SHIP PRODUCTION COMMITTEE
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EDUCATION AND TRAINING

May 1999
NSRP 0557
N1-96-6

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Automated Process Application in Steel Fabrication and Subassembly Facilities; Phase I (Process Analysis)

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

Report Documentation Page	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAY 1999	**N/A**	**-**

4. TITLE AND SUBTITLE	
The National Shipbuilding Research Program, Automated Process Application in Steel Fabrication and Subassembly Facilities; Phase I (Process Analysis)	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230-Design Integration Tools Bldg 192, Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**205**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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NSRP 1-96-6

AUTOMATED PROCESS APPLICATION IN STEEL FABRICATION AND SUBASSEMBLY FACILITIES PHASE I (PROCESS ANALYSIS)

A PROJECT OF

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

FOR

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

SHIP PRODUCTION COMMITTEE

SP-1 FACILITIES AND ENVIRONMENTAL EFFECTS PANEL

BY

NATIONAL STEEL AND SHIPBUILDING CO.

SAN DIEGO, CA

JULY 1998

Final Report

NSRP 1-96-6

Automated Process Application in Steel Fabrication and Subassembly Facilities

Phase I
(Process Analysis)

Contract Number N00167-94-H-0038

A project of

The National Shipbuilding Research Program

for

The Society of Naval Architects and Marine Engineers

Ship Production Committee

SP-1 Facilities and Environmental Effects Panel

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National Steel and Shipbuilding Co.
San Diego, CA

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July 1998

Table of Contents

EXECUTIVE SUMMARY

In an effort to produce cost competitive ships in a time of reduced Defense spending and dominance of the world commercial market by foreign yards, the American shipbuilding industry is investigating methods which will streamline production and reduce fabrication and assembly times. One such method is the introduction of automation into steel fabrication and subassembly processes. Many of the processes in these areas are both labor intensive and repetitive, characteristics which are ideally suited to be handled by automation. The drawback, however, is the capital cost associated with automation, especially when it is not known whether the automation will produce a positive return on the investment dollar. Computer simulation is being used in other manufacturing industries, world-wide, to gain insight into how the introduction of new resources affects the company's current manufacturing capabilities and whether or not the new resources will produce a positive return on investment. The objective of this project is to utilize computer simulation to provide American shipyards with a method of determining which of their specific processes, in steel fabrication and subassembly, are likely candidates for automation and to what degree.

The project is divided into two phases. In Phase I, the modeled yard, National Steel and Shipbuilding Company (NASSCO), was used to define and understand existing 'As-Is' steel subassembly and fabrication processes. Once defined, a computer simulation software package was selected to model the processes. The models were then used to identify bottlenecks and constraints in the system which could be potential areas for automation. In Phase II of the project, new, 'To-Be' models will be created which will include automation to reduce or eliminate the constraints in the system. The 'To-Be' and 'As-Is' models will be compared in an effort to determine the effect automation has on the performance of the system and Return on Investment (ROI). The performance of the 'To-Be' models will also be benchmarked against the performance of "world class" shipyards with similar automation to measure the degree to which the automation may make American yards more competitive in the commercial market.

This is the Phase I Final Report. It details the approach taken by the NASSCO project team to carry out the Phase I portion of this project from researching how to initiate a successful computer simulation project to the analysis of the 'As-Is' models for bottlenecks and constraints. The report contains information on simulation software, NASSCO's preparation for a simulation project, the process steps which should be followed when conducting a simulation project, and the approach taken to analyze the simulation models. Decision points and the logic applied by the project team at those points is included throughout this report to help the reader to gain insight into why or why not the same reasoning may be applicable to his or her yard. A general overview of computer simulation modeling is included as an appendix for those who may have little or no experience in this area. NASSCO's 'Simulation Specification', which became the guiding plan for the project, is included with this report to provide the first-time simulation project team with an idea of what is needed when subcontracting the services of a simulation consultant and the scope of work involved when the decision is made to utilize computer simulation.

Two models, the Profile Fabrication Area and the Panel Line, are used in this report to take the reader through the analysis of a simulation model for bottlenecks and constraints. From this analysis, it has been determined that the constraints in the Profile Fabrication Area ultimately become the manpower and space available for the fabrication of profiles. Automation, such as a robotic profile cutter, may eliminate these constraints by providing a higher throughput from a smaller workarea. The bottlenecks in the Panel Line are the one-sided welding operations, the stiffener fitting operations, and the web weldout process. Automation, such as robotic fitting and welding machines, may be utilized to increase throughput in these areas. These automated options will be investigated in Phase II.

Computer simulation is proving to be a valuable tool in this project. It not only allows the team to forecast the effect of future changes to the system's performance, but provides a means to focus attention on the strengths and weaknesses of the current process. The key to success in both cases is the proper planning of the project including the development of clear objectives. Without taking these measures the project can easily become sidetracked due to excessive model detail and unclear goals. Such experiences tend to foster undue negative feelings toward new tools such as computer simulation. Properly prepared for, however, computer simulation can achieve the same success in the American shipbuilding industry as it has seen in industries such as automotive, defense, medical, and electronics manufacturing.

GLOSSARY OF TERMS

CM	Cutting Machine
MT	Manufactured T-beam
NASSCO	National Steel and Shipbuilding
NC	Numerical Control
NSRP	National Shipbuilding Research Program
ROI	Return on Investment
SLNC	Sealift New Construction
SOC 1	Stage of Construction 1 - Steel Fabrication
SOC 2	Stage of Construction 2 - Subassembly
SOC 3	Stage of Construction 3 - Assembly
WIP	Work In Process

1.0 INTRODUCTION

The principal objective of this National Shipbuilding Research Program (NSRP) project is to develop a methodology to identify specific shipbuilding processes within steel fabrication and subassembly that are good candidates for automation, and to determine the degree and mix of automation which will have the best overall effect on the defined areas. The core of the methodology is a "what if" type analysis using computer simulation models. The theory is that by using the simulation model(s), one can select an optimum mix of automation within steel fabrication and subassembly operations that will meet selected production goals.

This project has been divided into two phases, analysis of current 'As-Is' processes and comparison to 'To-Be' models incorporating automation. This report is the Phase I Final Report of this NSRP project, which was conducted by the Industrial Engineering department at National Steel and Shipbuilding Company (NASSCO) in San Diego, California. Portions of the project were performed on a contractual basis by First Marine International and by Kiran & Associates. Project participants have backgrounds in ship production, production automation, and computer simulation.

Background

To become more competitive in the world commercial market, the American shipbuilding industry must streamline current production methods to reduce span times and production costs. One of the best methods to reduce span times and production costs is to automate production processes. Automation lends itself to labor intensive repetitive processes. Steel fabrication and subassembly, the initial stages of ship production, consist of many production processes that are both labor intensive and repetitive. These two areas have great potential for the application of process automation, and are therefore the focal point of this project.

The automation of shipbuilding production processes is very capital intensive, and the interdependencies between these processes are such that extensive analysis and justification are required by management to make prudent decisions related to the application of automation. Computer simulation software is a tool that can be very beneficial in this analysis and justification. Using simulation models, various automation scenarios can be evaluated for their impact to a particular process as well as to the overall production system within a relatively short period of time and without the need to make capital expenditure. The data output from simulation models can help management to optimize their capital expenditures for process automation. For this reason, computer simulation software has been selected as the primary decision making tool for this project.

In Phase I of this project, a computer simulation model of a sample shipyard's 'As-Is' production processes for steel fabrication and steel subassembly has been created. NASSCO was used as the sample shipyard. Using the 'As-Is' simulation model, system bottlenecks, constraints, resource requirements, and throughput capacities have been defined and documented. The second phase of the project includes benchmarking activities to identify 'world class' methods and processes for steel fabrication and steel subassembly. The results of the benchmarking activities will be used to define various automation scenarios for the sample shipyard. These scenarios will be simulated by using modified versions of the original simulation model. Projected impacts to the production system for the various automation scenarios will be defined by the outputs of the simulation models. The ultimate goal of these efforts is to use the simulation results as a direct input to related cost benefits analysis.

2.0 SIMULATION OVERVIEW

Study of simulation fundamentals prior to beginning a simulation project for the first time is highly recommended.

There are numerous articles and books on the subject of computer simulation. Many of these publications can be found in college libraries. A large amount of information on simulation can be found by browsing the Internet (e.g. www.wintersim.org). Another good source of information is professional organizations. The following is a list of professional organizations that promote the application of computer simulation.

American Statistical Association (ASA)
Association for Computing Machinery / Special Interest Group on Simulation (ACM / SIGSIM)
Institute for Ops Research and the Management Sciences / College of Simulation (INFORMS / CS)
Institute of Electrical and Electronics Engineers / Computer Society (IEEE / CS)
Institute of Industrial Engineers (IIE)
National Institute of Standards and Technology (NIST)
The Society for Computer Simulation, International (SCS)

3.0 SIMULATION PROCESS STEPS

The process approach used for this project is taken from the basic steps recommended by most texts to be applied to any simulation project. These steps are illustrated by Figure 4.0-1. The overall process is iterative with activities being refined or even redefined during each cycle. Because of the iterative nature of the process, each step does not have to be carried through to completion before the next one can begin. Each of the steps is discussed in detail within the body of this report.

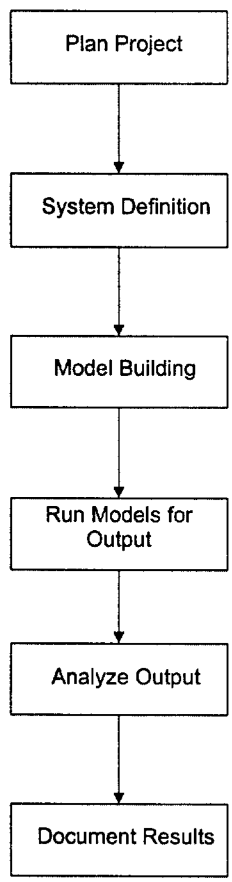


Figure 3.0-1: Simulation Modeling Steps

4.0 PLANNING THE PROJECT

Experienced simulation project participants will emphasize the necessity of good planning in any simulation study. Because of the nature of simulation modeling, it is quite possible for projects with good funding and knowledgeable personnel to fail due to poor planning. Therefore, the number one priority of the NASSCO project team was to outline a plan detailing the objectives of the simulation study and the steps which would be taken to achieve those objectives. This plan became the 'Simulation Specification' in Appendix B of this report.

4.1 Research

The first action taken by the NASSCO project team was to learn about computer simulation. The majority of this task was completed by attending the '96 Winter Simulation Conference. At this conference the project team learned about applications and capabilities of computer simulation. This gave the project team the knowledge needed to define the level of detail required by the model to meet the project objective. The Conference also helped the team to gain insight into the extensive consulting and software resources available in the simulation modeling community.

4.2 Simulation Software and Vendor Selection

Prior to starting a simulation project, one must select the simulation software that is going to be used for the project. There is a wide variety of simulation software packages available for purchase. The reader should make his or her own evaluation of the various simulation packages, and select the one which will best fit their needs. Discrete event simulation is normally used when modeling production processes. Therefore, the selected software package should be good at discrete event simulation. After a review of most of the available PC based simulation packages, the project team narrowed their preference to SiMPLE++ and ProModel.

Due to the magnitude and complexity of a single simulation model covering both steel fabrication and steel subassembly activities, it was determined that the required level of expertise in simulation modeling did not exist at NASSCO. Therefore, it was decided that a simulation consultant would be hired to perform all programming tasks. Just as there are numerous simulation software packages available on the market, there are also numerous simulation consultants. Most consultants will specialize with one simulation software package. Therefore, final selection of the software package was influenced by the selection of the consultant, and visa versa. The 'Simulation Specification' (Appendix B) was distributed to two simulation consultants - A & P Appledore who specializes in SiMPLE++, and Kiran and Associates who specializes in ProModel. The consultants were asked to bid on the programming portion of the project. An evaluation matrix (see Figure 4.2-1) was created to compare the two software packages and the vendor's proposals. Additional pros and cons of each software package are explained in Sections 4.2.1 and 4.2.2.

	ProModel	SiMPLE++
Software license	$16,900 includes 1st year of software maintenance.	Full development license = $29K 2000 Object License = $15K 1000 Object License = $10K Application License = $10K
Software maintenance	$2.25K per year	Depending upon the type of software license, annual maintenance fees are $1.5K, $2.3K, or $4.5K
Minimum hardware requirements	Pentium 133Mhz, 16 Mb RAM, 25 Mb Free Disk Space, 16 Mb Swap File, SVGA, Windows 3.1	Pentium 133Mhz, 64 Mb RAM, 50Mb Free Disk Space, CD ROM, 256 color w/ 1024 x 768, Windows NT
Operating system requirements	Windows 3.1 or better	Windows NT
Software training	Purchase of software includes three day training class for one person. Additional three day training sessions $ 1,100 per person.	Three day class. $1,500 per person. Not included with purchase of software.
Statistical analysis software	Included	Not included.
Hierarchical modeling used to create the overall model.	Performed external to ProModel using Visual Basic	Built in as part of the object oriented logic.
Inheritance	Limited	Built in as part of the model logic. Will reduce the time required to make model changes.
Model optimization	SimRunner optimization software included	None
Ease of software use	Very straightforward	High skill level necessary for complex models.
Software user base	Very large user base (>2500) Includes the Navy, Air Force, Army, Newport News, Boeing, Hughes, Vought, Northrop, GM, Ford, Motorola, Hewlett Packard, IBM, Sony, Caterpillar, Disney, and Anderson Consulting	Smaller user base, includes A&P Appledore, Bosch, BMW, Ciba Geigy, Ford, Hewlett Packard, IBM, John Deere, Mercedes Benz, Levi, and Nokia
Consultant	Kiran & Associates	A&P Appledore
Location of consultant	San Diego, CA	Newcastle, England
Accessibility of consultant	Local to NASSCO	20 manweeks on site else communicate by phone, fax, and e-mail
Consultant's proposed project time span	12-14 weeks	25-27 weeks
Consulting Fees	$40K - $50K using stochastic data for inputs	$205K using production data for inputs $176K using stochastic data for inputs
Consultant's knowledge of shipbuilding	None	Extensive

Figure 4.2-1: Software and Vendor Evaluation Matrix

4.2.1 Pros and Cons of SiMPLE++

The object oriented and hierarchical features of SiMPLE++ are very beneficial when creating the overall model. Each one of the individual modules is created incorporating all of the required details. The modules are then summarized into a single object within the overall model (i.e.; the single object representation of a module can be thought of as a black box with all of the related detail activities occurring within the box). This gives the user the ability to run the overall model using different combinations of the 'what if' modules, and the ability to zoom in on any of the modules to view the detail activities occurring within. However, the complexity of the software is such that in-house development of simulation models with SiMPLE++ would be limited, and therefore in all probability the utilization of the software as a tool within the shipyard would be limited as well. The level of expertise required to develop models with SiMPLE++ is reflected in the higher consulting fees.

4.2.2 Pros and Cons of ProModel

The manufacturing orientation and graphics interface of ProModel is considered to be of great value for in-house development of future simulation models. The hierarchical requirements of the overall model are achieved by using a Visual Basic interface to ProModel. The Visual Basic approach provides the same black box logic provided when using object oriented software. ProModel has a larger user base, so the exchange of tips and techniques is more prevalent. The software is very easy to work with, and therefore improves the probability of extended application within the shipyard. The purchase price and consulting fees are moderately priced. Based on these reasons, ProModel was the selected software for the project and Kiran and Associates was the selected vendor.

4.3 ProModel Basics

Once the software selection was made, it was apparent that in order to be able to provide Kiran and Associates the information necessary to build the models and to be able to draw conclusions from the output, the project team members would have to become familiar with ProModel. The basic training included with the purchase of ProModel proved to be valuable in every stage of the project.

ProModel is a discrete event simulator. Time is broken down into blocks during which events are occurring to change the system and blocks during which nothing is happening at all. Four "characteristics" of the system to be simulated need to be defined in ProModel:

- Entities
- Locations
- Path Networks
- Resources

The *entities* in ProModel are individual objects such as pieces or products which move from location to location . The entities drive the system. The *locations* are positions in the model to which entities and resources are directed. The *path networks* are the defined pathways over which the entities and resources travel. The *resources* are people or equipment which process or transport the entities. All four of these "characteristics" interact through:

- Processing
- Arrivals

The *processing* of an entity is a set of instructions for that entity. Typically the processing instructions for an entity are to capture a resource, use the resource to perform an operation on the entity, and then route it to a new location. The *arrivals* are instructions for the introduction of material (entities) into the system.

The model is further enhanced through other ProModel features:

- Variables
- Attributes
- Macros
- Shift Assignments

Variables can be set up in ProModel and used to keep track of data. They are also used for standard computer programming functions such as do loops. *Attributes* are specific details which can be assigned to an entity or location such as dimensions of a part or area of a workstation. These attributes are specific to each piece in the system and can be used for the collection of data. *Macros* perform a similar function as variables, however, in a more flexible way. The macros can represent not only a number but also a set of instructions such as a subroutine. In addition, the modeler has the added benefit of setting up the macro as "user-defined." This will allow the user of the software to enter in his or her own numbers to be utilized in the model. The input of manning and some process times in the steel fabrication and subassembly models are done using "user-defined" macros. *Shift assignments* allow the modeler to create a more accurate scenario of how the resources are utilized in the system by including lunches and breaks into the simulation time.

5.0 SYSTEM DEFINITION

The first step of the model design phase is to define the system boundary. For this project, the system boundary shall include all manufacturing processes and facilities that are directly related to steel fabrication and steel subassembly. The overall facility layout for NASSCO is shown in Figure 5.0-1. The shaded portions represent NASSCO's steel fabrication and subassembly areas. All related manufacturing processes are performed within the shaded areas.

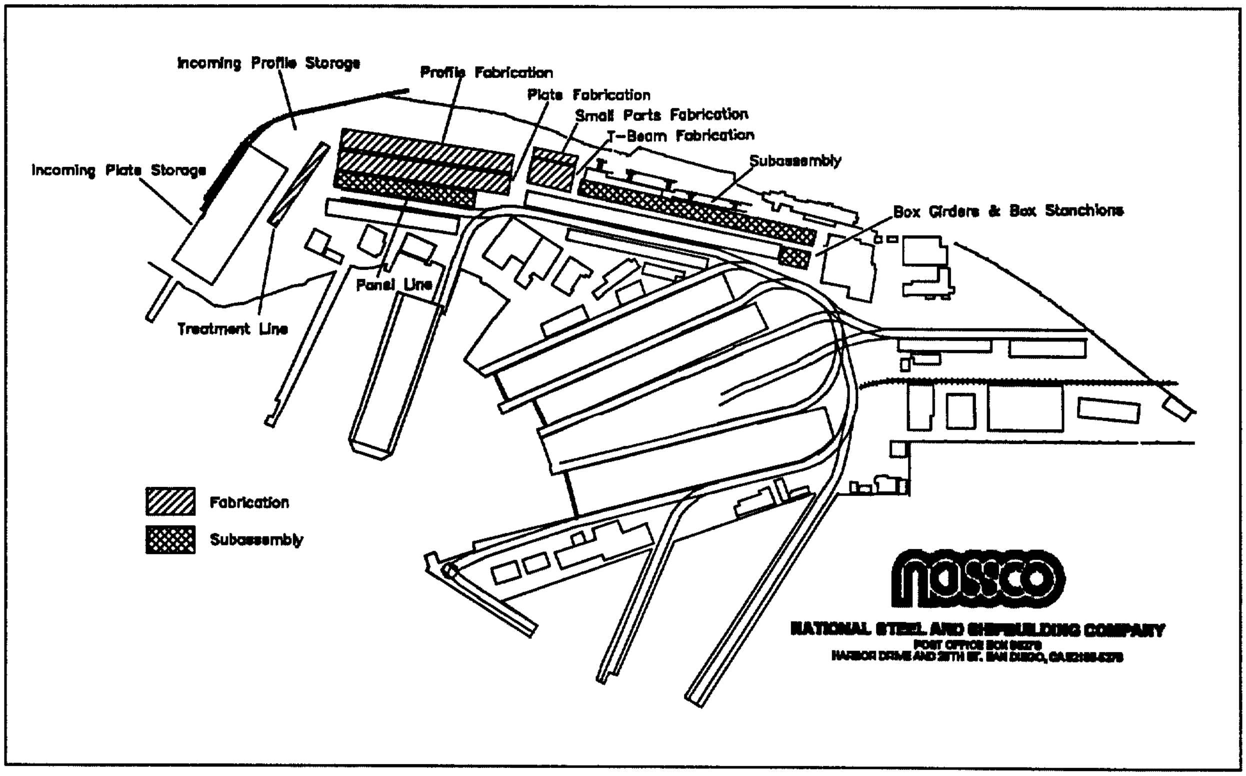


Figure 5.0-1: NASSCO Facility Layout

NASSCO's steel fabrication consists of five major areas: Treatment Line, Plate, Profile, Small Parts, and T-Beam Fabrication. NASSCO's subassembly consists of three major areas: General Subassembly, Box Girder & Box Stanchion Cell, and Panel Line. The incoming plate and profile storage areas are shown in Figure 5.0-1 to illustrate the location of external inputs to the system.

Selecting the boundary of the simulation model to include both steel fabrication and subassembly creates a problem in that, when one applies the level of detail required to truly show the impact of automation to these areas, the size of the model becomes extremely large and difficult to manage. Within the system boundary there are numerous work centers with multiple pieces of equipment, which perform various processes. In addition, there are several entity types, each of which can have numerous routings and decision points within the model.

The general concept used to simplify the simulation model as defined by this project is to break it down into a collection of modules. These modules are individual simulation models of specific areas within the system. Details of the system logic are defined within the individual modules. The outputs of one module are the inputs to another module. For example, primed plates that output from the treatment line module will be the inputs to the plate fabrication module. The completed modules are joined together into an overall model of the entire system. Interrelationships between the different modules can be seen with the overall model. This is why it is important that the computer simulation software have hierarchical capability.

Multiple variations of the individual modules will be created for the 'What If' (or 'To-Be') analysis portion of the project. Different scenarios for profile fabrication could include: adding a single robotic profile cutter, adding two robotic profile cutters, adding a robotic profile cutter and a specialized machine to cut flatbar only, etc. This will show the impact of different levels of automation within a given area. Different combinations of the 'What If' individual modules will be input into the overall model to ascertain the best mix of automation.

In the NASSCO example, the logical modules are the eight areas highlighted by Figure 5.0-1. Therefore, there will be one overall simulation model of the system consisting of eight integrated modules. Figure 5.0-2 illustrates the overall conceptual design for the NASSCO model.

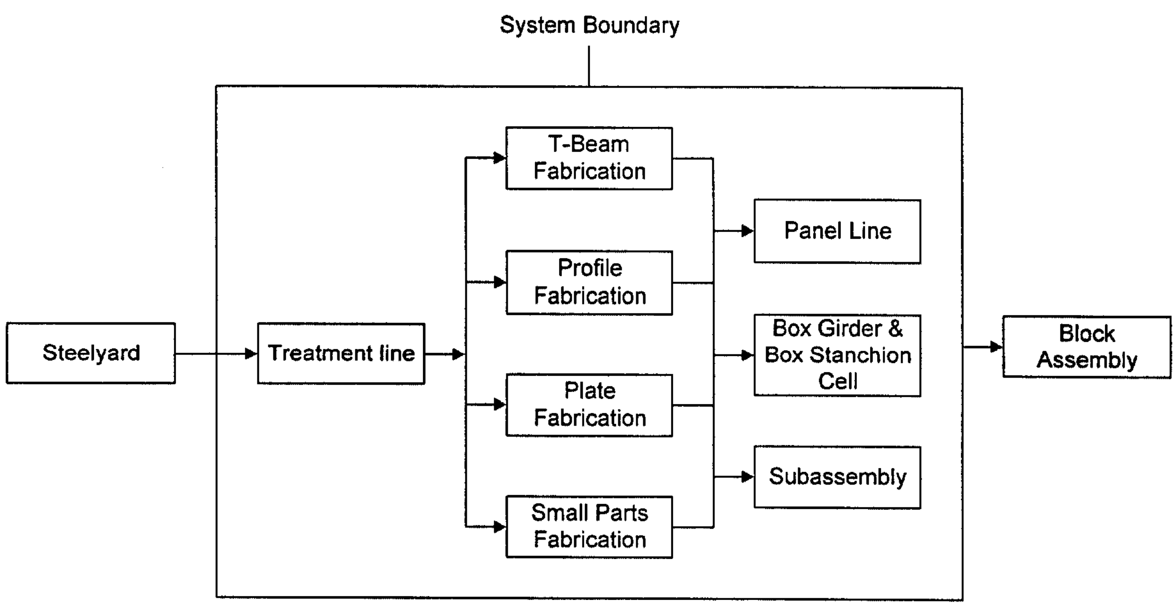


Figure 5.0-2: NASSCO Simulation Model Conceptual Design

5.1 Module Definition

Once the general system boundary has been defined, the data collecting process can begin. A good starting point for data collection is to create detailed definitions of the identified system modules. This includes creating detailed facility layouts, defining the processes performed, identifying all pieces of the processing equipment and associated parameters, defining all routings and associated logic, defining all methods of material handling, and defining all inputs and outputs of the module.

The following subsections define the different modules for the NASSCO model. This can serve as a good example for other shipyards. Although the specific details will be different for other shipyards, the processes, material handling methods, inputs, outputs, and data requirements will be very similar to the NASSCO model.

5.1.1 Treatment Line

The treatment line lies in a north/south direction and is adjacent to the steelyard. The treatment line is used to remove mill scale and to add primer to plates and profiles. The equipment consists of an input conveyor system, a shot blast unit (wheelabrator), automated spray painter & dryer, and an output conveyor system.

Plates are loaded onto the input conveyor with the steelyard crane via a transfer car and profiles are loaded onto the input conveyor with a forktruck. Plates are processed one at a time, and are typically processed on second shift. Profiles are processed in batches of up to four at a time, and are typically processed on first shift. Completed plates are delivered to the plate fabrication area with an automated material handling system (collocator car). Profiles are removed from the end of the output conveyor with a fork truck. Processed profiles are grouped together into cassettes. Fully loaded cassettes of profiles are delivered to the profile fabrication area with a log carrier. The general layout of the NASSCO treatment line is shown in Figure 5.1-1. The entities and resources involved in the system and the key requirements used in modeling the area shown in Table 5.1-1.

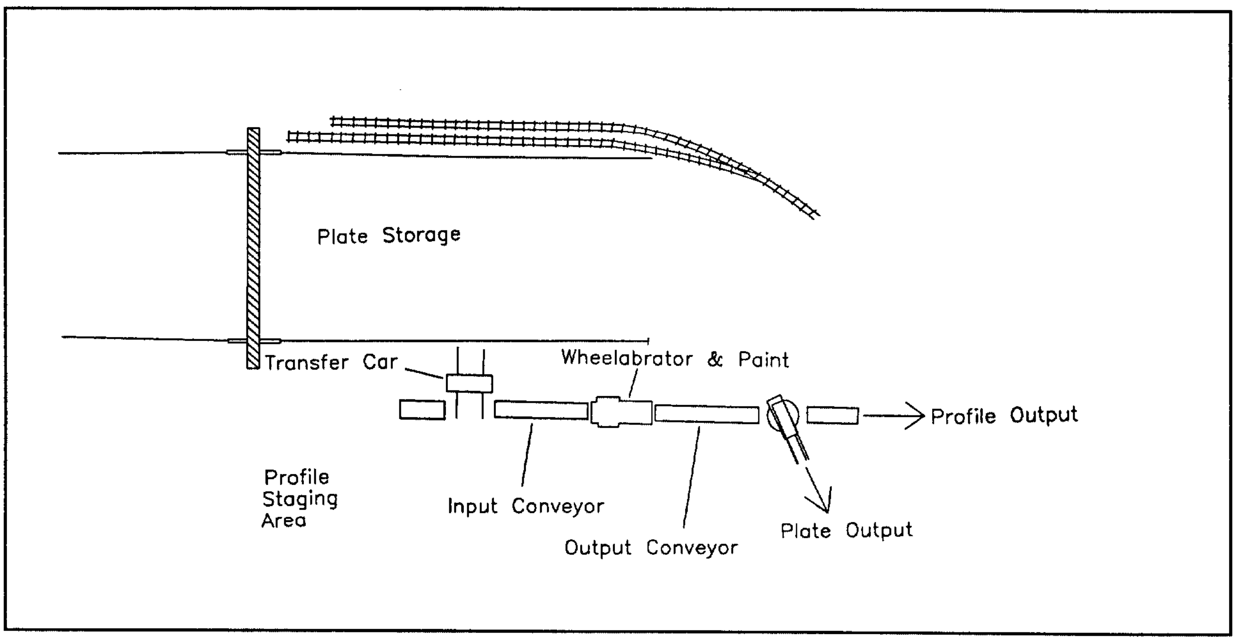


Figure 5.1-1: NASSCO Treatment Line

Entities	Attributes	Parent Entity	Arrival Rate
raw plates	size (length)	none	user defined
raw flatbar	size (length and width)	none	user defined
raw bulb flats	size (length and width)	none	user defined
raw angles	size (length and width)	none	user defined
raw T's	size (length and width)	none	user defined
raw MT's	size (length and width)	none	user defined

Resources	Key Parameters
steelyard crane	operational speed, distance traveled, and downtime
transfer car	operational speed, distance traveled, and downtime
forktruck	quantity, operational speed, and downtime
conveyor system	length, width, operational speed, and downtime
wheelabrator	downtime
painting system	downtime
collocator car	operational speed, distance traveled, and downtime
profile cassettes	quantity and capacity

Table 5.1-1: Treatment Line Entities and Resources

5.1.2 Plate Fabrication

Plate fabrication is contained within a single crane bay. The plate fabrication process consists of cutting / burning detail parts from large blank plates of primed steel.

