hierarchical approach than a procedure.

1. Aim for the "theoretical ideal system"
2. Conceptualize the "ultimate ideal system"
3. Design the "technologically workable ideal system"
4. Install the "recommended system"

Tompkins also outlines Apple's and Reed's plant layout procedure. Apple uses a detailed list of steps, but they don't have to be performed in the given sequence. Reed uses a systematic plan of attack requiring the sequence to be followed [Tompkins, etal 1984].

Usher used a straight forward approach to redesigning an existing layout. Initially he laid out the existing facility and conducted a product, process, department, flow, and space analysis. He then utilized Muthers [1973] Systematic Layout Planning (SLP) by constructing routing matrices, relationship charts, space relationship diagrams, and concluded with a block layout sketch. He used the different tools to develop his alternatives as he completed each step. He also utilized managers, engineers, and key department employees as a team to determine the new layout. [Usher 1990]

Suskind [1991] described his approach to planning warehouse space without drafting a facility layout. He estimates the space estimates through a six step process.

1. Sketch how the loads can be arranged on the floor
2. Count number of loads in sketch
3. Calculate the square footage of space occupied
4. Divide square footage by number of loads. This gives a factor of sq.ft. per load for one tier
5. Determine number of tiers based on constraints
6. Divide step 4 value by step 5 value to get the space estimation factor. Then multiplied by the number of loads stored in the warehouse to get the storage space estimate.

Heragu [1992] discussed the seven basic algorithms to aid in solving the layout problem.

- 2-way exchange algorithm
- 3-way exchange algorithm
- Computerized Relative Allocation of Facilities Technique (CRAFT)
- Modified Penalty (MP) algorithm
- Simulated Annealing (SA) algorithm
- Tabu Search (TS) algorithm
- Hybrid Simulated Annealing (HSA) algorithm

He explains that the SA and HSA algorithms yielded the best quality solutions in a reasonable computation time. Additionally, he concluded that the 3-opt performs better than the 2-opt and MP algorithms. The MP also out performs the 2-opt. He did not examine CRAFT. He asserted that many algorithms assume the facility to be square in shape and of equal size, but in practice this is not the case. However, Usher [1992] explained the most important phase in the layout process is the location of departments within the facility regardless of the area or shape of the departments.

Most research found in plant layout was divided into two categories. The first category dealt with the minimization of material handling cost between departments [Buffa 1963]. The second category considered the qualitative reasons for department positions [Muther 1973]. Tompkin [1984] explained five quantitative and qualitative computer-aided layout programs. CRAFT and COFAD (Computerized Facilities Design) use quantitative inputs. CORELAP (COmputerized RElationship LAyout Planning) and ALDEP (Automated Layout DEsign Program) use qualitative inputs. While PLANET (Plant Layout ANalysis and Evaluation Technique) incorporates both qualitative and quantitative inputs.

The categories of models are criticized for not having the capacity for crunching multiple-criteria problems faced in facility layout problems. There is also a lack of integration of both qualitative and quantitative factors. Some research showed an effort to combine the two through an adaption to Saaty's Analytical Hierarchy Process (AHP)[Partovi 1992].

The three steps in using AHP are:

1. Describe the complex decision problem as a hierarchy
2. Use pairwise comparisons to estimate the relative importance of the various elements on each level of the hierarchy
3. Integrate the pairwise comparisons to develop an overall evaluation of decision alternatives.

Partovi's facility layout hierarchy includes independent criteria such as safety, noise, ease of supervision, floor space utilization, layout flexibility, ease of expansion, material handling efficiency, manpower utilization, and its mesh with organizational structure. He suggests a maximum of seven criteria in the hierarchy. At the first hierarchy level, the decision maker must specify the relative importance of each of the criteria to obtain the ideal layout. Performance ratings are established along with weights and priorities. This includes qualitative and quantitative factors. The program figures an AHP score. The highest ranking set of departments are assigned near each other near the center of the layout. The second highest priority score is placed next to the first, unless it doesn't have a common department with the first. Then it is placed in a priority queue. After the placement of a department set, the procedure continues by checking the priority queue. Unlike other multi-criteria layout designs which compare existing layout alternatives, this one constructs a layout [Partovi].

CHAPTER 3

PROBLEM STATEMENT

The main problem areas within the SHARE-Tampa Bay facility are the material handling practices, the process flow for food distribution, the layout design, and space utilization.

3.1 MATERIAL HANDLING

In general, it is known that a part spends 80% of shop time being handled and 20% in productive work done on it. The SHARE-Tampa Bay warehouse material movement is much more than necessary and possibly with the wrong equipment. This leads to inefficiencies and loss of production. A study is needed of the material handling devices, their effectiveness, material movement reduction and routing. The fork lifts are presently the most used material handler due to the movement of full pallets of food around the warehouse.

The movement of material is an area of interest to examine productivity. The study of the movement of material starts with delivery from suppliers through to the distribution to the host sites. The pallets of food are taken off the trucks, and placed in the staging area temporarily. They are then inspected, counted, and then placed in appropriate locations. Some pallets are taken to be bagged and returned. On the Friday prior to Distribution Day, the satellite warehouses have their pallets pre-staged and counted, then returned to their location (cooler, freezer) and wait until the trailer arrives later for loading. Through this process of three satellite warehouse many interruptions and emergencies occur. There have been errors in counting of materials for the satellite warehouses as well as missing products. The number of material handling moves can be reduced considerably by redefining the material handling steps.

3.2 PROCESS FLOW

The individual host sites that pick up their packages on Friday afternoon and Saturday mornings deal with a separate type of distribution. The flow of individual host sites through the warehouse on Saturday morning to pick up food packages has several drawbacks (Appendix 5). The flow causes the host sites to travel unnecessary distances and the appropriate path for the host sites can be confusing. The path of the host sites through the warehouse conflict with the forklifts movement around the warehouse. This is evident in the area between the freezer storage and the frozen pick-up area. Both travel along the same route in both directions. This creates a potentially dangerous situation. Bottlenecks are also a problem in the staging area and near the loading doors. The staging area houses many functions such as check-in, cart pick-up, and the dock loading. In addition, host sites travel through the staging area with their carts causing a large bottleneck. The loading doors area in the bagging room causes a bottleneck due to the amount of two way traffic along a small aisle.

3.3 LAYOUT DESIGN AND SPACE UTILIZATION

The winter months are the peak times in the volume of food distribution. With the current techniques, space is limited during the winter months. There is a need for increased storage capacity of the cooler, freezer, and dry product. The Director of Operations feels that the volume will continue to grow and may possibly out grow the warehouse facility. SHARE would like to utilize the warehouse as long as possible and more efficiently with respect to space. The 24,000 square foot warehouse has two loading docks servicing the tractor trailer deliveries and pick-ups during distribution week. Since the docks are so heavily used during the distribution week refrigerated trailers cannot be used for storage.

The side building is not utilized efficiently through unplanned placement of materials, pallets, and food. Space utilization techniques can be very effective for efficient use of the space. Racking is well utilized in the cooler and other strategic areas around the warehouse. However, the current racking could be used more effectively in addition to racking in the freezer and side building.

The layout of the Distribution Day process flow also creates problems discussed in the previous section. The problems should be relieved through the analysis of both the flow and layout (Appendix 5).

There is a need for promoting orderliness, cleanliness, and good housekeeping changes. This will be addressed in all of the above areas for solutions.

The main problem area at SHARE-Tampa Bay is the materials handling. The material handling problems fall into three areas. The first is the process of tagging and shipping the food for the satellite warehouses. The second relates to the process flow and the associated material handling on distribution day. The third is the redesign of the facility and distribution day layout so as to reduce material handling.

CHAPTER 4

METHODOLOGY

To fully analyze the system, a time period of approximately four months was used for analysis in order to understand the entire material handling process at SHARE-Tampa Bay. The first step in any redesign process is to understand the existing process and techniques. This was done by direct observation of the existing processes, working with the staff in their different roles, and asking the employees about their job and methods. The employees have some excellent suggestions and ideas. Some suggestions have not been fully explored and others have been looked at, but were never implemented.

The scope of each area analyzed was based on its potential contribution to increased productivity and the needs of SHARE-Tampa Bay. Share-Tampa Bay is mostly concerned with the operations within the warehouse.

4.1 MATERIAL HANDLING

Initially, the problem areas were defined, investigated, and then potential alternatives found. After observation of the current process, the study of material handling was limited only to the efficiency of material handling.

4.1.1 Material Handling of Satellite Warehouse Food

A problem area is the productivity of the warehouse staff in handling material from when it is received to when it is shipped to the satellite warehouses. Information from the literature and actual observation of the process indicated that techniques such as an operations process chart would be very beneficial. These charts enabled analysis of the present and proposed future material handling methods. The number of transportation moves was used as the criteria for evaluating the results of possible alternatives.

4.1.2 Equipment Utilization

An in-depth study of the equipment usage does not seem necessary, since the amount of material handling required and the equipment needed are very basic. At present, the available equipment are being utilized efficiently based on distances to travel and weight of load to be moved. However, throughout the study, the material being transported must be examined for the necessity of movement.

4.2 PROCESS FLOW

The process flow of handling materials from receiving to repackaging, through to the distribution day was observed. The evaluation was limited to the process flow for the distribution day. However, this included analysis of the layout at the same time. The process flow analyses was accomplished by utilizing flow diagrams (Appendix 5). The method of flow diagrams aided in analyzing the sequence, congestion areas, and unnecessary travel. Four major departments are of concern: check-in, frozen, cooler, and dry. The process flow analyses assisted in determining the layout. Simulation experiments were also used to test the optimal process flow based on the time it takes for host sites to travel through the distribution process.

4.3 SIMULATION

4.3.1 Simulation Model

The SIMAN software package was used for the simulation. The simulation flow diagram, model, and experimental frame for the present distribution day flow are given in Appendix 1. The model and experimental frame for the proposed flow are given in Appendix 2. The program was modeled after the June 1993 distribution day and its food products. Only one month could be modeled, since the different number of food types change monthly. This included eleven cooler, 3 frozen and two dry food products. However, the simulation model could be adapted easily for another month. The seasonality change in volume which would change delay times was modeled allowing for the data of any month to be used.

The arriving host sites represented the entities and the pick-up of each food product represented the resources. An entire batch of created entities had to be introduced into the system before another batch could start. This allowed the creation of entities to follow the arrival schedule of SHARE-Tampa Bay. The simulation modeled the actual system of a service line. It modeled the constraint of having to wait till the host site in front has finished being serviced before it can seize the next resource. Queues were placed where there is a buffer space between resources. If no buffer space was available, the host site remained busy with the resource until the next resource was free. The simulation concludes each run when all the entities have left the system. The output from the simulation included the time to process all the host sites for each layout. This data was used to compare the two models.

4.3.2 Time Studies

In order to simulate the model of the distribution day flow, time studies were completed for the various host site sizes with the present process flow. These times represent the amount of time required to obtain the determined amount of food items. The time studies were accomplished by using the volunteers that verify the quantities the host sites load. They wrote down the times entering and exiting the cooler and frozen/dry sections. The times were broken up into 5 different size categories.

1. 0 to 50 packages
2. 51 to 100 packages
3. 101 to 150 packages
4. 151 to 200 packages
5. 201 and up packages

The time studies incorporated the delay time between resources. The model was designed with these waiting times in the system. Therefore, a value of 20% of the service times were used. The assumption was made that 80% of the time in the system is due to waiting.

4.3.3 Distribution Assumptions

The arrival times were based on scheduled host site arrivals. The arrival schedule for the month of June was used to create the entities.

The discrete probability distribution was used for assigning quantity sizes to the arriving host sites. The discrete empirical data was obtained by direct observation and was incorporated into the model.

The lognormal distribution was used to model the service times required to complete the task at each resource. This distribution was chosen because it has traditionally been used to model human performance. The human element adds a large amount of variability to task times and this distribution is suited for these situations.

The mean service times for the cooler and the frozen/dry departments were calculated from the formula for the mean of grouped data. The mean service time for each resource was obtained by dividing the appropriate mean by the number of resources in that department (Table 1). For example, the mean service time for the cooler for a host site of size 0 to 50 is 14.527 minutes. Since there are eleven resources in the cooler department, then the average service time for each resource = 14.527/11 = 1.3206 minutes.

The variance (Table 2) for each department was calculated based on the formula for the variance of grouped data. The standard deviation for each resource was calculated from the following formula.

$$S_{\bar{x}} = \frac{S}{\sqrt{n}} \qquad \text{where } n = \# \text{ of resources}$$

The standard deviation for the service times for those host sites whose sizes were greater than 200 were not calculated due to the unavailability of data (only two pieces of data were available).

The number of replications necessary to provide a given level of confidence for the system flow time was based on the 95% confidence level. A maximum error of 0.4 minute was considered acceptable for computing the average system time. Based on this, the replicate value n was computed using:

$$n = ((Z_{\alpha/2} * \sigma) / E)^2$$

The value computed for the replications was 18.5. The simulation was run for twenty replications ensuring the mean of the data is off by at most 0.4 minute.

TABLE 1. Calculation of Resource Service Time Means (Minutes)

NO. UNITS	PRODUCE TIME IN	OUT	TOTAL	FROZEN / DRY TIME IN	OUT	TOTAL
23	1050	1059	9	1050	1059	9
30	1043	1056	13	1100	1116	16
28	1011	1025	14	1025	1035	10
46	525	545	20	545	550	5
38	1048	1055	7	1048	1050	2
36	700	715	15	700	716	16
34	506	526	20	526	532	6
38	730	742	12	730	740	10
21	720	740	20	740	745	5
		MEAN	14.52721		MEAN	8.632653
		RESOURCE MEAN	1.320655		RESOURCE MEAN	1.726530

NO. UNITS	PRODUCE TIME IN	OUT	TOTAL	FROZEN / DRY TIME IN	OUT	TOTAL
54	851	859	8	900	914	14
58	1006	1025	19	1025	1030	5
59	840	855	15	834	859	25
63	922	935	13	922	930	8
68	1003	1022	19	1003	1015	12
70	839	859	20	845	855	10
74	1000	1016	16	1000	1011	11
75	1033	1048	15	1048	1057	9
77	836	850	14	850	855	5
86	943	955	12	943	950	7
92	615	630	15	630	635	5
92	601	615	14	601	620	19
99	702	725	23	725	735	10
		MEAN	15.81592		MEAN	10.56359
		RESOURCE MEAN	1.437811		RESOURCE MEAN	2.112719

NO. UNITS	PRODUCE TIME IN	OUT	TOTAL	FROZEN /DRY TIME IN	OUT	TOTAL
101	903	930	27	903	915	12
109	1000	1022	22	1000	1012	12
116	632	650	18	632	640	8
118	1002	1021	19	1021	1028	7
126	644	659	15	650	659	9
135	700	715	15	715	725	10
135	707	730	23	707	720	13
147	511	530	19	511	530	19
		MEAN	19.52178		MEAN	11.45491
		RESOURCE MEAN	1.774707		RESOURCE MEAN	2.290982

NO. UNITS	PRODUCE TIME IN	OUT	TOTAL	FROZEN / DRY TIME IN	OUT	TOTAL
151	1029	1050	21	1029	1045	16
152	604	625	21	606	630	24
155	800	818	18			0
181	910	930	20	910	925	15
197	1100	1120	20	1100	1115	15
		MEAN	19.99162		MEAN	17.23054
		RESOURCE MEAN	1.817420		RESOURCE MEAN	3.446108

NO. UNITS	PRODUCE TIME IN	OUT	TOTAL	FROZEN / DRY TIME IN	OUT	TOTAL
222	1000	1020	20	1000	1015	15
323	602	620	18	620	645	25
		MEAN	18.81467		MEAN	20.92660
		RESOURCE MEAN	1.710425		RESOURCE MEAN	4.185321

TABLE 2. Calculation of Standard Deviation

UNITS: 0 TO 50

NO UNITS	COOLER PROD TIME	X^2			FROZEN/DRY PROD TIME	X^2
23	9	81			9	81
30	13	169			16	256
28	14	196			10	100
46	20	400			5	25
38	7	49			2	4
36	15	225			16	256
34	20	400			6	36
38	12	144			10	100
21	20	400	N=	294	5	25
TOTAL	4271	68255		TOTAL	2538	28410
MEAN	14.52721			MEAN	8.632653	
		SIGMA=	21.19209		SIGMA=	22.18541
	RESOURCE STD DEV		1.388003		RESOURCE STD DEV	2.106438

UNITS: 51 TO 100

NO UNITS	COOLER PROD TIME	X^2			FROZEN/DRY PROD TIME	X^2
54	8	64			14	196
58	19	361			5	25
59	15	225			25	625
63	13	169			8	64
68	19	361			12	144
70	20	400			10	100
74	16	256			11	121
75	15	225			9	81
77	14	196			5	25
86	12	144			7	49
92	15	225			5	25
92	14	196			19	361
99	23	529	N=	967	10	100
TOTAL	15294	255262		TOTAL	10215	136313
MEAN	15.81593			MEAN	10.5636	
		SIGMA=	13.84393		SIGMA=	29.40563
	RESOURCE STD DEV		1.121846		RESOURCE STD DEV	2.425103

UNITS: 101 TO 150

NO UNITS	COOLER PROD TIME	X^2			FROZEN/DRY PROD TIME	X^2
101	27	729			12	144
109	22	484			12	144
116	18	324			8	64
118	19	361			7	49
126	15	225			9	81
135	15	225			10	100
135	23	529			13	169
147	19	361	N=	987	19	361
TOTAL	19268	389774		TOTAL	11306	143034
MEAN	19.52178			MEAN	11.45491	
		SIGMA=	13.82179		SIGMA=	13.71678
	RESOURCE STD DEV		1.120949		RESOURCE STD DEV	1.656308

UNITS: 151 TO 200

NO UNITS	COOLER PROD TIME	X^2			FROZEN/DRY PROD TIME	X^2	
151	21	441			16	256	
152	21	441			24	576	
155	18	324			0	0	
181	20	400			15	225	N=
197	20	400	N=	836	15	225	681
TOTAL	16713	335043		TOTAL	11734	211258	
MEAN	19.99163			MEAN	17.23054		
		SIGMA=	1.105319		SIGMA=	13.3453	
	RESOURCE STD DEV		0.316991		RESOURCE STD DEV	1.633726	

The same random number streams were used for the two models.

4.3.3 Proposed Flow Simulation Model

The same data from the time studies was used to run the alternative layout. Adjustments were made in the queues, the number of servers, and the order of resources to correspond with the process flow and layout. The resulting alternative layout and flow times were used to compare to the present layout flow times.

4.4 LAYOUT DESIGN

The entire layout was considered for redesign, but the constraint on funds and other resources was kept in mind. The analysis focused on the present building design, but also explored the possibility for expansion. The layout design incorporated both the storage areas and Distribution Day layout (Appendix 5).

4.4.1 Department Assignment

The following is the list of department names and assigned numbers corresponding to the layouts in Appendix 5.

Dept #	Department	Dept#	Department
1	Cooler Storage/Pick-up	8	Dry Product Storage 2
2	Frozen Storage	9	Loading Dock (lrg sites)
3	Frozen Pick-up (line 1)	10	Loading Area
4	Frozen Pick-up (line 2)	11	Individual Units Room
5	Dry Prod Pick-up (line 1)	12	Carts Storage
6	Dry Prod Pick-up (line 2)	13	Spare Boxes
7	Dry Product Storage 1	14	Check-in Desk

4.4.2 Plant Layout Software

The existing and the proposed layouts were evaluated by the Plant Layout: I.I.E. Micro-Software. The software is designed to evaluate a departmental layout by satisfying a relationship chart. The criteria for the relationship chart is the closeness of departments. The program used the following relative values:

6:	Absolutely Close	3:	Ordinary Close
5:	Especially Close	2:	Unimportant
4:	Important	1:	Undesirable

It accepted data in the form of department number and the number of the departments adjacent to it.

After department identification, the closeness relationships were determined among departments. Material handling productivity and qualitative factors such as safety, layout flexibility, and good housekeeping techniques were taken into consideration in assigning the closeness relationships.

4.4.3 Layout Comparison

The same closeness relationship values were used for both layouts. Only the department layout position changed. The software generates scores and recommended improvements from the present layout (Appendix 6). These recommendations aided in generating a proposed layout (Appendix 7). The scores were used to compare the two layouts.

CHAPTER 5

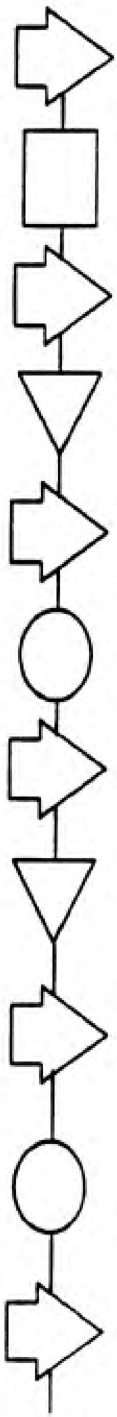
RESULTS

5.1 MATERIAL HANDLING

A careful analysis of the process of accepting incoming food pallets from the suppliers through to the distribution of food to satellite warehouses was accomplished. Table 3 is the operations process chart for the present method of handling the material during this time period. Table 4 is the proposed method operations process chart of accepting the pallets and the steps to handle them. From the tables, it is evident that the steps required to accomplish the same task has been reduced by 44%. The number of times the pallets are handled has been reduced from 14 to 7, which corresponds to a 50 percent reduction in material handling.

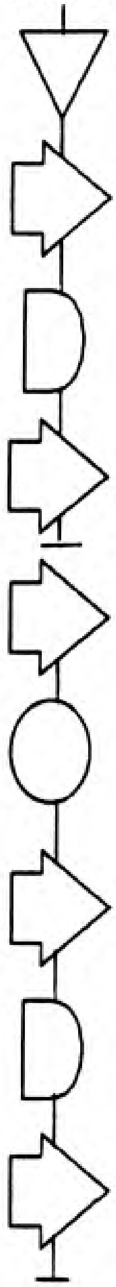
TABLE 3
PROCESS CHART: PRESENT METHOD
CHART BEGINS: Pallet Arrival CHART ENDS: Shipping

CHART SYMBOL



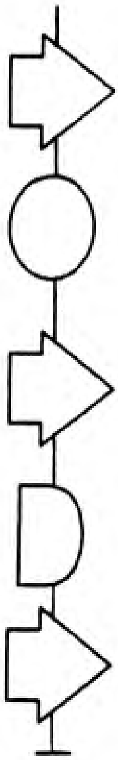
STEP	PROCESS DESCRIPTION
1	Truck arrives. All pallets unloaded to staging area.
2	Several pallets are verified for quantity, undamaged and unspoiled.
3	Pallets are placed in cooler, freezer or into dry storage areas.
4	Food is stored until needed.
5	Bulk food to be bagged is taken from respective area to bagging room.
6	Repackaged and repalletized
7	Pallets put into respective storage area
8	Food is stored until needed again.
9	Pallets brought to staging area on Thursday from freezer, cooler, and dry storage. Count made of pallets/partials needed.
10	Pallets are tagged for Sarasota and recorded on manifest.
11	Pallets placed back in cooler and freezer for following morning.

TABLE 3
PROCESS CHART - PRESENT METHOD
CHART BEGINS: Pallet Arrival CHART ENDS: Shipping



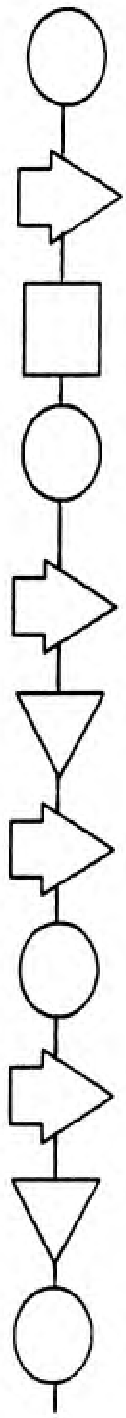
STEP	CHART SYMBOL	PROCESS DESCRIPTION
12		Stored until truck arrives on Friday.
13		Pallets pulled into staging area for storage until truck loading.
14		Wait for truck arrival.
15		Loaded on Trucks to Sarasota.
16		Count made of quantity of pallets & partials. Pallets brought to staging area for Ft. Meyers truck from cooler, freezer, and dry area.
17		Pallets are tagged for Ft Meyers and recorded on manifest.
18		Items frozen are placed back in freezer until truck arrives. Extra pallets from splits are placed back in respective areas.
19		Wait for truck arrival.
20		Pallets placed on truck from staging area and freezer.

TABLE 3
PROCESS CHART - PRESENT METHOD
CHART BEGINS: Pallet Arrival CHART ENDS: Shipping



STEP	CHART SYMBOL	PROCESS DESCRIPTION
21		Count made of quantity of pallets & partials. Pallets brought to staging area for Ocala truck from cooler, freezer, and dry area.
22		Pallets are tagged for Ocala and recorded on manifest.
23		Items frozen are placed back in freezer until truck arrives. Extra pallets from splits are placed back in respective areas.
24		Wait for truck arrival.
25		Pallets placed on truck from staging area and freezer. Reverified as loaded.

TABLE 4
PROCESS CHART: PROPOSED METHOD
CHART BEGINS: Before Arrival CHART ENDS: Shipping

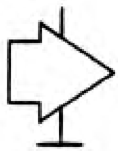
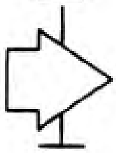
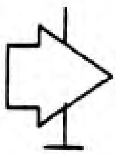


STEP	CHART SYMBOL	PROCESS DESCRIPTION
1		Plan number of pallets needed for all three satellite warehouses. Make-up tags, manifest. Prepare cooler configuration.
2		Truck arrives, pallets unloaded to cooler freezer, dry area. Number of pallets for tagging put in staging area.
3		Staging area pallets checked as sample for correct count, damage, spoilage.
4		Pallets are tagged for satellite sites. Premade manifest checked for correct pallet counts.
5		Tagged pallets placed in respective areas with first to be shipped accessible. Plan storage to have access to untagged shipments and subsequent shipments.
6		Food is stored till needed again.
7		Bulk food that needs to be bagged is taken from respective area to bagging room.
8		Repackaged and repalletized. Tag satellite warehouse pallets last.
9		Pallets put into respective storage area.
10		Food stored until trucks arrive on Fri.
11		Any additional late registrations added to pallets. Write on tag & manifest.