Plate cutting operations are performed on three NC burning machines (2 plasma and 1 oxy-fuel) contained within the crane bay. Each cutting machine has two cutting heads mounted to a single gantry and four table positions. Typically one operator is required to run each of the burning machines. All plates greater than one inch thick are cut on the oxy-fuel burning machine. It is common for more than one detail part to be cut from a single plate. Processing times are a function of the marking time, cut length and cutting speed. Cutting speeds are a function of the machine type (i.e.; plasma vs. oxy-fuel) and plate thickness.

There is an area setup for manual beveling operations at one end of the bay. A percentage of the plates cut on the plasma machines are sent to the manual beveling station for additional processing. The manual beveling process consists of using hand torches mounted in tractor type devices that ride on tracks. Usually there are two workers in the manual bevel area.

There is an overhead gantry crane that services the entire crane bay. The gantry crane is responsible for all significant material handling operations. Duties include, loading and unloading the burning machines and manual bevel tables, removing excess/scrap material from the burning tables and placing it in scrap bins, and loading completed plates onto outgoing material handling devices. (Note: The burn machine operator and or a helper manually removes small pieces of scrap material and small cut parts from the cutting tables.)

Incoming material is delivered from the treatment line by automated material handling equipment (i.e.; collocator system) and stored in piles within the collocator lane. In process material is stored in piles within the crane bay. Large outgoing detail parts are loaded onto trailers or transfer cars with the overhead crane. Smaller outgoing detail parts are removed from the area by fork truck. Trucks will remove loaded scrap tubs as required. Detail parts less than eighteen feet in length are removed from the bay with forktruck. The layout of the NASSCO plate fabrication bay is shown in Figure 5.1-2. The entities and resources involved in plate fabrication are listed in Table 5.1-2.

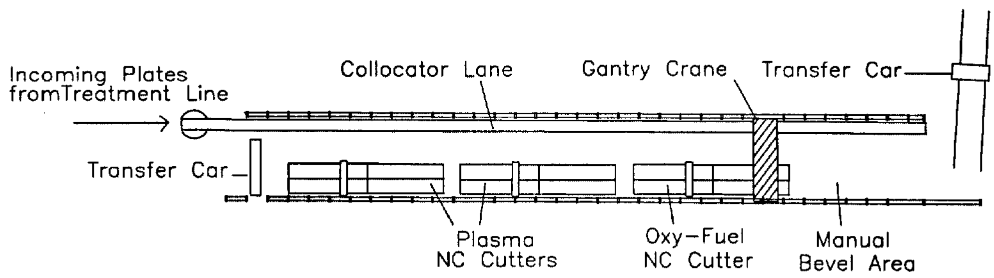


Figure 5.1-2: NASSCO Plate Fabrication

Entities	Attributes	Parent Entity	Arrival Rate
raw plates	size (thickness) cut length number of pieces in nest	none	user defined or input from treatment line
cut plate	size (length, width, thickness)	raw plate	process driven

Resources	Key Parameters
gantry crane	operational speed, distance traveled, and downtime
transfer cars	operational speed, distance traveled, and downtime
collocator car	operational speed, distance traveled, and downtime
plasma cutting machine #1	cutting speeds, setup time, gantry travel speed, and downtime
plasma cutting machine #2	cutting speeds, setup time, gantry travel speed, and downtime
oxy-fuel cutting machine	cutting speeds, setup time, gantry travel speed, and downtime
beveler (manual labor)	number of heads and efficiency
forktruck	quantity, operational speed, and downtime

Table 5.1-2: Plate Fabrication Entities and Resources

5.1.3 Profile Fabrication

Profile fabrication is performed in a single crane bay. The profile fabrication process consists of cutting / burning detail parts from long pieces of primed raw stock. The types of raw stock processed in the Profile Fabrication Area include flatbar, bulb flats, angles, and T's.

The current process is entirely manual and carried out on five rows of roller tables. The fabrication process consists of a layout and a labeling operation followed by a burning operation. The work is divided between a layout crew and a burning crew. The burning crew will follow the layout crew in a round robin fashion (a.k.a. Time Allocation Control Technique or TACT). It is typical for more than one detail part to be fabricated from a single piece of raw stock.

There is an overhead gantry crane that services profile fabrication. The gantry crane is used to load and unload the material (one piece at a time) onto the roller tables. The gantry crane is also used to remove completed parts and large end cuttings from the roller tables.

Log carriers deliver incoming material. Delivered material is in either cassettes or loaded onto carrier blocks. Large outgoing pieces are grouped by next assembly and placed into cassettes. A log carrier removes these cassettes from the area. Smaller outgoing pieces are grouped together by next assembly on pallets. Some of the smallest pieces are manually loaded onto the outgoing pallets. The pallets are removed from the area by forktruck. The layout of the NASSCO Profile Fabrication area is shown in Figure 5.1-3. The entities and resources involved in profile fabrication are shown in Table 5.1-3.

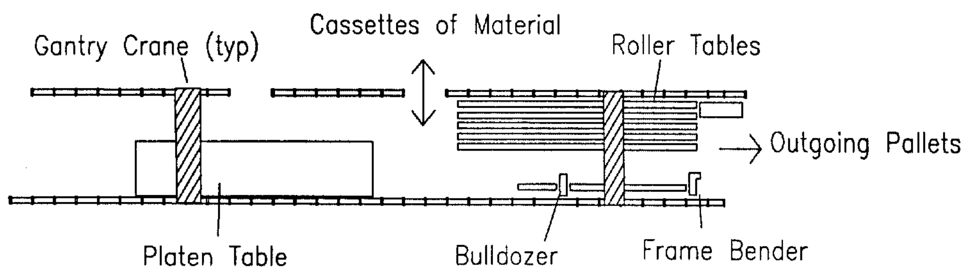


Figure 5.1-3: NASSCO Profile Fabrication

Entities	Attributes	Parent Entity	Arrival Rate
raw flatbar, bulb plates, angles, T's, & MT's	size (thickness) cut length number of pieces in nest	none	user defined or input from treatment line
cut flatbar, bulb plates, angles, T's, & MT's	size (length, width, thickness)	raw plate	process driven

Resources	Key Parameters
gantry crane	operational speed, distance traveled, and downtime
roller tables	length and number of rows
layout (manual labor)	number of heads and efficiency
burner (manual labor)	number of heads and efficiency
forktruck	quantity, operational speed, and downtime
log carrier	quantity, operational speed, and downtime
cassette	quantity, footprint and holding capacity

Table 5.1-3: Profile Fabrication Entities and Resources

5.1.4 Small Parts Fabrication

The Small Parts Fabrication Area is located in a small craneway. Small parts fabrication consists of cutting commonly used small detail parts (chocks, brackets, etc.) and production aides (wedges, padeyes, etc.)

from steel plate. Parts fabricated in this area are usually less than two-foot square in size.

This area consists of two NC burning machines. Each machine is an oxy-fuel type with multiple cutting heads. Parts cut in this area are cut in large lot sizes. Multiple copies of the same part are cut from a single plate.

Blank plates and large pieces of remnant material are delivered from the plate fabrication area with a transfer car. Incoming material is transported from the transfer car to a section of conveyor.

There are two small gantry cranes (running on the same set of tracks) that service this area. The gantry cranes are used to transfer incoming material from the incoming conveyor to a material storage area located between the two cutting machines. The gantry cranes are also used to load and unload the cutting machines.

Completed parts are grouped on pallets by part type and/or next assembly. Forktrucks remove the pallets of completed parts from the area. The layout of the Small Parts Fabrication area is shown in Figure 5.1-4. The entities and resources involved in small parts fabrication are listed in Table 5.1-4.

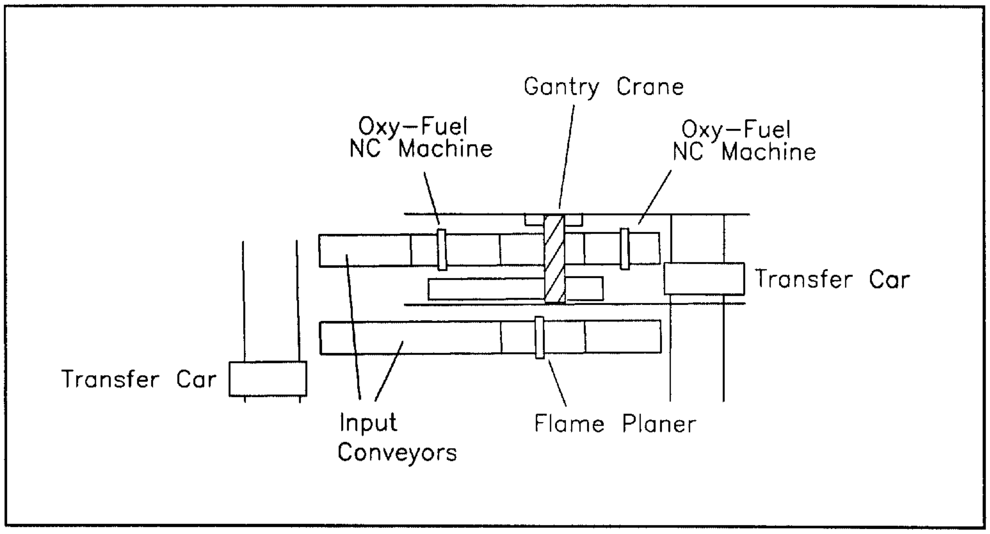


Figure 5.1-4: NASSCO Small Parts Fabrication

Entities	Attributes	Parent Entity	Arrival Rate
raw plates	size (thickness) cut length number of pieces in nest	none	user defined
cut plate	size (length, width, thickness)	raw plate	process driven

Resources	Key Parameters
gantry cranes	operational speed, distance traveled, and downtime
transfer car	operational speed, distance traveled, and downtime
oxy-fuel cutting machine #1	cutting speeds, setup time, gantry travel speed, and downtime
oxy-fuel cutting machine #2	cutting speeds, setup time, gantry travel speed, and downtime
oxy-fuel cutting machine	cutting speeds, setup time, gantry travel speed, and downtime
forktruck	quantity, operational speed, and downtime

Table 5.1-4: Small Parts Fabrication Entities and Resources

5.1.5 T-Beam Fabrication

T-beam fabrication is performed in an area adjacent to Small Parts Fabrication. There are two major pieces of processing equipment used for T-beam fabrication, a flame planer and a T-beam welder.

Unprimed plate material is delivered to the flame planer using automated material handling equipment. Plates are fed to the flame planer's input conveyor from a transfer car. The plates are then conveyed into position and cut to size by the flame planer. The stripped plates will be used for T-beam webs. The webs are conveyed from the flame planer to a second transfer car. The second transfer car will index over to the input side of the T-beam welder and feed the webs into the welder's input conveyor.

T-beam flanges are fabricated from flatbar. Long pieces of flatbar are stored in racks in the T-beam area. As required, pieces of flatbar are loaded onto sawhorses for cutting. Cutting of flatbar is performed manually with a hand held torch. Completed flange pieces are loaded into the T-beam welder's input conveyor.

The T-beam welder operator will position the web material normal to the flange prior to feeding the material into the welder. The T-beam welding process consists of passing the located web and flange pieces past two stationary welding torches. Completed T-beams output the machine onto a small section of conveyor. (Note: Completed T-beams are more commonly referred to as manufactured T's or MT's.)

There is an overhead gantry crane that services this area. The gantry crane is used to assist with the flange cutting operation, and to stack MT's onto carrier blocks. Log carriers are used to remove stacks of completed MT's from this area, and to deliver flatbar material. The layout of the T-Beam Fabrication area is shown in Figure 5.1-5. The entities and resources involved in T-Beam fabrication are shown in Table 5.1-5.

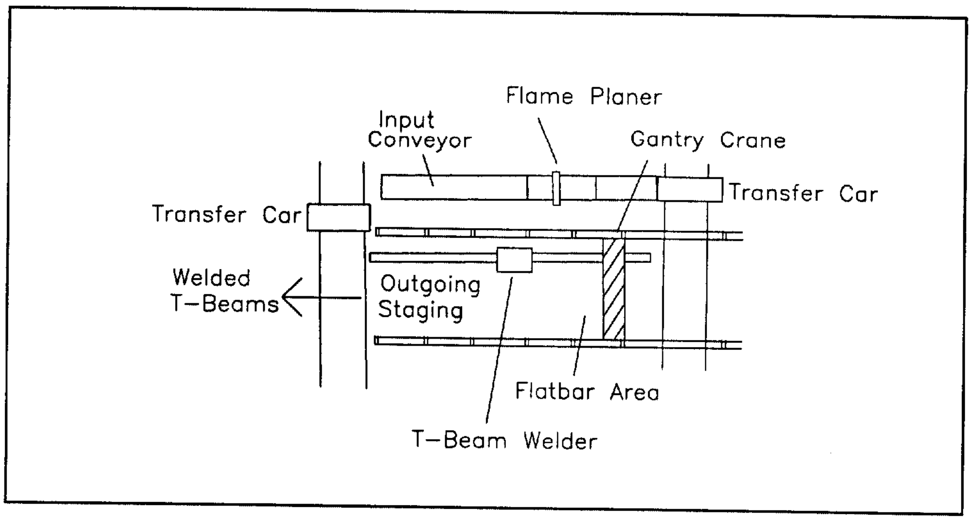


Figure 5.1-5: NASSCO T-Beam Fabrication

Entities	Attributes	Parent Entity	Arrival Rate
raw flatbar	size (thickness) cut length number of pieces in nest	none	user defined
raw plate	size (length, width, thickness	none	process driven
raw MT	size	cut flatbar cut plate	process driven

Resources	Key Parameters
gantry crane	operational speed, distance traveled, and downtime
transfer cars	operational speed, distance traveled, and downtime
flame planer	cutting speeds, setup time, and downtime
T-beam welder	setup time, welding speed, and downtime
manual labor	setup time, cutting speed, and availability
log carrier	quantity, operational speed, and downtime

Table 5.1-5: T-Beam Fabrication Entities and Resources

5.1.6 General Subassembly

General subassembly operations are contained within a long craneway located due east of the fabrication areas described above. Operations consist of the fitting and welding together of detail pieces into subassemblies.

This area is divided into a series of workcells. There are four basic types of workcells: minor subassembly, paneling, basic, and line heating. Incoming work is level loaded and grouped within these cells by subassembly type.

Small subassemblies are processed in the minor subassembly area. This area consists of two long waist high worktables. An overhead gantry crane is used to place the work material onto the tables. Fitting and welding operations are performed manually with stick and wire feed welding. There are two are jib cranes that assist with production.

The paneling area is setup to support submerged arc welding (SAW) processes. SAW processes are used mainly for seaming plates. During time periods with heavy concentrations of seaming requirements when floorspace is constrained, plates will be seamed and then transferred to another cell to complete the subassembly. During periods of lighter concentrations of seaming requirements the subassemblies are completed within the paneling area.

There are seven basic cells. Each cell contains a large work area complete with all fitting and welding utilities. All fitting operations consist of locating detail pieces in relation to one another and then tack welding them into position. The resources required for fitting operations include, stick welders, crane service, hand tools, and fitting aides. Usually only one fitter is assigned to a given subassembly. The fitting time is a function of the number of pieces, the size, and the complexity of a given subassembly. Welding operations are performed after fitting. Both manual and semi-automated process are used for welding. The number of welders assigned to a given subassembly will vary depending upon the size of the subassembly. The welding time is a function of the weld footage, weld size, and subassembly complexity.

There are four overhead gantry cranes that service the General Subassembly Area. Each of the cranes rides on the same set of rails, which extend from one end of the shop to the other. The cranes are used to assist with fitting operations, to turn workpieces, and to transport completed subassemblies to line heating and outgoing buffers.

Incoming material consists of subassembly kits (i.e. all plate and profile material for a given subassembly). Material is delivered to the shop on second shift. Material less than eighteen feet in length is delivered by forktruck. The collocator system and overhead gantry cranes deliver material greater than eighteen feet in length.

Completed subassemblies are transferred by overhead gantry crane from their build location to an outgoing buffer at the east end of the shop. A percentage of the completed subassemblies will require line heating. Line heating is performed on an acorn table located adjacent to the outgoing buffer area. Outgoing subassemblies are loaded onto trailers with the overhead gantry cranes for delivery to block assembly.

The total number of personnel assigned to the General Subassembly Area is a function of the production schedule. The layout of the General Subassembly Area is shown in Figure 5.1-6. The entities and resources involved in the subassembly process are shown in Table 5.1-6.

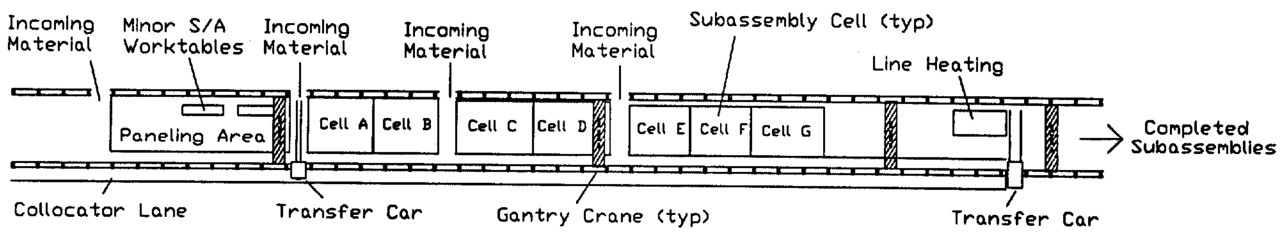


Figure 5.1-6: NASSCO General Subassembly

Entities	Attributes	Parent Entity	Arrival Rate
subassembly kits	size (laydown area) number of pieces weld footage complexity weight	cut plate cut flatbar cut bulb flat cut angles cut T's	user defined
completed subassembly	size (volume) weight	subassembly kits	process driven

Resources	Key Parameters
gantry crane	operational speed, distance traveled, and downtime
transfer cars	operational speed, distance traveled, and downtime
fitter (manual labor)	efficiency
welder (manual labor)	efficiency
line heater (manual labor)	efficiency
forktruck	quantity, operational speed, and downtime

Table 5.1-6: General Subassembly Entities and Resources

5.1.7 Box Girder & Box Stanchion Cell

Sealift New Construction (SLNC) centerline box girders and box stanchion are assembled in a dedicated cell. The cell is located at the east end of the main block assembly table.

The cell is divided into two areas, one half for box girders and one half for box stanchions. Each area consists of two stations. The first station is an assembly fixture. All fitting operations are completed in the assembly fixtures. The second station is a large open area used to complete welding operations.

There are two dedicated gantry cranes in the cell, one for each area. These cranes are used for fitting operations and to transfer subassemblies from station one to station two. The main block assembly gantry crane is required to assist with loading and unloading the box girder assembly fixture.

There is one fitter in the cell who will alternate between the two assembly fixtures. There is a group of welders that follow behind the welder to complete the subassemblies.

Incoming material less than eighteen feet in length is delivered by forktruck. The collocator system and the block assembly gantry crane deliver material greater than eighteen feet in length. Completed subassemblies are removed from the cell and delivered to block assembly with the yard's whirly gantry cranes. The layout of the Box Girder / Box Stanchion Cell is shown in Figure 5.1-7. The entities and resources involved in the fabrication of box girders and box stanchions are listed in Table 5.1-7.

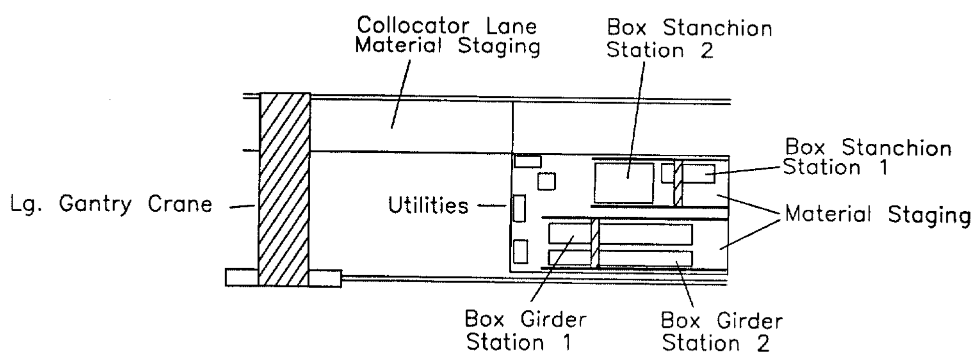


Figure 5.1-7: NASSCO Box Girder & Box Stanchion Cell

Entities	Attributes	Parent Entity	Arrival Rate
subassembly kit	size (length) number of pieces weld footage	cut plates	user defined
completed subassembly	size (length) weight	subassembly kit	process driven

Resources	Key Parameters
gantry cranes	operational speed, distance traveled, and downtime
fitter (manual labor)	number of heads and efficiency
welder (manual labor)	number of heads and efficiency
forktruck	quantity, operational speed, and downtime

Table 5.1-7: Box Girder / Box Stanchion Entities and Resources

5.1.8 Panel Line

Basic flat panels are fabricated on the Panel Line, which is located adjacent to the Plate Fabrication crane bay. The Panel Line is a series of nine stations connected by a common panel line drive system (similar to a conveyor). There is a single gantry crane that services the entire line.

Station One is the plate fitting station. Incoming plates are received from plate fabrication via a transfer car. Workers will perform some minor edge prep and then fit the incoming plate to the preceding plate. Workers use magnetic plate positioners to align and fair the plates. Deck sockets are installed in this station after all plates in a given panel have been fitted together. Deck sockets are cover-leaf patterns cut into the deck of the SLNC ships in order to lash wheeled cargo down. A bowl is attached to the underside of the deck to prevent water from spilling through the clover-leaf opening. The processing time in this station is a function of the number of plates in a panel and the number of deck sockets (if any).

Station Two is the plate seaming station. Fitted panels are fed into a one sided welder for seaming. The one sided welder can process one seam at a time. A percentage the seams will require rework. There is an inspection and repair pit immediately after the one sided welder. All rework is performed in the inspection pit. Processing time is a function of the number of seams, the length of each seam and the amount of rework.

Station Three is the layout station. Two workers will manually layout and mark the frame and longitudinal stiffener locations on the panel. In addition to layout operations, the edges of the panel are trimmed in this station. Processing time is a function of the layout and trimming times.

Station Four is the longitudinal stiffener fitting station. Log carriers deliver cassettes loaded with longitudinal stiffeners to the panel line. The cassettes are then placed in the stiffener fitting station with either the panel line gantry crane or with one of the yard's whirly gantry cranes. The panel line's gantry crane is used to remove individual stiffeners from the cassette and to position them onto the panel. Fitting aides are used to hold the stiffeners in an upright position, and the crane is released to get another stiffener. The panel is then positioned under a stiffener fitting gantry. The fitting gantry is simply a press used to squeeze out any gaps between the stiffener and the panel. As the stiffener is fitted, it is tack welded to the panel. The fitting gantry can process two stiffeners simultaneously. Processing time is a function of the number and quality of stiffeners in a panel, and the availability of the panel line gantry crane.

Station Five is the longitudinal stiffener welding station. This station consists of a gantry capable of simultaneously welding both sides of four longitudinal stiffeners. This is a fairly automated station. The only manual work consists of aligning the panels and completing wrap welds on the ends of each stiffener. Processing time is a function of the number of stiffeners and the weld lengths.

Stations Six and Seven are web fitting stations. Log carriers deliver webs to the panel line and drop them in the roadway adjacent to the line. One of the yard's whirly gantry cranes is used to place the load of webs onto to panel line. The panel line's gantry crane is then used to fit the webs into place on the panel. Various fitting aides are used for this process. The second web fitting station is simply a rate station. The number of fitters is a function of the number of webs per given panel and the desired line rate. Processing time is a function of the number of webs, the number of fitters assigned, and the availability of the panel line gantry crane.

Stations Eight and Nine are weld out stations. Each station has a service gantry with welding services for up to eight welders suspended above the work. The number of welders assigned to these stations is determined by the scheduled work content. Processing time is a function of the number of welders assigned and the total weld footage. Completed panels are removed from this station by one of the yard's whirly gantry cranes. The Panel Line layout is shown in Figure 5.1-8. The entities and resources involved in the fabrication of panels are listed in Table 5.1-8.

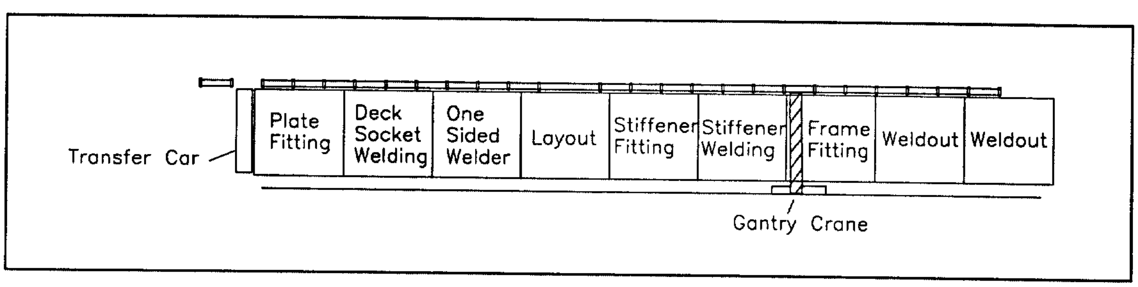


Figure 5.1-8: NASSCO Panel Line

Entities	Attributes	Parent Entity	Arrival Rate
plates	size (length)	none	input from plate fab
deck sockets	size (thickness)	none	input from storage
stiffeners	size (length)	none	input from storage
webs	size (length)	none	input from storage
panels	size (length and width)	none	none (output product)

Resources	Key Parameters
gantry cranes	operational speed, distance traveled, and downtime
fitter (manual labor)	number of heads and efficiency
welder (manual labor)	number of heads and efficiency
one-sided welder	operational speed and downtime
circular welder	operational speed, and number of machines
stiffener press	downtime
stiffener welder	operational speed, downtime, and number of stiffeners

Table 5.1-8: Panel Line Entities and Resources

5.2 Flowcharts

In addition to the module definitions, one must create process flowcharts of the entire system. The flowcharts will define the step-by-step progression of entities through the system. This includes defining the system logic, such as, material storage points, material handling rules, decision points, processing steps, etc. The flowcharts will communicate the system logic to a model developer.

Appendix D contains a copy of the NASSCO model overall flowchart. Originally, a flowchart was created for each of the different simulation modules. The separate flowcharts were then combined into an overall flowchart to show the interrelationships between the different areas. A narrative supplement was also created for the NASSCO model for further clarification to the model developer.

6.0 MODEL BUILDING

Once the processes to be modeled are defined, the actual building of the models can begin. Some general guidelines for the building of the model were established by the NASSCO project team. These guidelines not only addressed the general setup of the model, but also user interfaces, the type of data which was to be collected, and how that data was to be used in the model. During the building of the model additional data was collected, and the models were verified and validated by comparing the output to actual performance data.

6.1 Model Specifics

The following specifics were created by the NASSCO project team as basic guidelines for creating the simulation models.

- For development purposes, the individual modules were created in such a manner that they could be executed without input from other system modules. This reduced the confusion during the 'As-Is' model development and validation steps.

- Facilities outside the system boundary were defined but not modeled explicitly. In the NASSCO model, raw material is introduced to the system from the steelyard. The arrival rate and attributes of raw material entering the system is controlled by user defined functions. Completed detail parts and subassemblies, which are routed to block assembly (SOC 3), simply exit the system.

- Physical processes, such as cutting plates, within the system boundary were modeled to a level which provided an accurate analysis of the time and resources required.

- Material handling processes, such as transporting WIP by crane, were modeled to a level which provided an accurate analysis of the time and resources required.

- In process storage locations were modeled. This is required to show the effect that process and material handling changes have on WIP levels.

- Labor was also included in the model. Personnel are either dedicated (assigned to a specific station) or floating (not assigned to a specific station). Labor was divided into trade classes (e.g.; machine operator, layout, burner, fitter, welder, etc.)

- Resources within the model consist of physical processing equipment (cutting machines, welding units, etc.), material handling equipment (conveyors, fork trucks, cranes, log carriers, etc.), and labor (machine operators, fitters, welders, etc.).

- Downtime of resources is modeled. Downtime includes scheduled and unscheduled downtime.

- There are a variety of entity types within the system. As these entities flow through the system, they can change from one type to another. A single entity can produce several entities as the result of a physical process (A single raw plate will produce several detail parts.). Multiple entities can be joined together to create a single entity (Individual pieces welded together to produce a single subassembly.).

- Each entity has a set of defining attributes (entity type, length, width, height, weight, etc.). These attributes are used to determine routings and processing times. Entity attributes can change as an entity flows through the model.

6.2 User Interfaces

In addition to the ability to execute the overall model, the user should be given the ability to execute any of the individual modules. The user should have the ability to modify certain model parameters. These parameters should include things such as the following:

- simulation duration (clock time)
- resource availability (shift assignments, percent downtime, etc.)
- resource quantities (number of personnel in the labor pools, number of forktrucks, etc.)
- entity attribute functions (user defined distributions)
- entity arrival rates
- physical processing times (cutting and welding speeds, etc.)

6.3 Data Collection

In the data collection phase of the project, all of the pertinent information and system logic is defined, collected and documented. Data will come from a variety of sources including, observation, production, engineering, maintenance, and quality assurance. A general rule of thumb on data collection is the more accurate the data, the more accurate the model. Only key elements that have a direct effect on the system performance are included in the model. The following is a list of the types of data required by the simulation model.

- machine capacities
- machine downtimes (planned and unplanned)
- material handling equipment (types, quantities, speeds and lifting capacities)
- arrival rates of material (scheduled throughput requirements)
- entity types
- entity attributes
- process parameters (e.g. feedrates, welding speeds, etc.)
- process logic (e.g. decision rules, resource requirements, etc.)
- location definitions (e.g. physical locations of equipment and buffers, etc.)
- path definitions (e.g. physical routings used to transport material within the system)
- labor (trade classification, number of heads, capabilities, shift assignments)

Stochastic Data

For most models it is not practical to try to use actual production data from product break down structures and production schedules as direct system inputs. The size and complexity of a simulation model using actual production data would preclude the application of PC based simulation programs. This is what MRP II systems are for. Statistics are used to represent production data within simulation models. For instance, a good source of data for plate fabrication processes is electronic files containing the NC programs used by the burning machines. From this type of file, it is quite possible to attain a complete listing of all plate sizes (i.e. length, width, and thickness) and cutting lengths from which processing times can be derived. The proper method to use this data in a simulation model is to perform statistical analysis on the data in order to define a distribution that accurately represents the data. These distributions are then used within the model to assign attributes to entities. When a raw plate entity is created (enters the system) the simulation model will assign attributes to the entity based on user defined distributions. In this way, the module emulates the real world system without having the complexity of using actual production data.

There are numerous sources of randomness within simulation models of manufacturing systems. The following is an example of some of these sources of randomness.

- interarrival times of parts or raw material
- setup and processing times
- times between failure for equipment
- repair times for equipment
- material sizes (length, width, and thickness or height)
- number of pieces per nest

It is highly recommended that a statistical analysis software package be used to assist with the data analysis. A statistical analysis package will take data in spreadsheet format and automatically fit the data to the proper distribution by performing all applicable "goodness of fit" tests. There are several such packages available on the market. Some of the simulation packages, such as ProModel, include statistical analysis software.

6.4 Verification and Validation

Before the experiments can be run, the model must be verified and validated. This process ensures that the users have complete confidence in the output of the model. Only when this is achieved will the experiment results be fully appreciated. In order to achieve this the following must be undertaken.

First, the model must be verified whereby personnel with detailed knowledge of the production system being modeled are asked to check the model behavior to ensure that it reflects the true nature of the real system. An exact representation is not necessary to pass this test but it is important to ensure that key system behavior characteristics are not neglected. In addition, the modeler performs debugging during the verification phase of the project to make sure the model and its output are running true to the way it was programmed.

Once verified, the accuracy of the model must be validated. To do this, historical real system inputs are fed into the model and the model is executed. The model outputs are then compared against a matching set of historical real system outputs. *Note: Simulation models, which take account of the variability of processes, have outputs that are statistical in nature. The model outputs will therefore have a mean value and a variance associated with that mean.* If the model results and the historical real system outputs agree to within 10% - 15% at the highest level (e.g.; total entities processed within a given module, etc.), then accuracy comparisons on a detailed level can then be made throughout. This process should start by comparing buffer contents and throughputs of each area before getting to the individual resource performances.

It is likely that the model will not pass the validation and verification tests on the first attempt. In this case the following procedure should be carried out:

- Check each of the outputs at the global level for accuracy. The *global level* outputs are the highest level products produced by the model being validated. For example, the number of profiles produced in the Profile Fabrication Area model or the number of panels assembled on the Panel Line. This will isolate the areas in which the inaccuracy is the greatest.

- Having isolated the problem area, the system and product data relevant to these process areas should be verified by revisiting the appropriate data collection points.

- Review process descriptions and assumptions about the suspect area.

- Modify the system as required and revalidate the model.

7.0 RUN MODELS FOR OUTPUT

After the models have been verified and validated, they are run to produce the process performance output. The NASSCO project team has completed the building of all eight models (plus the overall model). Two models, the Profile Fabrication Area and the Panel Line, have been included in this report to explain to the reader the analysis process used in this project. The analysis of one or more additional models may be included in the Phase II Final Report.

There were different variations of the Profile Fabrication Area and the Panel Line models which were created for the Phase I analysis:

1. A "baseline" model
2. A "high output" model
3. A "most likely operating condition" model

These variations differed only in the manning levels and material rates which were input into the model.

7.1 "Baseline" Model

The "baseline" model uses as its inputs for manning a typical level for current production rates. This is the starting point for the comparison analysis to the automated models. A comparison could be done using only the 'baseline" model, however, because of the nature of ship production this may not be the highest possible throughput which may be handled by the system nor is it necessarily the most efficient in resource utilization. Therefore, other variations of the model had to be setup in order to create a "most likely operating condition" which was representative of an efficiently run real-life process.

7.2 "High Output" Model

The "high output" model uses as its inputs for manning the highest level possible based on constraints of the system. For example, in the Profile Fabrication Area this constraint is based on the number of positions at each workstation. There are 20 positions defined in the model for the Roller Table workstation. Therefore, since each position can support only one person due to equipment and space limitations, the manning limit for the resources which work at this workstation is 20.

Increased manning in the models typically caused decreased utilization of the resources due to the fact that material was being processed during the same time span by more resources. To counteract this decreased utilization, the input rate of material into the system is also increased until the maximum utilization of the location or resource was reached. A limit of 75% to 85% utilization was used in these models (as opposed to 100%) utilization to account for Personal Fatigue and Delay (PF & D). The PF & D takes into account lunches and breaks not currently defined in the shift assignment. ProModel has the capability of defining lunches and breaks in its shift assignment, however, creating a shift assignment for a model with a large number of resources and locations such as the Profile Fabrication Area can become quite involved. A blanket assignment of the same shift to both locations and resources can be done, however, since many resources, such as overhead cranes, do not begin a break without first completing the current task, this may not be the most realistic way to set up shift assignments. Priorities can be assigned for different work stoppage scenarios, however, setting up the priorities, which are in levels from 1 to 999, for each scenario can become quite time consuming. For the purposes of this analysis the project team decided to simplify the exercise by running a 2-8-5 shift with no breaks then applying the 75% to 85% utilization limit to take into account PF & D.

7.3 "Most Likely Operating Condition" Model

When the maximum throughput and manning levels are achieved in the "high output" model any inefficiencies in the model should be addressed and corrected if possible. This results in the creation of a "most likely operating condition" model. In this model, the resources are being used at the most efficient level possible, while material being supplied to the system allows for the highest possible throughput for that manning condition. This is the model which will be used as a comparison to a "most likely operating condition" of an automated process.

8.0 OUTPUT ANALYSIS

Just as it is important to have a clear set of goals when developing the models, it is necessary to plan the analysis of the output. There are many factors which influence the conclusions that can be drawn from the output of the models. Without understanding these factors it is possible to draw wrong conclusions from good results. The modeler must have an understanding of the software and the models in order to fully appreciate the results of the simulation runs.

8.1 Analysis of The Profile Fabrication Area Model

The work done in the Profile Fabrication Area is detailed in Section 5.1.3. The material in the model is brought into the bay by straddle carrier in carrier blocks where it is placed in a storage area The arrival of the raw stock material into the storage area will become important during the running of the simulation models. By controlling the flooding or starving of the storage area with raw stock material, the output and utilization of the locations and resources can be controlled by the modeler. The individual raw stock pieces are moved into the workstation by overhead crane where it is processed by layout, burners, and in some cases, welders and ironworkers. Once the processing is complete, the material is moved out of the workstation by the overhead crane and placed in a staging location where it remains until there are enough finished pieces to warrant a move to storage. The material is brought into the system in constant batch sizes which are defined by the model user. The number of pieces from each raw stock material piece is calculated using a distribution determined by current production data. The process times for each type of raw stock are based on the average actual process times per part.

8.1.1 Analysis of The "Baseline" Model

The "baseline" model for the Profile Fabrication Area was set up using a manning level characteristic of the level currently seen in that area today. The throughput for this manning level is also similar to current performance. The manning level and the throughput are shown in Table 8.1-1.

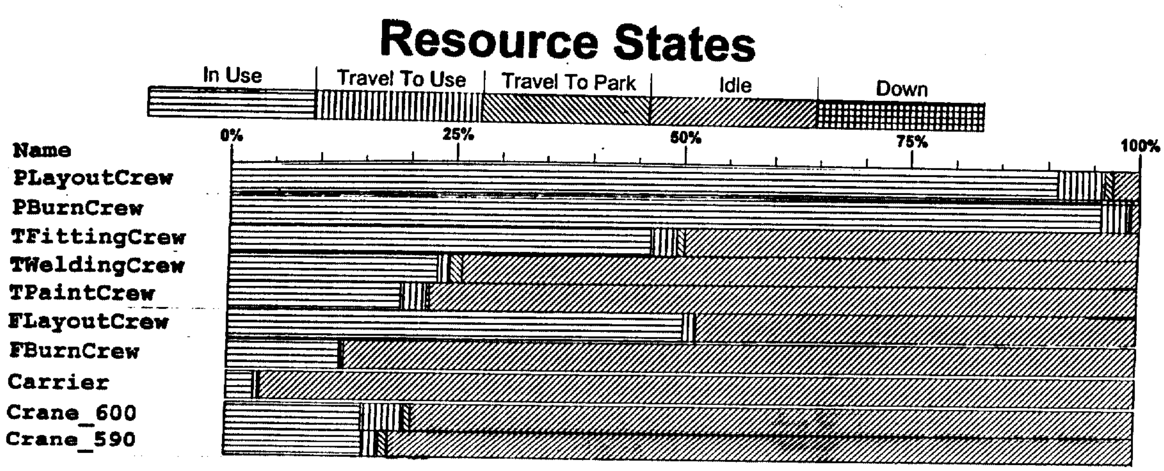
Manning	
Profile Layout Crew	3
Profile Burn Crew	5
T-Beam Fit Crew	1
Flatbar Layout Crew	3
Flatbar Burn Crew	6
T-Beam Weld Crew	2
T-Beam Paint Crew	1

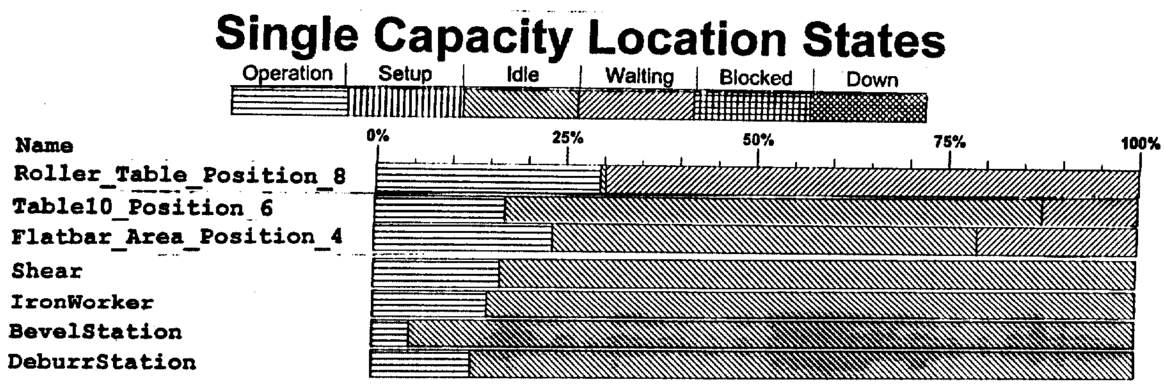
Carrier Block Arrivals Per 8 Hours	
Profiles	2
Flatbar	1
T-Beams	1

Throughput (1 Month)	
Raw Stock Profiles	699
Raw Stock Profiles Processed	683
Profile Pieces Produced	2890
Raw Stock Flatbar	624
Raw Stock Flatbar Processed	624
Flatbar Pieces Produced	4217
Raw Stock T-Beams	138
Raw Stock T-Beams Processed	134
T-Beam Pieces Produced	195

Table 8.1-1: "Baseline" Model Inputs and Throughputs

Graphs of the Resource and Location States for this simulation run are shown in Graph 8.1-1. In order to make the graphs more readable, the positions shown in the Location States for the Roller Table, Production Table 10, and Flatbar Area are only one of several positions defined for those workstations in the simulation model. A more detailed collection of the "baseline" model output statistics (including all of the resources and locations) are included in Appendix E.





Graph 8.1-1: "Baseline" Model Resource and Location States

The resource states from the simulation run show a very high usage for the profile layout crew (90%) and profile burn crew (95%). These numbers are well above the 75% to 85% usage limit that was determined based on PF & D. This basically means that the additional 15% to 20% of the work will actually have to be done on third shift or weekends which is sometimes the case in this area during peak production periods. There are two possible options to lower the resource usage to the acceptable 2-8-5 level used in the models. The amount of material being input into this area can be reduced or the manning can be increased.

The Single Capacity Location State graph shows that almost 75% of the scheduled working time for the Roller Tables is time spent waiting for resources. More people are needed in the Roller Table Workstation to process the material. A further review of the Resource States graph also shows quit a bit of idle time for the T - Welding Crew and Cranes (resources which handle the products from the roller tables). These resources, therefore, would be able to handle additional work from the roller tables if the throughput is increased due to additional manpower. Based on the high percentage of wait time for resources in the roller table area, and the ability of the downstream resources to handle the additional throughput, increasing the manning level for the roller tables seems to be the better of the two options.

The high idle times in the T-Beam Area (Production Table 10), Flatbar Area, and their associated resources suggest that additional work could be processed in these areas. Manning could also be increased since Table 8.1-1 shows that the manning is below the 9 position constraint in these areas. To determine the effects of additional manpower and material input in the Roller Table, T-Beam (Production Table 10), and Flatbar Workstations a "high output" model was created.

8.1.2 Analysis of The "High Output" Model

To see the effects of adding manpower and material input to the system the "high output" model was created in two stages. First, the manpower was increased to the maximum number of people the area could accommodate based on the number of individual positions at the workstation. Second, the amount of raw stock material entering the storage area at the beginning of the process was increased. Controlling the input of material into the storage area was used to starve or flood the system with raw stock in order to bring the throughputs and resource/location usage in line with utilization limits and realistic output data. The changes had no effect on the identification of bottlenecks or constraints in the system because the changes where made at the head of the process.

Increase in Manpower

The results of increasing the manpower at all of the workstations is shown in Table 8.1-2.

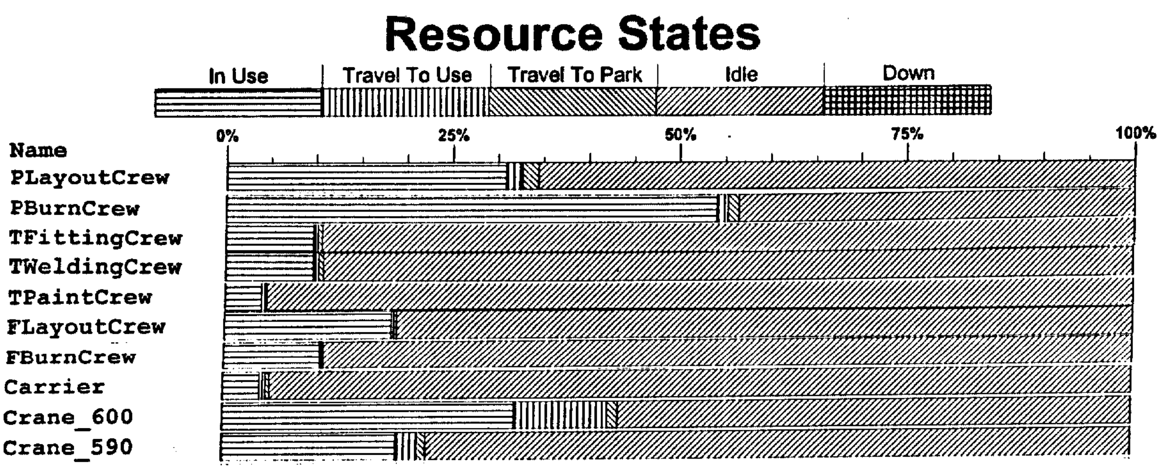
Manning	
Profile Layout Crew	20
Profile Burn Crew	20
T-Beam Fit Crew	9
Flatbar Layout Crew	9
Flatbar Burn Crew	9
T-Beam Weld Crew	9
T-Beam Paint Crew	9

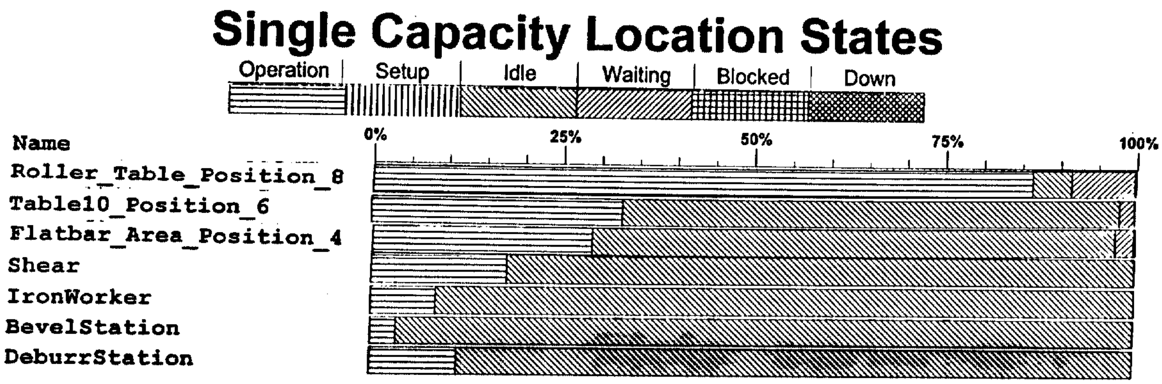
Carrier Block Arrivals Per 8 Hours	
Profiles	2
Flatbar	1
T-Beams	1

Throughput (1 Month)	
Raw Stock Profiles	1577
Raw Stock Profiles Processed	1566
Profile Pieces Produced	6232
Raw Stock Flatbar	688
Raw Stock Flatbar Processed	688
Flatbar Pieces Produced	4174
Raw Stock T-Beams	298
Raw Stock T-Beams Processed	291
T-Beam Pieces Produced	372

Table 8.1-2: "High Output" Model Inputs and Throughput for
"Increased Manpower" Condition

The Resource and Location States are shown in Graph 8.1-2. The detailed statistics for the "High Output - Increased Manpower" condition are shown in Appendix E.





Graph 8.1-2: "High Output - Increased Manpower" Model
Resource and Location States

The throughput increased dramatically by adding people to the model, which is not unexpected. With the addition of people, more work is being processed in the same amount of time.

A review of the Resource States shows that the usage of all of the resources (with the exception of the cranes) has been reduced compared to the performance of the "Baseline Condition" because the additional throughput of the system starves the storage area of raw input material. When this happens, no material is being fed into the system and the resources and locations are idle. In addition, the amount of work is spread over more people so that the average utilization per person is lower. The idle time suggests that the system can handle a further increase in material input into the storage area, thus increasing the amount of raw material available as input to the system.

The graph of the Single Capacity Location States also shows a large amount of idle time for all the locations except the Roller Table Position. The 85% usage in this area is due to a couple of factors. First, there is a greater number of profiles entering the system than T-Beams or flatbars (2 carrier blocks of profiles vs. 1 carrier block of T-Beams or flatbar, see Table 8.1-2). In addition, the Roller Table Area is used to process both profiles and T-Beams. Once processed, the profiles leave the system and the T-Beams are routed to Production Table 10 for further processing. This causes the Roller Table Workstation to have a higher volume of work than Production Table 10, Flatbar Area, Shear, Bevel Station, Deburr Station, or the Ironworker which handle a smaller batch of a single product type. Second, two functions are being performed in the Roller Table Workstation - layout and burning. Since the manning level is high enough to provide manpower when needed, the burning operations are able to begin immediately after the completion of the layout process. Therefore, the utilization of the Roller Table Positions equals the addition of the utilizations of the Profile Layout and Burning Crews. In fact, because of the high manning level this additive effect of the utilizations also occurs in the Flatbar Area and Production Table 10 (FLayout Crew + FBurn Crew = Flatbar Area Position 4 and TFitting Crew + TWelding Crew + TPaint Crew = Table 10 Position 6).

The usage of all of the workstations in the Single Capacity Location States has increased with the additional manpower (with the exception of the Ironworker station and the shear which had no increase in manning). There is some wait time for the workstations, however, the time for each workstation is relatively low and was not considered a constraint to the operations at this point. Although the usage times for the locations has increased there is still quite a bit of idle time for Production Table 10, Flatbar Area, Shear, Ironworker, Bevel Station, and Deburr Station. Therefore, the system is able to handle an increase in the amount of raw flatbar and T-Beams entering the storage area, which once again, increases the amount of raw stock input to the system.

Increase in Material to the Storage Area

The effects of increasing the amount of raw stock entering the Storage Area are shown in Table 8.1-3.

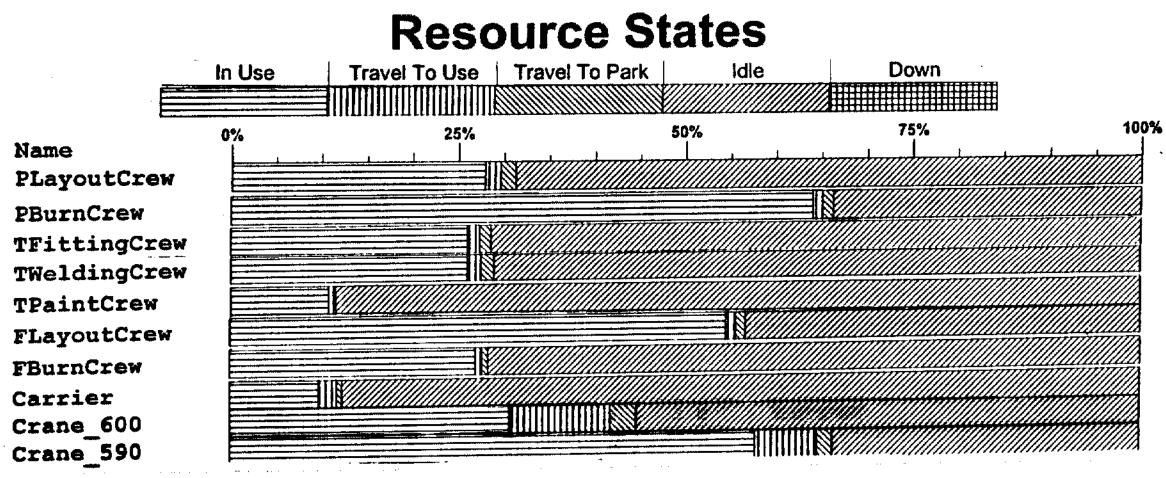
Manning	
Profile Layout Crew	20
Profile Burn Crew	20
T-Beam Fit Crew	9
Flatbar Layout Crew	9
Flatbar Burn Crew	9
T-Beam Weld Crew	9
T-Beam Paint Crew	9

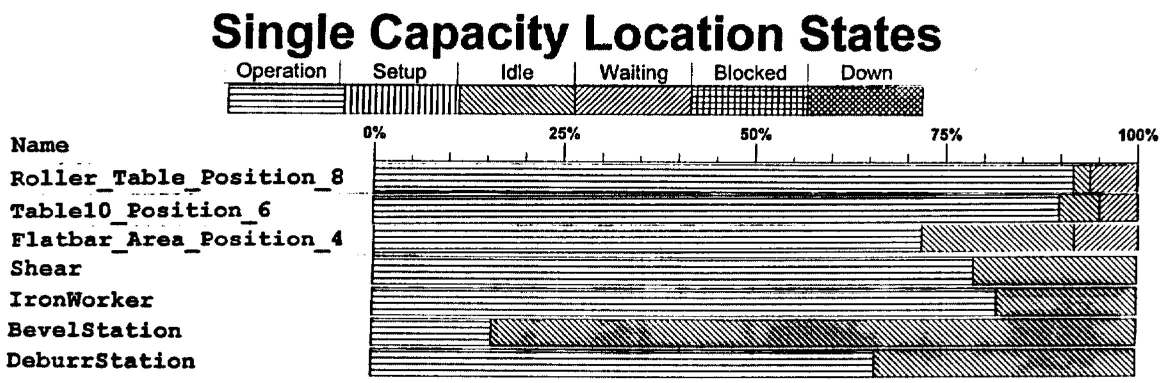
Carrier Block Arrivals Per 8 Hours	
Profiles	2
Flatbar	6
T-Beams	4

Throughput (1 Month)	
Raw Stock Profiles	984
Raw Stock Profiles Processed	981
Profile Pieces Produced	4074
Raw Stock Flatbar	2426
Raw Stock Flatbar Processed	2417
Flatbar Pieces Produced	19905
Raw Stock T-Beams	757
Raw Stock T-Beams Processed	741
T-Beam Pieces Produced	990

Table 8.1-3: "High Output" Model Inputs and Throughput for Increased Manning and Material Condition

The Resource and Location States are shown in Graph 8.1-3. The detailed statistics for the "High Output - Increased Manning and Material" condition are included in Appendix E.





Graph 8.1-3: "High Output - Increased Manning and Material" Model
Resource and Location States

Since Production Table 10 (where brackets and outfitting are added to cut T-Beams from the roller tables) has a large amount of idle time in the "increased manning" model, the decision was made to increase the amount of T-Beam raw stock which entered the system and keep the amount of profiles entering the system the same as in the "baseline" model. Only one of the two could be increased because both the profiles and T-Beams are cut on the roller tables. The increase in T-Beam raw stock creates a decrease in the profile throughput in the system. This accounts for the changes in the Profile and T-Beam throughput numbers seen in Table 8.1-3. The amount of flatbar raw stock entering the system was also increased which resulted in an increase in the throughput of flatbars in the system. Although the throughput of the system has been maximized, the Resource and Location States show that the system is not running at its most efficient level. Many of the resources are in use less than 30% of the time while the locations are operating above the 75% to 85% limit. This implies that the manning level is too high. In order to observe the effects of reducing manpower to increase the efficiency of the system the "most likely operation condition" model was created.

8.1.3 Analysis of The "Most Likely Operating Condition" Model

Although the "high output" model may produce the highest throughput for the system, it may not be the most efficient means to provide that throughput. Typically, a process should be run at a level which produces a reasonably high throughput while utilizing the resources at their highest possible efficiency. This "most likely operating condition" model was created by using the manning and material arrival rate from the "high output" model and decreasing the manpower until each resource group is operating at its most efficient level. After stepping down the resources and monitoring the output, the final results for the "most likely operating condition" model are shown in Table 8.1-4.

Manning	
Profile Layout Crew	7
Profile Burn Crew	17
T-Beam Fit Crew	3
Flatbar Layout Crew	6
Flatbar Burn Crew	3
T-Beam Weld Crew	3
T-Beam Paint Crew	2

Carrier Block Arrivals Per 8 Hours	
Profiles	2
Flatbar	6
T-Beams	4

Throughput (1 Month)	
Raw Stock Profiles	1036
Raw Stock Profiles Processed	1028
Profile Pieces Produced	3779
Raw Stock Flatbar	2019
Raw Stock Flatbar Processed	2010
Flatbar Pieces Produced	19813
Raw Stock T-Beams	788
Raw Stock T-Beams Processed	776
T-Beam Pieces Produced	977

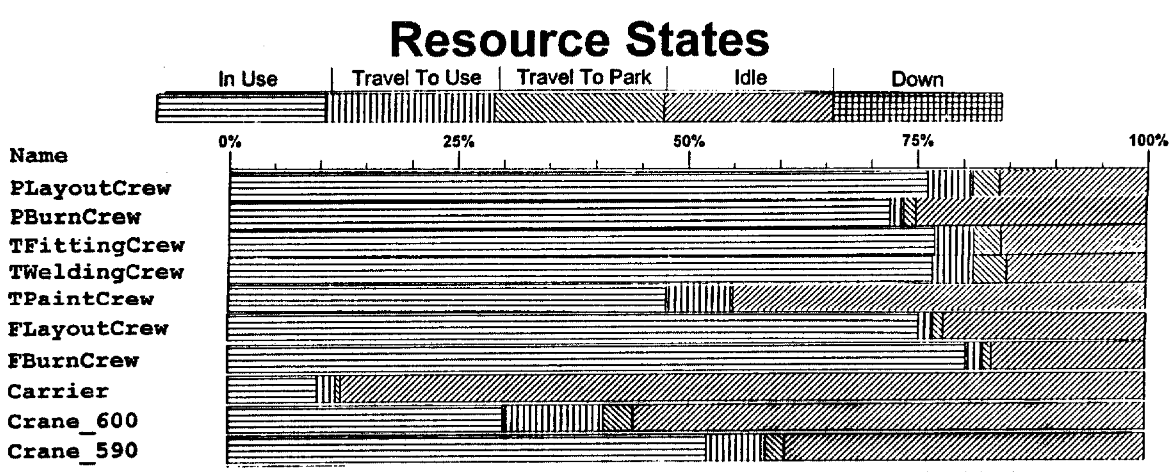
Table 8.1-4: "Most Likely Operating Condition" Model Inputs and Throughput

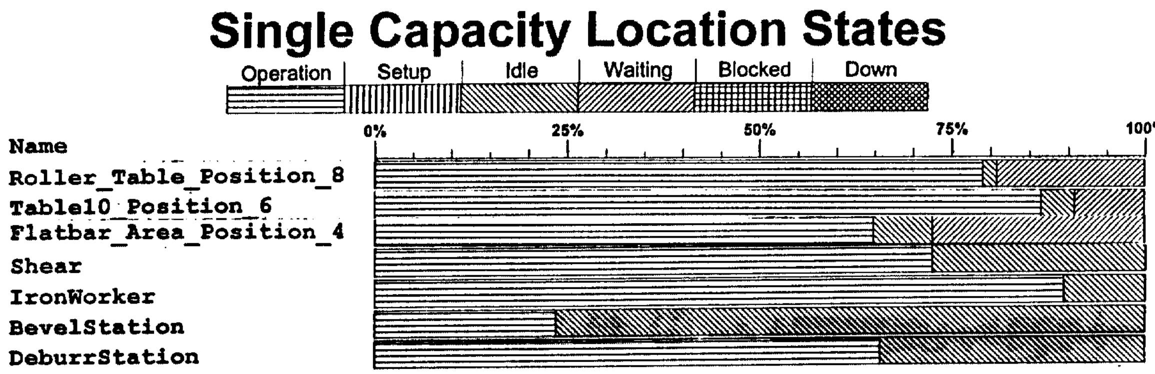
Although there was a decrease in the manning for the Profile and T-Beam areas, the input raw material being handled by the system in these areas increased by about 5%. This, at first, seems contrary to what is expected. The increase in raw material into the system may be due to the fact that the lower number of people in the system creates a better loading situation for the workstations. The timing due to the manpower level allows for more opportunities for the crane to load additional work onto the tables.