TABLE 4

PROCESS CHART: PROPOSED METHOD

CHART BEGINS: Before arrival CHART ENDS: Shipping

STEP	CHART SYMBOL	PROCESS DESCRIPTION
12		Food pallets pretagged for Sarasota are pulled from areas & reverified with the manifest as loaded on truck.
13		Food pallets pretagged for Ft Meyers are pulled from areas and reverified with the manifest as loaded on truck.
14		Food pallets pretagged for Ocala are pulled from areas and reverified with the manifest as loaded on truck.

5.2 LAYOUT DESIGN AND PROCESS FLOW

The I.I.E. Micro-Software compared the existing layout and the proposed layout. The software is designed to evaluate a departmental layout by satisfying a relationship chart. The criteria for the relationship chart was the closeness of departments. The following is the list of departments used:

Dept #	Department	Dept#	Department
1	Cooler Storage/Pick-up	8	Dry Product Storage 2
2	Frozen Storage	9	Loading Dock (lrg sites)
3	Frozen Pick-up (line 1)	10	Loading Area
4	Frozen Pick-up (line 2)	11	Individual Units Room
5	Dry Prod Pick-up (line 1)	12	Carts Storage
6	Dry Prod Pick-up (line 2)	13	Spare Boxes
7	Dry Product Storage 1	14	Check-in Desk

5.2.1 Present Layout Results

The output from the software for the present layout is in Appendix 6. The output for the proposed layout is in Appendix 7. The evaluation score for the present method equaled 393 out of a maximum of 455. Table 5 shows the following recommendations to bring the following departments closer. This increased the score to 408 out of the maximum of 455.

Table 5. Evaluation #1 - Present Layout

Evaluation Score: 408	Dept 2 & Dept 3	Dept 2 & Dept 4
	Dept 5 & Dept 8	Dept 6 & Dept 8
	Dept 11 & Dept 14	

Evaluation # 1 recommended to place the frozen pick-up and storage departments closer to increase the score. The software also recommended to place the dry product storage 2 next to the dry product pick-up. The final recommendation of evaluation #1 was to place the check-in desk near the individual units room.

Table 6 shows evaluation #2 and the recommended changes for the closeness of departments. The score increased to 425 out of the maximum of 455.

Table 6. Evaluation #2 - Present Layout

Evaluation Score: 425	Dept #		Dept #	Dept #		Dept #
	1	&	3	1	&	4
	1	&	5	1	&	6
	1	&	10	3	&	9
	3	&	14	4	&	9
	4	&	9	4	&	14
	5	&	9	5	&	14
	6	&	9	6	&	14
	9	&	11	10	&	12
	10	&	14			

Evaluation # 2 had more recommended moves, but the advantages of most moves were small. The most beneficial moves recommended were for the cooler to be near the frozen pick-up and dry product pick-up. Many of the pick-up departments were recommended to be closer to the large site loading dock. The last recommendations were to locate the loading area near the carts storage and the check-in desk.

5.2.2 Proposed Layout Results

The proposed layout used the same closeness values from the present layout. Only the adjacent department assignment change. The total evaluation score was 440 out of a maximum of 455. The recommendations in Table 7 were made to increase the score.

Table 7. Evaluation of Proposed Layout

Evaluation Score: 446	Dept 5 & Dept 8 Dept 6 & Dept 8
Evaluation Score: 442	Dept 9 & Dept 11
Evaluation Score: 447	Dept 2 & Dept 11 Dept 5 & Dept 9 Dept 6 & Dept 9 Dept 7 & Dept 8 Dept 7 & Dept 9 Dept 8 & Dept 9 Dept 8 & Dept 11

The recommendations for evaluation #1 of the proposed layout were to place the dry products storage 2 closer to the dry pick-up. Evaluation # 2 recommends the individual units room be placed near the large site loading dock. This results in a minimal score increase. Evaluation # 3 recommends that the dry departments all be placed near the large site loading dock. It also recommended to place the frozen storage and dry storage 2 close to the individual units room.

5.3 SIMULATION

The simulation output for the present process flow is in Appendix 3. The proposed process flow output is in Appendix 4. A sample of the output is shown in Table 8. The replication end time represents the system time from the first to the last host site. The 'flowtime' tally variable represents the average system time for a host site. The average system time is then categorized for each host site size.

Table 8. Simulation Output (minutes)

Summary for Replication 1 of 10

Project: THESIS Run execution date : 3/ 6/1992
Analyst: Paul Bernasconi Model revision date: 3/ 6/1992

Replication ended at time : 390.569

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	14.163	.93599	.13155	68.822	170
HOST SIZE 50	13.458	.98599	.13155	68.822	64
HOST SIZE 100	15.287	.89840	.34503	50.939	66
HOST SIZE 150	11.598	1.1601	.55505	50.399	21
HOST SIZE 200	16.509	.75951	1.8131	39.401	14
HOST SIZE 250	12.558	.73293	8.4420	29.024	5

The distribution day layout flow was simulated to enable a comparison of the present and proposed process flows. A confidence level of 95% was used to compare the mean values through a confidence interval. Table 9 shows the average system times of the twenty replications for each layout flow. By the confidence interval, there is no statistical difference between the two means. Therefore, either layout flow will take the same amount of time to allow all the host sites to be serviced.

Table 9. Simulation Results: Mean System Times

LAYOUT	MEAN (minutes)	STD DEV	CONFIDENCE INTERVAL (95%) (minutes)
PRESENT	441.86	119.39	$385.98 < u < 497.74$
PROPOSED	440.56	117.52	$385.56 < u < 495.56$

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 MATERIAL HANDLING

6.1.1 Planning

The proposed process will require planning prior to the supplier arrivals during bagging week. This planning will include determining the number of pallets needed for each satellite warehouse. Once this is accomplished, the pallet tags and manifest can be prepared for each satellite warehouse. In addition, the cooler and freezer layout must be determined and which food will need to be bagged into individual size portions. This planning can be preformed before the rush of bagging week. This pre-planning will allow for the pallets to be handled efficiently upon arrival. The reduction of mistakes are expected since the calculations and paperwork will be done prior to arrival of the food. The time necessary to distribute and load the trucks on Friday should be reduced since the steps of counting, preparing the tags and the manifest are already accomplished.

6.1.2 Arrival Process

The general arrival process is to place all the pallets of food directly into the cooler, freezer, and dry storage areas. Only the number of pallets needed for tagging will be placed in the staging area. These pallets can be used for the inspection of spoilage/damage of product and count verification. The congestion of the staging area will be reduced with the elimination of the excess staged pallets. The dry product that needs to be bagged can be placed directly in the dry rack storage area in the bagging room, except those necessary to check count and spoilage. Those will be placed in the staging area. Surplus dry product is placed in the dry room storage. The cooler products that need to be bagged can be placed entirely in the cooler, except those necessary to verify count and condition of the cooler product. These pallets will be tagged upon completion of bagging.

6.1.3 Pallet Placement

After being tagged, all product will be placed in appropriate locations. The first satellite pallets to be shipped will be the last to be tagged and the last to be placed in the appropriate storage location. This procedure will follow through to the last pallets shipped. The last pallets shipped will be the first to be tagged and placed first in the appropriate storage area. This order will allow access to the satellite pallets in the order they are needed for shipment.

6.1.4 Distribution

The manifest can be checked before the distribution begins on Friday to ensure all the little details such as extra packages, shortages from the previous month, or specialty items are marked on the manifest for the correct truck. The verifier can increase the accuracy that the pallets and manifest match, while the pallets are loaded on the trailer. The concentration of work is spread out over time by the proposed operations process. The time consuming planning is done prior to the supplier arrivals. The pallet counts, pallet tags, and the manifest are all completed allowing the storage of the pallets to be organized. On Friday, only verification of the manifest to the pallets need to be accomplished. This enables the system to be more manageable, creates less problems with unit counts, while still moving the material less.

Efforts can be made with the Alterman Trucking Company to increase the frequency for pick-up after the proposed method is tested and proves to work properly. This will eliminate the problem areas associated with the combination of host sites and truck loading on Friday afternoon. These problem areas are the staging, dry, and cooler areas. The forklift and host sites are maneuvering in the same areas.

This creates a hazardous condition.

6.2 LAYOUT DESIGN AND PROCESS FLOW

The layout redesign of the warehouse strived to combine a better department layout for storage and an improved layout for distribution day. The improvements focused on material handling issues, but were not limited to them.

6.2.1 Check-in

The direction of flow was reversed in order to reduce congestion and reduce excess travel. The check-in desk and cart pick-up are located in the bagging room in the proposed layout. This is the first stop upon entering the building for the host sites. They no longer have to walk through to the far side of the warehouse to reach the check-in desk. The check-in desk will have a standardized location for bagging week and distribution day. This will create less confusion for the volunteers and host sites. The carts will also be located adjacent to the loading door in order to have the pick-up and drop off of carts easily assessable at the entrance/exit doors. This will also reduce travel.

6.2.2 Dry Department

The second department reached by the host sites is the dry products department. The dry product storage will be on the racks next to the dry product pick-up to reduce material handling. All surplus dry product will be placed in the dry room storage. Presently, four of the racks in the bagging room are either not utilized or used to store trash and pallets. The dry product will be moved from storage to the pick-up floor space prior to the start of distribution day. The pallets are placed in two rows back to back enabling service from both sides. No forklifts are needed in this area of the warehouse, since sufficient space is available to place all of the dry product on the floor.

Racking can be placed in the dry room storage to increase storage capacity. The placement of product in the dry room storage must be planned according to when the product will need to be retrieved. The sooner product will be retrieved, the more the product needs to be accessible.

6.2.3 Frozen Department

The frozen pick-up department in the staging area is the third department. The frozen pick-up has a single line to service the host sites. The department is directly adjacent to the freezer and allows no host site/forklift interaction. The forklift can travel directly from the freezer to the frozen service line. Only one forklift will be needed to supply the frozen line, instead of the two presently needed. Two volunteer safety positions can also be eliminated. They were positioned to warn and clear the path of the forklifts exiting the freezer into the path of host sites and though the doorway between the bagging and staging rooms.

Racking can be placed in the freezer to increase storage capacity for frozen product.

6.2.4 Process Flow

The last stop is the cooler storage/pick-up department. The change made in the cooler reverses the direction of flow. Upon exiting there is a direct path to the exit door.

If the cart gets full anywhere along the path, the host site only has to join the exiting path anywhere along the flow. They no longer have to work around the other host sites still retrieving their food.

The use of floor arrows and markings can facilitate the flow of distribution. Through the proposed layout, congestion areas in the bagging room have been eliminated. This congestion was caused by the service lines for the frozen and dry product. There was insufficient space for two way traffic around the service lines. The two way traffic included the full carts exiting in one direction and the host sites arriving or returning their carts in the other direction. Splitting the frozen and dry pick-up departments also allows for an extra queue between the two.

6.3 SIMULATION

The purpose of simulating the distribution day flow was to allow a comparison of the two layouts. This comparison was needed to ensure the proposed layout would not increase the system time for Distribution Day. It has been observed that distribution day process lasts for approximately 410 minutes. In the simulation model, the average total system times for both layouts varied by 1.30 minutes. This yields less than a 1% difference in the total time. One can conclude that either layout will service all the host sites in approximately the same time. This is acceptable, since the focus of this study was to reduce material handling.

6.4 SUGGESTIONS FOR FURTHER RESEARCH

The unresolved problems faced during this research deals with the accuracy of the time studies. It was difficult to obtain accurate and sufficient data. It was impossible to get data on each resource for the different size host sites. It was not possible to obtain enough manpower at each resource to record the times. An additional problem to successfully obtain time studies on each resource was proper size identification of each host site. I depended on the volunteers that verified the host site food counts. Not everyone recorded the times, therefore I didn't have data from every host site that month. The uniformity of recording is unknown, but assumed erratic. I had to try for two months in order to receive the amount of data I used in this research.

The simulation model is a reasonable model of the system. If accurate data can be obtained, this simulation model could be used to test more about queues, number of resource servers, and various changes to the layout.

Only the data from one month can be used per simulation due to the different number of food products each month. However, the simulation model is designed for adaption to different quantities in each department.

The cost requirements of implementing this proposal are minimal. No construction is required, only the set-up of the Distribution Day flow changes and flowing different operation processes.

Future research can be done in the area of using a distribution to match the actual arrival of host sites into the system. Host sites do not always arrive at their scheduled time.

An additional research topic available at SHARE-Tampa Bay relates to the process integration of optimizing the price of food ordered while maximizing the nutritional value.

REFERENCES

Apple, James, "The Systems Concept in Material Handling," Material Handling For Increased Productivity, Atlanta, September 20-22, 1972, 6-11

Backart, Lloyd, "Conveyor Systems for Cost Improvement," Material Handling and the Industrial Engineer, Chicago, March 5-7, 1975, 15-20

Buffa, E.S. and Armour, G.C., "A heuristic algorithm and simulation approach to relative location of facilities," Management Science, Vol 9, 1987, 294-309

Carrie, Allan, Simulation of Manufacturing Systems, John Wiley & Sons, New York, 1988.

Condit, Frank, "Systems Applied to Racks, Pallets, Containers," Material Handling Systems, Pittsburgh, September 16-17, 1971, 21-26

Corish, M. J., "The use of simulation as an aid to the design of an automated factory," Simulation In Manufacturing; Proceedings of the 4th International Conference, London, November 2-3, 1988, 197-206

Elliott, Kim, "A Guide To Systematic Data Gathering For A Warehouse Facility Design," Industrial Engineering, June 1988, 34-38

Falagan, P., Sevillano, J.L., and A. Velez, "Simulation helps choose material handling system in an automated plant," Simulation In Manufacturing; Proceedings of the 4th International Conference, London, November 2-3, 1988, 207-216

Fasold, Arthur, "Equipment Concepts (Non Truck)," Material Handling Systems, Pittsburgh, September 16-17, 1971, 27-32

Frazier, Don, "Material Handling Improvement Opportunities in the Small Plant," Material Handling and the Industrial Engineer, Pittsburgh, March 2-4, 1976, 55-60

Heragu, Sunderesh, "Recent models and techniques for solving the layout problem," European Journal of Operational Research, Vol 57, No. 2, March 1992, 136-144

Immer, J.R., Layout Planning Techniques, McGraw-Hill, New York, 1950

Jarnebrant, Lars and Eadie John, "4th Generation of SW for Food Plant Control," ICHEME Symposium Series, No. 126, 1992, 371-376

Liang, M., Dutton, S.P. and Abdou G.H., "A New Approach To Material Handling Equipment Selection in a Manufacturing Environment," International Industrial Engineering Conference Proceedings, Toronto, May 14-17, 1989, 225-230

Markell, George, "Measuring Productivity - And Improving it Through Material Handling," Material Handling for Increased Productivity, Atlanta, September 20-22, 1972, 1-5

Matson, J.O., Mellichamp, J.M. and Swaminathan, S.R., "Excite: Expert consultant for in-plant transportation equipment," International Journal of Production Research, Volume 30, No. 8, August 1992, 1969-1983

Moore, James, "Criteria for Material Handling Equipment Selection," Material Handling for Increased Productivity, Atlanta, September 20-22, 1972, 17-24

Muther, R.R., Systematic Layout Planning, 2nd ed., Cahners Books, Boston, 1973

Nadler, G., "What Systems Really Are", Modern Materials Handling, Volume 2, No. 7, July 1965, 41-47

Niebel, Benjamin, Motion and Time Studies, 8th ed., Irwin, Homewood, Illinois, 1988

Partovi, Fariborz, "Analytical Hierarchy Approach to Facility Layout," Computers and Industrial Engineering, Volume 22, No. 4, 1992, 447-457

Pegden, Dennis, Shannon, Robert and Randall Sadowski, Introduction to Simulation Using SIMAN, McGraw-Hill Inc, New York, 1990

Phillips, Roger, "Material Handling Requirements for a Distribution Center," Proceedings of the 1991 Winter Simulation Conference, Volume 23, 1991, 396-401

Rogers, Ed, "Ten Nontraditional Aspects of Facility Planning," Industrial Engineering, February 1992, 18-20

Seevers, C., "Simulation before automation," Simulation In Manufacturing: Proceedings of the 4th International Conference, London, November 2-3, 1988, 217-224

Sims, Ralph, "How to solve material Handling Problems," Material Handling and the Industrial Engineer, Chicago, March 5-7, 1975, 3-5

Suskind, Peter, "Six-Step Approach to Planning Warehouse Space Without Drafting a Facility Layout," Industrial Engineering, September 1991, 25-28

Tompkins, James and White, John, Facilities Planning, John Wiley and Sons, New York, 1984

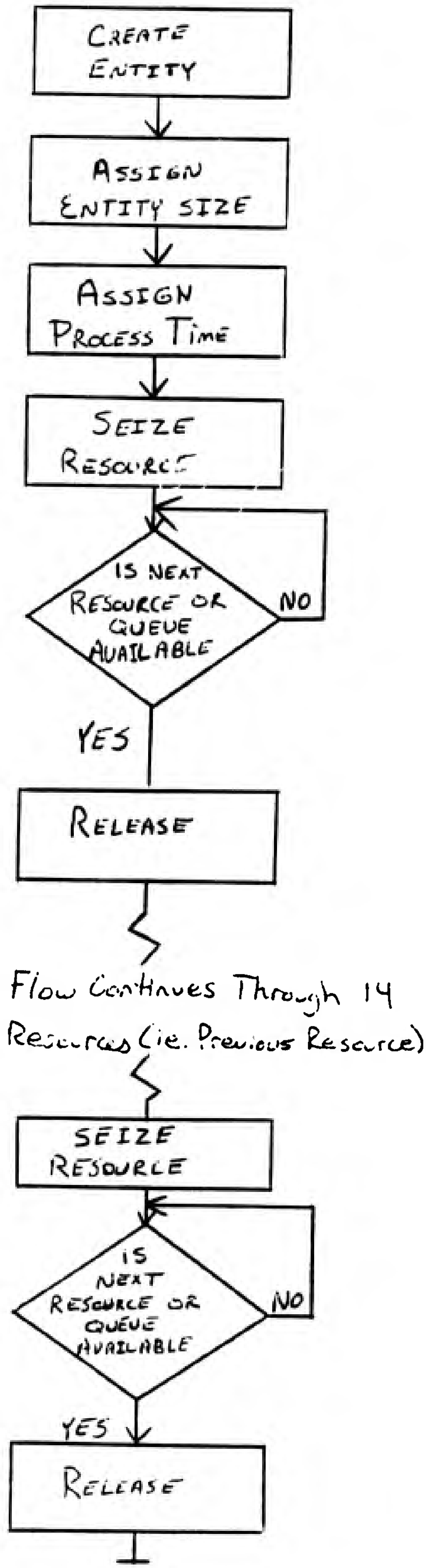
Usher, John, Clesielski, C.A. and Johanson, Ralph, "Redesigning an Existing Layout Presents A Major Challenge - And Produces Dramatic Results," Industrial Engineering, June 1990, 45-50

Velury, Jayadev and Kennedy, W.J., "A systematic procedure for the selection of bulk material handling equipment," International Journal of Production Economics, Volume 27, No. 3, October 1992, 233-240