The number of profile pieces produced dropped by 8%. The reduced amount of pieces produced is probably due to a combination of reduced manpower and the statistical nature of how the model determines the number of profiles cut from each raw stock. The calculation is done using stochastic data. Therefore, the number will not be exactly the same for each run, but it should be within the defined range based on the data. In any event, these differences are less than 10%. Realizing that the simulation models are only a representation of the actual process, it can be said that these two sets of numbers are reasonably the same to those from the "high output" model, and that this is a fair representation for the throughput of the system.

The changes in the flatbar area resulted in effects which seem much more in line with what happens when you reduce manpower in an area. The amount of input raw material into the system dropped by 20% while the number of pieces produced remained about the same as in the "high output" model (once again, probably due to the stochastic data). Graph 8.1-4 indicates that there is a greater usage of the Flatbar Layout and Burn Crew, as well as, an increase in the utilization of the Flatbar Tables and Ironworker Area. This accounts for the lower material input. The work areas are too full to add the additional material. These numbers, once again, are reasonable to use for comparisons.

The Resource and Location States graphs show a much better overall usage of the resources and locations. All of which is within the 75% to 85% limits. The detailed performance statistics for the "most likely operating condition" model are included in Appendix E.





Graph 8.1-4: "Most Likely Operating Condition" Model Resource and Location States

8.1.4 Determining Constraints and Bottlenecks in the Profile Fabrication Area

Using the "most likely operating condition" model, the bottlenecks and constraints in the system are determined. The Profile Area model has only a few locations which could be potential bottlenecks by restraining material input into the next workstation where additional processing is to be done. T-Beams, which are cut on the roller tables, are also sent to Table 10 for additional processing. Some flatbars are sent from the Flatbar Area to the Ironworker for beveling, deburring, and further processing. Both the Roller Table and the Flatbar Areas have utilizations which are lower than the downstream destination for their products. Therefore, they are not bottlenecks to the system. All of the workstations have high utilizations, however, and limit additional throughput of material into the system. The constraints in this model are the amount of manpower and the space available for manufacturing.

The use of automation to eliminate these constraints will be investigated in Phase II. Preliminary research has indicated that the use of a robotic profile cutter in place of the Roller Table Workstation and Flatbar Area may be a likely option. The profile cutter would provide a high throughput in less space than what is currently being devoted to profile and flatbar processing. In addition, the manning for the area would be reduced from thirty-three people in the "most likely operating condition" model to three or four needed to run the profile cutter. The effect that the robotic profile cutter would have on the support equipment (cranes, forktrucks, etc.) and the storage areas will also be modeled in the next phase of the project.

8.2 Analysis of the Panel Line Model

The work done on the Panel Line is detailed in Section 5.2.8. The Panel Line model is based on a five plate deck panel with longitudinals, webs, and deck sockets. This is the average type of panel which is run down the line. Plates are loaded onto the line by transfer car and moved to each individual station by drive rollers. The panels are removed from the line by one of the yard's gantry cranes. The plates, stiffeners, webs, and deck socket bowls are replenished in the system as they are consumed so there is no delay in the arrival of material. The process times for each workstation are based on the actual average station time for a five panel deck plate. Because the deck sockets are able to be fitted and welded in the first three stations, they are not considered a constraint to the line move. Therefore, they are not being modeled in the Panel Line model used for this Phase of the project.

A process similar to the one used to analyze the Profile Fabrication Area was used to analyze the Panel Line models, however, only two variations of the model were created :

- A "high output" model
- A "most likely operating condition" model

The model for the Panel Line was created using data from a previous Panel Line study. This study detailed the theoretical maximum throughput of the system using current process times and manning levels for a five plate deck panel. The throughput of the actual line is lower due to inefficiencies in the process which were factored out of the theoretical "maximum," and the use of the line for doing work other than five plate panels. In addition, input material such as plates, webs, stiffeners, etc. are replenished in the modeled system as soon as it is consumed. There is no wait time for the material unless it is specified by the modeler (which will be done to create the most likely operating condition model). Because of these three factors the starting point for the Panel Line model is actually a "high output" model rather than a "baseline" model.

8.2.1 Analysis of the "High Output" Model for the Panel Line

Using the manning level and process times specified in the report the performance for one month was determined by the model and is shown in Table 8.2-1.

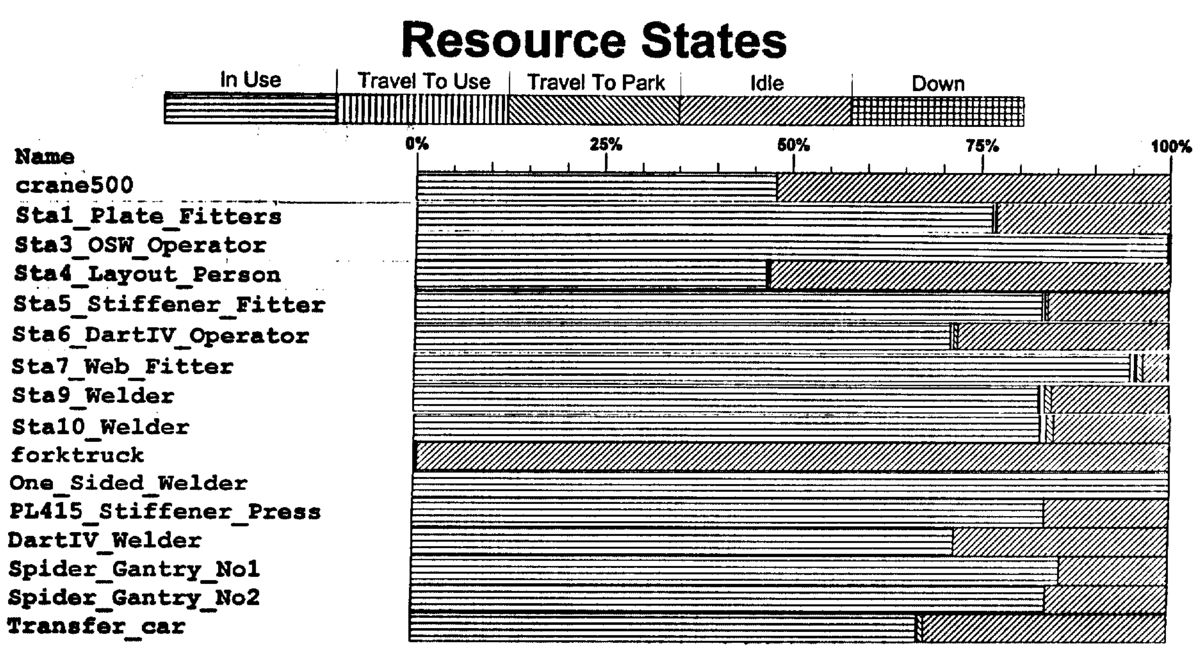
Manning	
Dk Socket Fitters	2
Dk Socket Welders	4
Stiffener Fitters	4
Web Fitters	6
Web Welders (Sta 9)	8
Web Welders (Sta 10)	8
Hold Time at Trans Car	0

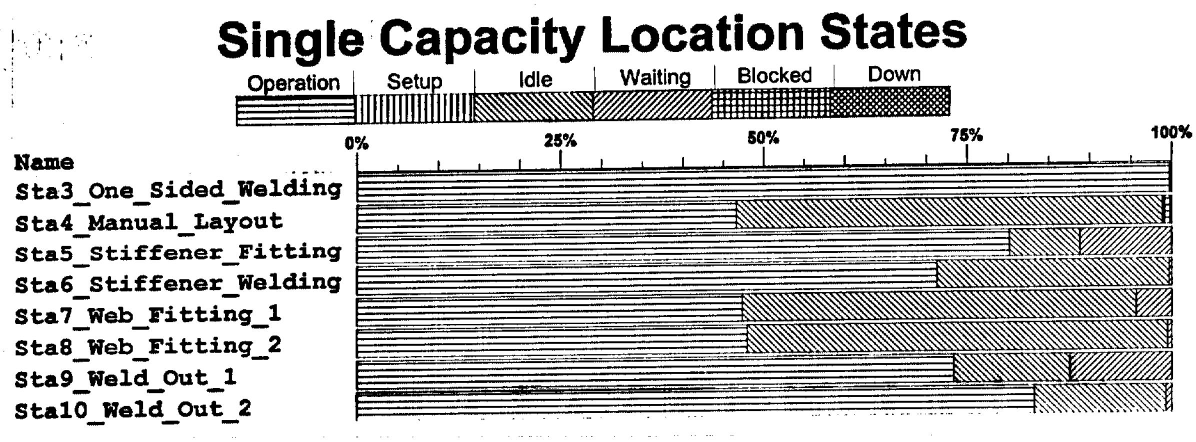
Performance (1 Month)	
Number of Panels Completed	60
Number of Panels Per 8 Hour Shift	1.30
Panel WIP	7

Table 8.2-1: "High Output" Model Inputs and Performance

Although there are process times and a manning level at every station along the line, the categories listed in Table 8.2-1 are the ones which are flexible according to the report. Other stations have manning levels and process times which remain constant and cannot be changed due to equipment and space limitations. These categories are "hard-wired" into the model. The output for one month, shown in Table 8.2-1, is equal to the theoretical throughput documented in the report. This is a good validation test for the model.

The Resource and Location States for the "high output" model are shown in Graph 8.2-1. Some of the stations and resources have been left out of the graph for clarity. The detailed performance statistics for the "High Output" model are included in Appendix E.





Graph 8.2-1: "High Output" Model Resource and Location States

Three of the resources are above the 75% to 85% usage limit.

- Station 3 One-Sided Welding operator (100%)
- Station 7 Web Fitters (94%)
- One - Sided Welding machine (100%)

In addition, the Location States graph shows that the One-Sided Welding location is also in operation 100% of the time. These usages need to be lowered to within the 75% to 85% limit. This will be done for the creation of the "most likely operating condition" model.

8.2.2 Analysis of "Most Likely Operating Condition" Model

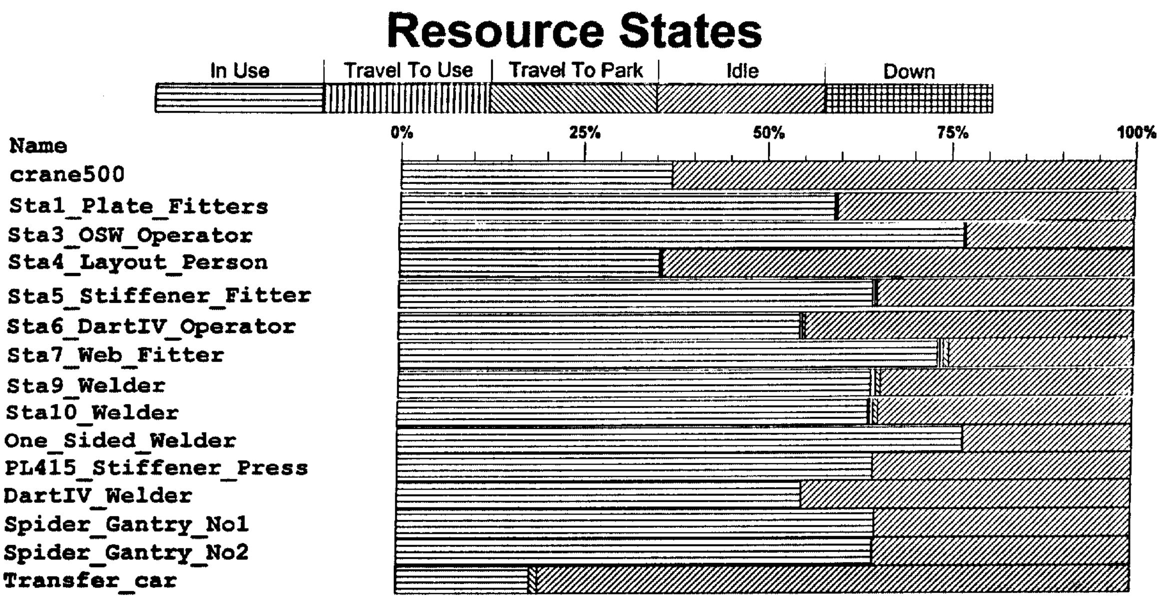
In order to reduce the utilization of the Station 3 One-Sided Welder to the 75% limit each plate was held on the transfer car for a period of time. This starved the line so that the panel which was being seamed could be completed and moved out of Station 3 before the panel behind it was ready to move. Holding each plate on the transfer car created some idle time in Station 3 to account for the PF & D not included in the shift assignment. Creating idle time by holding each plate on the transfer car is something which would never be done in the current real-life process. It can be done, however, in the simulation model as long as the effects of creating the holdup are understood. Because the holdup is at the head of the line all of the Stations are affected the same and the bottlenecks and constraints created relative to each other without the holdup will be the same as those with the holdup. The model inputs for the "most likely operating condition" model and the resulting output are shown in Table 8.2-2.

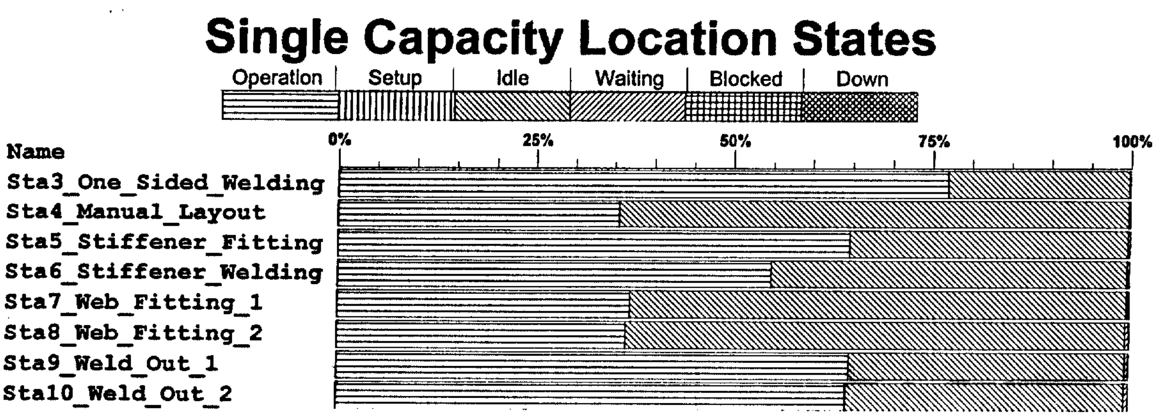
Manning	
Dk Socket Fitters	2
Dk Socket Welders	4
Stiffener Fitters	4
Web Fitters	6
Web Welders (Sta 9)	8
Web Welders (Sta 10)	8
Hold Time at Trans Car	40

Performance (1 Month)	
Number of Panels Completed	46
Number of Panels Per 8 Hour Shift	1.00
Panel WIP	4

Table 8.2-2: "Most Likely Operating Condition" Model Inputs and Performance

With a hold time on the transfer car of 40 minutes per plate, the number panels produced per shift dropped to 1.00. This number is close to the average number of panels per shift which is currently being produced today. As seen in the Resource and Location States Graph 8.2-2 (The detailed statistics are shown in Appendix E.), the Station 3 One-Sided Welding Area now has a 76% utilization. This accounts for the PF & D. The resources also have reasonable utilizations with all of the usages below 75%.





Graph 8.2-2: "Most Likely Operating Condition" Model Resource and Location States

8.2.3 Determining Constraints and Bottlenecks in the Panel Line

Using a hold time of 40 minutes per panel results in one panel being produced per shift. The output, once again, helps to validate the model since this is comparable to the current output of the line. Using the Resource and Single Capacity Location States graphs, the bottlenecks are identified as:

- Station 3 One-Sided Welding operations (76%)
- Station 5 Stiffener Fitting operations (65%)
- Station 9 and 10 Weldout operations (65%)

Automation is being considered to eliminate the bottlenecks caused by the Station 5 Stiffener Fitting operations and the Station 9 and 10 Weldout operations. A robotic stiffener fitting station is being proposed as a replacement for the current fitting operations in Station 5. The robot removes sequenced stiffeners from a cassette, positions them on the panel, and tack welds them into place. Robots will be utilized in Station 9 and 10 to perform the weldout of the panel webs. The automation in both areas will provide the advantages of a higher throughput rate and lower manning. The one-sided welding done in Station 3 is currently a fairly automated process so not much can be done in the way of adding automation to eliminate the bottleneck. Therefore, the bottleneck will have to be eliminated by making changes to the one-sided welding machine and seaming process to increase the throughput of the area. The effects of changes to the one-sided welding operations and the introduction of robotics will be investigated in Phase II.

9.0 NEXT STEP - PHASE II

Once the analysis is complete for all eight sub-modules, the overall model will be validated and its output analyzed. Phase II will begin at this point with the development of 'To-Be' models which incorporate automation into the 'As-Is' models. The automation will be introduced in areas which constrain the flow of material and are suitable for automation. In order to accurately model the automated processes some benchmarking trips will have to be made to yards with a high degree of automation. The trips will be used to research process times and throughputs for automated processes such as robotic profile cutting and robotic welding systems which will then be used in the 'To-Be' models. Once the 'To-Be' models are verified and validated, they will be analyzed for their performance and compared to the modeled performance of the 'As-Is' simulation models. Comparisons will not only be made on throughput and efficiency, but also return on investment. In addition, the 'To-Be' models will be compared to the benchmark information gathered from other yards to measure their performance to current "world class" shipbuilding standards.

10.0 CONCLUSIONS

The importance of proper planning cannot be emphasized enough when conducting a simulation project. Much of the success in this project can be attributed to the planning work which was done beforehand. For example, the NASSCO Project Team has had great success in their use of ProModel. The software has proved to be very compatible with the objectives of the project and the skills of the project team. This success is due to the preparation which was done in researching the different simulation software packages and the development of project objectives.

Formulating clear project objectives is also important. The first reaction when beginning a simulation project is to try to model everything that happens in the process exactly as it occurs in real life. Trying to model a real life process in exact detail will risk the failure of the project. There is too much detail involved. The fault lies not with the computer (with the exception of large models which use up too much memory), but with the modeler. The computer merely utilizes the instructions set up by the modeler. The more detailed the instructions; the closer the simulation mimics real-life. The modeler, however, must study, understand, and translate into a programming language, all of the steps which are involved in the process. This can become a very time consuming, complicated task resulting in budget and schedule overruns. Creating clear objectives at the start of the project helps to define the scope of the project and allows the modeler to make assumptions and decisions as to what should or should not be included in the model. It also helps to keep the project team focused when too much detail threatens to sidetrack the project.

It is highly recommended that a project team who is creating a simulation model for the first time use the services of a consultant to build the model. Compared to the other steps in the simulation process (planning, defining the model, analyzing the output, etc.) the actual building of the models in the computer should take the least amount of time. NASSCO's subcontractor to build the models, Kiran and Associates, was able to complete even the most complicated of the project's models in a matter of weeks as opposed to the months it would have taken for the project team to learn the software, understand how to go about setting up the models, and take advantage of the learning curve. In addition, Kiran and Associates was able to give recommendations as to what data should be collected in order to build a model which would meet the objectives of the project. This narrowed the focus of the project team's studies. If possible, the consultant should be on site or within driving distance of the project location. Because of the nature of the work, it is much easier to conduct project meetings in person rather than over the phone or via the Internet. Frequently, in-person demonstrations of the computer model are needed to understand the frame of reference of both the modeler and project team. Since the validation of a model is a continuous process and corrections have a quick turnaround time, these meetings will happen more often than just the beginning, middle, and end of the project. The modeler should also have a visual understanding of the process which is going to be modeled, so visits to the process location are a must. All of this is more convenient if the consultant is nearby.

Computer simulation has proven to be a valuable tool in this project. The processes which were modeled are large with many interactions and variables. These factors plus the randomness that occurs in the process makes it difficult to use other techniques, such as average times and a spreadsheet, to accurately gain insight into the process. Dealing with these factors is the main advantage of computer simulation. The modeler is able to set up large systems with many decision points, interactions, and variables and then allow the computer to keep track of what is going on during the process. The speed at which this is done by the computer is also beneficial to the project team. For example, the focus of this project is to take a group of existing processes, optimize them, and then compare them to optimized conceptual processes. Once the processes are modeled, years worth of production runs can be done in a matter of minutes, and each run can include changes which alter the entire system. This helps the modeler optimize the model in a short period of time. The conceptual models can be created, viewed, and analyzed to investigate whether improvements will be made by changing the process. All of this can be done before making costly investments in capital or disrupting production to make changes in the manufacturing process.

Although computer simulation has proven to be a valuable tool in this project with an endless list of possibilities in other shipyard applications, it should not be viewed as the ultimate "decision making tool." Since a simulation model is only a representation of the process being modeled, and it is impossible to develop the model in enough detail to take into account all of the possible outcomes, it should be viewed as one of several tools to be used in the decision making process. The role of computer simulation in this function can be successfully performed with proper planning and project team training, and will definitely aid American shipbuilders in their effort to produce a more cost competitive ship.

APPENDIX A
GENERAL SIMULATION OVERVIEW

See

Computer Simulation – A Practical Perspective

By Roger McHaney

Academic Press, San Diego, Ca, 1991

APPENDIX B
SIMULATION SPECIFICATION

NATIONAL STEEL AND SHIPBUILDING COMPANY

Automated Process Application

in Steel Fabrication

and Sub-Assembly Facilities

Simulation Specification

March 18, 1997

Simulation Specification

CONTENTS

1.0 INTRODUCTION

1.1 Background

US Shipbuilders are currently addressing the substantial gap in competitiveness between International and US yards. One area of potential improvement is the application of automated processes in steel fabrication and assembly. National Steel and Shipbuilding Company (NASSCO) is undertaking a project to develop a standard methodology for identifying potential areas for automation and assessing the effect prior to implementation. The core of the approach is a simulation model whose functionality and method of construction is explained in this document.

1.2 General

The simulation project will have five stages:

- simulation specification,
- data collection,
- model formulation,
- model verification and validation,
- experiments and analysis.

The model will be formulated using a PC based simulation tool. This simulation specification is the first stage of the project. The main body of the document defines:

- project scope and boundaries,
- general description of the area to be modeled,
- model fundamentals and form,
- model functionality,
- outputs and inputs,
- project method,
- deliverables,
- model testing and validation.

2.0 PROJECT OBJECTIVES

2.1 Overall objective

The overall project objective is to develop a method of determining which specific processes, in the area of steel fabrication and sub-assembly, are likely candidates for an upgrade to an automated system, and to what degree. To be classified as a "likely candidate", the conversion to an automated system must reduce production time and produce a positive return on the investment dollar. A computer simulation program will be utilized to examine what degree of automation will be most beneficial to the shipyard. All information will then be gathered into a fixed set of criteria for the analysis and review of the future automated process implementation.

Operations at NASSCO are divided amongst several Stages of Construction (SOC). A given operation will belong to one of the SOC levels as defined below:

SOC 1 Fabrication
SOC 2 Subassembly
SOC 3 Block Assembly
SOC 4 Unit Assembly
SOC 5 On Block
SOC 6 On Board
SOC 7 Test and Trials

The simulation model will focus on NASSCO's current fabrication (SOC 1) and subassembly (SOC 2) areas as a test bed to develop this methodology. The simulation model will be used to:

- simulate current performance of these areas,
- identify production operations that currently constrain the overall throughput,
- perform "what if" scenarios with the insertion of automated processes to replace existing processes which have been identified as constraining the throughput and to determine the effect on performance.

Recent facility developments, (i.e. T-beam process lane), changing from a manual process to an automated process will be used as a case study which will examine the "as was" and "as is" processes to assess the effectiveness of the simulation approach.

The scope of the project described here satisfies all the analytical requirements of the project.

2.2 Requirements of the model

Each operation in the manufacturing process will be modeled as a logical object in isolation. Systems will be modeled by aggregating these objects. Operations will run with dependency on the input conditions, resource allocations and constraints such as sequences, schedules and buffers sizes which will be largely inherent in the model logic.

The simulation model will be capable of the following:

- calculating and displaying the results of changes to the model conditions on each of the objects and on the overall performance of the entire model,
- accepting new and additional performance metrics for any process as the drivers for performance of the objects and the rest of the model,
- providing comparative results data, in tabular and graphical form to allow comparison of "as is" and "candidate automation" processes identified through bottleneck analysis,
- being expanded as a model to incorporate the later stages of construction,
- being used as a "black box" input to other models created at a later time,
- modeling process handling and transportation equipment, labor resources and material
- being used as a shop loading tool to assess process capacity, utilization, duration and efficiency for various product mixes and rate scenarios.

3.0 SCOPE

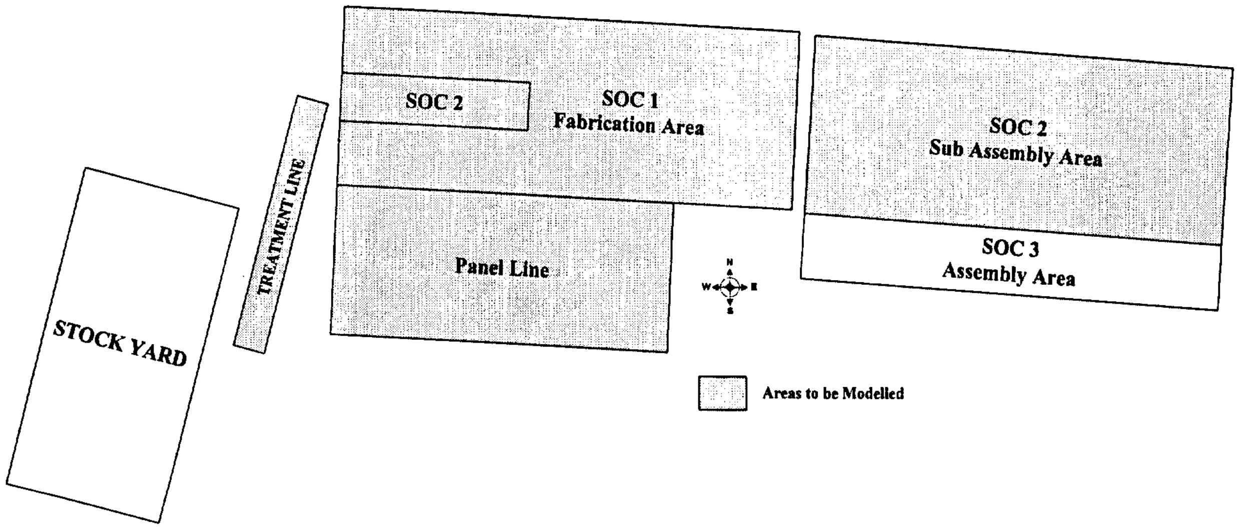
3.1 General

The purpose of this section is to define the area within NASSCO which will be represented in the simulation model. The perimeter of the model area so defined is known as the system boundary. The information given here outlines the major processes within the system boundary.

The areas of the yard identified for simulation analysis are the treatment line, SOC 1, SOC 2 and the panel line. SOC 1 is the area in which the majority of fabrication work is carried out. SOC 2 is the area in which the majority of sub-assemblies are manufactured. SOC 2 is split geographically into two areas with some sub-assemblies being produced from an area nested at the west end of SOC 1. All processes within this boundary will be modeled in detail.

No external areas will be modeled explicitly, but the simulated area will be connected to external areas via the model interfaces. The stockyard is the supplier of all material (plates and profiles) to the modeled area. SOC 3 is the major customer for SOC 1, SOC 2 and panel line products. These two areas are therefore the most important of the interfaces to the modeled area. The model interfaces will show how changes within the simulated area effect the external areas. In some cases the interfaces may also be used to apply a load or constraint to the simulated area. The configuration of these interfaces is defined in detail in Section 4.3

The general outline of the area is shown in the figure below.



3.2 Material and product interfaces

Stockyard - This is a large storage area for all incoming plates and profiles. It is the source for all materials in the simulation model area. Plates are handled by a large gantry crane (507 crane). Profiles are picked by a large jib crane or forklift, pre-staged and transported to the treatment line by forklift or straddle carrier.

SOC 3 (excluding the panel line) - This area consists of a number tables on which blocking is carried out and some of the large sub-assemblies are also manufactured.

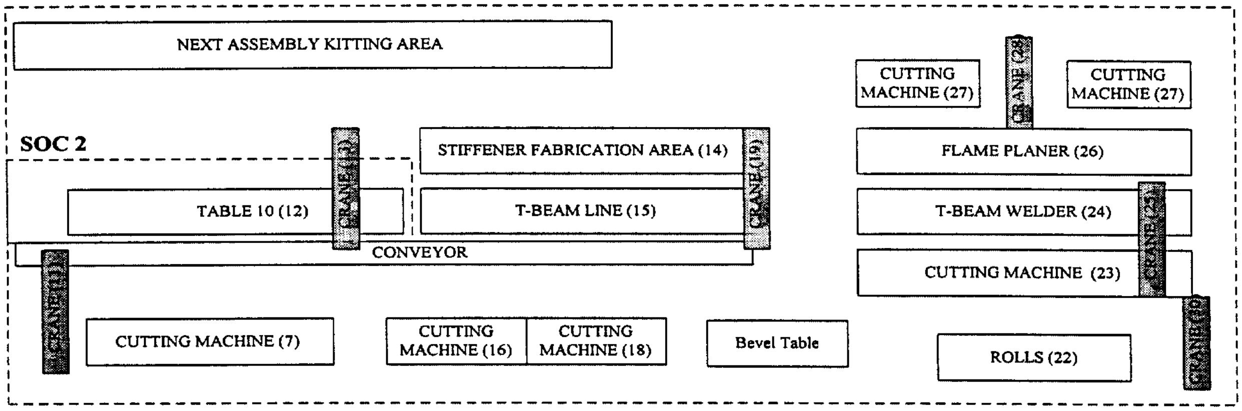
3.3 General description of the area to be simulated

The subject areas lie along the northern boundary of the yard with the stockyard to the west. Material flow is generally west to east but routes are convoluted and areas are not always dedicated to one type of work.

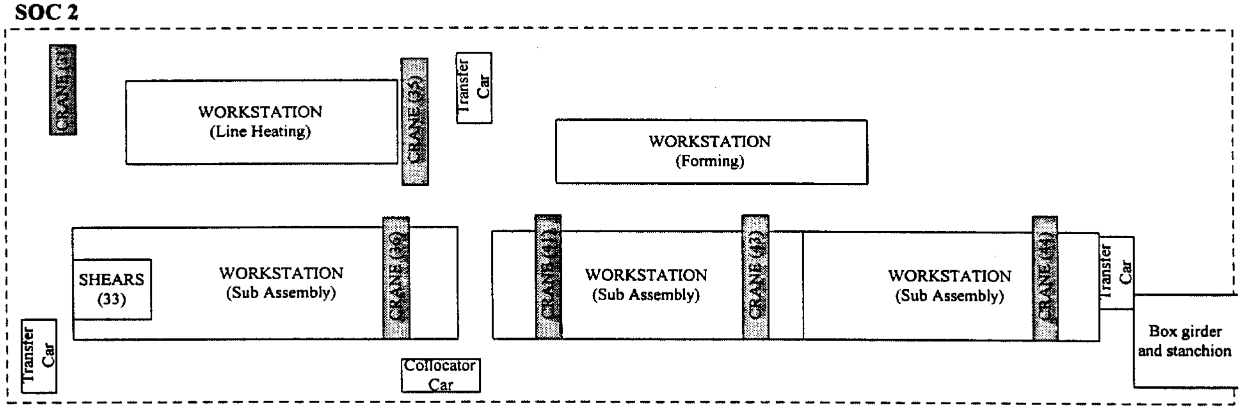
The area is split into several bays which are serviced by overhead cranes. Several conveyers are used in SOC1 and a collocator system moves material through the whole area. Several transfer cars are used to move material between conveyers, the collocator system and the different crane bays. Forklifts and straddle carriers are also used to move material around within the area and across the boundary to the other areas.

The block diagrams below show the relative position of the major process areas in SOC 1 and SOC 2. The diagrams include the T-beam process lane developments currently underway.

SOC 1



SOC 2



The major production areas to be included in the simulation are as follows.

Treatment line - The treatment line lies in a north/south direction and is adjacent to the stockyard. The line which handles both plates and profiles includes shot-blasting, paint spraying and drying. In general profiles are processed during the day and plates are processed at night. Incoming and outgoing material are handled by a conveyor system.

Plate cutting - Plate cutting operations are conducted by six NC burning machines, one flame planer and a manual bevel workstation located within four uncovered bays.

- CM100.3 - This is a 2 axis NC plasma machine located in the 2000 crane bay,
- CM100.4 - This is a 3 axis NC plasma machine located in the 2000 crane bay,
- CM100.2 - This is a 3 axis NC gas machine located in the 2000 crane bay,
- Manual Bevel - This workstation located at the east end of the 2000 crane bay consists of tables and sawhorses upon which cut plates are manually beveled using semi-automated cutting torches. This area services the NC burning machines within the 2000 crane bay.

Material for the above machines is delivered from the treatment line to the collocator system were it is stored in buffer piles within the collocator lane. An large gantry crane (2000 crane) is used to load/unload the NC and manual bevel tables. Product leaves the area by forktruck (< 18'), trailer, and the collocator system. Product is delivered to the panel line via a transfer car (T4) at the west end of the 2000 crane bay.

- Flame Planer - This is a mutlihead gas machine located north of the T-beam welder and its primary function is to supply the T-beam welder. Material is delivered from the treatment line by the collocator system (C2 to T2). Outgoing material is delivered to the next assembly area by a transfer car (T3).

- CM300.1 and CM300.2 - These are smaller NC gas machines equipped with multiple torches for cutting of small parts and are located to the north of the flame planer. Some of the incoming material is delivered from the treatment line by the collocator system (C2 to T2). The remainder of the material comes from a storage of remnants within the same crane bay. Outgoing material is placed on pallets and removed by fork trucks.

- Avenger 3 - This is a new 2 axis NC plasma machine located south of the T-beam welder. It is part of the new T-beam process lane. Material is delivered from the treatment line by the collocator system. This machine's primary function is to supply cut webs to the T-beam welder.

Profile cutting - Profile (less flat bar) manual marking and cutting is located at the east end of the 591 crane bay. The process is entirely manual and carried out on tables. Most of the material is delivered in cassettes by a carrier. The remainder of the material is delivered by fork truck or by the collocator system (C2 to T2).

Flatbar cutting - Major flatbar fabrication operations include manual layout and burn, shear, and iron worker. The location of these operations are split between the middle of the 591 crane bay and the west end of the sub-assembly area.

Forming - Forming is carried out at a number of areas in and around the main shop. Major equipment includes one 45ft roll, two small rolls, brake form, frame bender, bulldozer, and a line heating station.

Transverse deck beams - The current manufacture of T-beams draws in material from the flame planer into the MT welder. After the MT welding, products are transported by straddle carrier back to the stockyard and effectively become stock. The T-beams are then scheduled via the treatment line to the manual profile cutting area for layout and cutting work before going to the Table 10 sub-assembly area.

The current operations of the T-beam fabrication and subassembly are being removed from the manual profile cutting area and Table 10 sub-assembly operation and relocated to a new line which includes a new NC plasma cutting machine and assembly conveyors. In the new operation, the necessary parts will be produced from the planer and a new NC cutting machine before the MT welder operation. The T-beams will then be moved by transfer car on to the new transverse deck beam assembly line for final cutting and all welding operations.

Kitting - Immediately after fabrication, the majority of cut plates and profiles are delivered to a kitting area where they are sorted and collocated into kits for next assembly. The kits are grouped together by block and stored in the kitting area until needed. The kitting area is the large area north of SOC 1 and SOC 2. All material handling is performed by fork truck and straddle carrier.

Plates greater than eighteen feet in length are not part of this operation and are stored for next assembly in the 2000 crane bay and the C1 collocator lane.

Longitudinal stiffeners are sorted by block and stored in cassettes in the west end of the kitting area.

Transverse deck beams are sorted by block and stored on carrier blocks in the west end of the kitting area.

Box Girders - Box girders are assembled in a dedicated process lane at the East end of Table 1. Large plates (>/=18') are delivered to the process lane via the collocator system (C1) and the SOC 3 crane (E2). Smaller plates (< 18') are delivered by fork truck. There is a dedicated buffer storage area in the collocator lane for incoming box girder material. The process lane consists of an assembly fixture and a weld out station. The process lane uses a dedicated 15 ton crane for daily operations. Outgoing sub-assemblies planned for Table 1 are delivered to SOC 3 via the E1 and E2 cranes. All other sub-assemblies will be transported to SOC 3 by whirley crane.

Box Stanchions - As with box girders, the manufacture of these interim products is performed in a process lane adjacent to the box girder lane. Incoming material and outgoing sub-assemblies will be handled the same as with box girders. The box stanchion process lane consists of an assembly fixture and two weld out stations. There is a dedicated 10 ton crane in this process lane.

Sub-Assembly - The majority of sub-assemblies are built in essentially two areas: Table 10 which is the small part of SOC 2 nested at the west end of the 591 crane bay and the primary SOC 2 area which includes the majority of the shop east of the T-beam and flame planer.

Table 10 equipment includes the 591 and 600 overhead cranes. Materials and products are transported to and from this area by forktruck and straddle carrier. The common parts built in this area are the transverse deck beams. Under the new developments, the manufacture of T-beams is being transferred to the dedicated T-beam process lane. Both processes will be modeled and compared as a case study.

The primary sub-assembly area consists of 26,000 square feet of table space which is divided into six manufacturing cells. Work is sorted by block and job type and then allocated to these cells. This area is equipped with four overhead bay cranes each of which has a 5 ton capacity. Kits are delivered to this area by fork truck and straddle carrier. Some of the completed sub-assemblies are removed by fork truck through the various shop entrances. The majority of completed sub-assemblies exit the shop at the east, where they can be removed by fork truck, carrier, or trailer.

There is a line heating workstation at the east end of the sub-assembly area. All line heating for sub-assembly is performed in this area.

Minor sub-assemblies are processed on two sets of tables within the main area. In addition to the use of the four overhead cranes, there are two jib cranes dedicated to minor sub-assembly.

Panel line - The panel line is located to the south of the burning machines and produces built up stiffened flat panels. Plates are delivered one at a time from the 2000 crane bay by transfer car. Frames and longitudinals are delivered by straddle carrier and are lifted on to the table by whirley crane. The line consists of 9 workstations which are: fitting, one-side welding, layout, stiffener fitting, stiffener welding, web fitting, two web welding workstations and load-out. The line is serviced by the 500 bay crane which has a capacity of 25 t.

Buffers - Currently, buffer exists between all processing areas.

4.0 MODEL FUNDAMENTALS AND FORM

4.1 Introduction

This section deals with a number of issues which must be defined at the beginning of the simulation project. These are:

- key features,
- model interfaces,
- model hierarchy,
- product and process,
- transportation,
- management,
- representation of manpower,
- processing assumptions,
- other assumptions,
- model users,
- future developments.

4.2 Key features of the model

In order to satisfy the objectives, the model will be designed with the following key features:

- Clearly defined system boundary as described in Section 3.
- All physical and control and management processes (machines, transport) within this boundary will be modeled. Facilities outside the boundary will be defined but not modeled explicitly. The simulated area will be connected to these areas via the interfaces, described in Section 4.3.
- Modular approach. Model modules will be created as stand alone objects. This has a number of advantages and allows each model module to be built and validated in isolation. Examples of these modules in the NASSCO model are: treatment line, panel line, Table 10 etc.
- Complete separation of product and process. This means that the definition of the system is totally independent of the material that flows through it.
- Where product is produced by a specific machine, the machine is modeled explicitly. An example of this would be a plate cutting machine. Raw material (uncut plate) will flow to it and product (cut plate) will flow from it.
- The transportation network will be modeled to a level which provides an accurate analysis of time taken to move material between processes. This is required in order to accurately evaluate the effect of changes in material flow and transport enhancements.

4.3 Model interfaces

The model interacts with areas outside the model boundary through interfaces.

The interfaces to the model are:

- steel plates and profiles at the input to the treatment line,
- steel products at output to block assembly,
- technical information,
- consumables such as welding rods and cutting heads,
- outfit items,
- labor resource pool demands (for labor that comes in from other areas of the facility not modeled explicitly).

Since the scope of this study does not include evaluating the impact of external system performances, they will not be considered as constraints. The model will produce demand curves for inputs such as technical information, materials and equipment. These curves can then be used to determine if the input producers can meet the demands of the model. The interface to SOC3 will be used to create the demand which will drive the model.

4.4 Model hierarchy

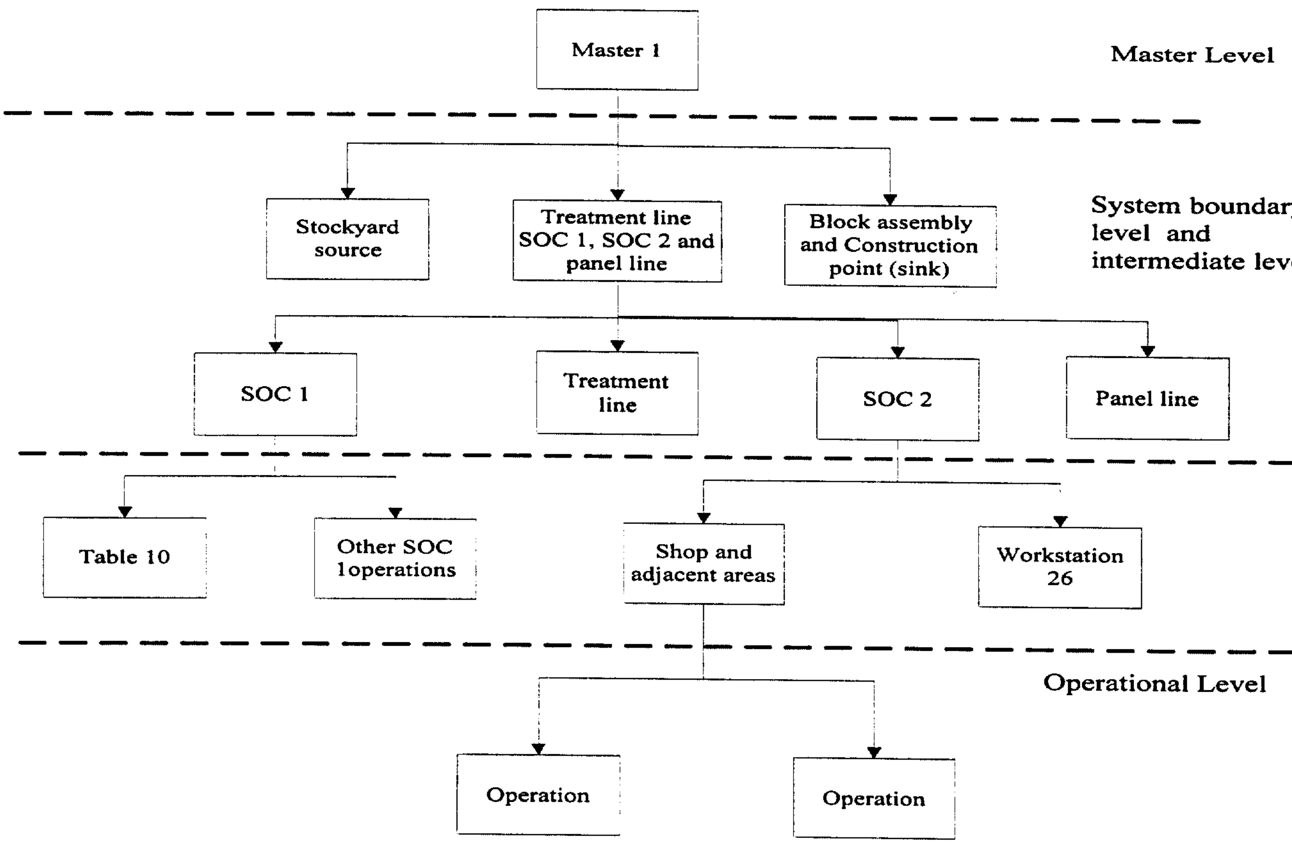
The final model will consist of a number of hierarchical levels represented by a series of nested frames. These frames will principally fall into one of three categories:

- Master frame. This is the environment within which the entire system operates. All other frames are contained within the master. There is no transfer of material or information across the master.
- System boundary frame. This is defined by the scope of the area to be modeled explicitly. There is no transfer of material or information across the system boundary frame other than through the designated interfaces.
- Intermediate frame. The intermediate frames simply allows the logical groupings that are present in the facility to be represented in the model. The first level intermediate frames in this model are the treatment line, SOC 1, SOC 2 and the panel line.
- Operational frame. This type of frame is designed to represent the level at which actual processing is done in the facility and is the lowest level in the model hierarchy. All calculations of event duration's are carried out at this level in the model. An example of such a frame would be an NC cutting machine.

The grouping of objects does not relate necessarily to the possible "candidate automation processes". It refers to physical groups based on proximity. The analysis of logical groups such as the "candidate automation processes" will be carried out by tracking the product routes through the facility during the experimentation phase. In modeling the facility, individual machines and workstations must be treated in isolation. The connections between these machines and workstations is established through logical decisions made by the model during the simulation runs or by the attributes of the produce. Even where fixed routes do exist in the facility now, its is desirable that the model have the flexibility to change material routings.

If process lanes were to be modeled as logical groupings, then the dependencies of other process lanes, on the workstations within the logical grouping, would not be represented.

The diagram below shows an example of how the frames will relate to each another. In addition there are source and sink frames. These are the basic material input and output interfaces of stock yard, block assembly, grand assembly and construction point. Only a small number of operational frames have been shown. There will be many others in the model and these will be finalized at the model building stage.



4.5 Products and processes

When representing the physical system, there are only two categories of object:

- products, defined as those objects which have work done to them.
- processes, defined as those objects that do the work.

Products are defined in terms of interim product type (IP type). Processes are defined in terms of IP type capability. Work is allocated in the system by matching IP type for products and processes.

In many cases it will be necessary to define process capability to a greater level of detail and specify secondary parameters (dimensions, material etc.) for each interim product. Such processes will be allocated work by IP type provided that secondary parameter requirements are met.

4.6 Transportation

Transportation can be represented in two ways:

Explicit transport - The process of moving products from one physical location to another is carried out by a transporter object. This type of representation is used in situations where the availability of transporters is a constraint and where the destination of the product may vary depending on the availability of space and disruption from other activities. These types of transporter objects are sub-systems in the model.

Within the scope of the model specified, some transporters, such as the whirley cranes, are not dedicated to the area within the system boundary. The external demand for transports will be represented by an interface which restricts their availability.

With physical transportation, the transportation network is modeled explicitly and so becomes another process. The transportation network will be visible and fixed and material objects will only be able to travel along existing routes. In this model, the following transport systems will be modeled explicitly:

- bay cranes,
- whirley cranes,
- the collocators,
- conveyors,
- forklift trucks,
- straddle carriers,
- trailers.

There will be other minor transport instances within the model which may be modeled explicitly, although this cannot be finalized until the model design stage is reached.

Virtual transport - The process of moving products from one physical location to another is not modeled explicitly, but is attributed a time on an event by event basis. This time may be obtained from a probability distribution (derived from field data) which represents the natural behavior of the process. The time would also be given a dependence on the attributes of the task, such as the distance traveled and the weight of the load. In modeling terms, this type of representation is relatively easy to create and is used in process flow situations where products have a clearly defined route and usually some dedicated transport equipment. An example of this is the transport if interim products along the panel line.

In virtual transportation material objects simply move between processes and buffers instantly. The routing and transportation of the material object is contained in the model logic. This is done where the system is not sensitive to transportation issues.

4.7 Management

Modeling the management of the system is just as important as modeling the processes within the system. The functions of the management system within the model will be:

- **Material flow** - how material is moved around the system.
- **Assignment of work** - how interim products are allocated for processing.
- **Control of system parameters** - changing system parameters such as processing time to reflect differing interim product capability at a workstation.
- **Collection of data** - controlling the collection of data in the model so that output is consistent and of the required format.
- **Calendar control** - controlling the shift patterns of labor and workstations.

One way of handling these functions efficiently is through a production controller. This will be modeled as a single object which appears at each hierarchical level and within each module throughout the model. At the top level the production controller will control the model input data and start the model running.

The production controller is responsible for all communication and decision making in the model including product allocation routing. Each frame in the model contains a production controller that is concerned only with operations in that frame.

The production controller in intermediate frames controls all communication and logic within this frame, but does not interfere with control in frames above or below in the hierarchical model structure. At the highest frame in the hierarchical structure, the master frame, the production controller inputs and outputs from each of the model modules as well as transportation sub-systems that cross some or all of the model module boundaries.

In order for the model to accurately represent the true behavior of the facility, it is necessary for relevant information from planning, scheduling, routing and production control logic to be represented within the production controller. The first decision is whether to make the system "push" or "pull" managed. Through experience, it has been decided to make the essential driver for the system to be the demand for interim products from SOC 3. The model will therefore be essentially a pull system. However, in reality the area under consideration doesn't operate strictly on a pull basis because some corruption of the build sequence occurs. This can be modeled by allowing individual machines and processes to build interim products out of sequence. The logic for this is as follows:

- Each machine or process area has a sequenced priority task list of interim products to build. In the event that the parts necessary to build the first item on the list are not available, the machine or process area can look down the task list to see if all parts are available.
- If "true" then build that product.
- If "false" then look at the next task on the list and so on.

The level of allowable sequence corruption is defined by the number of tasks the machines or process areas can look through before it finds one that it can build. This number will be set at the data collection stage, but will also form part of the experimentation phase to see the effect of sequence corruption on WIP.

4.8 Representation of manpower

The assignment of personnel will fall into one of the following three categories:

- **Dedicated** - Personnel can be dedicated to a workstation. For example the personnel who look after the NC burning machines.
- **Process Orientated** - Personnel can be dedicated to a number of workstations because they are good at particular processes. Therefore a man good at manual burning will be assigned to a number of workstations that perform that task.
- **Floating** - Personnel can be used at any workstation where needed.

A "pool" of personnel will be available in every major area, e.g. SOC 1. These personnel will have an attribute which will identify their skills and efficiency.

Further attributes will be added to each person depending on their category. The dedicated personnel will have an attribute detailing what workstation they are dedicated to. In the case of the process orientated personnel, the attribute will be a table listing the processes which they can do.

4.9 Processing assumptions

The following assumptions will be made:

- for the current processes, the sequence of construction of intermediate products may not be known,
- in order to derive process times in the automated systems, it must be assumed that the product work breakdown structure is defined to plate and bundles of stiffener level. In addition, information will be required on work types and values in a given product,
- automated processes will derive the process times from the Product Work Breakdown Structure,
- undefined process areas will use the same basic product data and empirical performance measures together with resource allocation and efficiency to estimate the necessary times,
- in some cases, the duration of a particular event has little dependency on the attributes of the work. In these cases an empirical time is assigned to the process.

Modeling of the current system involves a breakdown into areas or modules based on the physical layout of the system. At present, modeling the physical layout means that some product types could be processed at a number of different locations.

For well defined or automated processes, this definition will be straight forward, since parts are manufactured in a consistent sequence using methods, machines or tools with an easily quantifiable performance, given the material attributes of the product. For manual areas, due to corruption of assembly sequences and variety in methods used to make similar products, it may not be possible to model the process and derive a time directly in the way described above. However, it will still be possible to obtain good results in this type of situation by collecting data on work content in man-hours for types of interim product and applying the same constraints to the execution of the work set out above.

4.10 Other assumptions

In addition to the assumptions made above, a number of other factors will be taken into consideration. These are:

- the effect of weather conditions in disrupting work and affecting accuracy,
- the level of rework,
- the level of absenteeism and vacation.

4.11 Model users

The model will be used by the Industrial Engineering department.

On completion of this project, the model could be developed as described in Section 4.12. The user base may therefore expand to include planners, foremen and area managers. The potential future use and expansion of the user base will not be a primary consideration in the development of the model.

4.12 Possible future development of the model

Possible future uses include:

- develop the system interfaces to constraint enabled so that not only will the influx and egress of objects over the boundary be modeled, but can also be disrupted,
- extend system boundary to include others areas such as SOC3.

Extension of the system boundary is a natural progression with the possible long term aim of creating a model of the entire shipyard.

5.0 MODEL FUNCTIONALITY

5.1 Introduction

This section details the functionality required to satisfy the demands of the model outputs and the model user. The live elements of the model output will be handled by the user interface. The user interface will also give easy access to the system history output which will be necessary for testing, validation and experimentation as detailed in the following sections.

5.2 User interface elements

Elements of the user interface fall into one of two categories:

- **Interaction** - the element requires an action from the user for it to open or change its state, for example double clicking on a machine to open the characteristics dialogue box.

- **Display** - the element displays system parameters for the user, for example a display of machine status.

Elements and features of the user interface will be defined during the model development. Examples (taken from Simple++) are given below:

- **The Gauge** - displays a value either graphically as a small bar or as a digit. Typically used to display an output metric or storage area contents.

- **The Plotter** - displays a graph over time and will be used where "change in state" analysis is required. Typically used to display resource (men and equipment) utilization.

- **The Dialogue** - A pop up box with user defined elements used for adjusting or displaying system parameters. These will be used to simplify the operation of the model by grouping elements in a logical and easy to use way. Typically used for adjusting the processing characteristics of a machines: cutting speed, downtime, etc.

- **Object Animation and Color** - Both the animation of the products and processing areas can be controlled. This is useful for changing the element's picture when its status changes- red for when a part is blocked, for example, or changing the icon of a workstation according to status.

The following are examples of live outputs that will be used in the model:

- each workstation will have a status indicator showing:
  - ⇒ idle (yellow)
  - ⇒ processing (green)
  - ⇒ blocked (red)

- each workstation will have a gauge indicating its current utilization,

- each workstation will have an indicator showing output per week (throughput),

- where workstations have a capacity larger than one an indicator of current number will be included,

- resources will be kept on a "resource shelf" when not utilized.

6.0 OUTPUTS AND INPUTS

6.1 Outputs

The model outputs will be designed to satisfy the primary objective of this simulation project as defined in Section 2.

In order to carry out the evaluation, the following reports will be required.

- throughput reports:
  - ⇒ parts per period at all levels of system hierarchy
  - ⇒ tonnes per period and other metrics at all levels of system hierarchy
  - ⇒ value processed per period at all levels of system hierarchy
  - ⇒ utilization at all levels of system hierarchy.
- demand profiles for system inputs,
- demand profiles for resource and consumables,
- operation profile report showing exactly what is the status of each processing object during the model run period.

6.2 Inputs

The model will require two types of input:

- product definition file - this file will contain a complete definition of the product and will take the form of a Product Work Breakdown Structure. The exact structure and nature of this file will be determined in the model formulation stage.
- product and process object attributes - attributes assigned to objects so that the required output reports can be generated.

6.2.1 Process object attributes

- **NASSCO ID.** This is a unique identifier that refers to the shipyard name for the processing object.
- **Processing capabilities.** What type of work can the process do.
- **Capacity.** How much can it produce.
- **Status.** Status is categorized into working and not working. This is not strictly an input but is included in the list of attributes. The object is considered not working during scheduled global downtime caused by shift patterns, weekends or holidays. Working is subdivided into:

⇒ **Down**. The object is broken or undergoing maintenance.

⇒ **Blocked.** The object has finished processing but cannot release the product due to congestion in downstream processing objects.

⇒ **Waiting**. The object is ready to start processing but cannot because it is waiting for input material.

⇒ **Processing**. The object is doing work.

6.2.2 Product object attributes

- **Material ID**. This is a unique identifier that refers to the shipyard name for the product object.
- **Physical Attributes**. Categorized into weight, dimensions and other metrics to measure work content.
- **Routing.** This is the route the product objects take through the process objects.
- **Monetary value**.
- **Locations**. Times and locations recorded for the life span of the product.

6.3 Generation of reports

The reports outlined in Section 7.1 are produced at the end of the simulation run. The method for the production of each report is outline below.

- **Throughput reports**. By using the location log for each product object the passage of product objects through each processing object can be determined. When combined with this the relevant product object attributes and the throughput for each processing object can be calculated.
- **Demand profiles for resources and consumables**. The demand on the relevant resource pools and consumable stores is recorded during the model run. This is plotted out at the end of the run.
- **Demand profiles for system inputs**. The demand on the relevant input source is recorded during the model run. This is plotted at the end of the run.
- **Operational profile**. By analyzing the status logs for each processing object, the operational profile in terms of time spent in each of the different operation modes can be plotted.

7.0 PROJECT METHOD

7.1 Project steps

The simulation aspects of the project are divided in the stages shown in Section 1, which are:

- simulation specification,
- data collection,
- model formulation,
- model testing and validation,
- experiments and analysis.

In order to meet the project objectives, the modeling, experiment and analysis phases will be split into two parts. The first stage will be the modeling of the facility as it exists as defined in Section 3. Experiments and analysis will then be carried out to identify areas within the modeled area that could be improved through the introduction of automation.

In the second stage, the identified candidate automated processes will then be modeled as "what if" scenarios and the effect of these changes on performance will be quantified.

In addition, a case study will be carried out which models the T-beam process lane as it was and also as it now exists. The recent changes to the facility in this area will be used to examine the effectiveness of the simulation methodology.

The remainder of the project follows an established logical sequence which is explained in the following sections.

7.2 Data collection

In order to establish which data to collect prior to beginning data collection it is necessary to further define the system, the product work breakdown structure and report requirements. The principal steps in this are as follows:

1. Define, as in Section 3, the system boundary. Decide exactly which parts of the system are to be modeled and exactly how the system is constrained by its material inputs.

2. Break the manufacturing system down into logical elements. These element, referred to hereafter as processing objects, are the fundamental building blocks from which the model is created.

3. Produce a step by step logical description for the behavior of each of the defined process objects. It appears from the process flow information examples produced by the industrial engineering department that some of this information already exists, albeit in a slightly different form to that required for this step.

4. Determine precisely what parameters affect the performance of each processing object in terms of:
    - product specification and characteristics such as thickness, weld length and area,

- resource requirements including labor, cranage, floor space and consumables,
- environmental factors affecting the process such as the weather,
- operational downtime, shift patterns, maintenance schedules.

5. Some of this information has been collected as a result of previous studies. This will be reformatted and enhanced. Labor will be categorized by skill type.

6. Define the product or products that each process object is capable of producing. These products are referred to as interim products.

7. Describe the inputs to the system boundary. These are also considered to be interim products, the only difference is that they originate from outside the system boundary.

8. Produce a detailed list of all the system outputs.

9. Break down each output into its constituent interim products.

10. Define which attributes define each interim product in terms of the attributes associated with the process objects and information that maybe required to appear on a report. For example, if the throughput measure is tonnes per week, then each interim product must have a weight attribute. Similarly, if a cost profile is required then each interim product would be assigned an attribute that held some measure of the monetary value.