APPENDICES

APPENDIX 1

SIMAN Simulation Flow Diagram, Model and Experimental Frame: Present Layout Flow


CREATE ENTITY
ASSIGN ENTITY SIZE
ASSIGN PROCESS TIME
SEIZE RESOURCE
IS NEXT RESOURCE OR QUEUE AVAILABLE
NO
YES
RELEASE
Flow Continues Through 14 Resources (ie. Previous Resource)
SEIZE RESOURCE
IS NEXT RESOURCE OR QUEUE AVAILABLE
NO
YES
RELEASE

```
BEGIN;
        CREATE:           6,5:
                          MARK(TIMEIN);
        ASSIGN:           I=1:
                          NEXT(ATTRIBUTE);
        CREATE,           ,30:
                          3.3_ 9:
                          MARK(TIMEIN);
        ASSIGN:           I=2:
                          NEXT(ATTRIBUTE);
        CREATE,           ,60:
                          2.73,11:
                          MARK(TIMEIN);
        ASSIGN:           I=3:
                          NEXT(ATTRIBUTE);
        CREATE,           ,90:
                          2,15:
                          MARK(TIMEIN);
        ASSIGN:           I=4:
                          NEXT(ATTRIBUTE);
        CREATE,           ,120:
                          2,15:
                          MARK(TIMEIN);
        ASSIGN:           I=5:
                          NEXT(ATTRIBUTE);
        CREATE,           ,150:
                          1.67,18:
                          MARK(TIMEIN);
        ASSIGN:           I=6:
                          NEXT(ATTRIBUTE);
        CREATE,           ,180:
                          1.57,18:
                          MARK(TIMEIN);
        ASSIGN:           I=7:
                          NEXT(ATTRIBUTE);
        CREATE,           ,210:
                          2.31,13:
                          MARK(TIMEIN);
        ASSIGN:           I=8:
                          NEXT(ATTRIBUTE);
        CREATE,           ,240:
                          2,15:
                          MARK(TIMEIN);
        ASSIGN:           I=9:
                          NEXT(ATTRIBUTE);
        CREATE,           ,270:
                          2.31 13:
                          MARK(TIMEIN);
        ASSIGN:           I=10:
                          NEXT(ATTRIBUTE);
        CREATE,           ,300:
                          2.00,15:
                          MARK(TIMEIN);
        ASSIGN:           I=11:
                          NEXT(ATTRIBUTE);

                   CREATE,          ,330:
                                    2.14,14:
                                    MARK(TIMEIN);
                   ASSIGN:          I=12:
                                    NEXT(ATTRIBUTE);
                   CREATE,          ,360:
                                    3.33,9:
                                    MARK(TIMEIN);
                   ASSIGN:          I=13;
         ATTRIBUTE ASSIGN:          X(I)=DP(I,1);            !DETERMINE # UNITS REQD
                   BRANCH,          1:
                                    IF,X(I).EQ.50,B1:
                                    IF,X(I).EQ.100,E2:
                                    IF,X(I).EQ.150,B3:
                                    IF,X(I).EQ.200,B4:
                                    IF,X(I).EQ.250,B5:
                                    ELSE,ATTRIBUTE;
B1                 ASSIGN:          A(2)=LOGN(0.264,1.38):   !A(2)-TIME TO PROCESS PRODUCE
                                    A(3)=LOGN(0.345,2.10):   !A(2) - TIME TO PROCESS PRODUCE
                                    HOST=5:                  !A(3)-TIME TO PROCESS DRY&FROZE
                                    MARK(hsize5):
                                    NEXT(POTATOS);
B2                 ASSIGN:          A(2)=LOGN(0.287,1.12):   !A(2) - TIME TO PROCESS PRODUCE
                                    A(3)=LOGN(0.422,2.42):   !A(3)-TIME TO PROCESS DRY&FROZE
                                    HOST=10:
                                    MARK(hsize10):
                                    NEXT(POTATOS);
E3                 ASSIGN:          A(2)=LOGN(0.355,1.12):   !A(2) - TIME TO PROCESS PRODUCE
                                    A(3)=LOGN(0.458,1.65):   !A(3)-TIME TO PROCESS DRY&FROZE
                                    HOST=15:
                                    MARK(hsize15):
                                    NEXT(POTATOS);
B4                 ASSIGN:          A(2)=LOGN(0.363,.316):   !A(2) - TIME TO PROCESS PRODUCE
                                    A(3)=LOGN(0.689,1.63):   !A(3)-TIME TO PROCESS DRY&FROZE
                                    HOST=20:
                                    MARK(hsize20):
                                    NEXT(POTATOS);
B5                 ASSIGN:          A(2)=0.342:              !A(2) - TIME TO PROCESS PRODUCE
                                    A(3)=0.837:              !A(3)-TIME TO PROCESS DRY&FROZE
                                    HOST=25:
                                    MARK(hsize25);
POTATOS            QUEUE,           1;                       QUEUE FOR POTATOES
                   SEIZE:           POTATO;
                   DELAY:           A(2);
                   BRANCH,          1:
                                    IF,NQ(3).LT.2,RELPOTATO:
                                    ELSE,HOLDPOT;
HOLDPOT            QUEUE,           2,1;
                   WAIT:            1,1;
PELPOTATO          PELEASE:         POTATO;                  HOLC  OTATO RESOURCE
```

```
ONIONS      QUEUE,          3,2;                                QUEUE FOR ONIONS
            SEIZE:          ONION;
            SIGNAL:         1,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(5).LT.2,RELONION:
                            ELSE,HOLDONION;
HOLDONION QUEUE,            4,1;
            WAIT:           2,1;
RELONION RELEASE:           ONION;                              HOLD ONION RESOURCE
PEPPERS     QUEUE,          5,2;
            SEIZE:          PEPPER;                             QUEUE FOR PEPPERS
            SIGNAL:         2,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(7).LT.1,RELPEPPER:
                            ELSE,HOLDPEPPER;
HOLDPEPPER QUEUE,           6,1;
            WAIT:           3,1;
RELPEPPER RELEASE:          PEPPER;                             HOLD PEPPER RESOURCE
CUCUMBERS QUEUE,            7,1;
            SEIZE:          CUCUMBER;                           QUEUE FOR CUCUMBER
            SIGNAL:         3,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(9).LT.1,RELCUC:
                            ELSE,HOLDCUC;
HOLDCUC     QUEUE,          8,1;
            WAIT:           4,1;
RELCUC      RELEASE:        CUCUMBER;
TOMATOS     QUEUE,          9,1;
            SEIZE:          TOMATO;
            SIGNAL:         4,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(11).LT.1,RELTOMATO:
                            ELSE,HOLDTOMATO;
HOLDTOMATO QUEUE,           10,1;
            WAIT:           5,1;
RELTOMATO RELEASE:          TOMATO;
PEACHS      QUEUE,          11,1;
            SEIZE:          PEACH;
            SIGNAL:         5,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(13).LT.1,RELPEACH:
                            ELSE,HOLDPEACH;
HOLDPEACH QUEUE,            12,1;
            WAIT:           6,1;
RELPEACH RELEASE:           PEACH;
```

```
NECTOS      QUEUE,          13,1;
            SEIZE:          NECTO;
            SIGNAL:         6,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(15).LT.1,RELNECTOS:
                            ELSE,HOLDNECTOS;
HOLDNECTOS QUEUE,           14,1;
            WAIT:           7,1;
RELNECTOS RELEASE:          NECTO;
LIMES       QUEUE,          15,1;
            SEIZE:          LIME;
            SIGNAL:         7,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(17).LT.1,RELLIME:
                            ELSE,HOLDLIME;
HOLDLIME    QUEUE,          16,1;
            WAIT:           8,1;
RELLIME     RELEASE:        LIME;
APPLES      QUEUE,          17,1;
            SEIZE:          APPLE;
            SIGNAL:         8,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(19).LT.1,RELAPPLE:
                            ELSE,HOLDAPPLE;
HOLDAPPLE QUEUE,            18,1;
            WAIT:           9,1;
RELAPPLE RELEASE:           APPLE;
FISHS       QUEUE,          19,1;
            SEIZE:          FISH;
            SIGNAL:         9,1;
            DELAY:          A(3);
            BRANCH,         1:
                            IF,NQ(21).LT.1,RELFISH:
                            ELSE,HOLDFISH;
HOLDFISH    QUEUE,          20,1;
            WAIT:           10,1;
RELFISH     RELEASE:        FISH;
BUTTERS     QUEUE,          21,1;
            SEIZE:          BUTTER;
            SIGNAL:         10,1;
            DELAY:          A(2);
            BRANCH,         1:
                            IF,NQ(23).LT.3,RELBUTTER:
                            ELSE,HOLDBUTTER;
HOLDBUTTER QUEUE,           22,1;
            WAIT:           11,1;
RELBUTTER RELEASE:          BUTTER;
CHICKENS QUEUE,             23,3;
            SEIZE:          CHICKEN;
            SIGNAL:         11,1;
            DELAY:          A(3);
```

```
          BRANCH,          1:
                           IF,NR(GNDTKY).LT.2,
                           RELCHICKEN:
                           ELSE,HOLDCHICKEN;
HOLDCHICKEN QUEUE,         24,2;
          WAIT:            12,1;
RELCHICKEN RELEASE:        CHICKEN;
          SEIZE:           GNDTKY;
          DELAY:           A(3);
          BRANCH,          1:
                           IF,NR(TKYHAM).LT.2,
                           RELGNDTKYS:
                           ELSE,HOLDGNDTKY;
HOLDGNDTKY QUEUE,          26,2;
          WAIT:            13,1;
RELGNDTKYS RELEASE:        GNDTKY;
          SIGNAL:          12,1;
          SEIZE:           TKYHAM;
          DELAY:           A(3);
          BRANCH,          1:
                           IF,NR(CEREAL).LT.2,RELTKYHAM:
                           ELSE,HOLDTKYHAM;
HOLDTKYHAM QUEUE,          28,2;
          WAIT:            14,1;
RELTKYHAM RELEASE:         TKYHAM;
          SIGNAL:          13,1;
          SEIZE:           CEREAL;
          DELAY:           A(3);
          BRANCH,          1:
                           IF,NR(NOODLE).LT.2,RELCEREAL:
                           ELSE,HOLDCEREAL;
HOLDCEREAL QUEUE,          30,2;
          WAIT:            15,1;
RELCEREAL RELEASE:         CEREAL;
          SIGNAL:          14,1;
          SEIZE:           NOODLE;
          DELAY:           A(3);
          RELEASE:         NOODLE;
          SIGNAL:          15,1;
          TALLY:           FLOWTIME,INT(TIMEIN);
          BRANCH,          1:
                           IF,HOST.EQ.5,T2:
                           IF,HOST.EQ.10,T3:
                           IF,HOST.EQ.15,T4:
                           IF,HOST.EQ.20,T5:
                           IF,HOST.EQ.25,T6;
T2        TALLY:           2,INT(hsize5):
                           DISPOSE;
T3        TALLY:           3,INT(HSIZE10):
                           DISPOSE;
T4        TALLY:           4,INT(HSIZE15):
                           DISPOSE;
T5        TALLY:           5,INT(HSIZE20):
                           DISPOSE;
T6        TALLY:           6,INT(HSIZE25):
                           DISPOSE;
END;
```

```
BEGIN;
PROJECT,        THESIS,Paul Bernasconi;                    PRESENT LAYOUT
ATTRIBUTES:                                                !A(1), A(2), I
                1,I:
                2,TIMEPROD:                                !TIME FOR PRODUCE
                3,TIMEFROZ:                                !TIME FOR FROZEN/DRY
                4,TIMEIN:
                5,HSIZE5:
                6,HSIZE10:
                7,HSIZE15:
                8,HSIZE20:
                9,HSIZE25:
                10,HOST;
DISCRETE,       600,,32;
PARAMETERS:     1,.2,50,.6,100,.8,200,1,250:
                2,.44,50,.55,100,.88,150,1,250:
                3,.09,50,.454,100,.818,150,.908,
                200,1,250:
                4,.33,50,.8,100,.93,150,1,200:
                5,.4,50,.67,100,.8,150,1,200:
                6,.5,50,.72,100,.89,150,1,200:
                7,.5,50,.83,100,.89,150,.94,200,1,
                250:
                8,.23,50,.77,100,1,150:
                9,.2,50,.8,100,.87,150,1,200:
                10,.23,50,.77,100,.92,150,1,200:
                11,.53,50,.86,100,1,150:
                12,.43,50,.79,100,.86,150,1,250:
                13,.78,50,1,100;
QUEUES:         1,POTATOS:
                2,HOLDPOT:
                3,ONIONS:
                4,HOLDONION:
                5,PEPPERS:
                6,HOLDPEPPER:
                7,CUCUMBERS:
                8,HOLDCUC:
                9,TOMATOS:
                10,HOLDTOMATO:
                11,PEACHS:
                12,HOLDPEACH:
                13,NECTOS:
                14,HOLDNECTOS:
                15,LIMES:
                16,HOLDLIME:
                17,APPLES:
                18,HOLDAPPLE:
                19,FISHS:
                20,HOLDFISH:
                21,BUTTERS:
                22,HOLDBUTTER:
                23,CHICKENS:
                24,HOLDCHICKEN:
                26,HOLDGNDTKY:
                28,HOLDTKYHAM:
                30,HOLDCEREAL:
                32,HOLDNOODLE;
RESOURCES:      POTATO,1:
                ONION,1:
                PEPPER,1:
                CUCUMBER,1:
                TOMATO,1:
                PEACH,1:
                NECTO,1:
                LIME,1:
                APPLE,1:
                FISH,1:
                BUTTER,1:
                CHICKEN,2:
                GNDTKY,2:
                TKYHAM,2:
                CEREAL,2:
                NOODLE,2;
SEEDS:          1,1;
TALLIES:        1,FLOWTIME,:
                2,HOST SIZE 50,:
                3,HOST SIZE 100,:
                4,HOST SIZE 150,:
                5,HOST SIZE 200,:
                6,HOST SIZE 250,;
DSTATS:         1,NQ(POTATOS),POT:
                2,NQ(HOLDPOT),HOLDPOTa:
                3,NQ(ONIONS),ONI:
                4,NQ(HOLDONION),HOLDONI:
                5,NQ(PEPPERS),PEP:
                6,NQ(HOLDPEPPER),HOLDPEP:
                7,NQ(CUCUMBERS),CUC:
                8,NQ(HOLDCUC),HOLDCUCU:
                9,NQ(TOMATOS),TOM:
                10,NQ(HOLDTOMATO),HOLDTOM:
                11,NQ(PEACHS),PEAC:
                12,NQ(HOLDPEACH),HOLDPEA:
                13,NQ(NECTOS),NECT:
                14,NQ(HOLDNECTOS),HOLDNEC:
                15,NQ(LIMES),LIM:
                16,NQ(HOLDLIME),HOLDLIM:
                17,NQ(APPLES),APPL:
                18,NQ(HOLDAPPLE),HOLDAPP:
                19,NQ(FISHS),FIS:
                20,NQ(HOLDFISH),HOLDFIS:
                21,NQ(BUTTERS),BUTT:
                22,NQ(HOLDBUTTER),HOLDBUTT:
                23,NQ(CHICKENS),CHICK:
                24,NQ(HOLDCHICKEN),HOLDCHICK:
                26,NQ(HOLDGNDTKY),HOLDGNDTK:
                28,NQ(HOLDTKYHAM),HOLDTKYHM:
                30,NQ(HOLDCEREAL),HOLDCERE:
                32,NQ(HOLDNOODLE),HOLDNOODL;
REPLICATE,      20;
END;
```

APPENDIX 2

SIMAN Simulation Model and Experimental Frame: Proposed Layout Flow

```
BEGIN;
          CREATE:          6,5:
                           MARK(TIMEIN);
          ASSIGN:          I=1:
                           NEXT(ATTRIBUTE);
          CREATE,          ,30:
                           3.33,9:
                           MARK(TIMEIN);
          ASSIGN:          I=2:
                           NEXT(ATTRIBUTE);
          CREATE,          ,60:
                           2.73,11:
                           MARK(TIMEIN);
          ASSIGN:          I=3:
                           NEXT(ATTRIBUTE);
          CREATE,          ,90:
                           2,15:
                           MARK(TIMEIN);
          ASSIGN:          I=4:
                           NEXT(ATTRIBUTE);
          CREATE,          ,120:
                           2,15:
                           MARK(TIMEIN);
          ASSIGN:          I=5:
                           NEXT(ATTRIBUTE);
          CREATE,          ,150:
                           1.67,18:
                           MARK(TIMEIN);
          ASSIGN:          I=6:
                           NEXT(ATTRIBUTE);
          CREATE,          ,180:
                           1.67,19:
                           MARK(TIMEIN);
          ASSIGN:          I=7:
                           NEXT(ATTRIBUTE);
          CREATE,          ,210:
                           2.31,13:
                           MARK(TIMEIN);
          ASSIGN:          I=8:
                           NEXT(ATTRIBUTE);
          CREATE,          ,240:
                           2,15:
                           MARK(TIMEIN);
          ASSIGN:          I=9:
                           NEXT(ATTRIBUTE);
          CREATE,          ,270:
                           2.31,13:
                           MARK(TIMEIN);
          ASSIGN:          I=10:
                           NEXT(ATTRIBUTE);
          CREATE,          ,300:
                           2.00,15:
                           MARK(TIMEIN);
          ASSIGN:          I=11:
                           NEXT(ATTRIBUTE);

          CREATE,          ,330:
                           2.14,14:
                           MARK(TIMEIN);
          ASSIGN:          I=12:
                           NEXT(ATTRIBUTE);
          CREATE,          ,360:
                           3.33,9:
                           MARK(TIMEIN);
          ASSIGN:          I=13;
ATTRIBUTE ASSIGN:          X(I)=DP(I,1);                    !DETERMINE # UNITS REQD
          BRANCH,          1:
                           IF,X(I).EQ.50,B1:
                           IF,X(I).EQ.100,B2:
                           IF,X(I).EQ.150,B3:
                           IF,X(I).EQ.200,B4:
                           IF,X(I).EQ.250,B5:
                           ELSE,ATTRIBUTE;
B1        ASSIGN:          A(2)=LOGN(0.264,1.38):           !A(2)-TIME TO PROCESS PRODUCE
                           A(3)=LOGN(0.345,2.10):           !A(2) - TIME TO PROCESS PRODUCE
                           HOST=5:                          !A(3)-TIME TO PROCESS DRY&FROZE
                           MARK(hsize5):
                           NEXT(CEREALS);
B2        ASSIGN:          A(2)=LOGN(0.287,1.12):           !A(2) - TIME TO PROCESS PRODUCE
                           A(3)=LOGN(0.422,2.42):           !A(3)-TIME TO PROCESS DRY&FROZE
                           HOST=10:
                           MARK(hsize10):
                           NEXT(CEREALS);
B3        ASSIGN:          A(2)=LOGN(0.355,1.12):           !A(2) - TIME TO PROCESS PRODUCE
                           A(3)=LOGN(0.458,1.65):           !A(3)-TIME TO PROCESS DRY&FROZE
                           HOST=15:
                           MARK(hsize15):
                           NEXT(CEREALS);
B4        ASSIGN:          A(2)=LOGN(0.363,.316):           !A(2) - TIME TO PROCESS PRODUCE
                           A(3)=LOGN(0.689,1.63):           !A(3)-TIME TO PROCESS DRY&FROZE
                           HOST=20:
                           MARK(hsize20):
                           NEXT(CEREALS);
B5        ASSIGN:          A(2)=0.342:                      !A(2) - TIME TO PROCESS PRODUCE
                           A(3)=0.837:                      !A(3)-TIME TO PROCESS DRY&FROZE
                           HOST=25:
                           MARK(hsize25);
CEREALS   QUEUE,           29,100;
          SEIZE:           CEREAL;
          DELAY:           A(3);
          BRANCH,          1:
                           IF,NQ(31).LT.1,RELCEREAL:
                           ELSE,HOLDCEREAL;
HOLDCEREAL QUEUE,          30,2;
          WAIT:            15,1;
RELCEREAL RELEASE:         CEREAL;
```

```
NOODLES   QUEUE,          31,1;
          SEIZE:          NOODLE;
          SIGNAL:         15,1;
          DELAY:          A(3);
          BRANCH,         1:
                          IF,NQ(23).LT.3,RELNOODLE:
                          ELSE,HOLDNOODLE;
HOLDNOODLE QUEUE,         32,2;
          WAIT:           16,1;
RELNOODLE RELEASE:        NOODLE;
CHICKENS  QUEUE,          23,3;
          SEIZE:          CHICKEN;
          SIGNAL:         16,1;
          DELAY:          A(3);
          BRANCH,         1:
                          IF,NR(GNDTKY).LT.1,
                          RELCHICKEN:
                          ELSE,HOLDCHICKEN;
HOLDCHICKEN QUEUE,        24,2;
          WAIT:           12,1;
RELCHICKEN RELEASE:       CHICKEN;
          SEIZE:          GNDTKY;
          DELAY:          A(3);
          BRANCH,         1:
                          IF,NR(TKYHAM).LT.1,
                          RELGNDTKYS:
                          ELSE,HOLDGNDTKY;
HOLDGNDTKY QUEUE,         26,2;
          WAIT:           13,1;
RELGNDTKYS RELEASE:       GNDTKY;
          SIGNAL:         12,1;
          SEIZE:          TKYHAM;
          DELAY:          A(3);
          BRANCH,         1:
                          IF,NQ(21).LT.3,RELTKYHAM:
                          ELSE,HOLDTKYHAM;
HOLDTKYHAM QUEUE,         28,2;
          WAIT:           14,1;
RELTKYHAM RELEASE:        TKYHAM;
          SIGNAL:         13,1;
BUTTERS   QUEUE,          21,3;
          SEIZE:          BUTTER;
          SIGNAL:         14,1;
          DELAY:          A(2);
          BRANCH,         1:
                          IF,NQ(19).LT.1,RELBUTTER:
                          ELSE,HOLDBUTTER;
HOLDBUTTER QUEUE,         22,1;
          WAIT:           11,1;
RELBUTTER RELEASE:        BUTTER;
```

```
FISHS     QUEUE,          19,1;
          SEIZE:          FISH;
          SIGNAL:         11,1;
          DELAY:          A(3);
          BRANCH,         1:
                          IF,NQ(17).LT 2,RELFISH:
                          ELSE,HOLDFISH.
HOLDFISH  QUEUE,          20,1;
          WAIT:           10,1;
RELFISH   RELEASE:        FISH;
APPLES    QUEUE,          17,2;
          SEIZE:          APPLE;
          SIGNAL:         10,1;
          DELAY:          A(2);
          BRANCH,         1:
                          IF,NQ(1).LT.2,RELAPPLE:
                          ELSE,HOLDAPPLE;
HOLDAPPLE QUEUE,          18,1;
          WAIT:           9,1;
RELAPPLE  RELEASE:        APPLE;
FOTATOS   QUEUE,          1,2;
          SEIZE:          POTATO;                 QUEUE FOR POTATOES
          SIGNAL:         9,1;
          DELAY:          A(2);
          BRANCH,         1:
                          IF,NQ(3).LT.2,RELPOTATO:
                          ELSE,HOLDPOT;
HOLDPOT   QUEUE,          2,1;
          WAIT:           1,1;
RELPOTATO RELEASE:        POTATO;                 HOLD POTATO RESOURCE
ONIONS    QUEUE,          3,2;
          SEIZE:          ONION;                  QUEUE FOR ONIONS
          SIGNAL:         1,1;
          DELAY:          A(2);
          BRANCH,         1:
                          IF,NQ(5).LT.2,RELONION:
                          ELSE,HOLDONION;
HOLDONION QUEUE,          4,1;
          WAIT:           2,1;
RELONION  RELEASE:        ONION;                  HOLD ONION RESOURCE
PEPPERS   QUEUE,          5,2;
          SEIZE:          PEPPER;                 QUEUE FOR PEPPERS
          SIGNAL:         2,1;
          DELAY:          A(2);
          BRANCH,         1:
                          IF,NQ(7).LT.1,RELPEPPER:
                          ELSE,HOLDPEPPER;
HOLDPEPPER QUEUE,         6,1;
          WAIT:           3,1;
RELPEPPER RELEASE:        PEPPER;                 HOLD PEPPER RESOURCE
```

```
CUCUMBERS QUEUE,        7,1;                     QUEUE FOR CUCUMBER
          SEIZE:        CUCUMBER;
          SIGNAL:       3,1;
          DELAY:        A(2);
          BRANCH,       1:
                        IF,NQ(9).LT.1,RELCUC:
                        ELSE,HOLDCUC;
HOLDCUC   QUEUE,        8,1;
          WAIT:         4,1;
RELCUC    RELEASE:      CUCUMBER;
TOMATOS   QUEUE,        9,1;
          SEIZE:        TOMATO;
          SIGNAL:       4,1;
          DELAY:        A(2);
          BRANCH,       1:
                        IF,NQ(11).LT.1,RELTOMATO:
                        ELSE,HOLDTOMATO;
HOLDTOMATO QUEUE,       10,1;
          WAIT:         5,1;
RELTOMATO RELEASE:      TOMATO;
PEACHS    QUEUE,        11,1;
          SEIZE:        PEACH;
          SIGNAL:       5,1;
          DELAY:        A(2);
          BRANCH,       1:
                        IF,NQ(13).LT.1,RELPEACH:
                        ELSE,HOLDPEACH;
HOLDPEACH QUEUE,        12,1;
          WAIT:         6,1;
RELPEACH  RELEASE:      PEACH;
NECTOS    QUEUE,        13,1;
          SEIZE:        NECTO;
          SIGNAL:       6,1;
          DELAY:        A(2);
          BRANCH,       1:
                        IF,NQ(15).LT.1,RELNECTOS:
                        ELSE,HOLDNECTOS;
HOLDNECTOS QUEUE,       14,1;
          WAIT:         7,1;
RELNECTOS RELEASE:      NECTO;

LIMES     QUEUE,        15,1;
          SEIZE:        LIME;
          SIGNAL:       7,1;
          DELAY:        A(2);
RELLIME   RELEASE:      LIME;
          TALLY:        FLOWTIME,INT(TIMEIN);
          BRANCH,       1:
                        IF,HOST.EQ.5,T2:
                        IF,HOST.EQ.10,T3:
                        IF,HOST.EQ.15,T4:
                        IF,HOST.EQ.20,T5:
                        IF,HOST.EQ.25,T6;
T2        TALLY:        2,INT(hsize5):
                        DISPOSE;
T3        TALLY:        3,INT(HSIZE10):
                        DISPOSE;
T4        TALLY:        4,INT(HSIZE15):
                        DISPOSE;
T5        TALLY:        5,INT(HSIZE20):
                        DISPOSE;
T6        TALLY:        6,INT(HSIZE25):
                        DISPOSE;
END;
```

```
BEGIN;
PROJECT,          THESIS,PAUL BERNASCONI;            PROPOSED LAYOUT
ATTRIBUTES:                                          !A(1), A(2), I
                  1,I:
                  2,TIMEPROD:                        !TIME FOR PRODUCE
                  3,TIMEFROZ:                        !TIME FOR FROZEN/DRY
                  4,TIMEIN:
                  5,HSIZE5:
                  6,HSIZE10:
                  7,HSIZE15:
                  8,HSIZE20:
                  9,HSIZE25:
                  10,HOST;
DISCRETE,         600,,32;
PARAMETERS:       1,.2,50,.6,100,.8,200,1,250:
                  2,.44,50,.55,100,.88,150,1,250:
                  3,.09,50,.454,100,.818,150,.908,
                  200,1,250:
                  4,.33,50,.8,100,.93,150,1,200:
                  5,.4,50,.67,100,.8,150,1,200:
                  6,.5,50,.72,100,.89,150,1,200:
                  7,.5,50,.83,100,.89,150,.94,200,1,
                  250:
                  8,.23,50,.77,100,1,150:
                  9,.2,50,.8,100,.87,150,1,200:
                  10,.23,50,.77,100,.92,150,1,200:
                  11,.53,50,.86,100,1,150:
                  12,.43,50,.79,100,.86,150,1,250:
                  13,.78,50,1,100;
QUEUES:           POTATOS:
                  HOLDPOT:
                  ONIONS:
                  HOLDONION:
                  PEPPERS:
                  HOLDPEPPER:
                  CUCUMBERS:
                  HOLDCUC:
                  TOMATOS:
                  HOLDTOMATO:
                  PEACHS:
                  HOLDPEACH:
                  NECTOS:
                  HOLDNECTOS:
                  LIMES:
                  HOLDLIME:
                  APPLES:
                  HOLDAPPLE:
                  FISHS:
                  HOLDFISH:
                  BUTTERS:
                  HOLDBUTTER:
                  CHICKENS:
                  HOLDCHICKEN:
                  HOLDGNDTKY:
                  HOLDTKYHAM:
                  CEREALS:
                  HOLDCEREAL:
                  NOODLES:
                  HOLDNOODLE;
```

```
RESOURCES:        POTATO,1:
                  ONION,1:
                  PEPPER,1:
                  CUCUMBER,1:
                  TOMATO,1:
                  PEACH,1:
                  NECTO,1:
                  LIME,1:
                  APPLE,1:
                  FISH,1:
                  BUTTER,1:
                  CHICKEN,1:
                  GNDTKY,1:
                  TKYHAM,1:
                  CEREAL,2:
                  NOODLE,2;
SEEDS:            1,1;
TALLIES:          1,FLOWTIME:
                  2,HOST SIZE 50:
                  3,HOST SIZE 100:
                  4,HOST SIZE 150:
                  5,HOST SIZE 200:
                  6,HOST SIZE 250;
DSTATS:           1,NQ(CEREALS),CERE:
                  2,NQ(HOLDCEREAL),HOLDCERE:
                  3,NQ(NOODLES),NOODL:
                  4,NQ(HOLDNOODLE),HOLDNOODL:
                  5,NQ(CHICKENS),CHICK:
                  6,NQ(HOLDCHICKEN),HOLDCHICK:
                  7,NQ(HOLDGNDTKY),HOLDGNDTK:
                  8,NQ(HOLDTKYHAM),HOLDTKYHM:
                  9,NQ(BUTTERS),BUTT:
                  10,NQ(HOLDBUTTER),HOLDBUTT:
                  11,NQ(FISHS),FIS:
                  12,NQ(HOLDFISH),HOLDFIS:
                  13,NQ(APPLES),APPL:
                  14,NQ(HOLDAPPLE),HOLDAPP:
                  15,NQ(POTATOS),POT:
                  16,NQ(HOLDPOT),HOLDPOTa:
                  17,NQ(ONIONS),ONI:
                  18,NQ(HOLDONION),HOLDONI:
                  19,NQ(PEPPERS),PEP:
                  20,NQ(HOLDPEPPER),HOLDPEP:
                  21,NQ(CUCUMBERS),CUC:
                  22,NQ(HOLDCUC),HOLDCUCU:
                  23,NQ(TOMATOS),TOM:
                  24,NQ(HOLDTOMATO),HOLDTOM:
                  25,NQ(PEACHS),PEAC:
                  26,NQ(HOLDPEACH),HOLDPEA:
                  27,NQ(NECTOS),NECT:
                  28,NQ(HOLDNECTOS),HOLDNEC:
                  29,NQ(LIMES),LIM;
REPLICATE,        30;
END;
```

APPENDIX 3

SIMAN Simulation Output: Present Layout Flow

Summary for Replication 3 of 10

oject: THESIS
nalyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

plication ended at time : 388.645

TALLY VARIABLES

dentifier	Average	Variation	Minimum	Maximum	Observations
LOWTIME	9.3328	.96655	.17169	40.772	170
OST SIZE 50	10.102	1.0194	.17169	36.487	66
OST SIZE 100	7.9598	.95460	.23416	32.573	67
OST SIZE 150	9.0588	.72238	.38947	27.078	23
OST SIZE 200	13.896	.94046	2.6488	40.772	11
OST SIZE 250	8.4420	.10436E-05	8.4420	8.4420	3

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
OT	.00884	10.781	.00000	2.0000	.00000
OLDPOTa	.00647	12.392	.00000	1.0000	.00000
NI	.15092	3.3039	.00000	2.0000	.00000
OLDONI	.07282	3.5684	.00000	1.0000	.00000
EP	.24870	2.5659	.00000	2.0000	.00000
OLDPEP	.12247	2.6768	.00000	1.0000	.00000
UC	.15988	2.2923	.00000	1.0000	.00000
OLDCUCU	.11879	2.7236	.00000	1.0000	.00000
OM	.15686	2.3184	.00000	1.0000	.00000
OLDTOM	.11522	2.7711	.00000	1.0000	.00000
EAC	.15147	2.3668	.00000	1.0000	.00000
OLDPEA	.10478	2.9230	.00000	1.0000	.00000
ECT	.14497	2.4286	.00000	1.0000	.00000
OLDNEC	.09724	3.0470	.00000	1.0000	.00000
IM	.12451	2.6517	.00000	1.0000	.00000
OLDLIM	.07874	3.4205	.00000	1.0000	.00000
PPL	.11293	2.8016	.00000	1.0000	.00000
OLDAPP	.05320	4.2187	.00000	1.0000	.00000
IS	.08823	3.2146	.00000	1.0000	.00000
OLDFIS	.04010	4.8925	.00000	1.0000	.00000
UTT	.06442	3.8109	.00000	1.0000	.00000
OLDBUTT	.34154E-03	54.101	.00000	1.0000	.00000
HICK	.02274	9.9241	.00000	3.0000	.00000
OLDCHICK	.01082	12.487	.00000	2.0000	.00000
OLDGNDTK	.00864	13.557	.00000	2.0000	.00000
OLDTKYHM	.00361	19.254	.00000	2.0000	.00000
OLDCERE	.00119	28.925	.00000	1.0000	.00000
OLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 4 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 482.151