Performance data relating to the process objects is collected from existing input/output from the MRP system, measurements taken by planners, production personnel or the industrial engineering group or, as last resort, time study. There is a considerable amount of data already available although some of this is conflicting and this must be clarified prior to inclusion in the data base. The attributes relating to the interim products are quantified by reviewing the design and the Product Work Breakdown Structure. Again much of this data exists or can be easily generated from TRIBON and CALMA (engineering design CAD systems).

7.3 Model Formulation

The model formulation is the actual model construction.

7.4 Model testing and validation

The model testing and validation specifications are defined in detail in Section 8 of this document.

7.5 Experimenting with the model

This stage of the simulation project assumes that a tested and validated model of the system has been created.

There are numerous investigations that can be carried out with this simulation model. However, the primary objective of this part of the project is to evaluate the effect of automating parts of the steel work areas so the user will be concentrating on what if analysis.

The experiments fall into one of two categories: process experiments and sensitivity analysis. The comparison of the experiment results must be conducted within a framework of known model error.

7.5.1 Process experiments

The process experiments should deal with the following:

- identifying bottleneck areas which have repetitive manual processes and possible were material handling is convoluted,
- quantifying the effectiveness of automation in these areas identified.

The introduction of automation invariably involves capital expenditure and therefore results will highlight a ranked list of improvements against cost.

7.5.2 Sensitivity

The following sensitivities are suggested for experimentation:

- the effect of variance on each process time on overall cycle time,
- the effect of changing the buffer size on throughput or WIP,
- vary the maintenance schedule and breakdown probabilities to gauge the effect on throughput,
- vary the probability of rework at the various workstations

8.0 DELIVERABLES

8.1 General

The following is an outline of what will be produced during the course of the simulation project. A more detailed list will be derived during the development of the proposal for the next phase of the simulation project.

- data collection requirements and specification of data inputs required,
- complete simulation model to the specification outlined in this document,
- a simulation model user manual,
- project reports and documentation of project methodology,
- experiments and analysis to meet the project requirements.

8.2 Responsibilities

The development of the simulation model specified in this document is a major task. The best way to organize and manage the work is to adopt a team approach involving both specialist external resources and NASSCO employees. In general, NASSCO employees will be responsible for data collection, project reports, and conducting experiments. Specialist external resources will be responsible for development of the simulation model, creation of a user manual, and general consulting in the application of the model.

8.3 Project time scale

The expected project program in weeks is shown below.

Project Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
DATA																											
Detailed specification and sourcing	■	■	■																								
Data collection on process				■	■	■	■	■	■	■	■	■															
Data collection on product				■	■	■	■	■	■	■	■	■															
MODEL DESIGN																											
Hierarchical level	■	■	■	■																							
Object classification				■	■	■																					
Operational level design						■	■	■																			
MODEL BUILDING OF EXISTING FACILITY																											
Hierarchical level								■	■	■	■	■	■	■	■												
Operational Level										■	■	■	■	■	■												
TESTING AND VALIDATION																											
Simulation runs																■	■										
Comparison with facility outputs																	■	■									
Iterative model correction																	■	■									
BOTTLENECK ANALYSIS																											
Identification of possible automation areas																			■	■	■						
MODELING OF AUTOMATION																											
Creation of new objects																					■	■	■				
Integration with existing model																						■	■				
EXPERIMENTS AND ANALYSIS																											
Evaluation of automation impact																							■	■	■	■	
REPORTS																											
Methodology																					■	■	■	■	■	■	■
Project reports																								■	■	■	■
User manuals														■	■												

9.0 MODEL TESTING AND VALIDATION

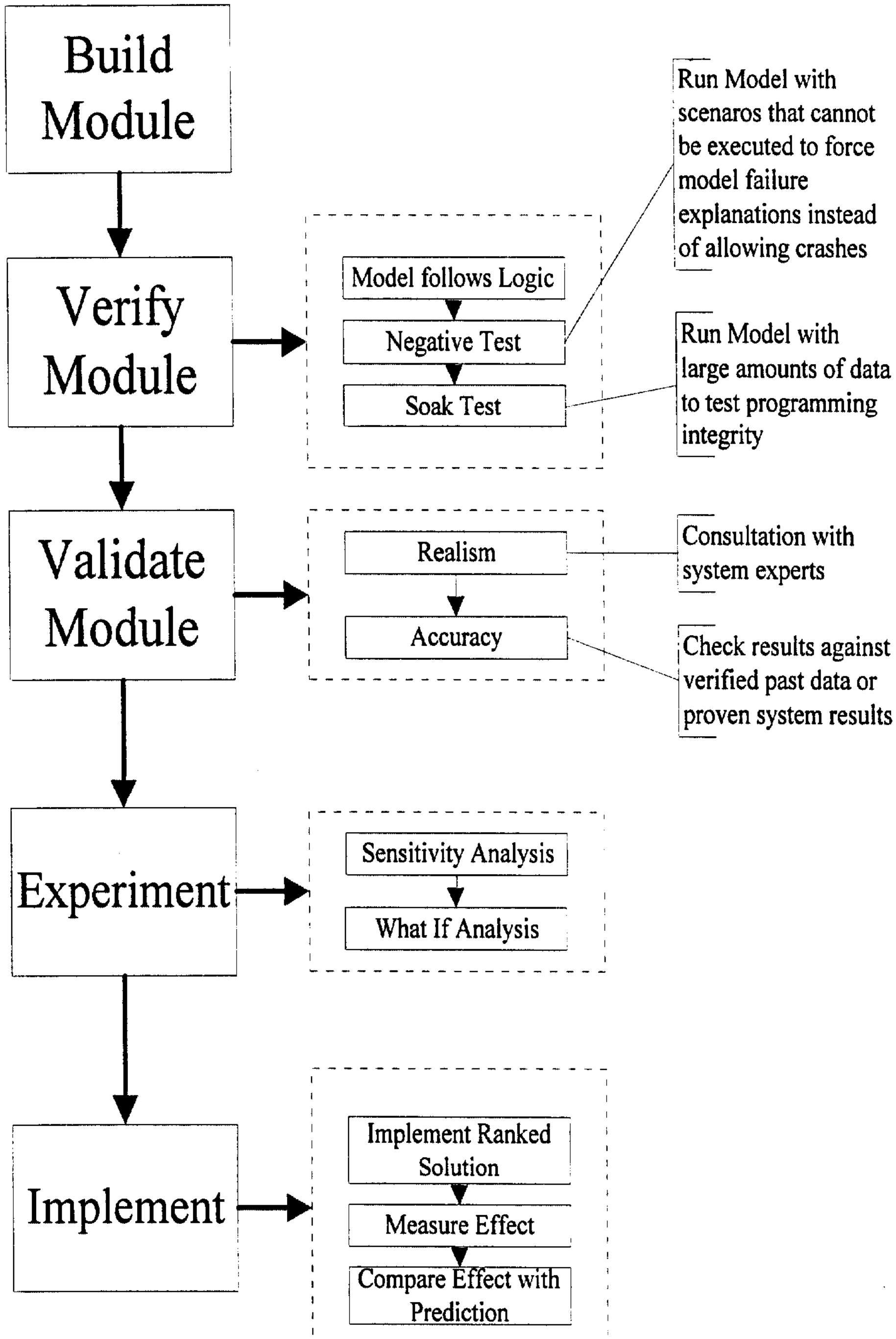
9.1 Overview

This section details the testing and validation procedure that takes place during model building and on completion of the model prior to experimentation.

The model testing will follow the same hierarchical approach as the modeling itself. Therefore, since the model is broken down into a set of modules which interact to make up the whole model, the following approach will be taken:

- test each module individually,
- test the interaction (interface) between two modules,
- test the overall model.

The diagram overpage shows the overall modeling process from building through to implementing results from model experimentation:


Build Module
Verify Module
Model follows Logic
Negative Test
Soak Test
Run Model with scenaros that cannot be executed to force model failure explanations instead of allowing crashes
Run Model with large amounts of data to test programming integrity
Validate Module
Realism
Accuracy
Consultation with system experts
Check results against verified past data or proven system results
Experiment
Sensitivity Analysis
What If Analysis
Implement
Implement Ranked Solution
Measure Effect
Compare Effect with Prediction

9.2 Module logic follows system logic

In the model design phase of the project the model logic and assumptions will be defined and documented after, consultation between NASSCO personnel and the modeling team. This logic and assumptions will be used in the model building phase. The verification of the model logic is the first testing procedure. The model logic should follow the system logic as defined. A manual check of the logic diagrams to ensure that the rules are being obeyed is usually sufficient in the first instance although a logic testing "cradle" is constructed to do this where necessary. This cradle feeds the system module with all its required inputs and checks that the correct logic paths are traveled and outputs obtained.

9.3 Negative

The model logic should be designed so that invalid experiment scenarios cause the model to react in a positive manner. If an invalid scenario occurs the model should not fail but flag the problem and attempt to explain why it cannot deal with it. In simple modeling terms this could mean simple messages are displayed explaining why the model has stopped or is not running. For this test the model should be loaded with invalid scenarios to ensure the model does not just stop or crash.

9.4 Soak

To verify that the model is stable within its environment, i.e. the computer and software on which it is run, the model is run with an overload of data and/or repetitively for a long period of time. This will give confidence that there are no sporadic software glitches or hardware problems associated with the model. This is important when the model is left to carry out experiments for a length of time unattended.

9.5 Validation

Before experimentation can begin, the model must be validated. The validation process ensures that the users have complete confidence in the output of the model. Only when this is achieved will the experiment results be fully appreciated. In order to achieve this the following tests must be undertaken.

9.5.1 Realism

This is a consultative test whereby the system experts, with detailed working knowledge of the system modeled, are asked to check the model behavior to ensure that it reflects the true nature of the real system. An exact representation is not necessary to pass this test but it is important to ensure that important system behavior characteristics are not neglected.

9.5.2 Accuracy

To check model accuracy, the model outputs are compared against an historical or derived data set. In previous sections some consideration has been given to the appropriate level of model accuracy. At the first stage, the accuracy of the model does not have to be particularly high, but the correct logic of the model is crucial.

Simulation models which take account of the variability of processes will have outputs that are also statistical in nature. The results of the model will therefore have a mean value and a variance associated with that mean. A truly validated model must have good matching of both these parameters.

Validation can take place in the same hierarchical way in which model testing is done. This will require that the logic testing cradle not only has the correct inputs and outputs for the running of a module, but that these outputs are realistic. Data must therefore be collected to satisfy the module inputs and outputs.

The procedure for module and complete model validation is essentially the same and includes the following steps:

- Collect data to satisfy the module or model boundary inputs and outputs.

- Run the model over a period of time which is equivalent to the length of time which the real system took to process the material represented by the collected data. For example, for the complete system model, the simulation might be run for the equivalent of one weeks production.

- Collect detailed statistics from the real system about the actual throughput of work over the same period. This data collection will be carried out by area supervisors and will be a simple list of completed work and the date and time on which it was completed.

- Compare the results of the simulation model and the real system for the model outputs. This comparison is done at the highest level first with throughput of blocks and the input of plates and stiffeners.

If the model results and the real system outputs agree to within 10%-15% at the highest level, the accuracy comparisons can then be made throughout the model hierarchy. This process will start by comparing buffer contents and then move on to the throughput of each area and workstation before getting to individual machine performances.

The measures of throughput and general system performance are called system metrics. The outputs of the simulation model reflect these system metrics. The following metrics can be compared at global and local levels throughout the validation stage:

Throughput:

- make-span (the time that components spend in the system),

- process times at workstations and product areas including set-up and load-out times,

- resource requirements of particular product areas, for example model predictions of the number of welders required in the sub-assembly areas,

- buffer utilization.

What if the model accuracy does not meet the required accuracy?

When the model is first tested it is likely that the accuracy that was set initially will not be met. In this case the following procedure should be carried out:

- Check each of the outputs at the global and local levels for accuracy. This will isolate the areas in which the inaccuracy is greatest.
- Having isolated the problem area, the system and product data relevant to these process areas in the model should be verified by revisiting the appropriate data collection points.
- The problem may lie with an unrealistic description of the process or erroneous assumptions about the activities in that area.
- Modify the system data, product breakdown, system logic or a combination of all three and revalidate the model.

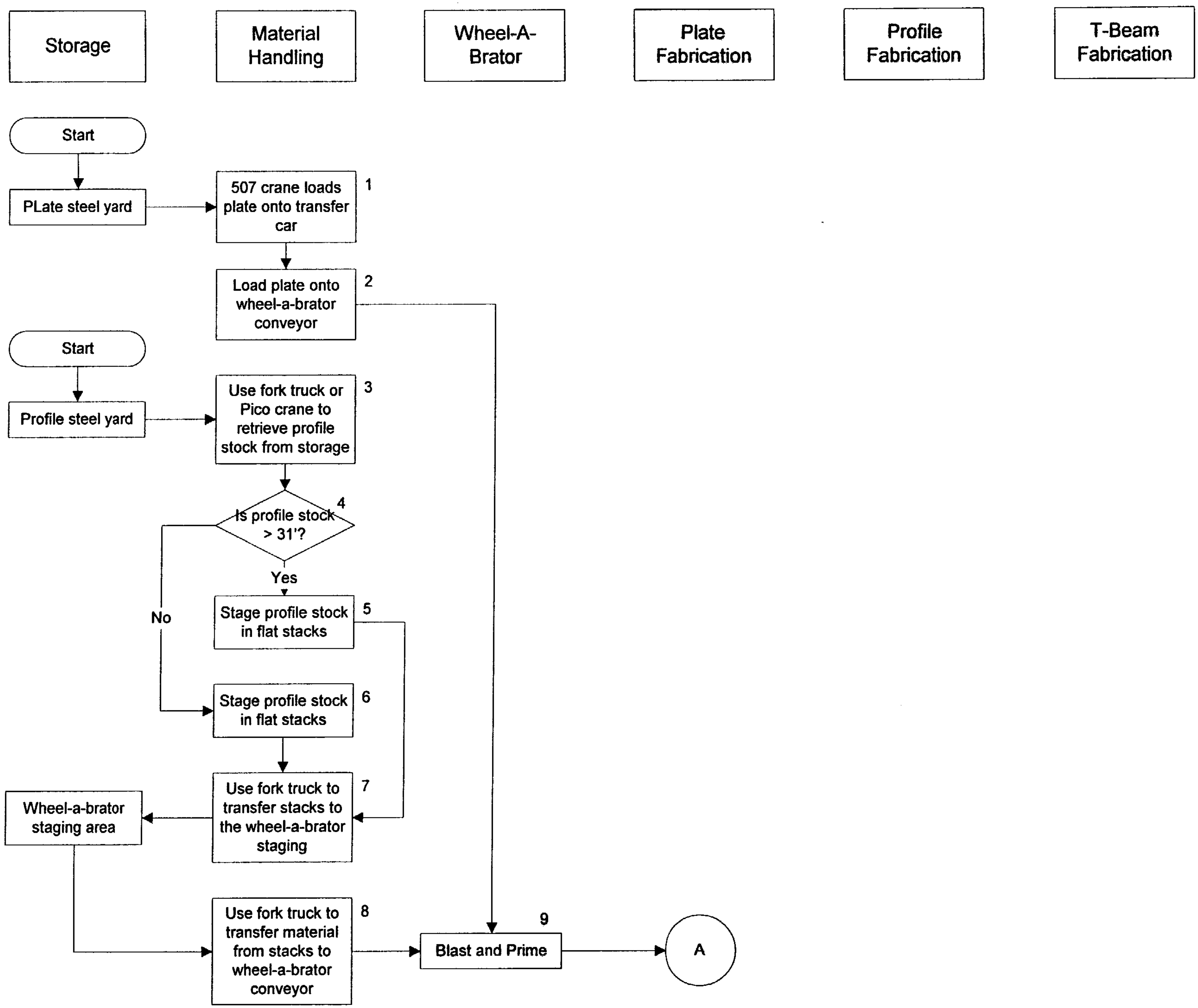
The process of validation usually requires a number of iterations until a satisfactory level of accuracy is achieved.

APPENDIX C
SIMULATION SOFTWARE PACKAGES

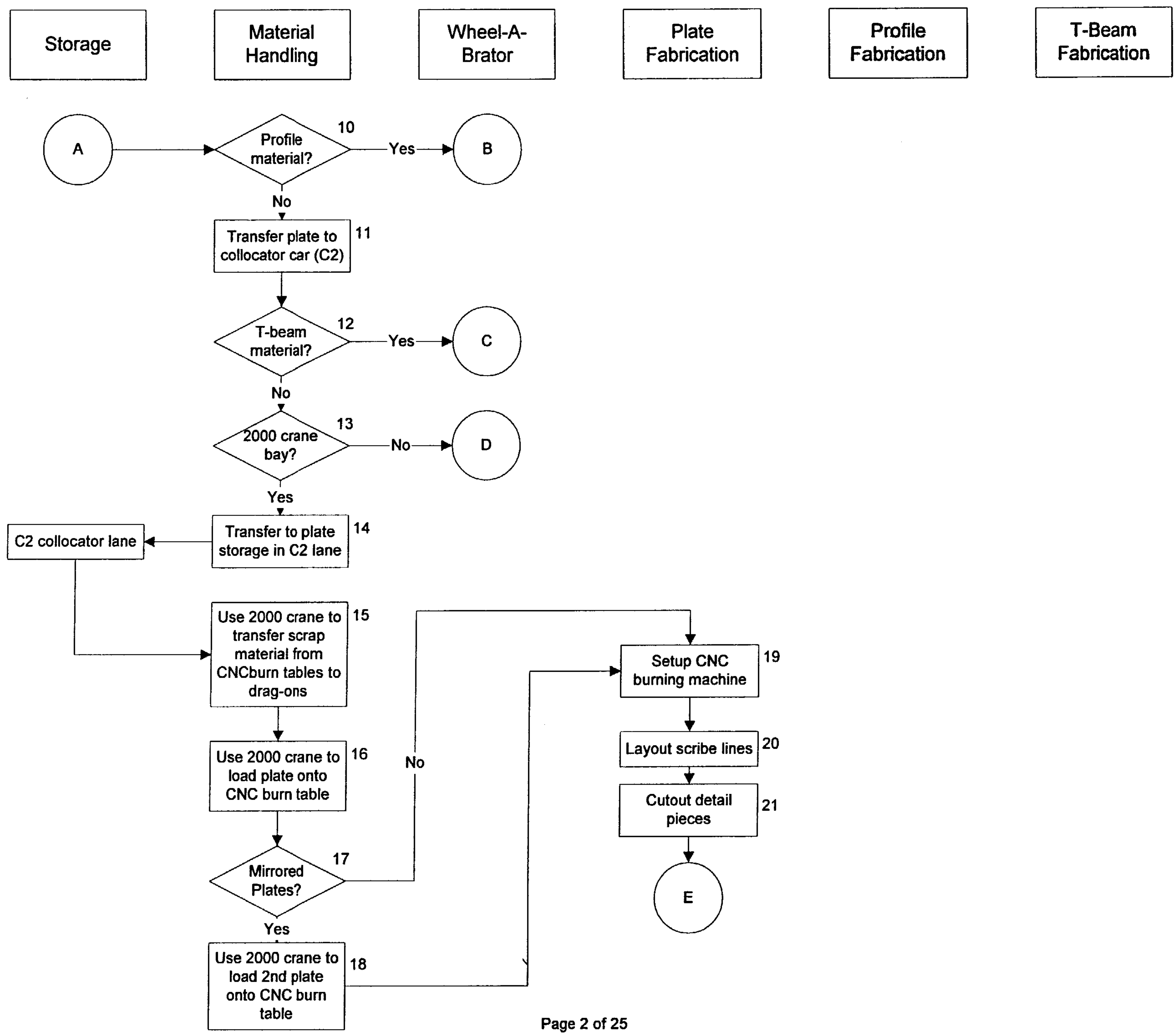
See
"Software for Simulation"
By Jerry Banks
Published in the Proceedings of the 1996 Winter Simulation Conference

APPENDIX D
NASSCO STEEL FABRICATION AND SUBASSEMBLY FLOWCHART

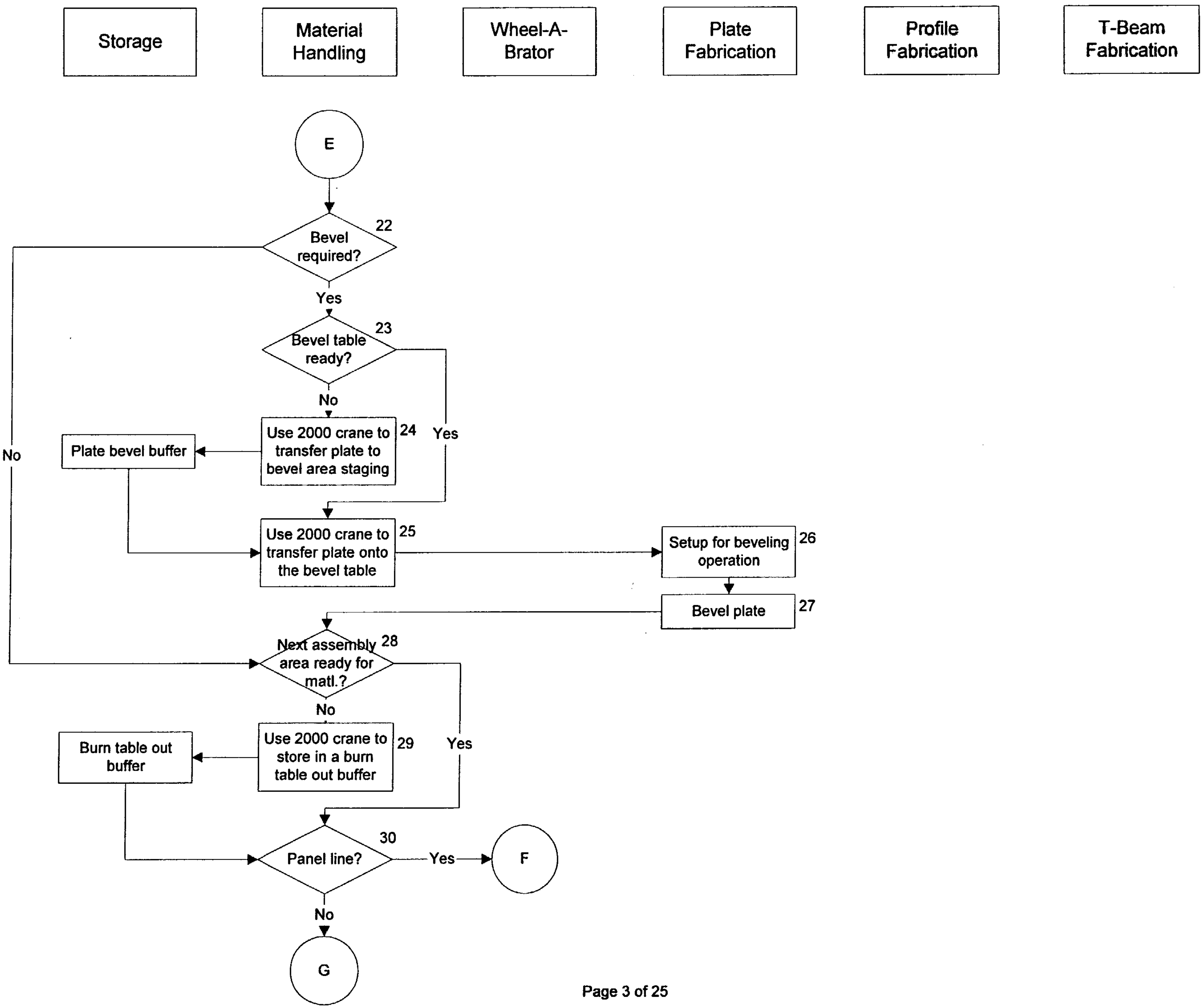
NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



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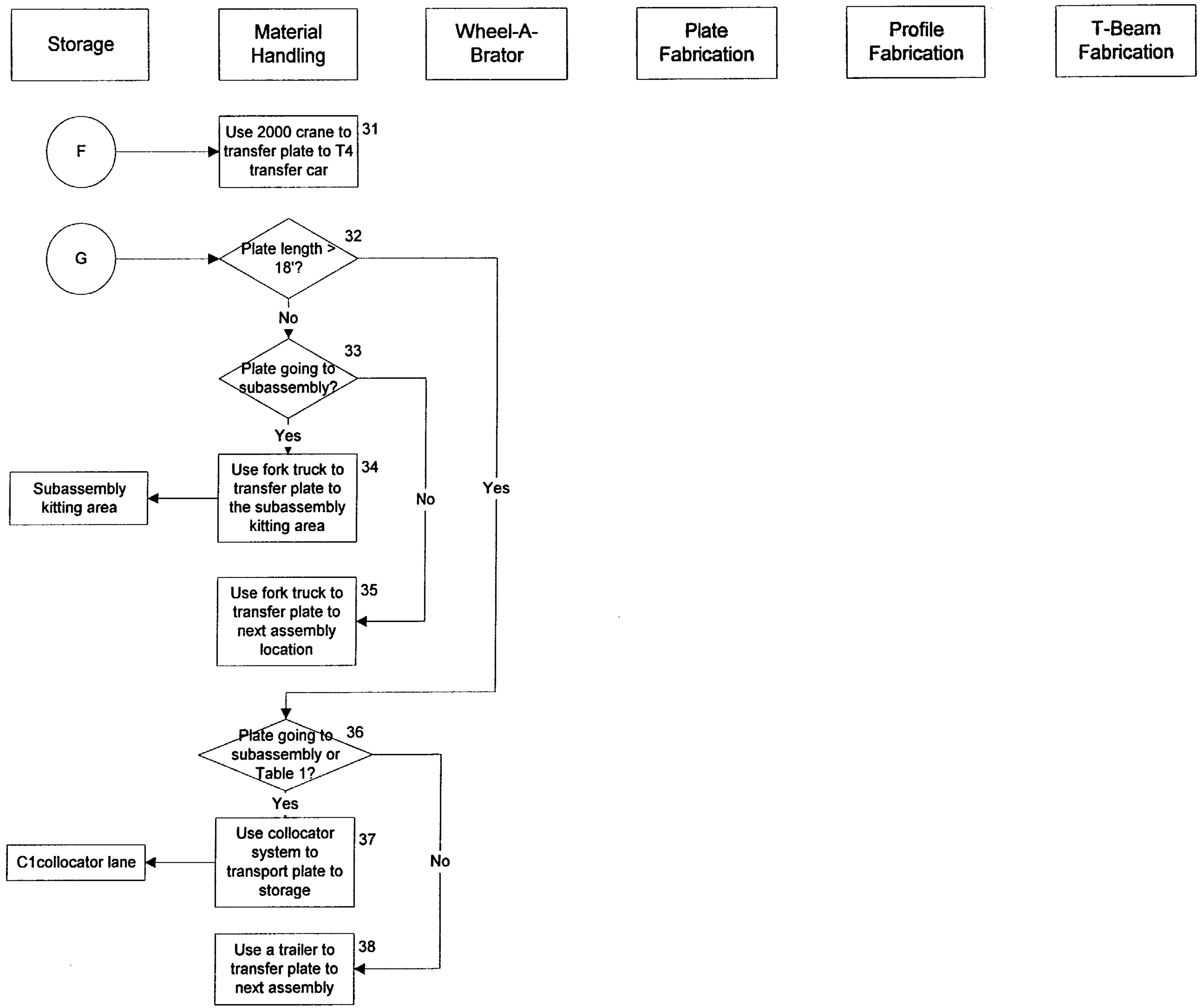
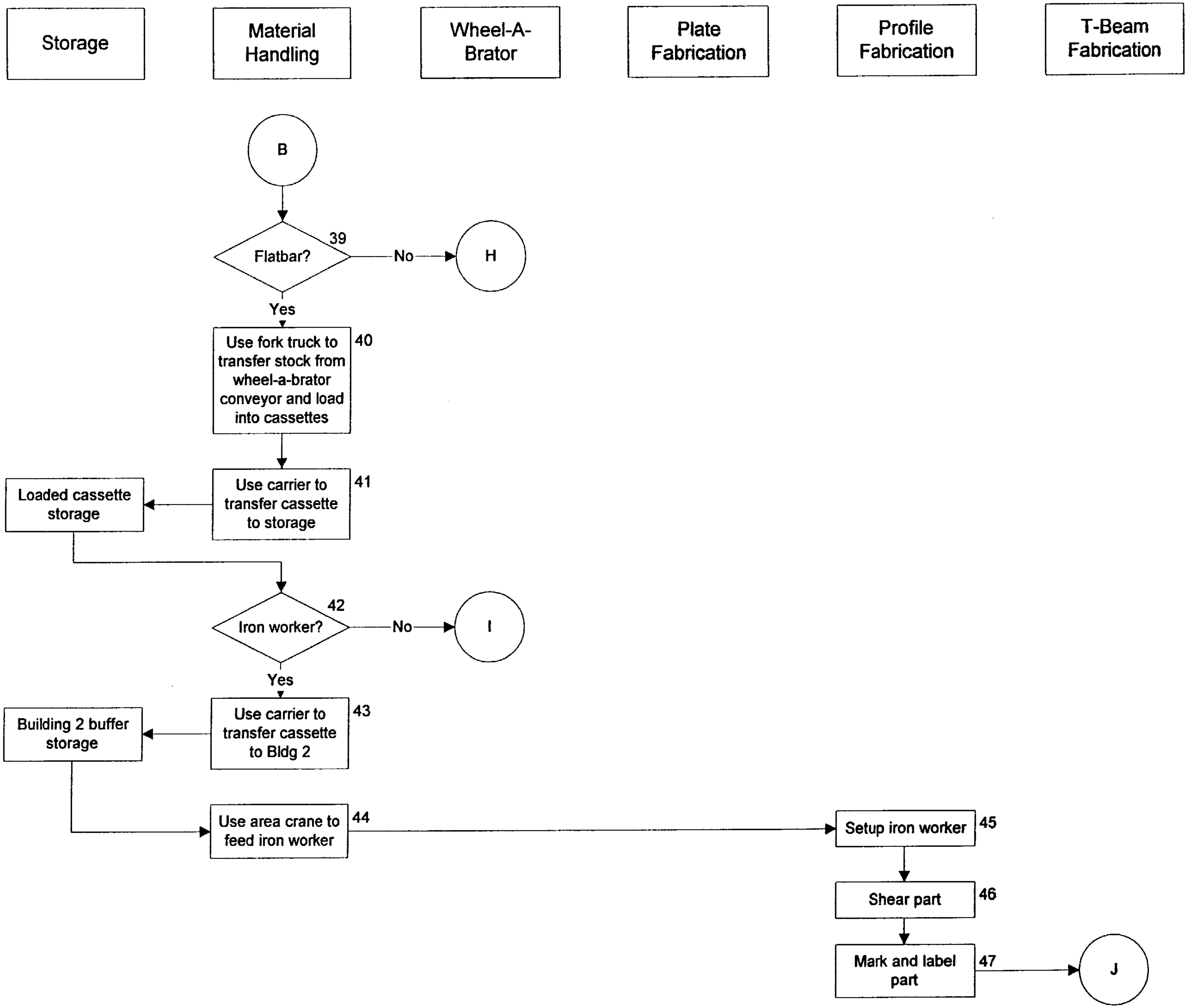
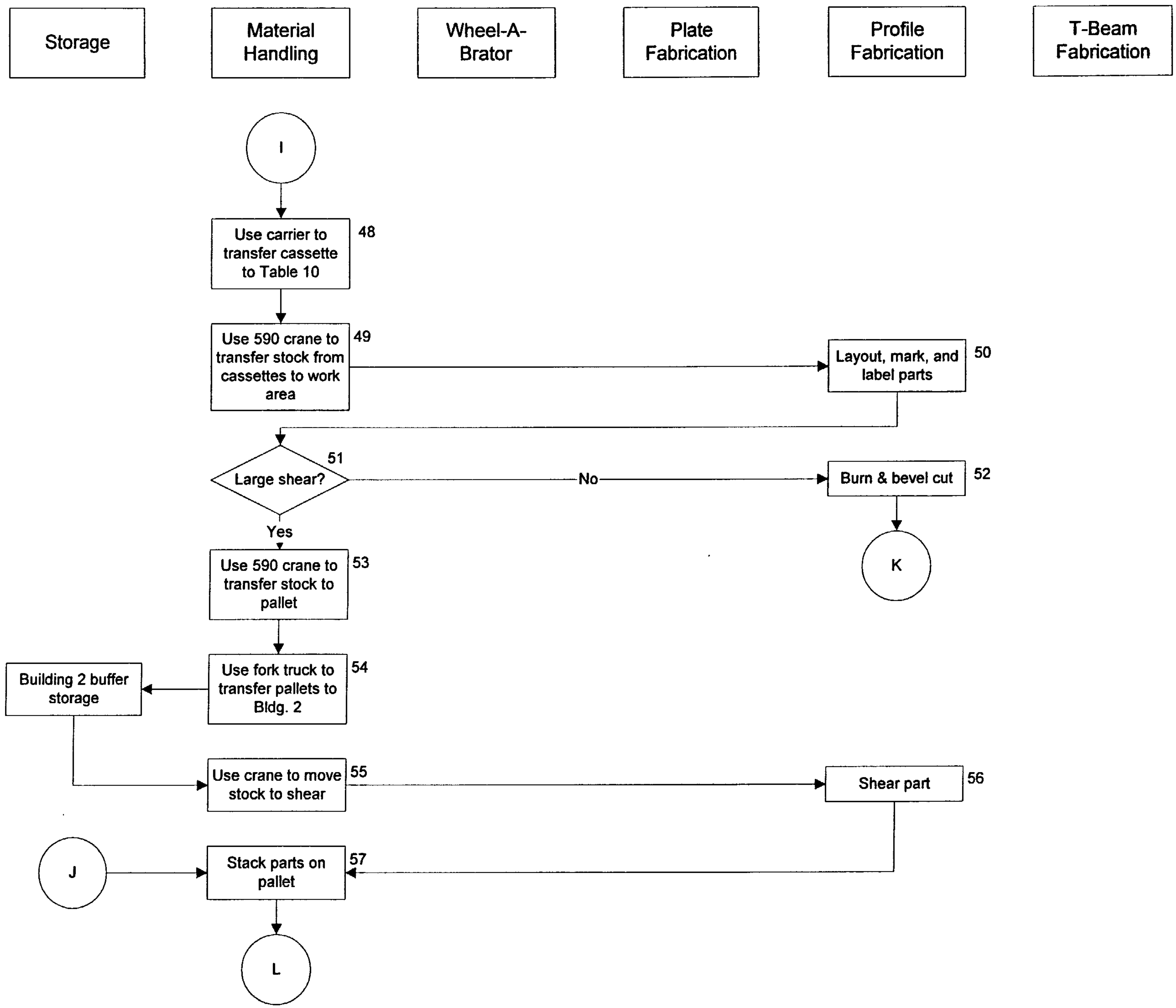


NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



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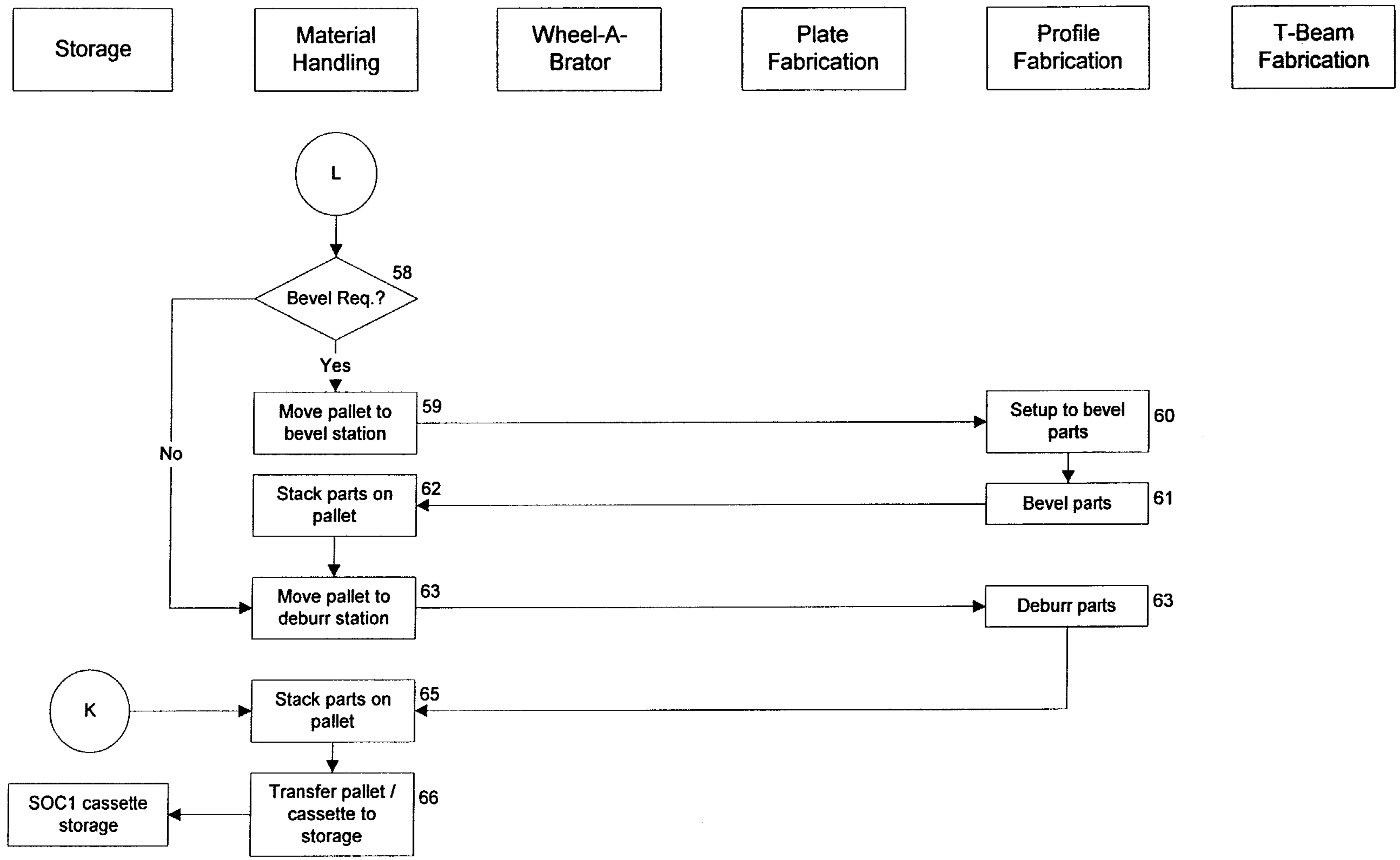

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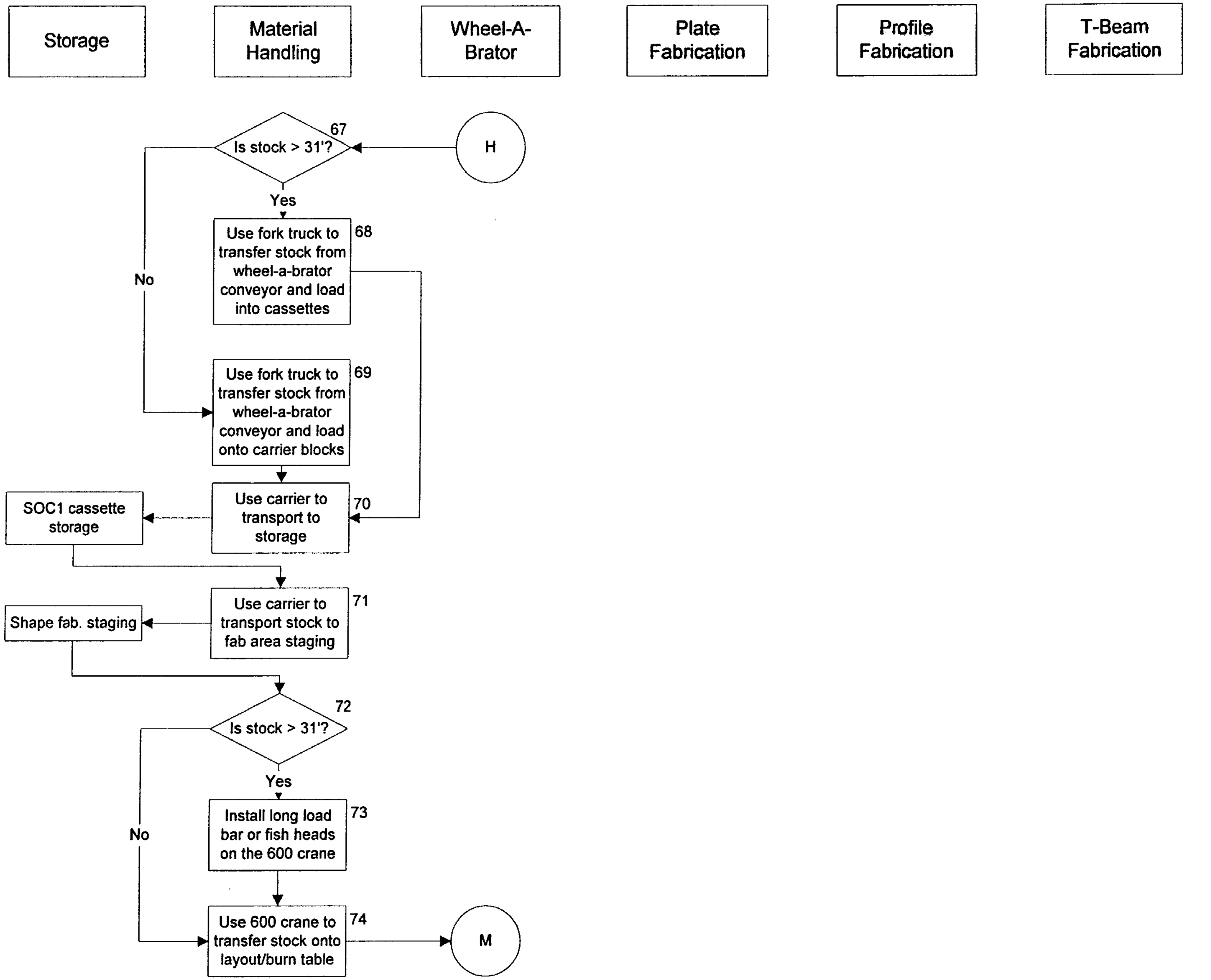

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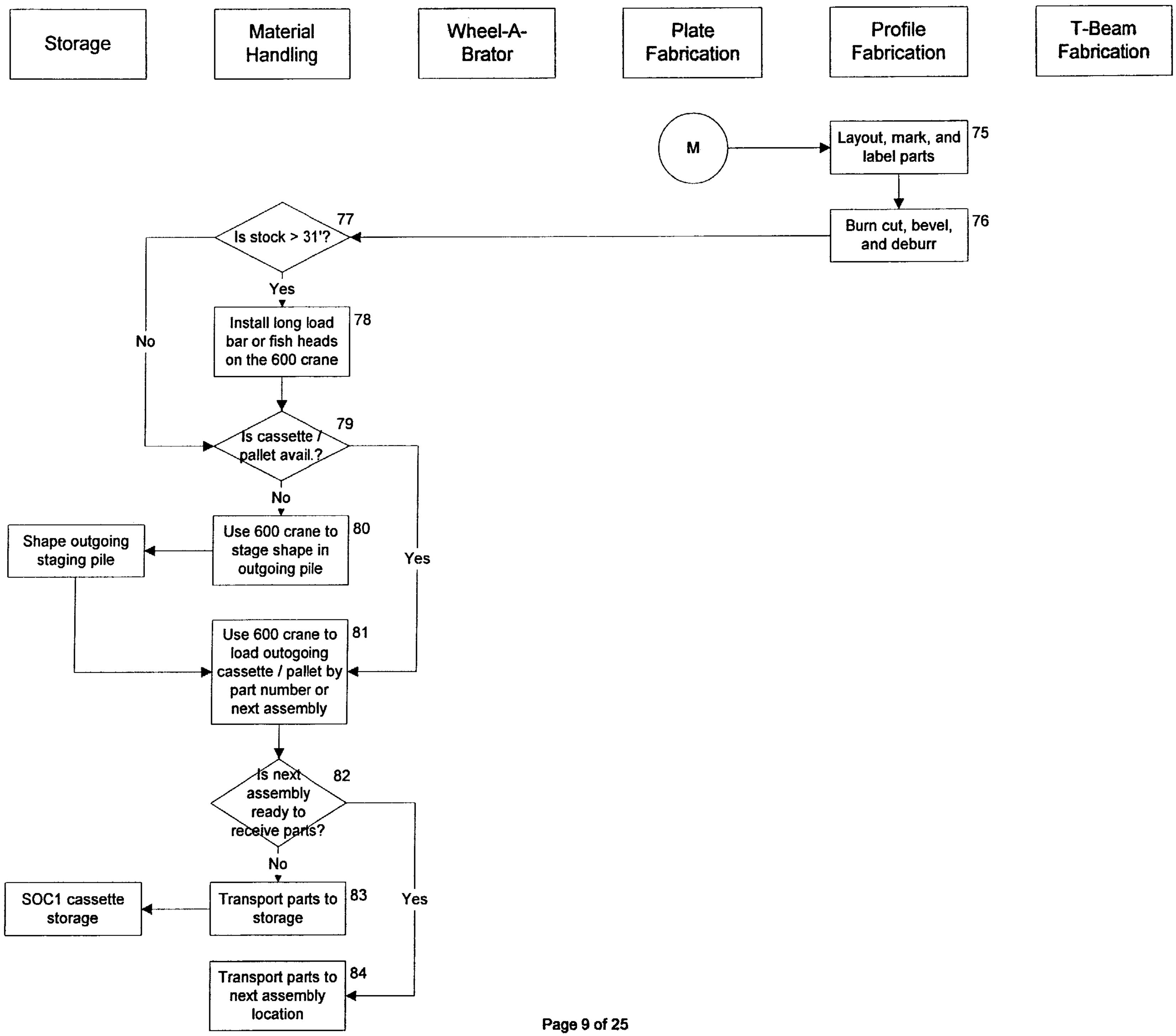

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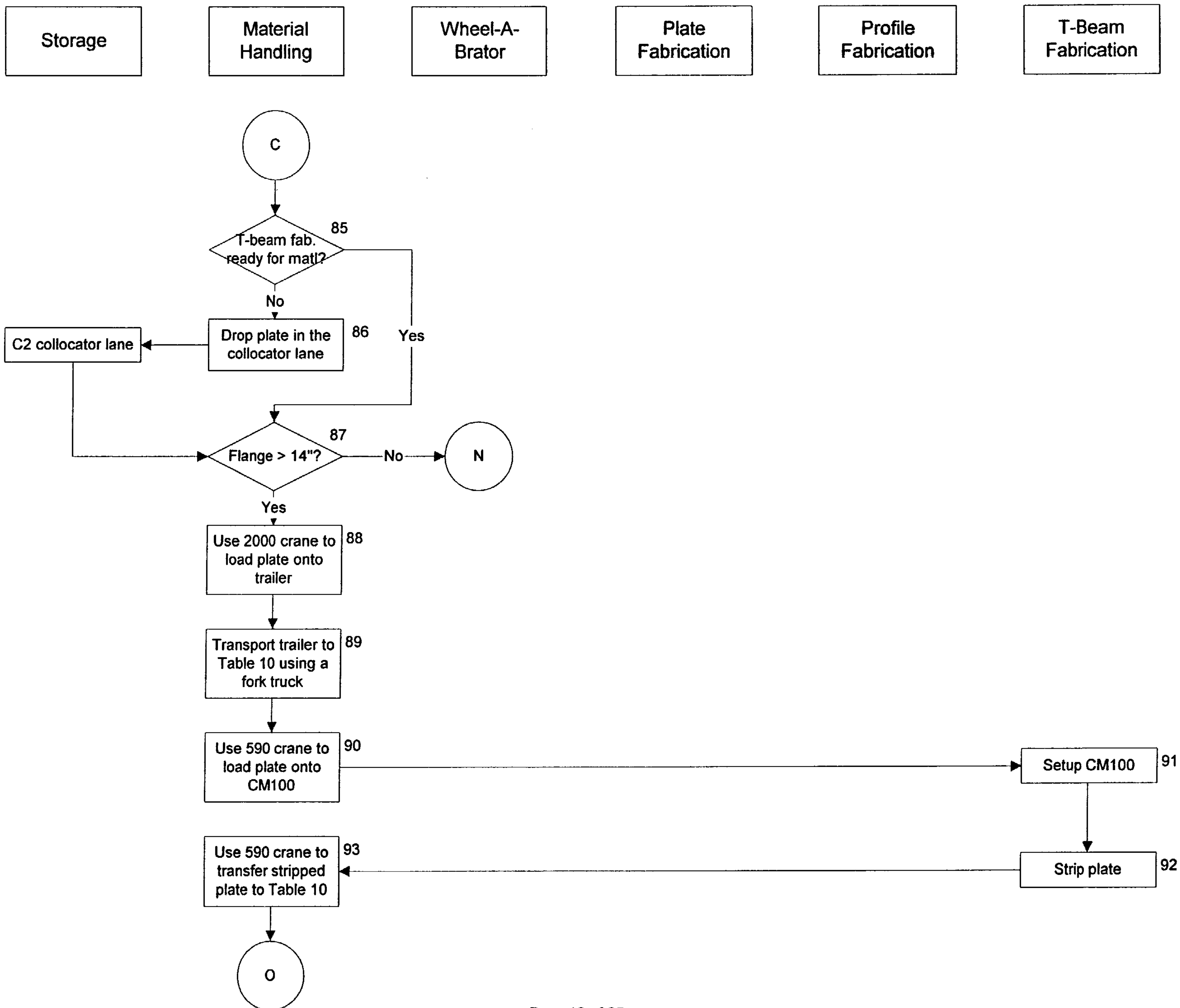

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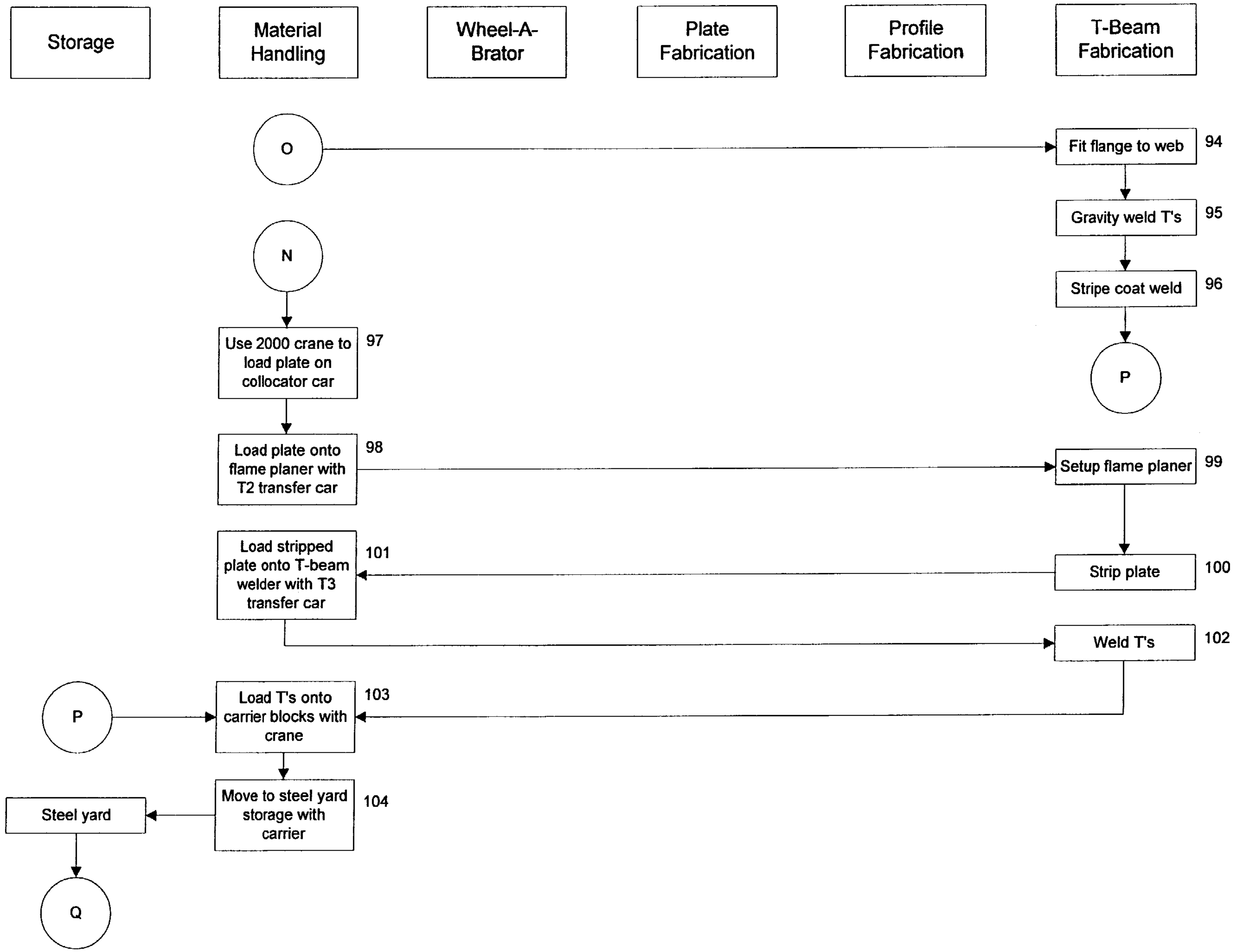

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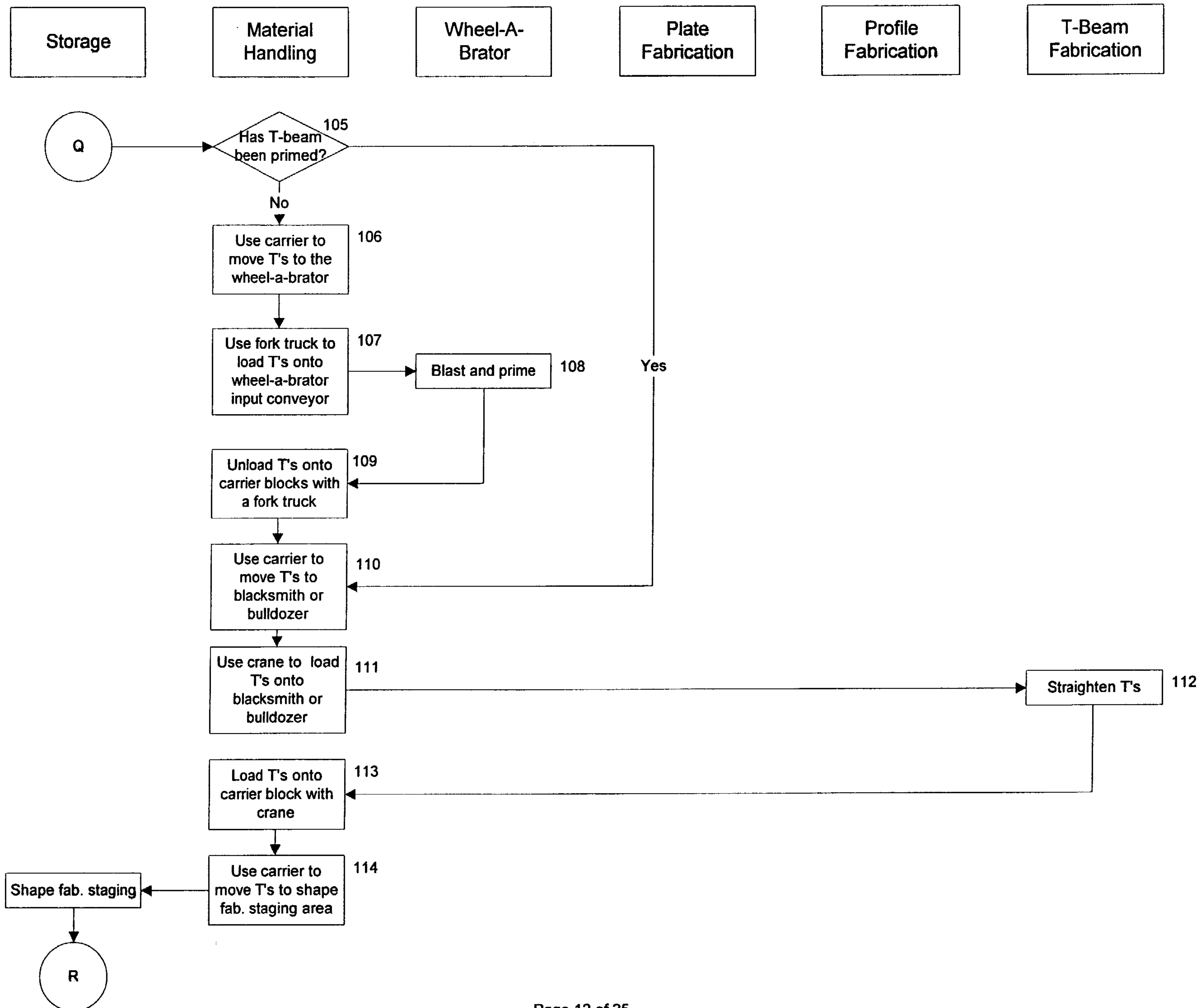