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	8.7944	1.7416	.18625	103.41	170
HOST SIZE 50	11.959	1.9180	.23688	103.41	67
HOST SIZE 100	6.9440	.93149	.18625	24.913	68
HOST SIZE 150	4.4577	.83180	.33498	13.798	20
HOST SIZE 200	5.8795	1.1129	1.2249	19.763	7
HOST SIZE 250	11.413	.47723	8.4420	21.962	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.02515	8.2021	.00000	3.0000	.00000
HOLDPOTa	.01938	7.1131	.00000	1.0000	.00000
ONI	.06064	5.2706	.00000	2.0000	.00000
HOLDONI	.02407	6.3674	.00000	1.0000	.00000
PEP	.12381	3.4727	.00000	2.0000	.00000
HOLDPEP	.05733	4.0551	.00000	1.0000	.00000
CUC	.10490	2.9210	.00000	1.0000	.00000
HOLDCUCU	.06713	3.7278	.00000	1.0000	.00000
TOM	.11733	2.7429	.00000	1.0000	.00000
HOLDTOM	.07623	3.4811	.00000	1.0000	.00000
PEAC	.12246	2.6770	.00000	1.0000	.00000
HOLDPEA	.07680	3.4671	.00000	1.0000	.00000
NECT	.11910	2.7197	.00000	1.0000	.00000
HOLDNEC	.07558	3.4973	.00000	1.0000	.00000
LIM	.11565	2.7653	.00000	1.0000	.00000
HOLDLIM	.06049	3.9409	.00000	1.0000	.00000
APPL	.08635	3.2528	.00000	1.0000	.00000
HOLDAPP	.03407	5.3248	.00000	1.0000	.00000
FIS	.07944	3.4041	.00000	1.0000	.00000
HOLDFIS	.03393	5.3357	.00000	1.0000	.00000
BUTT	.04897	4.4069	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.01512	10.640	.00000	3.0000	.00000
HOLDCHICK	.00461	18.138	.00000	2.0000	.00000
HOLDGNDTK	.00340	21.899	.00000	2.0000	.00000
HOLDTKYHM	.24131E-03	64.366	.00000	1.0000	.00000
HOLDCERE	.30163E-03	57.570	.00000	1.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 5 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 391.334

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	9.6659	1.1096	.07037	80.104	170
HOST SIZE 50	9.4879	1.0041	.07037	35.323	58
HOST SIZE 100	9.8861	1.3795	.17447	80.104	62
HOST SIZE 150	9.4769	.92178	.43695	30.275	32
HOST SIZE 200	9.3706	.65270	1.7580	19.670	10
HOST SIZE 250	10.374	.52684	8.4420	23.901	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.00839	10.874	.00000	1.0000	.00000
HOLDPOTa	.00174	23.980	.00000	1.0000	.00000
ONI	.05929	4.8540	.00000	2.0000	.00000
HOLDONI	.03261	5.4469	.00000	1.0000	.00000
PEP	.22098	2.6972	.00000	2.0000	.00000
HOLDPEP	.11026	2.8407	.00000	1.0000	.00000
CUC	.14448	2.4334	.00000	1.0000	.00000
HOLDCUCU	.12316	2.6683	.00000	1.0000	.00000
TOM	.15106	2.3706	.00000	1.0000	.00000
HOLDTOM	.11256	2.8078	.00000	1.0000	.00000
PEAC	.15272	2.3554	.00000	1.0000	.00000
HOLDPEA	.11063	2.8354	.00000	1.0000	.00000
NECT	.14696	2.4093	.00000	1.0000	.00000
HOLDNEC	.09994	3.0010	.00000	1.0000	.00000
LIM	.14661	2.4126	.00000	1.0000	.00000
HOLDLIM	.08728	3.2338	.00000	1.0000	.00000
APPL	.13523	2.5288	.00000	1.0000	.00000
HOLDAPP	.08192	3.3476	.00000	1.0000	.00000
FIS	.11355	2.7268	.00000	1.0000	.00000
HOLDFIS	.03859	4.9917	.00000	1.0000	.00000
BUTT	.06171	3.8993	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.00705	12.635	.00000	2.0000	.00000
HOLDCHICK	.00569	17.763	.00000	2.0000	.00000
HOLDGNDTK	.01269	11.046	.00000	2.0000	.00000
HOLDTKYHM	.01597	10.553	.00000	2.0000	.00000
HOLDCERE	.02307	9.1255	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 6 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 387.451

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	16.534	1.0348	.07730	112.97	170
HOST SIZE 50	16.981	.96750	.32336	59.134	61
HOST SIZE 100	15.580	.99108	.07730	56.714	71
HOST SIZE 150	21.120	1.2189	.21272	112.97	23
HOST SIZE 200	13.646	.90550	1.4094	27.269	7
HOST SIZE 250	10.938	.51287	8.4420	24.638	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.28805	2.3220	.00000	3.0000	.00000
HOLDPOTa	.18782	2.0795	.00000	1.0000	.00000
ONI	.50635	1.6898	.00000	2.0000	.00000
HOLDONI	.21050	1.9366	.00000	1.0000	.00000
PEP	.52300	1.6488	.00000	2.0000	.00000
HOLDPEP	.21983	1.8839	.00000	1.0000	.00000
CUC	.26166	1.6798	.00000	1.0000	.00000
HOLDCUCU	.20968	1.9414	.00000	1.0000	.00000
TOM	.25103	1.7273	.00000	1.0000	.00000
HOLDTOM	.20450	1.9723	.00000	1.0000	.00000
PEAC	.24375	1.7614	.00000	1.0000	.00000
HOLDPEA	.18612	2.0911	.00000	1.0000	.00000
NECT	.22864	1.8368	.00000	1.0000	.00000
HOLDNEC	.15432	2.3409	.00000	1.0000	.00000
LIM	.19115	2.0571	.00000	1.0000	.00000
HOLDLIM	.13519	2.5292	.00000	1.0000	.00000
APPL	.18518	2.0977	.00000	1.0000	.00000
HOLDAPP	.11735	2.7426	.00000	1.0000	.00000
FIS	.18314	2.1119	.00000	1.0000	.00000
HOLDFIS	.04301	4.7169	.00000	1.0000	.00000
BUTT	.07869	3.4218	.00000	1.0000	.00000
HOLDBUTT	.00273	19.128	.00000	1.0000	.00000
CHICK	.06022	5.9585	.00000	3.0000	.00000
HOLDCHICK	.02465	8.2238	.00000	2.0000	.00000
HOLDGNDTK	.00606	13.044	.00000	2.0000	.00000
HOLDTKYHM	.00535	15.199	.00000	2.0000	.00000
HOLDCERE	.00237	21.546	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 7 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 386.864

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	6.9960	1.2311	.07617	40.797	170
HOST SIZE 50	6.5426	1.3564	.07617	35.532	72
HOST SIZE 100	7.3262	1.3366	.23804	40.797	57
HOST SIZE 150	6.1368	.88925	.10675	16.491	26
HOST SIZE 200	7.4625	.48683	2.3631	14.265	10
HOST SIZE 250	13.297	.81643	8.4420	32.717	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.00489	14.271	.00000	1.0000	.00000
HOLDPOTa	.00451	14.861	.00000	1.0000	.00000
ONI	.07564	4.3403	.00000	2.0000	.00000
HOLDONI	.06555	3.7450	.00000	1.0000	.00000
PEP	.16498	3.2086	.00000	2.0000	.00000
HOLDPEP	.07106	3.6157	.00000	1.0000	.00000
CUC	.08871	3.2050	.00000	1.0000	.00000
HOLDCUCU	.07107	3.6153	.00000	1.0000	.00000
TOM	.08492	3.2826	.00000	1.0000	.00000
HOLDTOM	.06233	3.8787	.00000	1.0000	.00000
PEAC	.08405	3.3012	.00000	1.0000	.00000
HOLDPEA	.05877	4.0019	.00000	1.0000	.00000
NECT	.08405	3.3012	.00000	1.0000	.00000
HOLDNEC	.05646	4.0879	.00000	1.0000	.00000
LIM	.07667	3.4704	.00000	1.0000	.00000
HOLDLIM	.04405	4.6585	.00000	1.0000	.00000
APPL	.06757	3.7118	.00000	1.0000	.00000
HOLDAPP	.04420	4.6504	.00000	1.0000	.00000
FIS	.08542	3.2722	.00000	1.0000	.00000
HOLDFIS	.02302	6.5141	.00000	1.0000	.00000
BUTT	.03767	5.0541	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.01528	12.576	.00000	3.0000	.00000
HOLDCHICK	.00912	13.697	.00000	2.0000	.00000
HOLDGNDTK	.00178	31.364	.00000	2.0000	.00000
HOLDTKYHM	.00164	24.668	.00000	1.0000	.00000
HOLDCEFE	.00000	--	.00000	.00000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 8 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 387.265

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	14.538	1.4415	.09448	176.31	170
HOST SIZE 50	14.433	1.3469	.09448	63.069	65
HOST SIZE 100	12.735	1.2271	.21796	61.684	65
HOST SIZE 150	19.122	1.8776	.81384	176.31	23
HOST SIZE 200	15.307	1.2752	.66778	57.683	11
HOST SIZE 250	16.231	1.0755	8.4420	51.752	6

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.76816	2.9267	.00000	11.000	.00000
HOLDPOTa	.15715	2.3159	.00000	1.0000	.00000
ONI	.35349	2.1320	.00000	2.0000	.00000
HOLDONI	.15013	2.3793	.00000	1.0000	.00000
PEP	.35890	2.0948	.00000	2.0000	.00000
HOLDPEP	.14941	2.3860	.00000	1.0000	.00000
CUC	.18691	2.0857	.00000	1.0000	.00000
HOLDCUCU	.15655	2.3212	.00000	1.0000	.00000
TOM	.19268	2.0470	.00000	1.0000	.00000
HOLDTOM	.15588	2.3271	.00000	1.0000	.00000
PEAC	.19736	2.0166	.00000	1.0000	.00000
HOLDPEA	.15456	2.3388	.00000	1.0000	.00000
NECT	.20322	1.9801	.00000	1.0000	.00000
HOLDNEC	.15939	2.2965	.00000	1.0000	.00000
LIM	.19603	2.0251	.00000	1.0000	.00000
HOLDLIM	.15113	2.3700	.00000	1.0000	.00000
APPL	.18880	2.0728	.00000	1.0000	.00000
HOLDAPP	.13971	2.4815	.00000	1.0000	.00000
FIS	.16852	2.2213	.00000	1.0000	.00000
HOLDFIS	.04411	4.6551	.00000	1.0000	.00000
BUTT	.06639	3.7499	.00000	1.0000	.00000
HOLDBUTT	.01435	8.2891	.00000	1.0000	.00000
CHICK	.07733	5.7861	.00000	3.0000	.00000
HOLDCHICK	.00639	12.465	.00000	1.0000	.00000
HOLDGNDTK	.00772	15.007	.00000	2.0000	.00000
HOLDTKYHM	.00783	13.518	.00000	2.0000	.00000
HOLDCERE	.00315	20.974	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 9 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/1992
Model revision date: 3/ 6/1992

Replication ended at time : 390.473

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	5.9458	1.1889	.02667	57.976	170
HOST SIZE 50	4.4897	.98300	.02667	19.464	68
HOST SIZE 100	6.6518	1.3611	.05647	57.976	60
HOST SIZE 150	6.8433	1.2631	.44487	40.402	24
HOST SIZE 200	6.2326	.67720	2.3050	15.415	11
HOST SIZE 250	10.510	.31777	8.4420	16.359	7

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.00000	--	.00000	.00000	.00000
HOLDPOTa	.00000	--	.00000	.00000	.00000
ONI	.00702	11.896	.00000	1.0000	.00000
HOLDONI	.00000	--	.00000	.00000	.00000
PEP	.02172	6.3425	.00000	2.0000	.00000
HOLDPEP	.01021	9.8468	.00000	1.0000	.00000
CUC	.03766	5.0550	.00000	1.0000	.00000
HOLDCUCU	.01877	7.2312	.00000	1.0000	.00000
TOM	.04646	4.5305	.00000	1.0000	.00000
HOLDTOM	.02990	5.6965	.00000	1.0000	.00000
PEAC	.06124	3.9152	.00000	1.0000	.00000
HOLDPEA	.03914	4.9545	.00000	1.0000	.00000
NECT	.07269	3.5718	.00000	1.0000	.00000
HOLDNEC	.05212	4.2646	.00000	1.0000	.00000
LIM	.08814	3.2165	.00000	1.0000	.00000
HOLDLIM	.05719	4.0603	.00000	1.0000	.00000
APPL	.08493	3.2824	.00000	1.0000	.00000
HOLDAPP	.03993	3.9607	.00000	1.0000	.00000
FIS	.10283	2.9537	.00000	1.0000	.00000
HOLDFIS	.02725	5.9745	.00000	1.0000	.00000
BUTT	.04979	4.3688	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.01421	13.504	.00000	3.0000	.00000
HOLDCHICK	.23509E-03	65.212	.00000	1.0000	.00000
HOLDGNDTK	.44861E-04	149.30	.00000	1.0000	.00000
HOLDTKYHM	.54750E-03	45.294	.00000	1.0000	.00000
HOLDCERE	.61735E-03	40.235	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	1.0000	.00000
			.00000	.00000	.00000

Summary for Replication 10 of 10

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 6/19
Model revision date: 3/ 6/19

Replication ended at time : 447.468

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	12.105	1.4159	.02655	79.790	170
HOST SIZE 50	16.670	1.3387	.02655	79.790	63
HOST SIZE 100	7.2727	1.5483	.05518	57.837	64
HOST SIZE 150	9.9259	1.1567	1.2627	49.503	19
HOST SIZE 200	10.977	.66681	1.6335	23.746	18
HOST SIZE 250	26.302	.98816	8.4420	60.441	6

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.09301	3.5958	.00000	2.0000	.00000
HOLDPOTa	.06914	3.6693	.00000	1.0000	.00000
ONI	.21131	2.8712	.00000	2.0000	.00000
HOLDONI	.07682	3.4667	.00000	1.0000	.00000
PEP	.21937	2.6796	.00000	2.0000	.00000
HOLDPEP	.07840	3.4285	.00000	1.0000	.00000
CUC	.13661	2.5139	.00000	1.0000	.00000
HOLDCUCU	.08668	3.2459	.00000	1.0000	.00000
TOM	.13392	2.5431	.00000	1.0000	.00000
HOLDTOM	.09475	3.0909	.00000	1.0000	.00000
PEAC	.15001	2.3804	.00000	1.0000	.00000
HOLDPEA	.11053	2.8368	.00000	1.0000	.00000
NECT	.16058	2.2864	.00000	1.0000	.00000
HOLDNEC	.10783	2.8757	.00000	1.0000	.00000
LIM	.15324	2.3506	.00000	1.0000	.00000
HOLDLIM	.10327	2.9467	.00000	1.0000	.00000
APPL	.14673	2.4115	.00000	1.0000	.00000
HOLDAPP	.07676	3.4681	.00000	1.0000	.00000
FIS	.11266	2.8065	.00000	1.0000	.00000
HOLDFIS	.03010	5.6768	.00000	1.0000	.00000
BUTT	.06116	3.9180	.00000	1.0000	.00000
HOLDBUTT	.00212	21.705	.00000	1.0000	.00000
CHICK	.02834	8.9040	.00000	3.0000	.00000
HOLDCHICK	.00244	20.209	.00000	1.0000	.00000
HOLDGNDTK	.75761E-03	36.317	.00000	1.0000	.00000
HOLDTKYHM	.86513E-04	107.51	.00000	1.0000	.00000
HOLDCERE	.24218E-03	64.251	.00000	1.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Run Time: 4 min(s) 1 sec(s)
Simulation run complete.

Summary for Replication 11 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 387.29

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	9.1915	1.1765	.16187	58.506	170
HOST SIZE 50	5.1670	1.1737	.17419	30.392	56
HOST SIZE 100	10.336	1.1658	.16187	49.402	63
HOST SIZE 150	10.302	.89199	.39996	32.758	29
HOST SIZE 200	17.467	1.0472	1.4068	58.506	14
HOST SIZE 250	9.8410	.23253	8.4420	14.759	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.01020	10.943	.00000	2.0000	.00000
HOLDPOTa	.03006	5.6802	.00000	1.0000	.00000
ONI	.20238	2.8726	.00000	2.0000	.00000
HOLDONI	.09114	3.1579	.00000	1.0000	.00000
PEP	.24068	2.6395	.00000	2.0000	.00000
HOLDPEP	.10152	2.9750	.00000	1.0000	.00000
CUC	.13636	2.5167	.00000	1.0000	.00000
HOLDCUCU	.10522	2.9161	.00000	1.0000	.00000
TOM	.14632	2.4155	.00000	1.0000	.00000
HOLDTOM	.10490	2.9212	.00000	1.0000	.00000
PEAC	.15069	2.3741	.00000	1.0000	.00000
HOLDPEA	.10633	2.8990	.00000	1.0000	.00000
NECT	.14628	2.4158	.00000	1.0000	.00000
HOLDNEC	.09381	3.1080	.00000	1.0000	.00000
LIM	.13097	2.5759	.00000	1.0000	.00000
HOLDLIM	.08151	3.3568	.00000	1.0000	.00000
APPL	.10738	2.8831	.00000	1.0000	.00000
HOLDAPP	.05083	4.3211	.00000	1.0000	.00000
FIS	.09248	3.1326	.00000	1.0000	.00000
HOLDFIS	.03208	5.4932	.00000	1.0000	.00000
BUTT	.05575	4.1154	.00000	1.0000	.00000
HOLDBUTT	.40801E-03	49.196	.00000	1.0000	.00000
CHICK	.00780	15.927	.00000	3.0000	.00000
HOLDCHICK	.00473	15.978	.00000	2.0000	.00000
HOLDGNDTK	.00543	17.380	.00000	2.0000	.00000
HOLDTKYHM	.00539	15.559	.00000	2.0000	.00000
HOLDCERE	.00274	22.302	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 12 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/199
Model revision date: 3/ 5/199

Replication ended at time : 478.594

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	35.676	1.3607	.05933	141.68	170
HOST SIZE 50	42.481	1.2353	.05333	141.68	69
HOST SIZE 100	37.343	1.2636	.25842	137.89	59
HOST SIZE 150	20.263	1.5703	.21122	123.82	28
HOST SIZE 200	8.3034	.75931	2.3197	21.141	9
HOST SIZE 250	57.688	1.0169	8.4420	124.86	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	5.6217	1.5912	.00000	27.000	.00000
HOLDPOTa	.30355	1.5147	.00000	1.0000	.00000
ONI	.65755	1.4122	.00000	2.0000	.00000
HOLDONI	.28685	1.5768	.00000	1.0000	.00000
PEP	.65259	1.4171	.00000	2.0000	.00000
HOLDPEP	.29023	1.5538	.00000	1.0000	.00000
CUC	.32395	1.4446	.00000	1.0000	.00000
HOLDCUCU	.27578	1.6205	.00000	1.0000	.00000
TOM	.30991	1.4922	.00000	1.0000	.00000
HOLDTOM	.24784	1.7421	.00000	1.0000	.00000
PEAC	.28345	1.5900	.00000	1.0000	.00000
HOLDPEA	.22584	1.8515	.00000	1.0000	.00000
NECT	.25720	1.6994	.00000	1.0000	.00000
HOLDNEC	.19284	2.0459	.00000	1.0000	.00000
LIM	.21947	1.8859	.00000	1.0000	.00000
HOLDLIM	.14255	2.4526	.00000	1.0000	.00000
APPL	.16725	2.2314	.00000	1.0000	.00000
HOLDAPP	.09259	3.1306	.00000	1.0000	.00000
FIS	.11927	2.7174	.00000	1.0000	.00000
HOLDFIS	.05987	3.9627	.00000	1.0000	.00000
BUTT	.08359	3.3111	.00000	1.0000	.00000
HOLDBUTT	.01391	8.4201	.00000	1.0000	.00000
CHICK	.07209	6.0982	.00000	3.0000	.00000
HOLDCHICK	.03215	7.5162	.00000	2.0000	.00000
HOLDGNDTK	.00779	13.080	.00000	2.0000	.00000
HOLDTKYHM	.00315	22.606	.00000	2.0000	.00000
HOLDCERE	.00137	28.749	.00000	2.0000	.00000
HOLDNOCDL	.00000	--	.00000	.00000	.00000

Summary for Replication 13 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 916.054

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	220.34	1.0132	.19067	544.40	170
HOST SIZE 50	250.93	.93537	.19067	541.21	63
HOST SIZE 100	249.64	.94441	.25494	544.40	72
HOST SIZE 150	123.53	1.6242	1.5031	491.51	20
HOST SIZE 200	195.48	1.2479	2.9756	504.74	10
HOST SIZE 250	189.79	1.2905	8.4420	485.94	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	32.757	.90748	.00000	72.000	.00000
HOLDPOTa	.58260	.84644	.00000	1.0000	.00000
ONI	1.2247	.78309	.00000	2.0000	.00000
HOLDONI	.53164	.93859	.00000	1.0000	.00000
PEP	1.1524	.85186	.00000	2.0000	.00000
HOLDPEP	.50461	.99083	.00000	1.0000	.00000
CUC	.52636	.94859	.00000	1.0000	.00000
HOLDCUCU	.45242	1.1002	.00000	1.0000	.00000
TOM	.47308	1.0554	.00000	1.0000	.00000
HOLDTOM	.39181	1.2459	.00000	1.0000	.00000
PEAC	.41560	1.1858	.00000	1.0000	.00000
HOLDPEA	.33897	1.3965	.00000	1.0000	.00000
NECT	.36349	1.3233	.00000	1.0000	.00000
HOLDNEC	.26597	1.6613	.00000	1.0000	.00000
LIM	.28375	1.5888	.00000	1.0000	.00000
HOLDLIM	.19421	2.0369	.00000	1.0000	.00000
APPL	.21818	1.8930	.00000	1.0000	.00000
HOLDAPP	.12270	2.6740	.00000	1.0000	.00000
FIS	.14074	2.4709	.00000	1.0000	.00000
HOLDFIS	.09246	3.1330	.00000	1.0000	.00000
BUTT	.09987	3.0021	.00000	1.0000	.00000
HOLDBUTT	.99036E-03	33.688	.00000	1.0000	.00000
CHICK	.01675	11.736	.00000	3.0000	.00000
HOLDCHICK	.00738	14.274	.00000	2.0000	.00000
HOLDGNDTK	.00207	22.559	.00000	2.0000	.00000
HOLDTKYHM	.00237	20.971	.00000	2.0000	.00000
HOLDCERE	.00265	23.732	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 14 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1[illegible]
Model revision date: 3/ 5/1[illegible]

Replication ended at time : 394.006

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	22.104	1.0043	.20068	99.382	170
HOST SIZE 50	20.193	1.0930	.20069	78.497	67
HOST SIZE 100	23.634	.95583	.68170	86.602	67
HOST SIZE 150	20.135	1.2074	.79095	99.382	21
HOST SIZE 200	30.395	.63056	3.9779	67.488	10
HOST SIZE 250	18.874	.87373	8.4420	47.809	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	1.7632	2.0225	.00000	12.000	.00000
HOLDPOTa	.24442	1.7582	.00000	1.0000	.00000
ONI	.60843	1.4855	.00000	2.0000	.00000
HOLDONI	.26515	1.6648	.00000	1.0000	.00000
PEP	.66606	1.3856	.00000	2.0000	.00000
HOLDPEP	.29620	1.5415	.00000	1.0000	.00000
CUC	.35091	1.3600	.00000	1.0000	.00000
HOLDCUCU	.28674	1.5772	.00000	1.0000	.00000
TOM	.35241	1.3556	.00000	1.0000	.00000
HOLDTOM	.29126	1.5986	.00000	1.0000	.00000
PEAC	.31977	1.4585	.00000	1.0000	.00000
HOLDPEA	.24679	1.7470	.00000	1.0000	.00000
NECT	.28331	1.5905	.00000	1.0000	.00000
HOLDNEC	.21181	1.9290	.00000	1.0000	.00000
LIM	.25913	1.6909	.00000	1.0000	.00000
HOLDLIM	.18717	2.0839	.00000	1.0000	.00000
APPL	.21489	1.9114	.00000	1.0000	.00000
HOLDAPP	.13303	2.5529	.00000	1.0000	.00000
FIS	.17004	2.2093	.00000	1.0000	.00000
HOLDFIS	.05511	4.1405	.00000	1.0000	.00000
BUTT	.07936	3.4061	.00000	1.0000	.00000
HOLDBUTT	.00243	20.050	.00000	1.0000	.00000
CHICK	.02792	8.4173	.00000	3.0000	.00000
HOLDCHICK	.01551	10.327	.00000	2.0000	.00000
HOLDGNDTK	.00388	17.535	.00000	2.0000	.00000
HOLDTKYHM	.00340	13.320	.00000	2.0000	.00000
HOLDCERE	.00131	27.621	.00000	1.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 15 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 397.68

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	12.891	1.0838	.03772	54.477	170
HOST SIZE 50	12.758	1.0576	.03772	51.665	68
HOST SIZE 100	10.011	1.2486	.04376	48.721	63
HOST SIZE 150	16.844	.91443	1.1585	54.477	29
HOST SIZE 200	17.484	1.0837	1.6919	44.814	7
HOST SIZE 250	27.469	.60268	8.4420	38.578	3

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.47468	2.9486	.00000	7.0000	.00000
HOLDPOTa	.10991	2.8457	.00000	1.0000	.00000
ONI	.27001	2.4712	.00000	2.0000	.00000
HOLDONI	.10719	2.8861	.00000	1.0000	.00000
PEP	.31555	2.2416	.00000	2.0000	.00000
HOLDPEP	.15245	2.3579	.00000	1.0000	.00000
CUC	.20293	1.9818	.00000	1.0000	.00000
HOLDCUCU	.15966	2.2342	.00000	1.0000	.00000
TOM	.21260	1.9245	.00000	1.0000	.00000
HOLDTOM	.18074	2.1291	.00000	1.0000	.00000
PEAC	.22454	1.8584	.00000	1.0000	.00000
HOLDPEA	.15775	2.2274	.00000	1.0000	.00000
HECT	.20031	1.9980	.00000	1.0000	.00000
HOLDNEC	.14405	2.4376	.00000	1.0000	.00000
LIM	.17804	2.1487	.00000	1.0000	.00000
HOLDLIM	.12244	2.6772	.00000	1.0000	.00000
APPL	.15015	2.3791	.00000	1.0000	.00000
HOLDAPP	.08524	3.2759	.00000	1.0000	.00000
FIS	.11032	2.8399	.00000	1.0000	.00000
HOLDFIS	.04551	4.5799	.00000	1.0000	.00000
BUTT	.06511	3.7585	.00000	1.0000	.00000
HOLDBUTT	.00674	12.136	.00000	1.0000	.00000
CHICK	.04264	7.7652	.00000	3.0000	.00000
HOLDCHICK	.01089	11.793	.00000	2.0000	.00000
HOLDGNDTK	.00263	19.464	.00000	1.0000	.00000
HOLDTKYHM	.00131	35.402	.00000	2.0000	.00000
HOLDCERE	.67972E-03	38.343	.00000	1.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 16 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/199
Model revision date: 3/ 5/199

Replication ended at time : 464.511

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	7.6993	1.5340	.02953	81.201	170
HOST SIZE 50	7.7921	1.8564	.05035	77.209	70
HOST SIZE 100	7.8886	1.5110	.02953	81.201	58
HOST SIZE 150	5.5354	.82139	.62411	20.096	20
HOST SIZE 200	9.4926	.84166	2.4448	27.764	9
HOST SIZE 250	8.4420	.79142E-05	8.4420	8.4421	13

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.01216	10.255	.00000	2.0000	.00000
HOLDPOTa	.01069	9.6216	.00000	1.0000	.00000
ONI	.04165	6.4754	.00000	2.0000	.00000
HOLDONI	.01570	7.9192	.00000	1.0000	.00000
PEP	.07782	4.3031	.00000	2.0000	.00000
HOLDPEP	.02557	6.1730	.00000	1.0000	.00000
CUC	.06355	3.8386	.00000	1.0000	.00000
HOLDCUCU	.03493	5.2565	.00000	1.0000	.00000
TOM	.07089	3.6204	.00000	1.0000	.00000
HOLDTOM	.04629	4.5391	.00000	1.0000	.00000
PEAC	.08680	3.2436	.00000	1.0000	.00000
HOLDPEA	.05197	4.2712	.00000	1.0000	.00000
HECT	.09322	3.1170	.00000	1.0000	.00000
HOLDNEC	.05772	4.0404	.00000	1.0000	.00000
LIM	.09761	3.0406	.00000	1.0000	.00000
HOLDLIM	.05162	4.2863	.00000	1.0000	.00000
APPL	.08963	3.6553	.00000	1.0000	.00000
HOLDAPP	.02758	5.9393	.00000	1.0000	.00000
FIS	.07708	3.4602	.00000	1.0000	.00000
HOLDFIS	.02355	6.4335	.00000	1.0000	.00000
BUTT	.04796	4.4557	.00000	1.0000	.00000
HOLDBUTT	.79350E-03	35.423	.00000	1.0000	.00000
CHICK	.01815	10.865	.00000	3.0000	.00000
HOLDCHICK	.01038	12.343	.00000	2.0000	.00000
HOLDGNDTK	.00809	13.954	.00000	2.0000	.00000
HOLDTKYHM	.00792	15.383	.00000	2.0000	.00000
HOLDCERE	.00394	21.098	.00000	2.0000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 17 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 413.935

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	7.8228	1.0216	.10540	52.648	170
HOST SIZE 50	7.5327	.96981	.13306	34.383	73
HOST SIZE 100	6.9216	1.1059	.10540	40.616	55
HOST SIZE 150	6.6997	.87037	.66089	20.326	26
HOST SIZE 200	14.789	.97781	2.5604	52.648	11
HOST SIZE 250	12.486	.43898	8.4420	21.028	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.00139	26.797	.00000	1.0000	.00000
HOLDPOTa	.00000	--	.00000	.00000	.00000
ONI	.01628	8.6376	.00000	2.0000	.00000
HOLDONI	.00139	26.786	.00000	1.0000	.00000
PEP	.06392	4.7489	.00000	2.0000	.00000
HOLDPEP	.03169	5.5281	.00000	1.0000	.00000
CUC	.06900	3.6732	.00000	1.0000	.00000
HOLDCUCU	.04761	4.4726	.00000	1.0000	.00000
TOM	.07882	3.4186	.00000	1.0000	.00000
HOLDTOM	.04945	4.3845	.00000	1.0000	.00000
PEAC	.08475	3.2862	.00000	1.0000	.00000
HOLDPEA	.05133	4.2992	.00000	1.0000	.00000
NECT	.09988	3.0020	.00000	1.0000	.00000
HOLDNEC	.05992	3.9611	.00000	1.0000	.00000
LIM	.10049	2.9934	.00000	1.0000	.00000
HOLDLIM	.05556	4.1229	.00000	1.0000	.00000
APPL	.10286	2.9533	.00000	1.0000	.00000
HOLDAPP	.05569	4.1104	.00000	1.0000	.00000
FIS	.11391	2.7338	.00000	1.0000	.00000
HOLDFIS	.02215	6.6426	.00000	1.0000	.00000
BUTT	.05076	4.3246	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.03111	8.0106	.00000	3.0000	.00000
HOLDCHICK	.01061	9.6573	.00000	1.0000	.00000
HOLDGNDTK	.01268	11.972	.00000	2.0000	.00000
HOLDTKYHM	.56194E-03	12.173	.00000	1.0000	.00000
HOLDCEFE	.67967E-03	38.344	.00000	1.0000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 18 of 20

Project: THESIS
Analyst: Paul Bernasconi

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 419.813

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	11.203	.90620	.10320	45.807	170
HOST SIZE 50	12.731	.91925	.12936	45.807	60
HOST SIZE 100	9.8192	.98873	.10320	36.477	72
HOST SIZE 150	11.815	.79071	.64154	35.994	20
HOST SIZE 200	10.442	.71929	2.2963	23.416	11
HOST SIZE 250	11.779	.39201	8.4420	20.156	7

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	.01068	9.6241	.00000	1.0000	.00000
HOLDPOTa	.02425	6.3435	.00000	1.0000	.00000
ONI	.18872	2.9329	.00000	2.0000	.00000
HOLDONI	.07503	3.5112	.00000	1.0000	.00000
PEP	.26679	2.4543	.00000	2.0000	.00000
HOLDPEP	.11107	2.8290	.00000	1.0000	.00000
CUC	.15742	2.3135	.00000	1.0000	.00000
HOLDCUCU	.12249	2.6765	.00000	1.0000	.00000
TOM	.16833	2.2228	.00000	1.0000	.00000
HOLDTOM	.13103	2.5752	.00000	1.0000	.00000
PEAC	.17126	2.1998	.00000	1.0000	.00000
HOLDPEA	.13392	2.5431	.00000	1.0000	.00000
NECT	.17236	2.1913	.00000	1.0000	.00000
HOLDNEC	.12729	2.6134	.00000	1.0000	.00000
LIM	.16522	2.2478	.00000	1.0000	.00000
HOLDLIM	.09364	3.1111	.00000	1.0000	.00000
APPL	.12282	2.6725	.00000	1.0000	.00000
HOLDAPP	.07426	3.5399	.00000	1.0000	.00000
FIS	.10588	2.9060	.00000	1.0000	.00000
HOLDFIS	.05014	4.3523	.00000	1.0000	.00000
BUTT	.07725	3.4562	.00000	1.0000	.00000
HOLDBUTT	.00000	--	.00000	.00000	.00000
CHICK	.00767	15.510	.00000	3.0000	.00000
HOLDCHICK	.00211	25.638	.00000	2.0000	.00000
HOLDGNDTK	.38502E-03	58.406	.00000	2.0000	.00000
HOLDTKYHM	.13343E-03	73.819	.00000	1.0000	.00000
HOLDCERE	.28754E-03	58.764	.00000	1.0000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 19 of 20

Project: THESIS Run execution date : 3/ 5/1992
Analyst: Paul Bernasconi Model revision date: 3/ 5/1992

Replication ended at time : 535.398

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	32.411	1.7100	.11893	207.40	170
HOST SIZE 50	40.092	1.5532	.11393	207.40	71
HOST SIZE 100	20.307	2.1367	.12345	180.66	57
HOST SIZE 150	33.985	1.5344	1.7810	172.47	24
HOST SIZE 200	11.488	.53748	3.5456	22.469	14
HOST SIZE 250	132.35	.62539	8.4420	181.03	4

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	2.8621	1.6483	.00000	15.000	.00000
HOLDPOTa	.30134	1.5227	.00000	1.0000	.00000
ONI	.65251	1.4161	.00000	2.0000	.00000
HOLDONI	.27813	1.6110	.00000	1.0000	.00000
PEP	.66723	1.3779	.00000	2.0000	.00000
HOLDPEP	.31341	1.4801	.00000	1.0000	.00000
CUC	.35590	1.3453	.00000	1.0000	.00000
HOLDCUCU	.30163	1.5216	.00000	1.0000	.00000
TOM	.34953	1.3642	.00000	1.0000	.00000
HOLDTOM	.29088	1.6001	.00000	1.0000	.00000
PEAC	.31889	1.4615	.00000	1.0000	.00000
HOLDPEA	.24615	1.7500	.00000	1.0000	.00000
HECT	.28282	1.5924	.00000	1.0000	.00000
HOLDHEC	.20090	1.9914	.00000	1.0000	.00000
LIM	.23066	1.8263	.00000	1.0000	.00000
HOLDLIM	.15930	2.2973	.00000	1.0000	.00000
APPL	.19025	2.0624	.00000	1.0000	.00000
HOLDAPP	.10832	2.8692	.00000	1.0000	.00000
FIS	.14021	2.4763	.00000	1.0000	.00000
HOLDFIS	.06499	3.7932	.00000	1.0000	.00000
BUTT	.08614	3.2531	.00000	1.0000	.00000
HOLDBUTT	.09836	10.518	.00000	1.0000	.00000
CHICK	.06390	6.2470	.00000	3.0000	.00000
HOLDCHICK	.02735	7.9874	.00000	2.0000	.00000
HOLDGHDTK	.01811	9.8395	.00000	2.0000	.00000
HOLDTKYHM	.00516	14.904	.00000	2.0000	.00000
HOLDCEPE	.00315	19.874	.00000	2.0000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000

Summary for Replication 20 of 20

Project: THESIS Run execution date : [illegible]
Analyst: Paul Bernasconi Model revision date: [illegible]

Replication ended at time : 336.881

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	21.255	1.2174	.11383	92.036	170
HOST SIZE 50	19.283	1.3198	.11383	89.950	64
HOST SIZE 100	23.338	1.1283	.22638	92.036	64
HOST SIZE 150	18.226	1.3083	.26598	80.537	28
HOST SIZE 200	33.249	1.0858	3.4414	88.986	9
HOST SIZE 250	15.214	.82463	8.4420	37.324	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
POT	3.0484	1.9169	.00000	21.000	.00000
HOLDPOTa	.23447	1.8069	.00000	1.0000	.00000
ONI	.53270	1.6363	.00000	2.0000	.00000
HOLDONI	.21439	1.9143	.00000	1.0000	.00000
PEP	.52917	1.6446	.00000	2.0000	.00000
HOLDPEP	.22174	1.8734	.00000	1.0000	.00000
CUC	.26555	1.6631	.00000	1.0000	.00000
HOLDCUCU	.21398	1.9166	.00000	1.0000	.00000
TOM	.26079	1.6936	.00000	1.0000	.00000
HOLDTOM	.20050	1.9969	.00000	1.0000	.00000
PEAC	.24284	1.7658	.00000	1.0000	.00000
HOLDPEA	.17136	2.1990	.00000	1.0000	.00000
HECT	.21088	1.9344	.00000	1.0000	.00000
HOLDHEC	.15609	2.3252	.00000	1.0000	.00000
LIM	.13953	2.0679	.00000	1.0000	.00000
HOLDLIM	.12141	2.6900	.00000	1.0000	.00000
APPL	.14621	2.4155	.00000	1.0000	.00000
HOLDAPP	.07931	3.4141	.00000	1.0000	.00000
FIS	.12649	2.6279	.00000	1.0000	.00000
HOLDFIS	.05525	4.1351	.00000	1.0000	.00000
BUTT	.07234	3.5811	.00000	1.0000	.00000
HOLDBUTT	.56447E-03	42.078	.00000	1.0000	.00000
CHICK	.00735	16.762	.00000	1.0000	.00000
HOLDCHICK	.00767	13.856	.00000	3.0000	.00000
HOLDGHDTK	.00580	15.972	.00000	2.0000	.00000
HOLDTKYHM	.01055	11.219	.00000	2.0000	.00000
HOLDCERE	.00197	22.517	.00000	2.0000	.00000
HOLDHOODL	.00000	--	.00000	1.0000	.00000
				.00000	.00000

Run Time: 2 min(s) 42 sec(s)
Simulation run complete.

APPENDIX 4

SIMAN Simulation Output:
Proposed Layout Flow

SIMAN IV - License #8810384
Univ. of South Florida

Summary for Replication 1 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 392.246

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	18.219	.66372	.13155	49.199	170
HOST SIZE 50	17.487	.69417	.13155	49.199	64
HOST SIZE 100	19.132	.61995	1.0016	47.456	66
HOST SIZE 150	15.814	.89736	.55505	45.466	21
HOST SIZE 200	21.199	.53136	6.1160	40.909	14
HOST SIZE 250	17.287	.47290	8.4420	25.273	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.02293	6.5275	.00000	1.0000	.00000
NOODL	.06643	4.5968	.00000	3.0000	.00000
HOLDNOODL	.16567	3.1042	.00000	2.0000	.00000
CHICK	.68071	1.7441	.00000	3.0000	.00000
HOLDCHICK	.21002	1.9394	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.13078	2.5791	.00000	1.0000	.00000
BUTT	.22460	2.9479	.00000	3.0000	.00000
HOLDBUTT	.10047	2.9922	.00000	1.0000	.00000
FIS	.14215	2.4466	.00000	1.0000	.00000
HOLDFIS	.05226	4.2584	.00000	1.0000	.00000
APPL	.32905	2.1173	.00000	2.0000	.00000
HOLDAPP	.15681	2.3189	.00000	1.0000	.00000
PCT	.42499	1.9687	.00000	2.0000	.00000
HOLDPOTa	.17384	2.1800	.00000	1.0000	.00000
ONI	.43809	1.8326	.00000	2.0000	.00000
HOLDONI	.17928	2.1395	.00000	1.0000	.00000
FEP	.46511	1.7811	.00000	2.0000	.00000
HOLDPEP	.18095	2.1275	.00000	1.0000	.00000
CUC	.21572	1.9011	.00000	1.0000	.00000
HOLDCUCU	.15662	2.3205	.00000	1.0000	.00000
TOM	.19704	2.0187	.00000	1.0000	.00000
HOLDTOM	.13394	2.5428	.00000	1.0000	.00000
PEAC	.16561	2.2446	.00000	1.0000	.00000
HOLDPEA	.09892	3.0181	.00000	1.0000	.00000
NECT	.12749	2.6150	.00000	1.0000	.00000
HOLDNEC	.05934	3.9815	.00000	1.0000	.00000
LIM	.07861	3.4236	.00000	1.0000	.00000

Summary for Replication 2 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/19
Model revision date: 3/ 5/19

Replication ended at time : 394.413

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observati
FLOWTIME	13.545	.83635	.19318	57.202	170
HOST SIZE 50	11.734	.97922	.19318	57.202	63
HOST SIZE 100	14.397	.73583	.45044	40.763	63
HOST SIZE 150	14.732	.89386	1.4866	43.173	26
HOST SIZE 200	16.440	.72329	3.1089	41.280	13
HOST SIZE 250	11.945	.42595	8.4420	19.599	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Valu
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.02282	6.5438	.00000	1.0000	.00000
NOODL	.05134	6.1234	.00000	3.0000	.00000
HOLDNOODL	.09953	4.1761	.00000	2.0000	.00000
CHICK	.47890	2.0358	.00000	3.0000	.00000
HOLDCHICK	.18564	2.0944	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.12268	2.6741	.00000	1.0000	.00000
BUTT	.18156	3.5164	.00000	3.0000	.00000
HOLDBUTT	.07882	3.4187	.00000	1.0000	.00000
FIS	.11253	2.8083	.00000	1.0000	.00000
HOLDFIS	.03399	5.3314	.00000	1.0000	.00000
APPL	.18611	2.9336	.00000	2.0000	.00000
HOLDAPP	.08559	3.2686	.00000	1.0000	.00000
POT	.25698	2.5025	.00000	2.0000	.00000
HOLDPOTa	.09956	3.0073	.00000	1.0000	.00000
ONI	.27322	2.4313	.00000	2.0000	.00000
HOLDONI	.09916	3.0311	.00000	1.0000	.00000
FEP	.28907	2.3568	.00000	2.0000	.00000
HOLDPEP	.11232	2.8112	.00000	1.0000	.00000
CUC	.15006	2.3799	.00000	1.0000	.00000
HOLDCUCU	.10616	2.9017	.00000	1.0000	.00000
TOM	.14091	2.4691	.00000	1.0000	.00000
HOLDTOM	.09410	3.1027	.00000	1.0000	.00000
PEAC	.12576	2.6366	.00000	1.0000	.00000
HOLDPEA	.07234	3.5810	.00000	1.0000	.00000
NECT	.10466	2.9248	.00000	1.0000	.00000
HOLDNEC	.04515	4.5934	.00000	1.0000	.00000
LIM	.06932	3.6641	.00000	1.0000	.00000

Summary for Replication 3 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 388.645

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	10.455	.84074	.17169	35.894	170
HOST SIZE 50	10.965	.92500	.17169	34.465	66
HOST SIZE 100	9.2641	.82423	.44928	31.329	67
HOST SIZE 150	11.031	.63705	.38947	27.615	23
HOST SIZE 200	13.990	.77188	2.9893	35.894	11
HOST SIZE 250	8.4420	.22290E-05	8.4420	8.4420	3

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.00695	11.956	.00000	1.0000	.00000
NOODL	.00000	--	.00000	.00000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000
CHICK	.18961	3.3509	.00000	3.0000	.00000
HOLDCHICK	.10084	2.9860	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.07289	3.5664	.00000	1.0000	.00000
BUTT	.12398	3.9708	.00000	3.0000	.00000
HOLDBUTT	.04189	4.7827	.00000	1.0000	.00000
FIS	.07297	3.5644	.00000	1.0000	.00000
HOLDFIS	.00739	11.598	.00000	1.0000	.00000
APPL	.08984	4.1330	.00000	2.0000	.00000
HOLDAPP	.03633	5.1467	.00000	1.0000	.00000
POT	.18704	2.9992	.00000	2.0000	.00000
HOLDPOTA	.07006	3.6433	.00000	1.0000	.00000
ONI	.25591	2.4812	.00000	2.0000	.00000
HOLDONI	.11052	2.8369	.00000	1.0000	.00000
PEP	.31129	2.2409	.00000	2.0000	.00000
HOLDPEP	.11399	2.7880	.00000	1.0000	.00000
CUC	.15350	2.2956	.00000	1.0000	.00000
HOLDCUCU	.10485	2.9219	.00000	1.0000	.00000
TOM	.14752	2.4039	.00000	1.0000	.00000
HOLDTOM	.09117	3.1015	.00000	1.0000	.00000
PEAC	.12965	2.5909	.00000	1.0000	.00000
HOLDPEA	.07415	3.5337	.00000	1.0000	.00000
NECT	.10311	2.9493	.00000	1.0000	.00000
HOLDNEC	.04641	4.5330	.00000	1.0000	.00000
LIM	.06894	3.6749	.00000	1.0000	.00000

Summary for Replication 4 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1
Model revision date: 3/ 5/1

Replication ended at time : 481.032

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observati
FLOWTIME	9.3840	1.6026	.18625	103.41	170
HOST SIZE 50	12.839	1.7515	.23828	103.41	67
HOST SIZE 100	7.3715	.79733	.18625	23.995	68
HOST SIZE 150	4.5704	.79002	.33498	14.097	20
HOST SIZE 200	7.4859	.91067	2.1400	20.266	7
HOST SIZE 250	10.752	.33037	8.4420	18.128	6

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Val
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.00709	11.832	.00000	1.0000	.00000
NOODL	.00000	--	.00000	.00000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000
CHICK	.11626	3.7926	.00000	3.0000	.00000
HOLDCHICK	.08433	3.2953	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.06277	3.8640	.00000	1.0000	.00000
BUTT	.09806	4.8955	.00000	3.0000	.00000
HOLDBUTT	.03892	4.9692	.00000	1.0000	.00000
FIS	.07122	3.6114	.00000	1.0000	.00000
HOLDFIS	.01935	7.3142	.00000	1.0000	.00000
APPL	.06578	5.0182	.00000	2.0000	.00000
HOLDAPP	.02312	6.5000	.00000	1.0000	.00000
POT	.07410	4.7587	.00000	2.0000	.00000
HOLDPOTA	.02718	5.9486	.00000	1.0000	.00000
ONI	.08760	4.2952	.00000	2.0000	.00000
HOLDONI	.03921	4.9501	.00000	1.0000	.00000
PEP	.16932	3.0215	.00000	2.0000	.00000
HOLDPEP	.06900	3.7022	.00000	1.0000	.00000
CUC	.11362	2.7930	.00000	1.0000	.00000
HOLDCUCU	.06825	3.6949	.00000	1.0000	.00000
TOM	.11140	2.8243	.00000	1.0000	.00000
HOLDTOM	.06265	3.8630	.00000	1.0000	.00000
PEAC	.10569	2.9089	.00000	1.0000	.00000
HOLDPEA	.05860	4.0082	.00000	1.0000	.00000
NECT	.09306	3.0327	.00000	1.0000	.00000
HOLDNEC	.04152	4.6326	.00000	1.0000	.00000
LIM	.05923	3.9853	.00000	1.0000	.00000

Summary for Replication 5 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 391.334

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	25.079	1.0209	.17447	80.104	170
HOST SIZE 50	28.016	.97047	.26813	71.478	58
HOST SIZE 100	23.261	1.1244	.17447	80.104	62
HOST SIZE 150	21.869	1.0510	.43695	68.829	32
HOST SIZE 200	37.158	.59747	4.2966	67.680	10
HOST SIZE 250	15.621	1.2999	8.4420	65.877	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.16160	2.2778	.00000	1.0000	.00000
NOODL	1.8727	2.2640	.00000	16.000	.00000
HOLDNOODL	.39709	1.9610	.00000	2.0000	.00000
CHICK	.99291	1.3562	.00000	3.0000	.00000
HOLDCHICK	.30058	1.5254	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.23434	1.8076	.00000	1.0000	.00000
BUTT	.65874	1.8387	.00000	3.0000	.00000
HOLDBUTT	.18778	2.0798	.00000	1.0000	.00000
FIS	.22566	1.8524	.00000	1.0000	.00000
HOLDFIS	.12540	2.6410	.00000	1.0000	.00000
APPL	.34699	2.1397	.00000	2.0000	.00000
HOLDAPP	.13653	2.5148	.00000	1.0000	.00000
POT	.36345	2.0658	.00000	2.0000	.00000
HOLDPOTa	.13097	2.5759	.00000	1.0000	.00000
ONI	.36753	2.0643	.00000	2.0000	.00000
HOLDONI	.13567	2.5211	.00000	1.0000	.00000
PEP	.27513	2.0250	.00000	2.0000	.00000
HOLDPEP	.15962	2.4823	.00000	1.0000	.00000
CUC	.18230	2.1179	.00000	1.0000	.00000
HOLDCUCU	.12306	2.6695	.00000	1.0000	.00000
TOM	.16909	2.2168	.00000	1.0000	.00000
HOLDTOM	.10610	2.9027	.00000	1.0000	.00000
PEAC	.14625	2.4161	.00000	1.0000	.00000
HOLDPEA	.08212	3.3433	.00000	1.0000	.00000
NECT	.11451	2.7809	.00000	1.0000	.00000
HOLDNEC	.04789	4.4589	.00000	1.0000	.00000
LIM	.07121	3.6115	.00000	1.0000	.00000

Summary for Replication 6 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ [illegible]
Model revision date: 3/ [illegible]

Replication ended at time : 400.647

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observat[illegible]
FLOWTIME	24.063	.69430	.07730	75.985	170
HOST SIZE 50	23.471	.64405	.72290	55.906	61
HOST SIZE 100	23.818	.73215	.07730	56.714	71
HOST SIZE 150	27.383	.71102	.21272	75.985	23
HOST SIZE 200	24.970	.86626	1.8579	50.989	7
HOST SIZE 250	20.416	.46743	8.4420	32.443	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final [illegible]
CERE	.00000	--	.00000	.00000	.0000[illegible]
HOLDCERE	.07141	3.5060	.00000	1.0000	.0000[illegible]
NOODL	.53427	3.0573	.00000	9.0000	.0000[illegible]
HOLDNOODL	.28546	2.3026	.00000	2.0000	.0000[illegible]
CHICK	1.1030	1.2174	.00000	3.0000	.0000[illegible]
HOLDCHICK	.33984	1.3937	.00000	1.0000	.0000[illegible]
HOLDGNDTK	.00000	--	.00000	.00000	.0000[illegible]
HOLDTKYHM	.21760	1.8962	.00000	1.0000	.0000[illegible]
BUTT	.38644	2.3949	.00000	3.0000	.0000[illegible]
HOLDBUTT	.12471	2.6493	.00000	1.0000	.0000[illegible]
FIS	.20606	1.9629	.00000	1.0000	.0000[illegible]
HOLDFIS	.07044	3.6326	.00000	1.0000	.0000[illegible]
APPL	.33261	2.1539	.00000	2.0000	.0000[illegible]
HOLDAPP	.13231	2.5553	.00000	1.0000	.0000[illegible]
POT	.42516	1.8454	.00000	2.0000	.0000[illegible]
HOLDPOTa	.16062	2.2860	.00000	1.0000	.0000[illegible]
ONI	.47040	1.7621	.00000	2.0000	.0000[illegible]
HOLDONI	.17511	2.1705	.00000	1.0000	.0000[illegible]
PEP	.48437	1.7080	.00000	2.0000	.0000[illegible]
HOLDPEP	.18440	2.1931	.00000	1.0000	.0000[illegible]
CUC	.24408	1.7598	.00000	1.0000	.0000[illegible]
HOLDCUCU	.17279	2.1880	.00000	1.0000	.0000[illegible]
TOM	.22542	1.8537	.00000	1.0000	.0000[illegible]
HOLDTOM	.14983	2.3914	.00000	1.0000	.0000[illegible]
PEAC	.18902	2.0714	.00000	1.0000	.0000[illegible]
HOLDPEA	.11193	2.8159	.00000	1.0000	.0000[illegible]
NECT	.14545	2.4238	.00000	1.0000	.0000[illegible]
HOLDNEC	.06636	3.7508	.00000	1.0000	.0000[illegible]
LIM	.08635	3.2529	.00000	1.0000	.0000[illegible]

Summary for Replication 7 of 10

Project: THESIS Run execution date : 3/ 5/1992
Analyst: PAUL BERNASCONI Model revision date: 3/ 5/1992

Replication ended at time : 386.864

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	9.4452	.93902	.14642	40.797	170
HOST SIZE 50	9.7311	.99783	.14642	36.861	72
HOST SIZE 100	9.7487	.97702	.24554	40.797	57
HOST SIZE 150	7.5761	.81133	.62456	21.530	26
HOST SIZE 200	8.9008	.28840	5.1764	11.953	10
HOST SIZE 250	12.677	.74697	8.4420	29.616	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.01271	8.3131	.00000	1.0000	.00000
NCODL	.00229	20.864	.00000	1.0000	.00000
HOLDNOODL	.03083	7.2548	.00000	2.0000	.00000
CHICK	.37115	2.4283	.00000	3.0000	.00000
HOLDCHICK	.14479	2.4303	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.09535	3.0802	.00000	1.0000	.00000
BUTT	.13197	3.9896	.00000	3.0000	.00000
HOLDBUTT	.05940	3.9795	.00000	1.0000	.00000
FIS	.08648	3.2501	.00000	1.0000	.00000
HOLDFIS	.01115	9.4180	.00000	1.0000	.00000
APPL	.06561	4.9643	.00000	2.0000	.00000
HOLDAPP	.02379	6.4063	.00000	1.0000	.00000
POT	.14514	3.2912	.00000	2.0000	.00000
HOLDPOTa	.05771	4.0408	.00000	1.0000	.00000
ONI	.13018	3.0639	.00000	2.0000	.00000
HOLDONI	.06452	3.8078	.00000	1.0000	.00000
PEP	.18671	2.9853	.00000	2.0000	.00000
HOLDPEP	.07345	3.5519	.00000	1.0000	.00000
CUC	.09944	3.0094	.00000	1.0000	.00000
HOLDCUCU	.06323	3.8491	.00000	1.0000	.00000
TOM	.09063	3.1677	.00000	1.0000	.00000
HOLDTOM	.05371	4.1274	.00000	1.0000	.00000
FEAC	.03193	3.3475	.00000	1.0000	.00000
HOLDPEA	.04286	4.7253	.00000	1.0000	.00000
NECT	.07039	2.6341	.00000	1.0000	.00000
HOLDNEC	.02731	5.9593	.00000	1.0000	.00000
LIM	.05163	4.2858	.00000	1.0000	.00000

Summary for Replication 8 of 10

Project: THESIS Run execution date : 3/ 5/1
Analyst: PAUL BERNASCONI Model revision date: 3/ 5/1

Replication ended at time : 387.265

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observati
FLOWTIME	35.788	1.0814	.17108	176.31	170
HOST SIZE 50	22.229	1.1953	.17108	114.66	65
HOST SIZE 100	48.953	.85635	.96826	129.90	65
HOST SIZE 150	43.998	1.1133	1.3355	176.31	23
HOST SIZE 200	33.288	1.1405	.66778	92.897	11
HOST SIZE 250	13.160	.64697	8.4420	29.853	6

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Val
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.16913	2.2165	.00000	1.0000	.00000
NOODL	5.5518	1.6465	.00000	27.000	.00000
HOLDNOODL	.63663	1.4297	.00000	2.0000	.00000
CHICK	1.3359	1.0954	.00000	3.0000	.00000
HOLDCHICK	.37158	1.3005	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.28123	1.5987	.00000	1.0000	.00000
BUTT	.67568	1.7831	.00000	3.0000	.00000
HOLDBUTT	.21406	1.9161	.00000	1.0000	.00000
FIS	.24934	1.7351	.00000	1.0000	.00000
HOLDFIS	.12024	2.7049	.00000	1.0000	.00000
APPL	.34825	2.1150	.00000	2.0000	.00000
HOLDAPP	.13291	2.5542	.00000	1.0000	.00000
POT	.35619	2.0925	.00000	2.0000	.00000
HOLDPOTa	.13663	2.5138	.00000	1.0000	.00000
ONI	.36095	2.0654	.00000	2.0000	.00000
HOLDONI	.13817	2.4975	.00000	1.0000	.00000
PEP	.37272	2.0183	.00000	2.0000	.00000
HOLDPEP	.14154	2.4628	.00000	1.0000	.00000
CUC	.18232	2.1178	.00000	1.0000	.00000
HOLDCUCU	.13186	2.5658	.00000	1.0000	.00000
TOM	.16863	2.2204	.00000	1.0000	.00000
HOLDTOM	.10948	2.8521	.00000	1.0000	.00000
PEAC	.14435	2.4347	.00000	1.0000	.00000
HOLDPEA	.03571	3.2560	.00000	1.0000	.00000
NECT	.11443	2.7820	.00000	1.0000	.00000
HOLDNEC	.04994	4.3618	.00000	1.0000	.00000
LIM	.06806	3.7004	.00000	1.0000	.00000

Summary for Replication 9 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 390.602

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	10.781	.98814	.03052	57.976	170
HOST SIZE 50	7.6256	.96503	.03052	42.457	68
HOST SIZE 100	13.498	.88927	.20589	57.976	60
HOST SIZE 150	12.212	1.0174	.59058	40.402	24
HOST SIZE 200	11.760	1.2568	2.3050	44.671	11
HOST SIZE 250	11.708	.39904	8.4420	20.400	7

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.04468	4.6239	.00000	1.0000	.00000
NOODL	.03371	7.4109	.00000	3.0000	.00000
HOLDNOODL	.08610	4.4020	.00000	2.0000	.00000
CHICK	.55013	1.9714	.00000	3.0000	.00000
HOLDCHICK	.19234	2.0491	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.13938	2.4849	.00000	1.0000	.00000
BUTT	.23867	3.1619	.00000	3.0000	.00000
HOLDBUTT	.03012	3.3885	.00000	1.0000	.00000
FIS	.11510	2.7727	.00000	1.0000	.00000
HOLDFIS	.02517	6.2234	.00000	1.0000	.00000
APPL	.10533	3.9508	.00000	2.0000	.00000
HOLDAPP	.02690	6.0142	.00000	1.0000	.00000
POT	.11265	3.3842	.00000	2.0000	.00000
HOLDPOTa	.03454	5.2869	.00000	1.0000	.00000
ONI	.13118	3.6130	.00000	2.0000	.00000
HOLDONI	.03917	4.9525	.00000	1.0000	.00000
PEP	.15040	3.3184	.00000	2.0000	.00000
HOLDPEP	.05160	4.2870	.00000	1.0000	.00000
CUC	.03860	3.2073	.00000	1.0000	.00000
HOLDCUCU	.05522	4.1364	.00000	1.0000	.00000
TOM	.09079	3.1645	.00000	1.0000	.00000
HOLDTOM	.05795	4.0318	.00000	1.0000	.00000
PEAC	.08278	3.3287	.00000	1.0000	.00000
HOLDPEA	.04754	4.4760	.00000	1.0000	.00000
NECT	.07038	3.6343	.00000	1.0000	.00000
HOLDNEC	.03339	5.4655	.00000	1.0000	.00000
LIM	.05172	4.2817	.00000	1.0000	.00000

Summary for Replication 10 of 10

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1
Model revision date: 3/ 5/1

Replication ended at time : 432.354

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observati
FLOWTIME	17.108	.96923	.05072	72.671	170
HOST SIZE 50	19.052	1.0789	.05072	72.671	63
HOST SIZE 100	15.479	.93517	.19690	57.793	64
HOST SIZE 150	17.343	.73763	2.5114	46.745	19
HOST SIZE 200	12.831	.46450	2.6309	23.837	18
HOST SIZE 250	26.156	.81772	8.4420	53.855	6

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Val
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.03612	5.1656	.00000	1.0000	.00000
NOODL	.33395	3.7315	.00000	8.0000	.00000
HOLDNOODL	.16391	3.2707	.00000	2.0000	.00000
CHICK	.55853	1.8779	.00000	3.0000	.00000
HOLDCHICK	.23178	1.8206	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.15769	2.3112	.00000	1.0000	.00000
BUTT	.26450	2.9051	.00000	3.0000	.00000
HOLDBUTT	.08974	3.1849	.00000	1.0000	.00000
FIS	.12964	2.5911	.00000	1.0000	.00000
HOLDFIS	.00993	9.9864	.00000	1.0000	.00000
APPL	.11772	3.6492	.00000	2.0000	.00000
HOLDAPP	.04179	4.7885	.00000	1.0000	.00000
POT	.20573	2.7424	.00000	2.0000	.00000
HOLDPOTa	.06949	3.6593	.00000	1.0000	.00000
ONI	.27816	2.4120	.00000	2.0000	.00000
HOLDONI	.09594	3.0697	.00000	1.0000	.00000
PEP	.30133	2.2521	.00000	2.0000	.00000
HOLDPEP	.11354	2.7941	.00000	1.0000	.00000
CUC	.16902	2.2173	.00000	1.0000	.00000
HOLDCUCU	.10795	2.8877	.00000	1.0000	.00000
TOM	.16154	2.2792	.00000	1.0000	.00000
HOLDTOM	.09255	3.1312	.00000	1.0000	.00000
PEAC	.14375	2.4406	.00000	1.0000	.00000
HOLDPEA	.07619	3.4820	.00000	1.0000	.00000
NECT	.12138	2.6905	.00000	1.0000	.00000
HOLDNEC	.04953	4.3808	.00000	1.0000	.00000
LIM	.08076	3.3739	.00000	1.0000	.00000

Summary for Replication 11 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 287.29

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	10.206	1.0451	.16187	49.402	170
HOST SIZE 50	6.4806	1.0219	.17410	30.833	56
HOST SIZE 100	11.514	1.0659	.16187	49.402	63
HOST SIZE 150	11.185	.80745	.43867	31.380	29
HOST SIZE 200	17.597	.93182	2.3212	45.680	14
HOST SIZE 250	9.4963	.16237	8.4420	12.777	8

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.93769E-05	326.56	.00000	1.0000	.00000
NOODL	.00000	--	.00000	.00000	.00000
HOLDNOODL	.00000	--	.00000	.00000	.00000
CHICK	.06742	4.1511	.00000	2.0000	.00000
HOLDCHICK	.08196	3.3469	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.05978	3.6513	.00000	1.0000	.00000
BUTT	.09610	4.4091	.00000	3.0000	.00000
HOLDBUTT	.03882	4.9758	.00000	1.0000	.00000
FIS	.07871	3.4212	.00000	1.0000	.00000
HOLDFIS	.02630	6.0846	.00000	1.0000	.00000
APPL	.18815	2.9227	.00000	2.0000	.00000
HOLDAPP	.07729	3.4552	.00000	1.0000	.00000
POT	.24259	2.5916	.00000	2.0000	.00000
HOLDPOTa	.08696	3.2403	.00000	1.0000	.00000
ONI	.26418	2.5075	.00000	2.0000	.00000
HOLDONI	.09629	3.0635	.00000	1.0000	.00000
PEP	.28231	2.3951	.00000	2.0000	.00000
HOLDPEP	.11544	2.7681	.00000	1.0000	.00000
CUC	.14804	2.3989	.00000	1.0000	.00000
HOLDCUCU	.10507	2.9194	.00000	1.0000	.00000
TOM	.13672	2.5128	.00000	1.0000	.00000
HOLDTOM	.09052	3.1697	.00000	1.0000	.00000
PEAC	.12039	2.7020	.00000	1.0000	.00000
HOLDPEA	.06861	3.6346	.00000	1.0000	.00000
NECT	.09854	3.0245	.00000	1.0000	.00000
HOLDNEC	.04121	4.8173	.00000	1.0000	.00000
LIM	.06718	3.7262	.00000	1.0000	.00000

Summary for Replication 12 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 464.591

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	39.429	1.1642	.21122	141.63	170
HOST SIZE 50	45.915	1.0740	.26566	141.63	69
HOST SIZE 100	41.922	1.1451	.25842	137.04	59
HOST SIZE 150	24.097	1.2885	.21122	124.29	28
HOST SIZE 200	14.795	.97658	2.6900	49.449	9
HOST SIZE 250	50.730	1.1428	8.4420	118.10	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.33708	1.4024	.00000	1.0000	.00000
NOODL	.94767	2.2771	.00000	9.0000	.00000
HOLDNOODL	.43723	1.8589	.00000	2.0000	.00000
CHICK	1.1386	1.2427	.00000	3.0000	.00000
HOLDCHICK	.38055	1.2759	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.36895	1.3078	.00000	1.0000	.00000
BUTT	1.1966	1.1923	.00000	3.0000	.00000
HOLDBUTT	.36593	1.3164	.00000	1.0000	.00000
FIS	.42297	1.1680	.00000	1.0000	.00000
HOLDFIS	.36007	1.3331	.00000	1.0000	.00000
APPL	.81040	1.1957	.00000	2.0000	.00000
HOLDAPP	.33391	1.3966	.00000	1.0000	.00000
POT	.76470	1.2535	.00000	2.0000	.00000
HOLDPOTa	.31481	1.4752	.00000	1.0000	.00000
ONI	.72652	1.2045	.00000	2.0000	.00000
HOLDONI	.29566	1.5434	.00000	1.0000	.00000
PEP	.69179	1.3615	.00000	2.0000	.00000
HOLDPEP	.27417	1.6271	.00000	1.0000	.00000
CUC	.30348	1.5150	.00000	1.0000	.00000
HOLDCUCU	.22724	1.8441	.00000	1.0000	.00000
TOM	.25546	1.7072	.00000	1.0000	.00000
HOLDTOM	.17823	2.1423	.00000	1.0000	.00000
PEAC	.20761	1.9537	.00000	1.0000	.00000
HOLDPEA	.12974	2.5839	.00000	1.0000	.00000
NECT	.15501	2.3348	.00000	1.0000	.00000
HOLDNEC	.07228	3.5825	.00000	1.0000	.00000
LIM	.09010	3.1778	.00000	1.0000	.00000

Summary for Replication 13 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 909.095

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	236.31	.98249	.23045	540.80	170
HOST SIZE 50	262.33	.88794	.23045	537.48	63
HOST SIZE 100	252.69	.92821	.36310	540.80	72
HOST SIZE 150	127.22	1.5737	2.3174	494.91	20
HOST SIZE 200	195.62	1.2231	2.9756	481.61	10
HOST SIZE 250	190.43	1.2762	8.4420	483.27	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.59440	.82606	.00000	1.0000	.00000
NOODL	23.507	.97575	.00000	56.000	.00000
HOLDNOODL	1.1887	.80991	.00000	2.0000	.00000
CHICK	2.0184	.68859	.00000	3.0000	.00000
HOLDCHICK	.65216	.73031	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.62337	.77729	.00000	1.0000	.00000
BUTT	1.8965	.74583	.00000	3.0000	.00000
HOLDBUTT	.57351	.86235	.00000	1.0000	.00000
FIS	.60768	.80350	.00000	1.0000	.00000
HOLDFIS	.57528	.85923	.00000	1.0000	.00000
APPL	1.2018	.80549	.00000	2.0000	.00000
HOLDAPP	.52804	.94541	.00000	1.0000	.00000
POT	1.1290	.86899	.00000	2.0000	.00000
HOLDPOTa	.48455	1.0314	.00000	1.0000	.00000
ONI	1.0482	.93325	.00000	2.0000	.00000
HOLDONI	.43774	1.1333	.00000	1.0000	.00000
PEP	.97151	1.0213	.00000	2.0000	.00000
HOLDPEP	.40601	1.2096	.00000	1.0000	.00000
CUC	.42764	1.1569	.00000	1.0000	.00000
HOLDCUCU	.34218	1.3865	.00000	1.0000	.00000
TOM	.36474	1.3197	.00000	1.0000	.00000
HOLDTOM	.27240	1.6343	.00000	1.0000	.00000
PEAC	.29177	1.5580	.00000	1.0000	.00000
HOLDPEA	.18722	2.0936	.00000	1.0000	.00000
NECT	.20433	1.9733	.00000	1.0000	.00000
HOLDNEC	.09608	3.9673	.00000	1.0000	.00000
LIM	.10857	2.8654	.00000	1.0000	.00000

Summary for Replication 14 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 393.339

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	25.302	.93085	.20068	92.106	170
HOST SIZE 50	24.351	1.0098	.20068	88.919	67
HOST SIZE 100	26.258	.93263	1.5544	92.106	67
HOST SIZE 150	22.222	.95963	1.8302	77.291	21
HOST SIZE 200	32.616	.59143	10.223	69.808	10
HOST SIZE 250	23.532	.65222	8.4420	49.327	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.20609	1.9627	.00000	1.0000	.00000
NOODL	.02199	7.9861	.00000	2.0000	.00000
HOLDNOODL	.12227	3.5344	.00000	2.0000	.00000
CHICK	.79750	1.4897	.00000	3.0000	.00000
HOLDCHICK	.31081	1.4891	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.25336	1.7167	.00000	1.0000	.00000
BUTT	.85847	1.5075	.00000	3.0000	.00000
HOLDBUTT	.26537	1.6638	.00000	1.0000	.00000
FIS	.33715	1.4022	.00000	1.0000	.00000
HOLDFIS	.23415	1.8085	.00000	1.0000	.00000
APPL	.59775	1.4767	.00000	2.0000	.00000
HOLDAPP	.25957	1.6889	.00000	1.0000	.00000
POT	.65107	1.4010	.00000	2.0000	.00000
HOLDPOTa	.26222	1.6774	.00000	1.0000	.00000
ONI	.61414	1.4786	.00000	2.0000	.00000
HOLDONI	.23414	1.8071	.00000	1.0000	.00000
PEP	.56811	1.5478	.00000	2.0000	.00000
HOLDPEP	.22371	1.8628	.00000	1.0000	.00000
CUC	.28373	1.5889	.00000	1.0000	.00000
HOLDCUCU	.20221	1.9863	.00000	1.0000	.00000
TOM	.25429	1.7125	.00000	1.0000	.00000
HOLDTOM	.17155	2.1976	.00000	1.0000	.00000
PEAC	.20841	1.9439	.00000	1.0000	.00000
HOLDPEA	.12454	2.6513	.00000	1.0000	.00000
NECT	.15505	2.3344	.00000	1.0000	.00000
HOLDNEC	.07029	3.6370	.00000	1.0000	.00000
LIM	.09102	3.1601	.00000	1.0000	.00000

Summary for Replication 15 of 20

Project: THESIS Run execution date : 3/ 5/1992
Analyst: PAUL BERNASCONI Model revision date: 3/ 5/1992

Replication ended at time : 398.164

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	14.517	.98211	.03772	54.477	170
HOST SIZE 50	14.514	.91805	.03772	51.655	68
HOST SIZE 100	10.884	1.1783	.07212	47.403	63
HOST SIZE 150	19.670	.85725	1.8134	54.477	29
HOST SIZE 200	21.725	.76767	1.6919	42.776	7
HOST SIZE 250	24.231	.57001	8.4420	34.075	3

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.00551	13.440	.00000	1.0000	.00000
HOODL	.00000	--	.00000	.00000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000
CHICK	.16941	3.2699	.00000	3.0000	.00000
HOLDCHICK	.13680	2.5119	.00000	1.0000	.00000
HOLDGNDTK	00000	--	.00000	.00000	.00000
HOLDTKYHM	.08729	3.2335	.00000	1.0000	.00000
BUTT	.23482	2.7874	.00000	3.0000	.00000
HOLDBUTT	.12599	2.6448	.00000	1.0000	.00000
FIS	.17653	2.1598	.00000	1.0000	.00000
HOLDFIS	.12093	2.6961	.00000	1.0000	.00000
APPL	.34020	2.1301	.00000	2.0000	.00000
HOLDAPP	.15114	2.3698	.00000	1.0000	.00000
PCT	.39812	1.9690	.00000	2.0000	.00000
HOLDPOTa	.16524	2.2476	.00000	1.0000	.00000
OHI	.42640	1.8677	.00000	2.0000	.00000
HOLDOHI	.16833	2.2224	.00000	1.0000	.00000
PEP	.44598	1.3268	.00000	2.0000	.00000
HOLDPEP	.17236	2.1913	.00000	1.0000	.00000
CUC	.20312	1.9807	.00000	1.0000	.00000
HOLDCUCU	.14581	2.4204	.00000	1.0000	.00000
TOM	.17644	2.1605	.00000	1.0000	.00000
HOLDTOM	.11737	2.7122	.00000	1.0000	.00000
PEAC	.14698	2.4091	.00000	1.0000	.00000
HOLDPEA	.09593	3.2615	.00000	1.0000	.00000
NECT	.11128	2.9260	.00000	1.0000	.00000
HOLDNEC	.05007	4.2558	.00000	1.0000	.00000
LIM	.06642	3.7491	.00000	1.0000	.00000

Summary for Replication 16 of 20

Project: THESIS Run execution date : 3/ 5/19
Analyst: PAUL BERNASCONI Model revision date: 3/ 5/19

Replication ended at time : 454.083

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	9.8361	1.1783	.05035	77.209	170
HOST SIZE 50	10.737	1.3447	.05035	77.209	70
HOST SIZE 100	9.4621	1.1622	.38519	70.778	58
HOST SIZE 150	7.8252	.66728	1.5480	21.227	20
HOST SIZE 200	11.107	.76034	2.4448	26.262	9
HOST SIZE 250	8.5990	.04922	8.4420	9.9027	13

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.01101	9.4766	.00000	1.0000	.00000
HOODL	.00000	--	.00000	.00000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000
CHICK	.25360	2.8650	.00000	3.0000	.00000
HOLDCHICK	.11224	2.8124	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.07822	3.4328	.00000	1.0000	.00000
BUTT	.11814	4.1891	.00000	3.0000	.00000
HOLDBUTT	.04471	4.6225	.00000	1.0000	.00000
FIS	.08052	3.3791	.00000	1.0000	.00000
HOLDFIS	.00376	16.267	.00000	1.0000	.00000
APPL	.06583	5.1319	.00000	2.0000	.00000
HOLDAPP	.01333	8.6044	.00000	1.0000	.00000
PCT	.07206	4.8071	.00000	2.0000	.00000
HOLDPOTa	.02434	6.2531	.00000	1.0000	.00000
OHI	.09272	4.2294	.00000	2.0000	.00000
HOLDOHI	.03267	5.4415	.00000	1.0000	.00000
PEP	.13926	3.3106	.00000	2.0000	.00000
HOLDPEP	.06233	3.8771	.00000	1.0000	.00000
CUC	.10937	2.8449	.00000	1.0000	.00000
HOLDCUCU	.06794	3.7038	.00000	1.0000	.00000
TOM	.11375	2.7912	.00000	1.0000	.00000
HOLDTOM	.06605	3.7604	.00000	1.0000	.00000
PEAC	.10896	2.8597	.00000	1.0000	.00000
HOLDPEA	.05735	4.0468	.00000	1.0000	.00000
NECT	.09739	3.0444	.00000	1.0000	.00000
HOLDNEC	.04174	4.7915	.00000	1.0000	.00000
LIM	.06256	3.8710	.00000	1.0000	.00000

Summary for Replication 17 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 412.101

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	13.974	.88531	.13306	53.034	170
HOST SIZE 50	15.923	.82062	.13306	50.146	73
HOST SIZE 100	13.273	.96843	.28455	42.728	55
HOST SIZE 150	10.764	.83353	.68134	39.278	26
HOST SIZE 200	13.602	1.0273	2.8609	53.034	11
HOST SIZE 250	10.728	.35268	8.4420	17.163	5

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.01963	7.2586	.00000	1.0000	.00000
HOODL	.39412	2.9156	.00000	6.0000	.00000
HOLDHOODL	.27500	2.4330	.00000	2.0000	.00000
CHICK	.69846	1.6895	.00000	3.0000	.00000
HOLDCHICK	.21301	1.8939	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.14205	2.4576	.00000	1.0000	.00000
BUTT	.16253	3.6019	.00000	3.0000	.00000
HOLDBUTT	.06556	3.7755	.00000	1.0000	.00000
FIS	.13454	2.5363	.00000	1.0000	.00000
HOLDFIS	.09361	16.615	.00000	1.0000	.00000
APPL	.05399	5.3085	.00000	2.0000	.00000
HOLDAPP	.09826	10.944	.00000	1.0000	.00000
POT	.08930	4.3668	.00000	2.0000	.00000
HOLDPOTa	.01903	7.1789	.00000	1.0000	.00000
ONI	.11442	3.6492	.00000	2.0000	.00000
HOLDONI	.03200	5.4999	.00000	1.0000	.00000
PEP	.15979	3.1211	.00000	2.0000	.00000
HOLDPEP	.05586	4.1113	.00000	1.0000	.00000
CUC	.10258	2.3578	.00000	1.0000	.00000
HOLDCUCU	.05633	4.0329	.00000	1.0000	.00000
TOM	.10991	2.8458	.00000	1.0000	.00000
HOLDTOM	.05962	3.9716	.00000	1.0000	.00000
PEAC	.10331	2.9281	.00000	1.0000	.00000
HOLDPEA	.05065	4.3233	.00000	1.0000	.00000
NECT	.08653	3.2490	.00000	1.0000	.00000
HOLDNEC	.03145	5.5499	.00000	1.0000	.00000
LIM	.06051	3.9405	.00000	1.0000	.00000

Summary for Replication 18 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1
Model revision date: 3/ 5/1

Replication ended at time : 419.467

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	12.523	.79878	.10320	45.807	170
HOST SIZE 50	14.461	.77342	.12936	45.807	60
HOST SIZE 100	11.293	.88395	.10320	36.753	72
HOST SIZE 150	12.532	.71037	2.8183	37.339	20
HOST SIZE 200	11.003	.66044	2.2963	24.759	11
HOST SIZE 250	11.175	.31915	8.4420	18.358	7

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.00184	23.283	.00000	1.0000	.00000
HOODL	.00000	--	.00000	.00000	.00000
HOLDHOODL	.00000	--	.00000	.00000	.00000
CHICK	.18047	3.2793	.00000	3.0000	.00000
HOLDCHICK	.11088	2.8317	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.08043	3.3812	.00000	1.0000	.00000
BUTT	.10303	4.2986	.00000	3.0000	.00000
HOLDBUTT	.03673	5.1210	.00000	1.0000	.00000
FIS	.08920	3.1954	.00000	1.0000	.00000
HOLDFIS	.01793	7.4220	.00000	1.0000	.00000
APPL	.14345	3.2064	.00000	2.0000	.00000
HOLDAPP	.05728	4.0568	.00000	1.0000	.00000
POT	.22434	2.6014	.00000	2.0000	.00000
HOLDPOTa	.08498	3.2935	.00000	1.0000	.00000
ONI	.26019	2.4554	.00000	2.0000	.00000
HOLDONI	.09378	3.1086	.00000	1.0000	.00000
PEP	.32656	2.1872	.00000	2.0000	.00000
HOLDPEP	.12388	2.6593	.00000	1.0000	.00000
CUC	.16989	2.2105	.00000	1.0000	.00000
HOLDCUCU	.11357	2.6632	.00000	1.0000	.00000
TOM	.16786	2.2265	.00000	1.0000	.00000
HOLDTOM	.11794	2.7348	.00000	1.0000	.00000
PEAC	.15008	2.2906	.00000	1.0000	.00000
HOLDPEA	.12556	2.9109	.00000	1.0000	.00000
NECT	.14814	2.2960	.00000	1.0000	.00000
HOLDNEC	.06881	3.6797	.00000	1.0000	.00000
LIM	.09402	3.1041	.00000	1.0000	.00000

Summary for Replication 19 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/1992
Model revision date: 3/ 5/1992

Replication ended at time : 540.783

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	31.552	1.7359	.74908	207.22	170
HOST SIZE 50	38.639	1.6079	.84763	207.22	71
HOST SIZE 100	21.260	1.9269	.74908	194.59	57
HOST SIZE 150	36.210	1.6091	1.7810	192.46	24
HOST SIZE 200	10.876	.44845	3.5456	18.163	14
HOST SIZE 250	96.822	1.0545	8.4420	189.13	4

DISCRETE-CHANGE VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.16053	2.2868	.00000	1.0000	.00000
NOODL	.00000	--	.00000	.00000	.00000
HOLDNOODL	.05088	5.3972	.00000	2.0000	.00000
CHICK	.54974	1.9704	.00000	3.0000	.00000
HOLDCHICK	.22341	1.8644	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.21923	1.8872	.00000	1.0000	.00000
BUTT	.69509	1.7378	.00000	3.0000	.00000
HOLDBUTT	.23202	1.8193	.00000	1.0000	.00000
FIS	.29254	1.5551	.00000	1.0000	.00000
HOLDFIS	.22046	1.8804	.00000	1.0000	.00000
APPL	.57522	1.5393	.00000	2.0000	.00000
HOLDAPP	.27252	1.6338	.00000	1.0000	.00000
POT	.63195	1.4450	.00000	2.0000	.00000
HOLDPOTa	.26510	1.6650	.00000	1.0000	.00000
ONI	.64079	1.4212	.00000	2.0000	.00000
HOLDONI	.26703	1.6568	.00000	1.0000	.00000
PEP	.64498	1.4151	.00000	2.0000	.00000
HOLDPEP	.27307	1.6316	.00000	1.0000	.00000
CUC	.31106	1.4882	.00000	1.0000	.00000
HOLDCUCU	.24215	1.7691	.00000	1.0000	.00000
TOM	.26932	1.6472	.00000	1.0000	.00000
HOLDTOM	.19692	2.0195	.00000	1.0000	.00000
PEAC	.21566	1.8848	.00000	1.0000	.00000
HOLDPEA	.13805	2.4894	.00000	1.0000	.00000
NECT	.15600	2.3260	.00000	1.0000	.00000
HOLDNEC	.07411	3.5347	.00000	1.0000	.00000
LIM	.08742	3.2309	.00000	1.0000	.00000

Summary for Replication 20 of 20

Project: THESIS
Analyst: PAUL BERNASCONI

Run execution date : 3/ 5/19..
Model revision date: 3/ 5/19..

Replication ended at time : 386.881

TALLY VARIABLES

Identifier	Average	Variation	Minimum	Maximum	Observations
FLOWTIME	28.200	.96198	.11383	98.882	170
HOST SIZE 50	27.856	.93534	.11383	96.946	64
HOST SIZE 100	29.747	.95355	.22638	98.882	64
HOST SIZE 150	24.942	1.0134	.49612	84.403	28
HOST SIZE 200	36.782	1.0106	3.4414	91.267	9
HOST SIZE 250	15.595	.84402	8.4420	38.759	5

DISCRETE-CHANGE VARIABLES

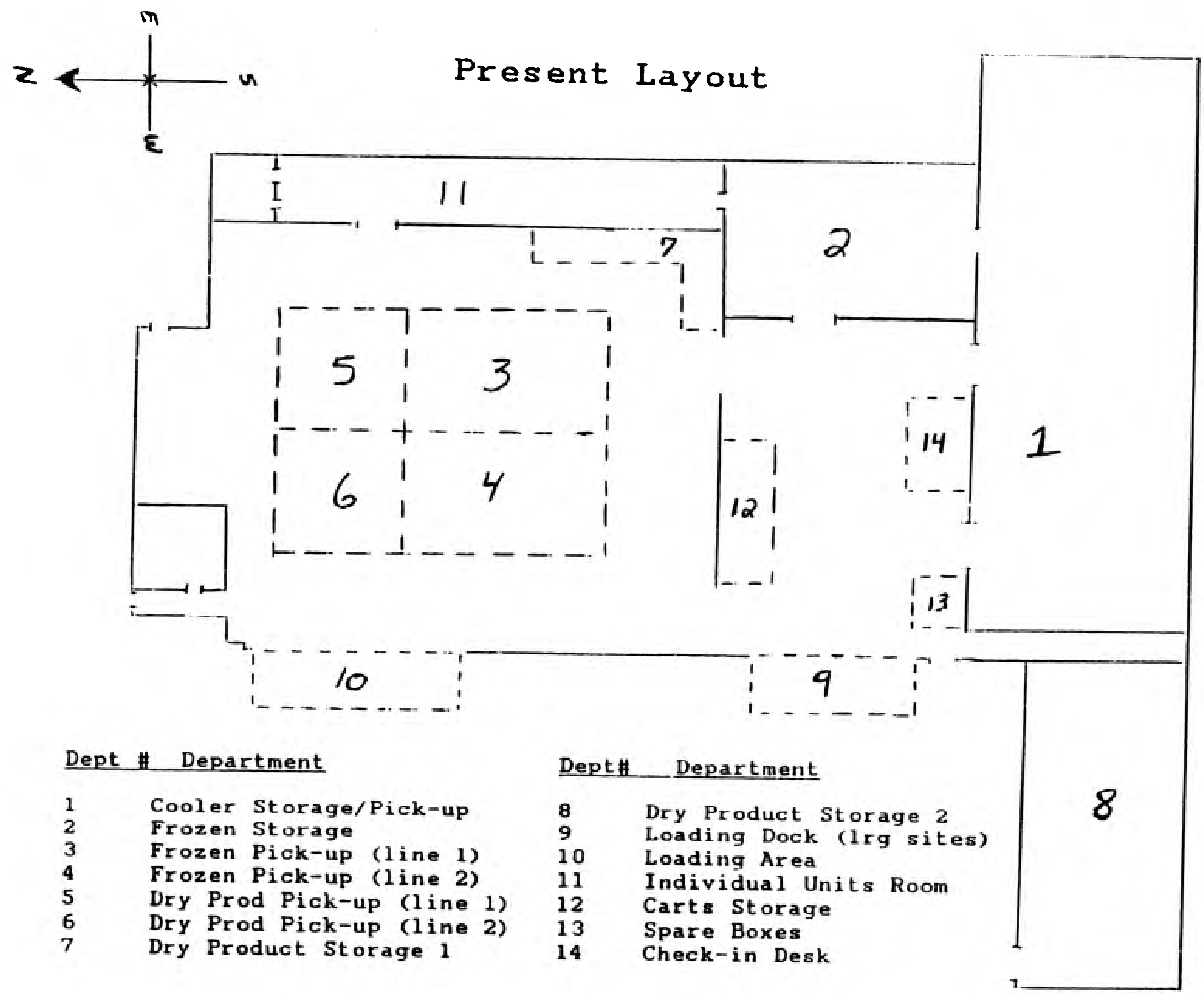
Identifier	Average	Variation	Minimum	Maximum	Final Value
CERE	.00000	--	.00000	.00000	.00000
HOLDCERE	.27370	1.6290	.00000	1.0000	.00000
NOODL	.60433	2.5548	.00000	8.0000	.00000
HOLDNOODL	.37503	2.0195	.00000	2.0000	.00000
CHICK	1.0204	1.3189	.00000	3.0000	.00000
HOLDCHICK	.35043	1.3613	.00000	1.0000	.00000
HOLDGNDTK	.00000	--	.00000	.00000	.00000
HOLDTKYHM	.31770	1.4655	.00000	1.0000	.00000
BUTT	1.0344	1.3338	.00000	3.0000	.00000
HOLDBUTT	.31399	1.4781	.00000	1.0000	.00000
FIS	.37102	1.3020	.00000	1.0000	.00000
HOLDFIS	.27747	1.6137	.00000	1.0000	.00000
APPL	.65243	1.4100	.00000	2.0000	.00000
HOLDAPP	.26331	1.6714	.00000	1.0000	.00000
POT	.62636	1.4640	.00000	2.0000	.00000
HOLDPOTa	.24093	1.7750	.00000	1.0000	.00000
ONI	.57453	1.5466	.00000	2.0000	.00000
HOLDONI	.22165	1.8739	.00000	1.0000	.00000
PEP	.55513	1.5843	.00000	2.0000	.00000
HOLDPEP	.20423	1.9739	.00000	1.0000	.00000
CUC	.25223	1.7213	.00000	1.0000	.00000
HOLDCUCU	.17629	2.1616	.00000	1.0000	.00000
TOM	.22484	1.8568	.00000	1.0000	.00000
HOLDTOM	.14759	2.4033	.00000	1.0000	.00000
PEAC	.18838	2.0757	.00000	1.0000	.00000
HOLDPEA	.10991	2.3453	.00000	1.0000	.00000
NECT	.14243	2.4438	.00000	1.0000	.00000
HOLDNEC	.05592	3.7922	.00000	1.0000	.00000
LIM	.08593	3.2636	.00000	1.0000	.00000

Run Time: 3 min(s) 37 sec(s)
Simulation run complete.

APPENDIX 5

Layout Design

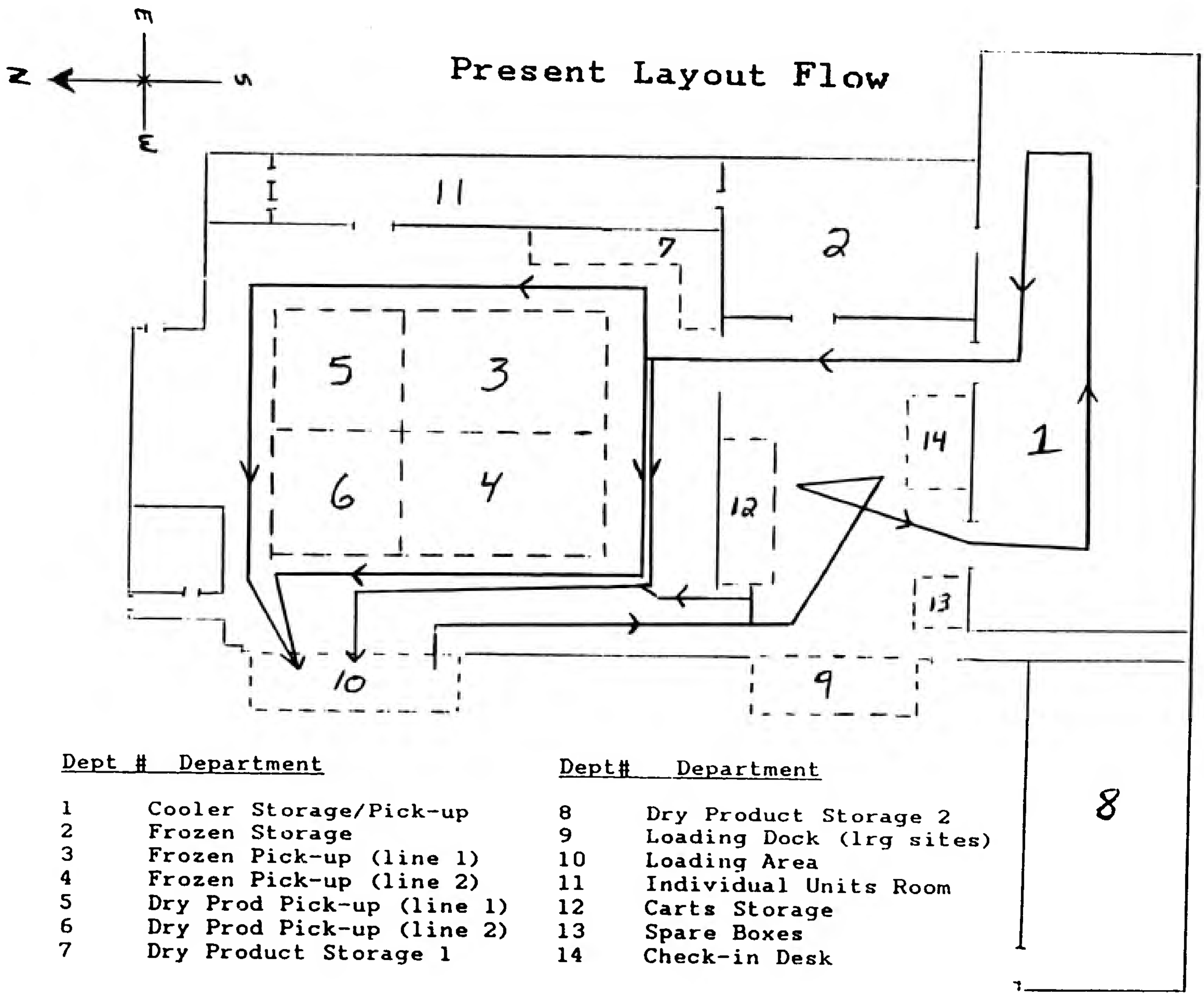
Present Layout



Dept #	Department
1	Cooler Storage/Pick-up
2	Frozen Storage
3	Frozen Pick-up (line 1)
4	Frozen Pick-up (line 2)
5	Dry Prod Pick-up (line 1)
6	Dry Prod Pick-up (line 2)
7	Dry Product Storage 1

Dept#	Department
8	Dry Product Storage 2
9	Loading Dock (lrg sites)
10	Loading Area
11	Individual Units Room
12	Carts Storage
13	Spare Boxes
14	Check-in Desk

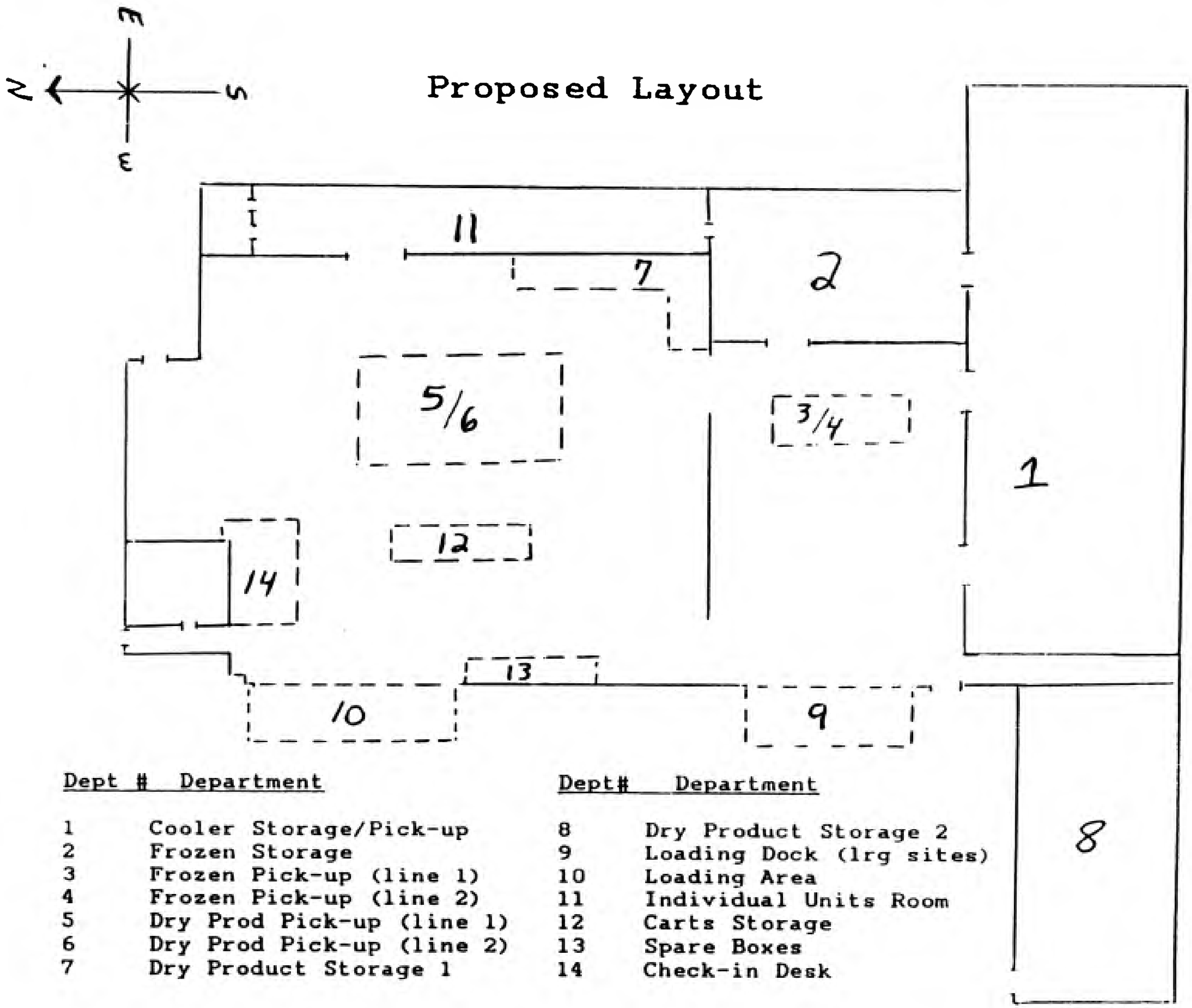
Present Layout Flow



Dept #	Department
1	Cooler Storage/Pick-up
2	Frozen Storage
3	Frozen Pick-up (line 1)
4	Frozen Pick-up (line 2)
5	Dry Prod Pick-up (line 1)
6	Dry Prod Pick-up (line 2)
7	Dry Product Storage 1

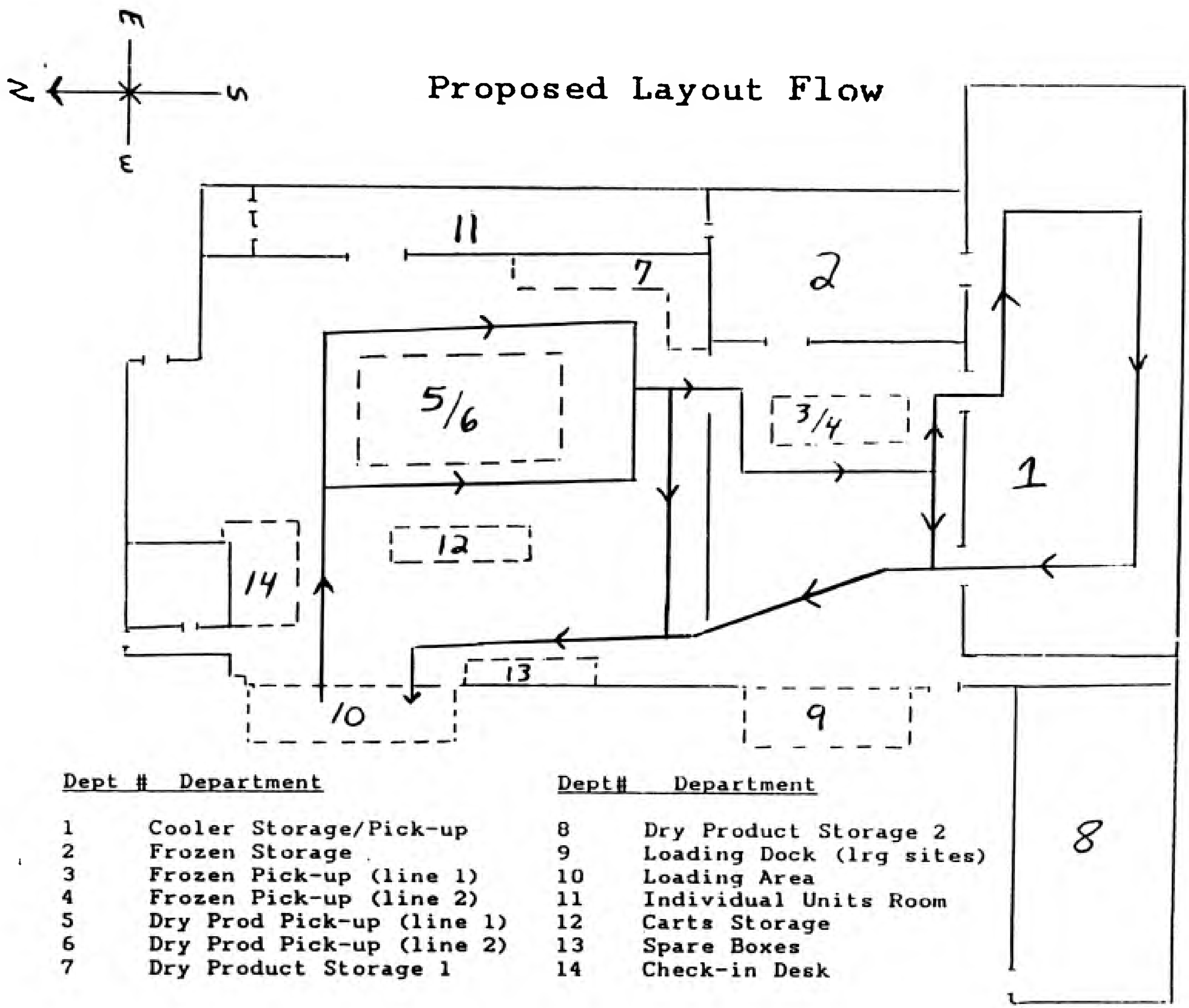
Dept#	Department
8	Dry Product Storage 2
9	Loading Dock (lrg sites)
10	Loading Area
11	Individual Units Room
12	Carts Storage
13	Spare Boxes
14	Check-in Desk

Proposed Layout



Dept #	Department	Dept#	Department
1	Cooler Storage/Pick-up	8	Dry Product Storage 2
2	Frozen Storage	9	Loading Dock (lrg sites)
3	Frozen Pick-up (line 1)	10	Loading Area
4	Frozen Pick-up (line 2)	11	Individual Units Room
5	Dry Prod Pick-up (line 1)	12	Carts Storage
6	Dry Prod Pick-up (line 2)	13	Spare Boxes
7	Dry Product Storage 1	14	Check-in Desk

Proposed Layout Flow



Dept #	Department
1	Cooler Storage/Pick-up
2	Frozen Storage
3	Frozen Pick-up (line 1)
4	Frozen Pick-up (line 2)
5	Dry Prod Pick-up (line 1)
6	Dry Prod Pick-up (line 2)
7	Dry Product Storage 1

Dept#	Department
8	Dry Product Storage 2
9	Loading Dock (lrg sites)
10	Loading Area
11	Individual Units Room
12	Carts Storage
13	Spare Boxes
14	Check-in Desk

APPENDIX 6

I.I.E. Micro-Software Data and Output: Present Layout

```
              PLANT DESIGN
           LAYOUT EVALUATION

                 I.I.E.
             MICRO-SOFTWARE
              COPYRIGHTED


INPUT DATA
----------


NO. OF DEPTS. INVOLVED  14

  DESIRED RELATIONSHIPS
  ---------------------

RELVAL BETWEEN DEPARTMENT  1
        AND DEPARTMENT  2  =  3
        AND DEPARTMENT  3  =  4
        AND DEPARTMENT  4  =  4
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  4
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  2
        AND DEPARTMENT  3  =  5
        AND DEPARTMENT  4  =  5
        AND DEPARTMENT  5  =  2
        AND DEPARTMENT  6  =  2
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  3
        AND DEPARTMENT  4  =  6
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  2
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4

RELVAL BETWEEN DEPARTMENT  4
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  2
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  5
        AND DEPARTMENT  6  =  6
        AND DEPARTMENT  7  =  5
        AND DEPARTMENT  8  =  5
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  3
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  6
        AND DEPARTMENT  7  =  5
        AND DEPARTMENT  8  =  5
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  3
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  7
        AND DEPARTMENT  8  =  3
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  8
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  9
        AND DEPARTMENT  10  =  3
        AND DEPARTMENT  11  =  4
        AND DEPARTMENT  12  =  4
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4
```

```
RELVAL BETWEEN DEPARTMENT  10
          AND DEPARTMENT  11  =  4
          AND DEPARTMENT  12  =  4
          AND DEPARTMENT  13  =  2
          AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  11
          AND DEPARTMENT  12  =  3
          AND DEPARTMENT  13  =  2
          AND DEPARTMENT  14  =  5
RELVAL BETWEEN DEPARTMENT  12
          AND DEPARTMENT  13  =  6
          AND DEPARTMENT  14  =  6
RELVAL BETWEEN DEPARTMENT  13
          AND DEPARTMENT  14  =  6
```

```
  LAYOUT DESCRIPTION
  ------------------

DEPT.  ADJACENT DEPARTMENTS

   1      2   13   14
   2      1   12
   3      4    5    7   11
   4      3    6   10
   5      3    6   11
   6      4    5   10
   7      3
   8
   9     12   13   14
  10      4    6
  11      3    5
  12      2    9   13   14
  13      1    9   12   14
  14      1    9   12   13
```

```
PROGRAM RESULTS
---------------

            LAYOUT EQUIVALENT
            RELATIONSHIP CHART
            ------------------

BETWEEN DEPT.#   1
             AND DEPT.#   2   LAYREL=  6
             AND DEPT.#   3   LAYREL=  2
             AND DEPT.#   4   LAYREL=  2
             AND DEPT.#   5   LAYREL=  2
             AND DEPT.#   6   LAYREL=  2
             AND DEPT.#   7   LAYREL=  2
             AND DEPT.#   8   LAYREL=  2
             AND DEPT.#   9   LAYREL=  5
             AND DEPT.#  10   LAYREL=  2
             AND DEPT.#  11   LAYREL=  2
             AND DEPT.#  12   LAYREL=  5
             AND DEPT.#  13   LAYREL=  6
             AND DEPT.#  14   LAYREL=  6
BETWEEN DEPT.#   2
             AND DEPT.#   1   LAYREL=  6
             AND DEPT.#   3   LAYREL=  2
             AND DEPT.#   4   LAYREL=  2
             AND DEPT.#   5   LAYREL=  2
             AND DEPT.#   6   LAYREL=  2
             AND DEPT.#   7   LAYREL=  2
             AND DEPT.#   8   LAYREL=  2
             AND DEPT.#   9   LAYREL=  5
             AND DEPT.#  10   LAYREL=  2
             AND DEPT.#  11   LAYREL=  2
             AND DEPT.#  12   LAYREL=  6
             AND DEPT.#  13   LAYREL=  5
             AND DEPT.#  14   LAYREL=  5
BETWEEN DEPT.#   3
             AND DEPT.#   1   LAYREL=  2
             AND DEPT.#   2   LAYREL=  2
             AND DEPT.#   4   LAYREL=  6
             AND DEPT.#   5   LAYREL=  6
             AND DEPT.#   6   LAYREL=  5
             AND DEPT.#   7   LAYREL=  6
             AND DEPT.#   8   LAYREL=  2
             AND DEPT.#   9   LAYREL=  2
             AND DEPT.#  10   LAYREL=  5
             AND DEPT.#  11   LAYREL=  6
             AND DEPT.#  12   LAYREL=  2
             AND DEPT.#  13   LAYREL=  2
             AND DEPT.#  14   LAYREL=  2
```

```
BETWEEN DEPT.#   4
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  6
              AND DEPT.#  5  LAYREL=  5
              AND DEPT.#  6  LAYREL=  6
              AND DEPT.#  7  LAYREL=  5
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  6
              AND DEPT.#  11  LAYREL=  5
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#   5
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  6
              AND DEPT.#  4  LAYREL=  5
              AND DEPT.#  6  LAYREL=  6
              AND DEPT.#  7  LAYREL=  5
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  5
              AND DEPT.#  11  LAYREL=  6
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#   6
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  5
              AND DEPT.#  4  LAYREL=  6
              AND DEPT.#  5  LAYREL=  6
              AND DEPT.#  7  LAYREL=  4
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  6
              AND DEPT.#  11  LAYREL=  5
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#   7
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  6
              AND DEPT.#  4  LAYREL=  5
              AND DEPT.#  5  LAYREL=  5
              AND DEPT.#  6  LAYREL=  4
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  4
              AND DEPT.#  11  LAYREL=  5
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
```

```
BETWEEN DEPT.#   8
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  2
              AND DEPT.#  4  LAYREL=  2
              AND DEPT.#  5  LAYREL=  2
              AND DEPT.#  6  LAYREL=  2
              AND DEPT.#  7  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  2
              AND DEPT.#  11  LAYREL=  2
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#   9
              AND DEPT.#  1  LAYREL=  5
              AND DEPT.#  2  LAYREL=  5
              AND DEPT.#  3  LAYREL=  2
              AND DEPT.#  4  LAYREL=  2
              AND DEPT.#  5  LAYREL=  2
              AND DEPT.#  6  LAYREL=  2
              AND DEPT.#  7  LAYREL=  2
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  10  LAYREL=  2
              AND DEPT.#  11  LAYREL=  2
              AND DEPT.#  12  LAYREL=  6
              AND DEPT.#  13  LAYREL=  6
              AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#   10
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  5
              AND DEPT.#  4  LAYREL=  6
              AND DEPT.#  5  LAYREL=  5
              AND DEPT.#  6  LAYREL=  6
              AND DEPT.#  7  LAYREL=  4
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  11  LAYREL=  4
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#   11
              AND DEPT.#  1  LAYREL=  2
              AND DEPT.#  2  LAYREL=  2
              AND DEPT.#  3  LAYREL=  6
              AND DEPT.#  4  LAYREL=  5
              AND DEPT.#  5  LAYREL=  6
              AND DEPT.#  6  LAYREL=  5
              AND DEPT.#  7  LAYREL=  5
              AND DEPT.#  8  LAYREL=  2
              AND DEPT.#  9  LAYREL=  2
              AND DEPT.#  10  LAYREL=  4
              AND DEPT.#  12  LAYREL=  2
              AND DEPT.#  13  LAYREL=  2
              AND DEPT.#  14  LAYREL=  2
```

```
BETWEEN DEPT.#  12
          AND DEPT.#  1  LAYREL=  5
          AND DEPT.#  2  LAYREL=  6
          AND DEPT.#  3  LAYREL=  2
          AND DEPT.#  4  LAYREL=  2
          AND DEPT.#  5  LAYREL=  2
          AND DEPT.#  6  LAYREL=  2
          AND DEPT.#  7  LAYREL=  2
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  6
          AND DEPT.#  10  LAYREL=  2
          AND DEPT.#  11  LAYREL=  2
          AND DEPT.#  13  LAYREL=  6
          AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  13
          AND DEPT.#  1  LAYREL=  6
          AND DEPT.#  2  LAYREL=  5
          AND DEPT.#  3  LAYREL=  2
          AND DEPT.#  4  LAYREL=  2
          AND DEPT.#  5  LAYREL=  2
          AND DEPT.#  6  LAYREL=  2
          AND DEPT.#  7  LAYREL=  2
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  6
          AND DEPT.#  10  LAYREL=  2
          AND DEPT.#  11  LAYREL=  2
          AND DEPT.#  12  LAYREL=  6
          AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  14
          AND DEPT.#  1  LAYREL=  6
          AND DEPT.#  2  LAYREL=  5
          AND DEPT.#  3  LAYREL=  2
          AND DEPT.#  4  LAYREL=  2
          AND DEPT.#  5  LAYREL=  2
          AND DEPT.#  6  LAYREL=  2
          AND DEPT.#  7  LAYREL=  2
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  6
          AND DEPT.#  10  LAYREL=  2
          AND DEPT.#  11  LAYREL=  2
          AND DEPT.#  12  LAYREL=  6
          AND DEPT.#  13  LAYREL=  6
```

```
    EVALUATION SCORING
    ------------------

FROM DEPT  1  TO DEPT  2  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  3  EVAL SCORE=  3
FROM DEPT  1  TO DEPT  4  EVAL SCORE=  3
FROM DEPT  1  TO DEPT  5  EVAL SCORE=  3
FROM DEPT  1  TO DEPT  6  EVAL SCORE=  3
FROM DEPT  1  TO DEPT  7  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  8  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  9  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  10  EVAL SCORE=  3
FROM DEPT  1  TO DEPT  11  EVAL SCORE=  4
FROM DEPT  1  TO DEPT  12  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  13  EVAL SCORE=  5
FROM DEPT  1  TO DEPT  14  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  3  EVAL SCORE=  2
FROM DEPT  2  TO DEPT  4  EVAL SCORE=  2
FROM DEPT  2  TO DEPT  5  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  6  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  7  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  8  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  9  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  10  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  11  EVAL SCORE=  4
FROM DEPT  2  TO DEPT  12  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  13  EVAL SCORE=  5
FROM DEPT  2  TO DEPT  14  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  4  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  5  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  6  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  7  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  8  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  9  EVAL SCORE=  3
FROM DEPT  3  TO DEPT  10  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  11  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  12  EVAL SCORE=  4
FROM DEPT  3  TO DEPT  13  EVAL SCORE=  5
FROM DEPT  3  TO DEPT  14  EVAL SCORE=  3
FROM DEPT  4  TO DEPT  5  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  6  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  7  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  8  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  9  EVAL SCORE=  3
FROM DEPT  4  TO DEPT  10  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  11  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  12  EVAL SCORE=  4
FROM DEPT  4  TO DEPT  13  EVAL SCORE=  5
FROM DEPT  4  TO DEPT  14  EVAL SCORE=  3
```

```
FROM DEPT 5  TO DEPT 6  EVAL SCORE= 5
FROM DEPT 5  TO DEPT 7  EVAL SCORE= 5
FROM DEPT 5  TO DEPT 8  EVAL SCORE= 2
FROM DEPT 5  TO DEPT 9  EVAL SCORE= 3
FROM DEPT 5  TO DEPT 10  EVAL SCORE= 5
FROM DEPT 5  TO DEPT 11  EVAL SCORE= 5
FROM DEPT 5  TO DEPT 12  EVAL SCORE= 4
FROM DEPT 5  TO DEPT 13  EVAL SCORE= 4
FROM DEPT 5  TO DEPT 14  EVAL SCORE= 3
FROM DEPT 6  TO DEPT 7  EVAL SCORE= 4
FROM DEPT 6  TO DEPT 8  EVAL SCORE= 2
FROM DEPT 6  TO DEPT 9  EVAL SCORE= 3
FROM DEPT 6  TO DEPT 10  EVAL SCORE= 5
FROM DEPT 6  TO DEPT 11  EVAL SCORE= 5
FROM DEPT 6  TO DEPT 12  EVAL SCORE= 4
FROM DEPT 6  TO DEPT 13  EVAL SCORE= 4
FROM DEPT 6  TO DEPT 14  EVAL SCORE= 3
FROM DEPT 7  TO DEPT 8  EVAL SCORE= 4
FROM DEPT 7  TO DEPT 9  EVAL SCORE= 4
FROM DEPT 7  TO DEPT 10  EVAL SCORE= 5
FROM DEPT 7  TO DEPT 11  EVAL SCORE= 5
FROM DEPT 7  TO DEPT 12  EVAL SCORE= 5
FROM DEPT 7  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 7  TO DEPT 14  EVAL SCORE= 5
FROM DEPT 8  TO DEPT 9  EVAL SCORE= 4
FROM DEPT 8  TO DEPT 10  EVAL SCORE= 5
FROM DEPT 8  TO DEPT 11  EVAL SCORE= 4
FROM DEPT 8  TO DEPT 12  EVAL SCORE= 5
FROM DEPT 8  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 8  TO DEPT 14  EVAL SCORE= 5
FROM DEPT 9  TO DEPT 10  EVAL SCORE= 4
FROM DEPT 9  TO DEPT 11  EVAL SCORE= 3
FROM DEPT 9  TO DEPT 12  EVAL SCORE= 5
FROM DEPT 9  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 9  TO DEPT 14  EVAL SCORE= 5
FROM DEPT 10  TO DEPT 11  EVAL SCORE= 5
FROM DEPT 10  TO DEPT 12  EVAL SCORE= 3
FROM DEPT 10  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 10  TO DEPT 14  EVAL SCORE= 3
FROM DEPT 11  TO DEPT 12  EVAL SCORE= 4
FROM DEPT 11  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 11  TO DEPT 14  EVAL SCORE= 2
FROM DEPT 12  TO DEPT 13  EVAL SCORE= 5
FROM DEPT 12  TO DEPT 14  EVAL SCORE= 5
FROM DEPT 13  TO DEPT 14  EVAL SCORE= 5
```

```
A TOTAL EVALUATION SCORE OF    393
      OUT OF
A MAXIMUM OF 455  WAS COMPUTED.

IF THE FOLLOWING DEPTS.
BECAME CLOSER ---

        DEPT.  2  & DEPT.  3
        DEPT.  2  & DEPT.  4
        DEPT.  5  & DEPT.  8
        DEPT.  6  & DEPT.  8
        DEPT.  11  & DEPT.  14

THIS WOULD INCREASE THE TOTAL
EVALUATION SCORE TO  408
OUT OF A POSSIBLE MAXIMUM OF  455


IF THE FOLLOWING DEPTS.
BECAME CLOSER ---

        DEPT.  1  & DEPT.  3
        DEPT.  1  & DEPT.  4
        DEPT.  1  & DEPT.  5
        DEPT.  1  & DEPT.  6
        DEPT.  1  & DEPT.  10
        DEPT.  3  & DEPT.  9
        DEPT.  3  & DEPT.  14
        DEPT.  4  & DEPT.  9
        DEPT.  4  & DEPT.  14
        DEPT.  5  & DEPT.  9
        DEPT.  5  & DEPT.  14
        DEPT.  6  & DEPT.  9
        DEPT.  6  & DEPT.  14
        DEPT.  9  & DEPT.  11
        DEPT.  10  & DEPT.  12
        DEPT.  10  & DEPT.  14

THIS WOULD INCREASE THE TOTAL
EVALUATION SCORE TO  425
OUT OF A POSSIBLE MAXIMUM OF  455
```

```
IF THE FOLLOWING DEPTS.
BECAME CLOSER ---

        DEPT.  1  & DEPT.  11
        DEPT.  2  & DEPT.  11
        DEPT.  3  & DEPT.  12
        DEPT.  4  & DEPT.  12
        DEPT.  5  & DEPT.  12
        DEPT.  5  & DEPT.  13
        DEPT.  6  & DEPT.  7
        DEPT.  6  & DEPT.  12
        DEPT.  6  & DEPT.  13
        DEPT.  7  & DEPT.  8
        DEPT.  7  & DEPT.  9
        DEPT.  8  & DEPT.  9
        DEPT.  8  & DEPT.  11
        DEPT.  9  & DEPT.  10
        DEPT.  11  & DEPT.  12

THIS WOULD INCREASE THE TOTAL
EVALUATION SCORE TO  408
OUT OF A POSSIBLE MAXIMUM OF  455
```

APPENDIX 7

I.I.E. Micro-Software Data and Output: Proposed Layout

```
        PLANT DESIGN
     LAYOUT EVALUATION

           I.I.E.
       MICRO-SOFTWARE
         COPYRIGHTED


INPUT DATA
----------

NO. OF DEPTS. INVOLVED  14

  DESIRED RELATIONSHIPS
  ---------------------

RELVAL BETWEEN DEPARTMENT  1
        AND DEPARTMENT  2  =  3
        AND DEPARTMENT  3  =  4
        AND DEPARTMENT  4  =  4
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  4
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  2
        AND DEPARTMENT  3  =  5
        AND DEPARTMENT  4  =  5
        AND DEPARTMENT  5  =  2
        AND DEPARTMENT  6  =  2
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  3
        AND DEPARTMENT  4  =  6
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  2
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  4
        AND DEPARTMENT  5  =  4
        AND DEPARTMENT  6  =  4
        AND DEPARTMENT  7  =  2
        AND DEPARTMENT  8  =  2
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  2
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  5
        AND DEPARTMENT  6  =  6
        AND DEPARTMENT  7  =  5
        AND DEPARTMENT  8  =  5
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  3
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  6
        AND DEPARTMENT  7  =  5
        AND DEPARTMENT  8  =  5
        AND DEPARTMENT  9  =  4
        AND DEPARTMENT  10  =  4
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  3
        AND DEPARTMENT  13  =  3
        AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  7
        AND DEPARTMENT  8  =  3
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  8
        AND DEPARTMENT  9  =  3
        AND DEPARTMENT  10  =  2
        AND DEPARTMENT  11  =  3
        AND DEPARTMENT  12  =  2
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  2
RELVAL BETWEEN DEPARTMENT  9
        AND DEPARTMENT  10  =  3
        AND DEPARTMENT  11  =  4
        AND DEPARTMENT  12  =  4
        AND DEPARTMENT  13  =  2
        AND DEPARTMENT  14  =  4
```

```
RELVAL BETWEEN DEPARTMENT  10
         AND DEPARTMENT  11  =  4
         AND DEPARTMENT  12  =  4
         AND DEPARTMENT  13  =  2
         AND DEPARTMENT  14  =  4
RELVAL BETWEEN DEPARTMENT  11
         AND DEPARTMENT  12  =  3
         AND DEPARTMENT  13  =  2
         AND DEPARTMENT  14  =  5
RELVAL BETWEEN DEPARTMENT  12
         AND DEPARTMENT  13  =  6
         AND DEPARTMENT  14  =  6
RELVAL BETWEEN DEPARTMENT  13
         AND DEPARTMENT  14  =  6

  LAYOUT DESCRIPTION
  ------------------

DEPT.  ADJACENT DEPARTMENTS

  1     2   3   4   9   13

  2     1   3   4

  3     1   2   4   9   13

  4     1   2   3   9   13

  5     6   7   11   12   14

  6     5   7   12   14

  7     5   6

  8

  9     1   3   4

  10    12   13   14

  11    5   6

  12    6   10   13   14

  13    10   12   14

  14    5   6   10   12   13
```

```
PROGRAM RESULTS
---------------

          LAYOUT EQUIVALENT
          RELATIONSHIP CHART
          ------------------

BETWEEN DEPT.#  1
           AND DEPT.#  2  LAYREL=  6
           AND DEPT.#  3  LAYREL=  6
           AND DEPT.#  4  LAYREL=  6
           AND DEPT.#  5  LAYREL=  4
           AND DEPT.#  6  LAYREL=  4
           AND DEPT.#  7  LAYREL=  3
           AND DEPT.#  8  LAYREL=  2
           AND DEPT.#  9  LAYREL=  6
           AND DEPT.#  10  LAYREL=  5
           AND DEPT.#  11  LAYREL=  3
           AND DEPT.#  12  LAYREL=  5
           AND DEPT.#  13  LAYREL=  6
           AND DEPT.#  14  LAYREL=  5
BETWEEN DEPT.#  2
           AND DEPT.#  1  LAYREL=  6
           AND DEPT.#  3  LAYREL=  6
           AND DEPT.#  4  LAYREL=  6
           AND DEPT.#  5  LAYREL=  3
           AND DEPT.#  6  LAYREL=  3
           AND DEPT.#  7  LAYREL=  2
           AND DEPT.#  8  LAYREL=  2
           AND DEPT.#  9  LAYREL=  5
           AND DEPT.#  10  LAYREL=  4
           AND DEPT.#  11  LAYREL=  2
           AND DEPT.#  12  LAYREL=  4
           AND DEPT.#  13  LAYREL=  5
           AND DEPT.#  14  LAYREL=  4
BETWEEN DEPT.#  3
           AND DEPT.#  1  LAYREL=  6
           AND DEPT.#  2  LAYREL=  6
           AND DEPT.#  4  LAYREL=  6
           AND DEPT.#  5  LAYREL=  4
           AND DEPT.#  6  LAYREL=  4
           AND DEPT.#  7  LAYREL=  3
           AND DEPT.#  8  LAYREL=  2
           AND DEPT.#  9  LAYREL=  6
           AND DEPT.#  10  LAYREL=  5
           AND DEPT.#  11  LAYREL=  3
           AND DEPT.#  12  LAYREL=  5
           AND DEPT.#  13  LAYREL=  6
           AND DEPT.#  14  LAYREL=  5
```

PROGRAM RESULTS

LAYOUT EQUIVALENT RELATIONSHIP CHART

```
BETWEEN DEPT.#  1
            AND DEPT.#  2  LAYREL=  6
            AND DEPT.#  3  LAYREL=  6
            AND DEPT.#  4  LAYREL=  6
            AND DEPT.#  5  LAYREL=  4
            AND DEPT.#  6  LAYREL=  4
            AND DEPT.#  7  LAYREL=  3
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  6
            AND DEPT.#  10  LAYREL=  5
            AND DEPT.#  11  LAYREL=  3
            AND DEPT.#  12  LAYREL=  5
            AND DEPT.#  13  LAYREL=  6
            AND DEPT.#  14  LAYREL=  5
BETWEEN DEPT.#  2
            AND DEPT.#  1  LAYREL=  6
            AND DEPT.#  3  LAYREL=  6
            AND DEPT.#  4  LAYREL=  6
            AND DEPT.#  5  LAYREL=  3
            AND DEPT.#  6  LAYREL=  3
            AND DEPT.#  7  LAYREL=  2
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  5
            AND DEPT.#  10  LAYREL=  4
            AND DEPT.#  11  LAYREL=  2
            AND DEPT.#  12  LAYREL=  4
            AND DEPT.#  13  LAYREL=  5
            AND DEPT.#  14  LAYREL=  4
BETWEEN DEPT.#  3
            AND DEPT.#  1  LAYREL=  6
            AND DEPT.#  2  LAYREL=  6
            AND DEPT.#  4  LAYREL=  6
            AND DEPT.#  5  LAYREL=  4
            AND DEPT.#  6  LAYREL=  4
            AND DEPT.#  7  LAYREL=  3
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  6
            AND DEPT.#  10  LAYREL=  5
            AND DEPT.#  11  LAYREL=  3
            AND DEPT.#  12  LAYREL=  5
            AND DEPT.#  13  LAYREL=  6
            AND DEPT.#  14  LAYREL=  5
BETWEEN DEPT.#  4
            AND DEPT.#  1  LAYREL=  6
            AND DEPT.#  2  LAYREL=  6
            AND DEPT.#  3  LAYREL=  6
            AND DEPT.#  5  LAYREL=  4
            AND DEPT.#  6  LAYREL=  4
            AND DEPT.#  7  LAYREL=  3
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  6
            AND DEPT.#  10  LAYREL=  5
            AND DEPT.#  11  LAYREL=  3
            AND DEPT.#  12  LAYREL=  5
            AND DEPT.#  13  LAYREL=  6
            AND DEPT.#  14  LAYREL=  5
BETWEEN DEPT.#  5
            AND DEPT.#  1  LAYREL=  4
            AND DEPT.#  2  LAYREL=  3
            AND DEPT.#  3  LAYREL=  4
            AND DEPT.#  4  LAYREL=  4
            AND DEPT.#  6  LAYREL=  6
            AND DEPT.#  7  LAYREL=  6
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  3
            AND DEPT.#  10  LAYREL=  5
            AND DEPT.#  11  LAYREL=  6
            AND DEPT.#  12  LAYREL=  6
            AND DEPT.#  13  LAYREL=  5
            AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  6
            AND DEPT.#  1  LAYREL=  4
            AND DEPT.#  2  LAYREL=  3
            AND DEPT.#  3  LAYREL=  4
            AND DEPT.#  4  LAYREL=  4
            AND DEPT.#  5  LAYREL=  6
            AND DEPT.#  7  LAYREL=  6
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  3
            AND DEPT.#  10  LAYREL=  5
            AND DEPT.#  11  LAYREL=  6
            AND DEPT.#  12  LAYREL=  6
            AND DEPT.#  13  LAYREL=  5
            AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  7
            AND DEPT.#  1  LAYREL=  3
            AND DEPT.#  2  LAYREL=  2
            AND DEPT.#  3  LAYREL=  3
            AND DEPT.#  4  LAYREL=  3
            AND DEPT.#  5  LAYREL=  6
            AND DEPT.#  6  LAYREL=  6
            AND DEPT.#  8  LAYREL=  2
            AND DEPT.#  9  LAYREL=  2
            AND DEPT.#  10  LAYREL=  4
            AND DEPT.#  11  LAYREL=  5
            AND DEPT.#  12  LAYREL=  5
            AND DEPT.#  13  LAYREL=  4
            AND DEPT.#  14  LAYREL=  5
```

```
BETWEEN DEPT.#  8
          AND DEPT.#  1  LAYREL=  2
          AND DEPT.#  2  LAYREL=  2
          AND DEPT.#  3  LAYREL=  2
          AND DEPT.#  4  LAYREL=  2
          AND DEPT.#  5  LAYREL=  2
          AND DEPT.#  6  LAYREL=  2
          AND DEPT.#  7  LAYREL=  2
          AND DEPT.#  9  LAYREL=  2
          AND DEPT.#  10  LAYREL=  2
          AND DEPT.#  11  LAYREL=  2
          AND DEPT.#  12  LAYREL=  2
          AND DEPT.#  13  LAYREL=  2
          AND DEPT.#  14  LAYREL=  2
BETWEEN DEPT.#  9
          AND DEPT.#  1  LAYREL=  6
          AND DEPT.#  2  LAYREL=  5
          AND DEPT.#  3  LAYREL=  6
          AND DEPT.#  4  LAYREL=  6
          AND DEPT.#  5  LAYREL=  3
          AND DEPT.#  6  LAYREL=  3
          AND DEPT.#  7  LAYREL=  2
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  10  LAYREL=  4
          AND DEPT.#  11  LAYREL=  2
          AND DEPT.#  12  LAYREL=  4
          AND DEPT.#  13  LAYREL=  5
          AND DEPT.#  14  LAYREL=  4
BETWEEN DEPT.#  10
          AND DEPT.#  1  LAYREL=  5
          AND DEPT.#  2  LAYREL=  4
          AND DEPT.#  3  LAYREL=  5
          AND DEPT.#  4  LAYREL=  5
          AND DEPT.#  5  LAYREL=  5
          AND DEPT.#  6  LAYREL=  5
          AND DEPT.#  7  LAYREL=  4
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  4
          AND DEPT.#  11  LAYREL=  4
          AND DEPT.#  12  LAYREL=  6
          AND DEPT.#  13  LAYREL=  6
          AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  11
          AND DEPT.#  1  LAYREL=  3
          AND DEPT.#  2  LAYREL=  2
          AND DEPT.#  3  LAYREL=  3
          AND DEPT.#  4  LAYREL=  3
          AND DEPT.#  5  LAYREL=  6
          AND DEPT.#  6  LAYREL=  6
          AND DEPT.#  7  LAYREL=  5
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  2
          AND DEPT.#  10  LAYREL=  4
          AND DEPT.#  12  LAYREL=  5
          AND DEPT.#  13  LAYREL=  4
          AND DEPT.#  14  LAYREL=  5
BETWEEN DEPT.#  12
          AND DEPT.#  1  LAYREL=  5
          AND DEPT.#  2  LAYREL=  4
          AND DEPT.#  3  LAYREL=  5
          AND DEPT.#  4  LAYREL=  5
          AND DEPT.#  5  LAYREL=  6
          AND DEPT.#  6  LAYREL=  6
          AND DEPT.#  7  LAYREL=  5
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  4
          AND DEPT.#  10  LAYREL=  6
          AND DEPT.#  11  LAYREL=  5
          AND DEPT.#  13  LAYREL=  6
          AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  13
          AND DEPT.#  1  LAYREL=  6
          AND DEPT.#  2  LAYREL=  5
          AND DEPT.#  3  LAYREL=  6
          AND DEPT.#  4  LAYREL=  6
          AND DEPT.#  5  LAYREL=  5
          AND DEPT.#  6  LAYREL=  5
          AND DEPT.#  7  LAYREL=  4
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  5
          AND DEPT.#  10  LAYREL=  6
          AND DEPT.#  11  LAYREL=  4
          AND DEPT.#  12  LAYREL=  6
          AND DEPT.#  14  LAYREL=  6
BETWEEN DEPT.#  14
          AND DEPT.#  1  LAYREL=  5
          AND DEPT.#  2  LAYREL=  4
          AND DEPT.#  3  LAYREL=  5
          AND DEPT.#  4  LAYREL=  5
          AND DEPT.#  5  LAYREL=  6
          AND DEPT.#  6  LAYREL=  6
          AND DEPT.#  7  LAYREL=  5
          AND DEPT.#  8  LAYREL=  2
          AND DEPT.#  9  LAYREL=  4
          AND DEPT.#  10  LAYREL=  6
          AND DEPT.#  11  LAYREL=  5
          AND DEPT.#  12  LAYREL=  6
          AND DEPT.#  13  LAYREL=  6
```