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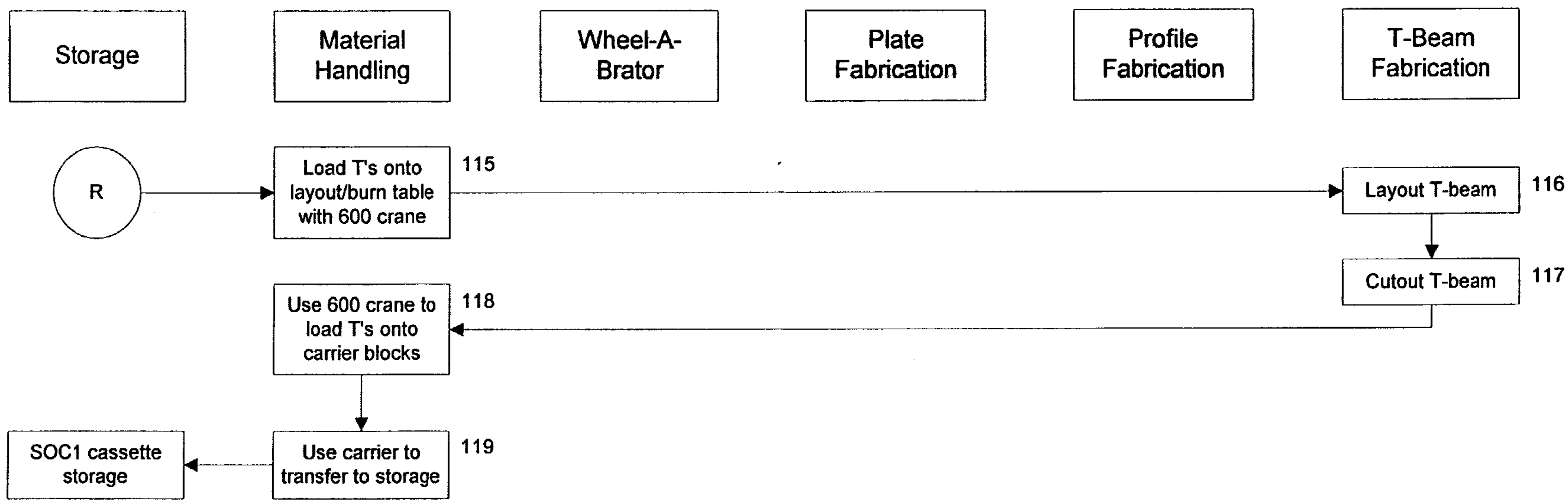
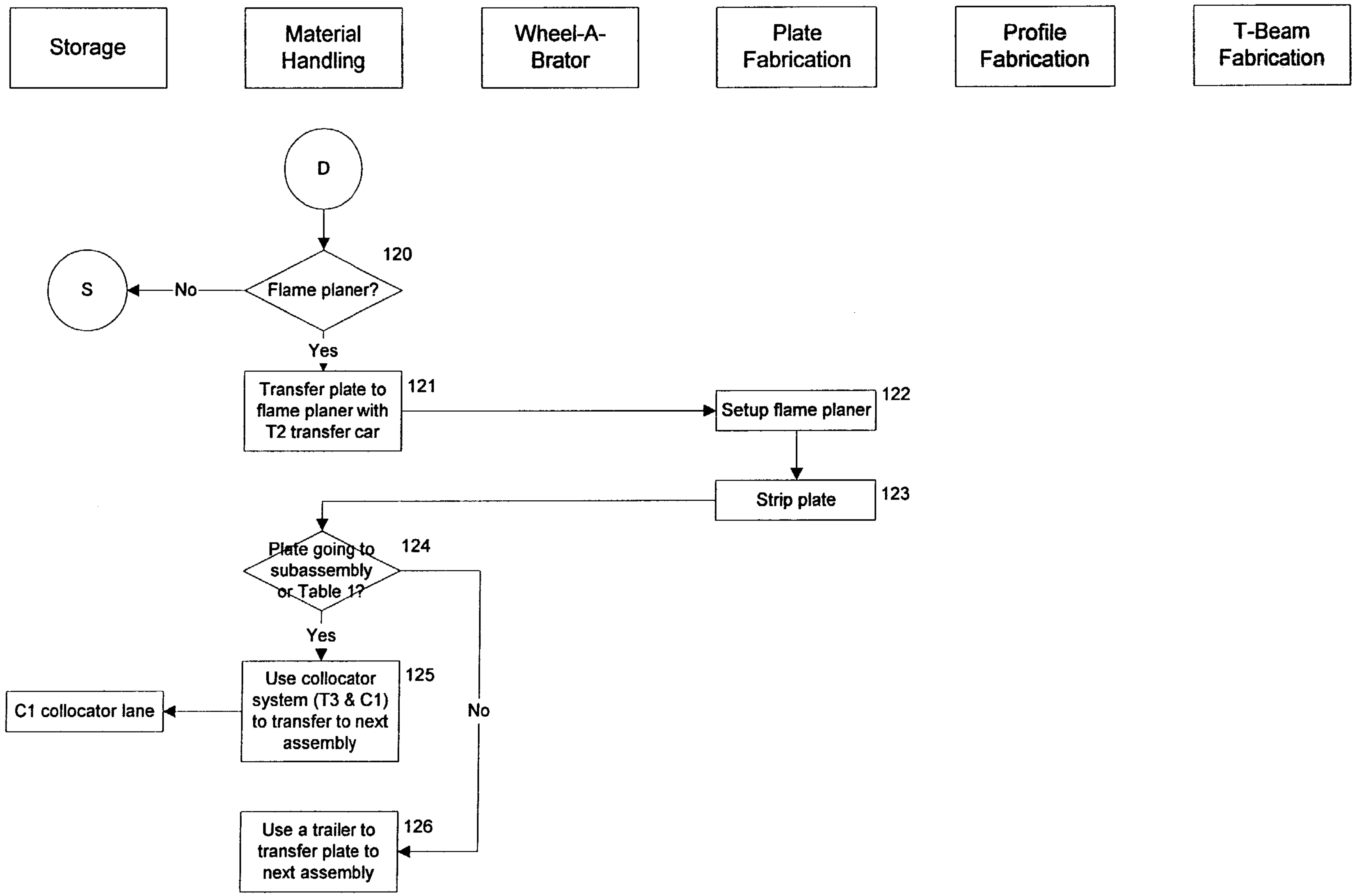
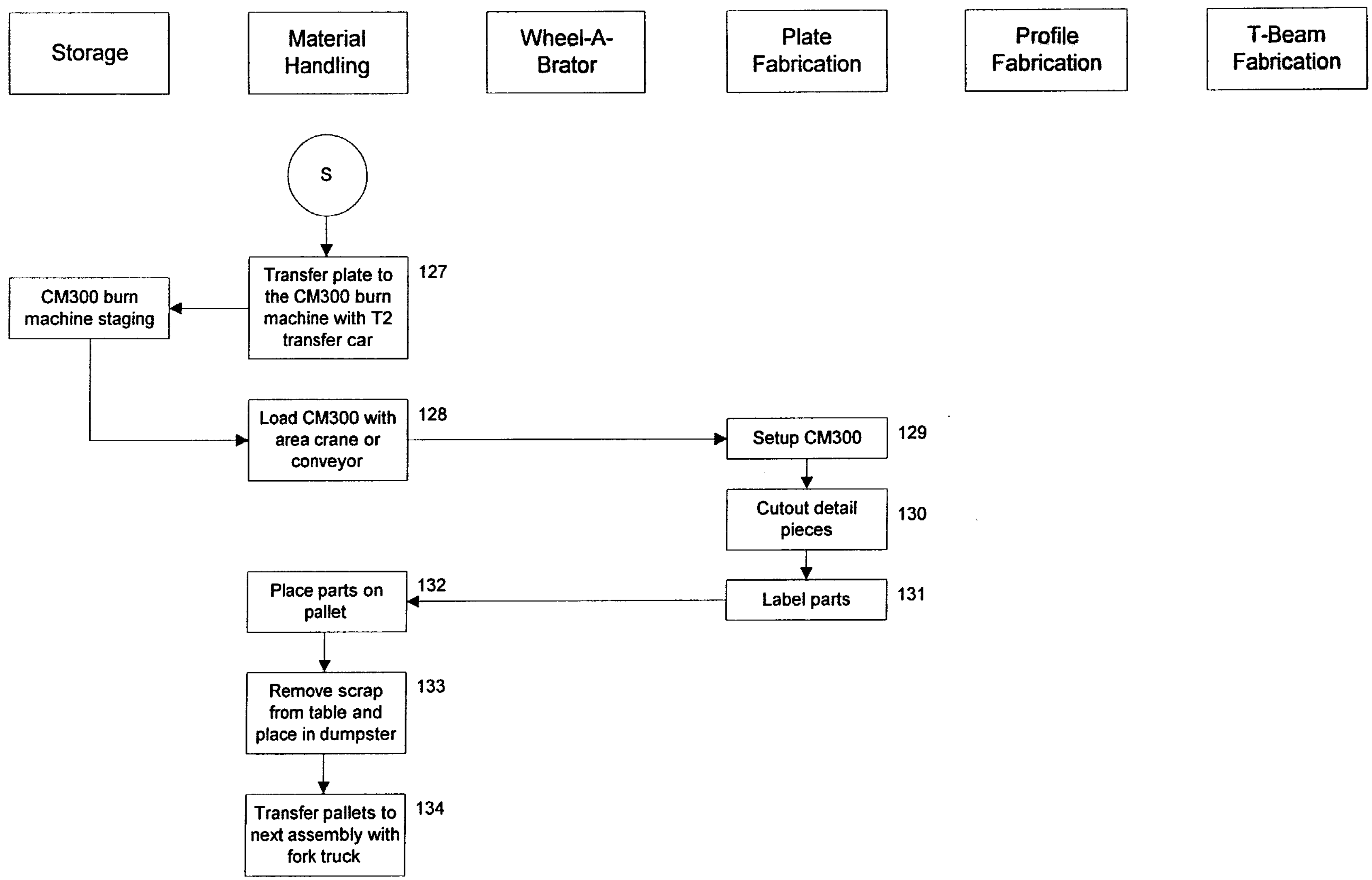


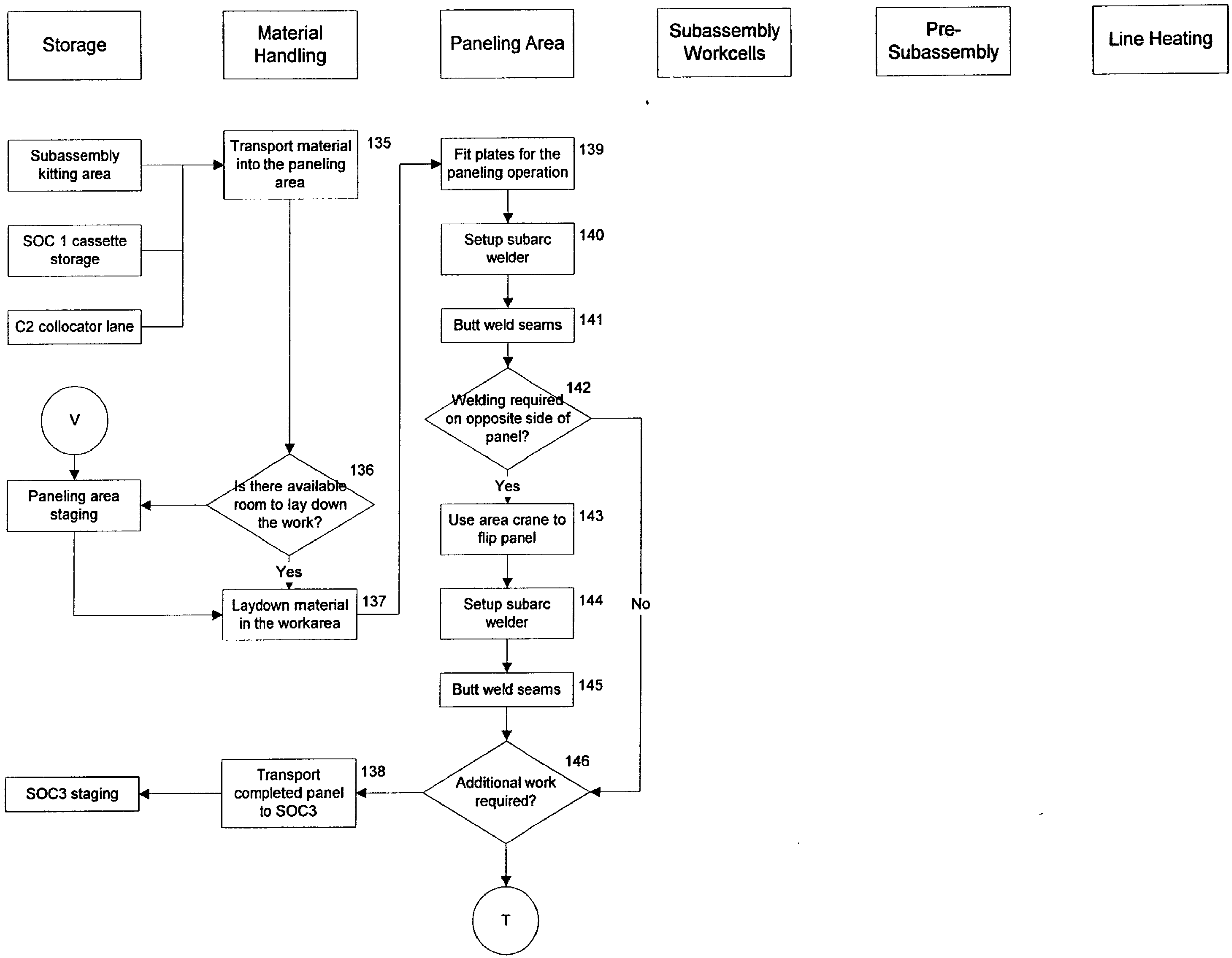
NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



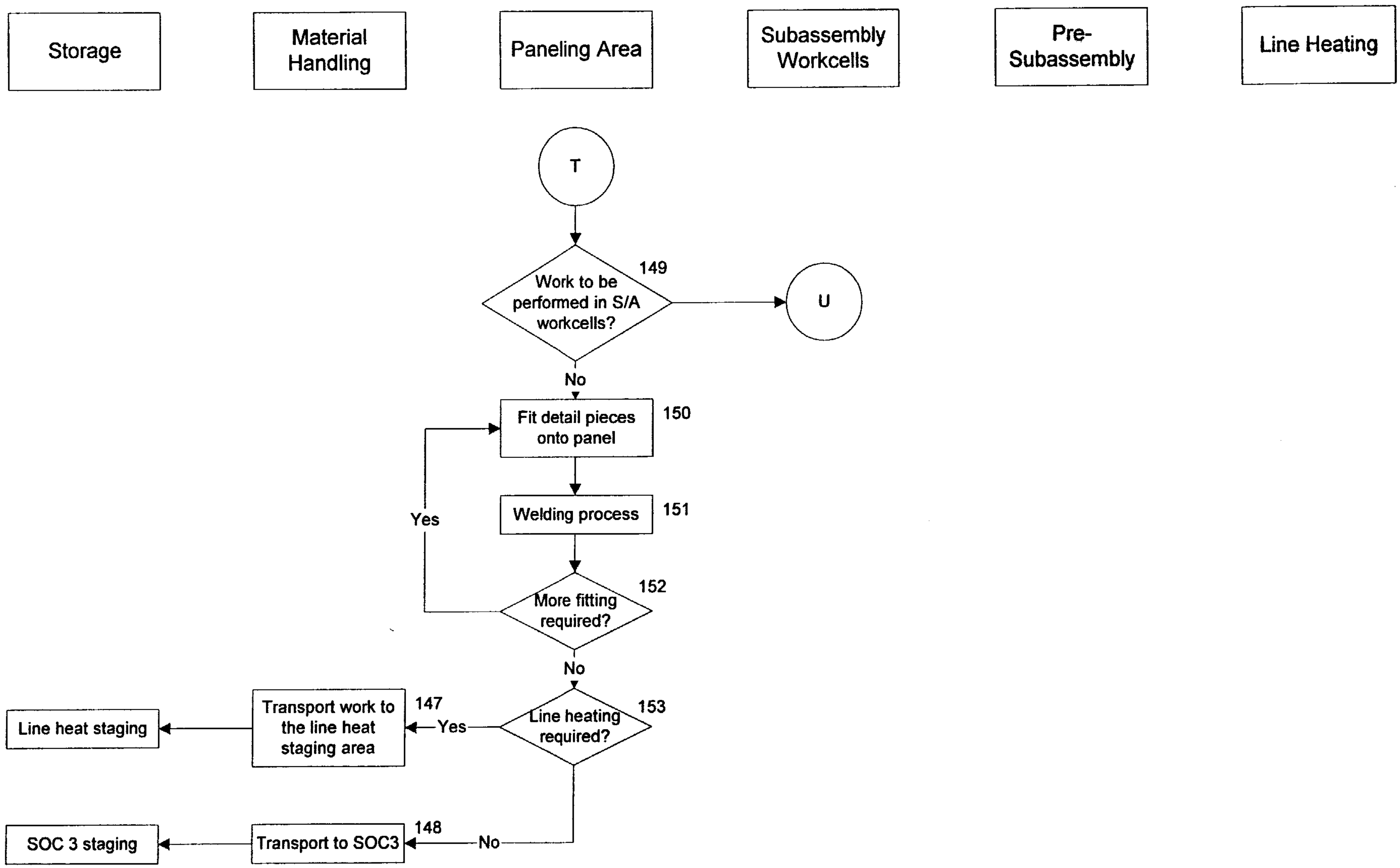
NASSCO Stage of Construction 1 - Steel Fabrication 'As-Is' Process Flowchart



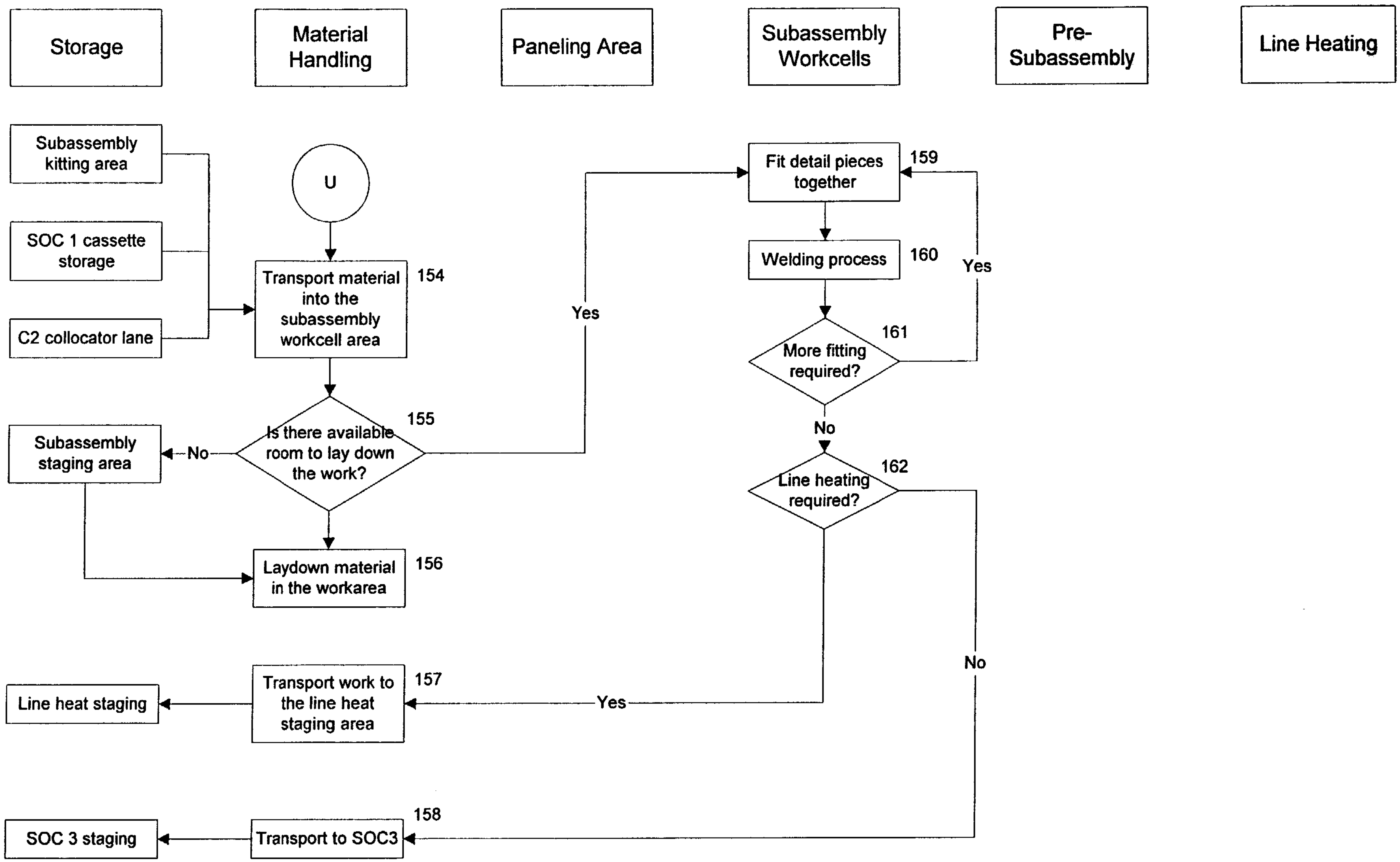
NASSCO Stage of Construction 2 - Steel Subassembly 'As-Is' Process Flowchart



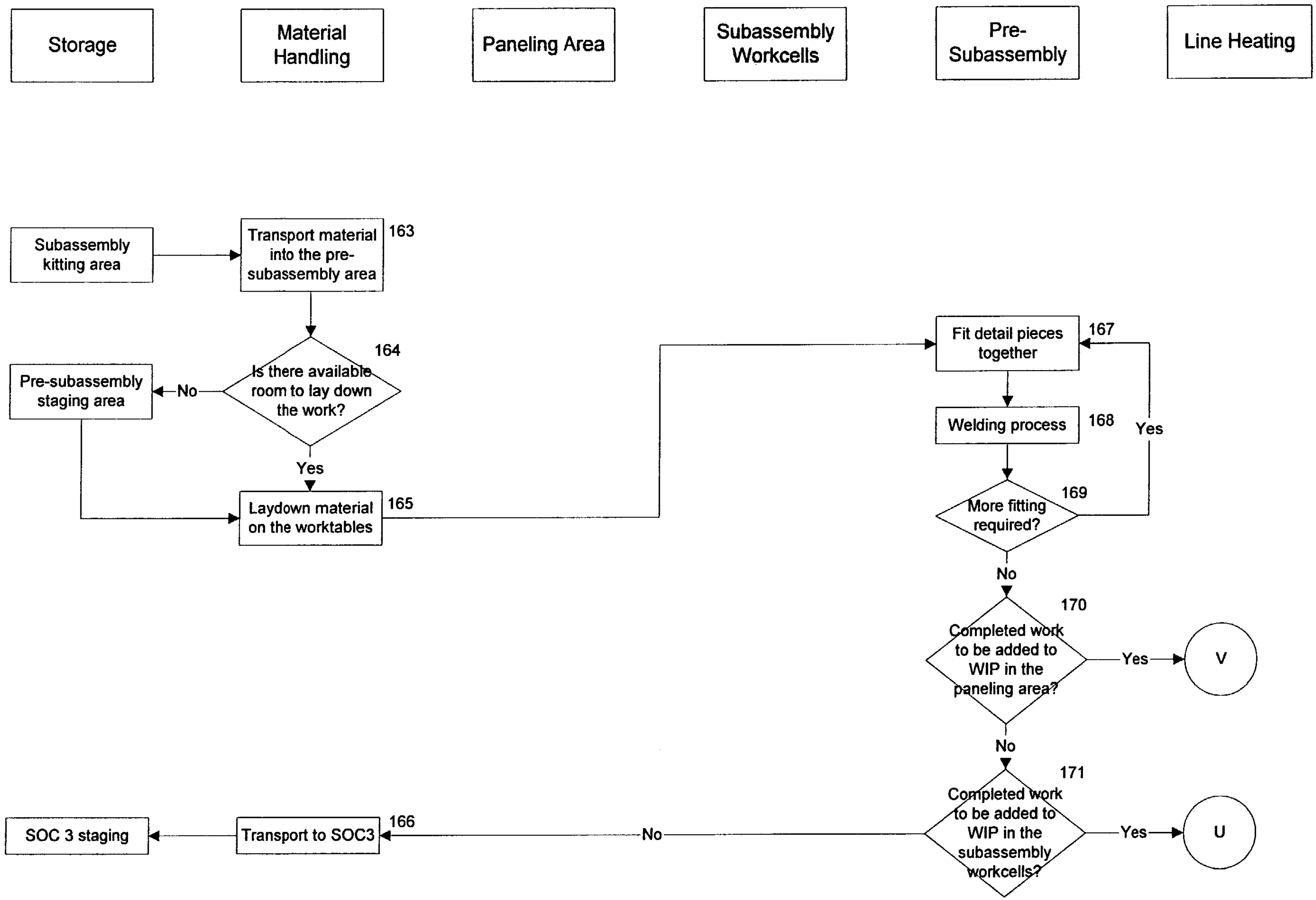
NASSCO Stage of Construction 2 - Steel Subassembly 'As-Is' Process Flowchart



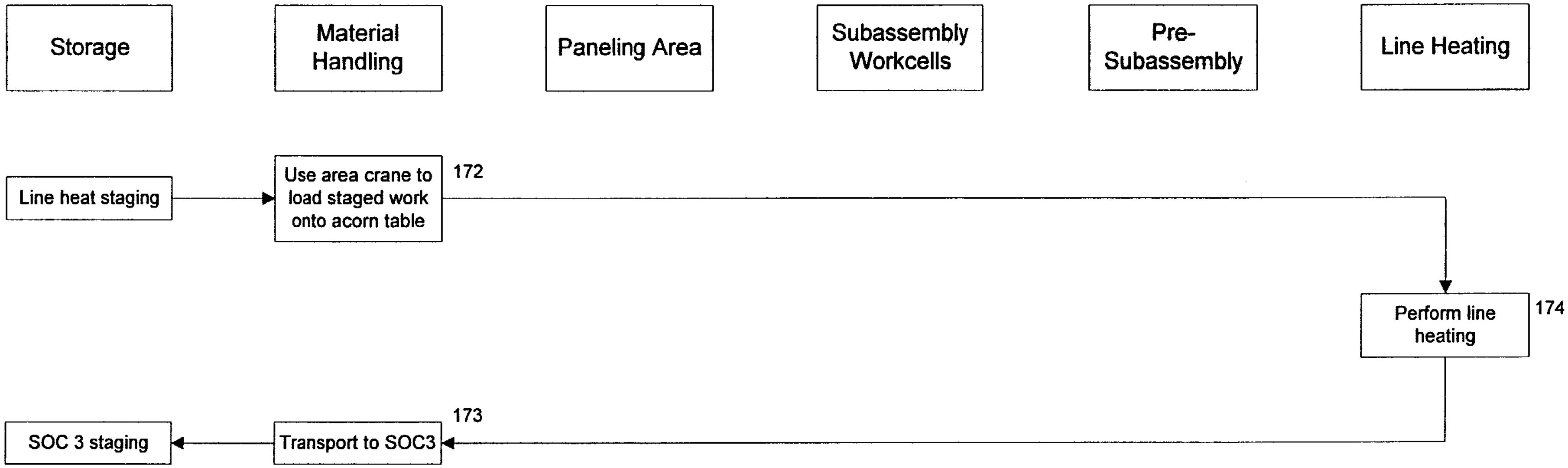
NASSCO Stage of Construction 2 - Steel Subassembly 'As-Is' Process Flowchart



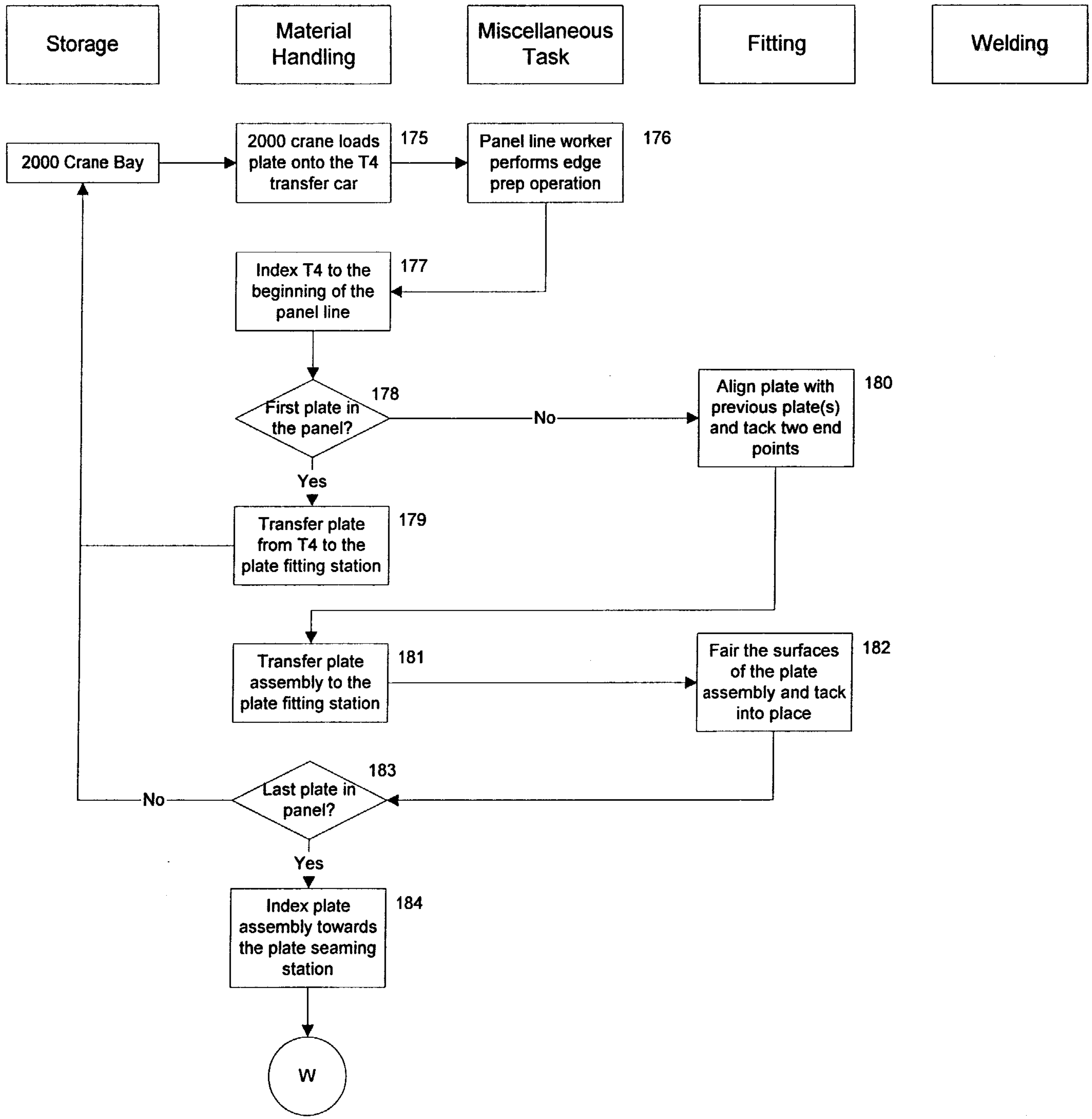
NASSCO Stage of Construction 2 - Steel Subassembly 'As-Is' Process Flowchart



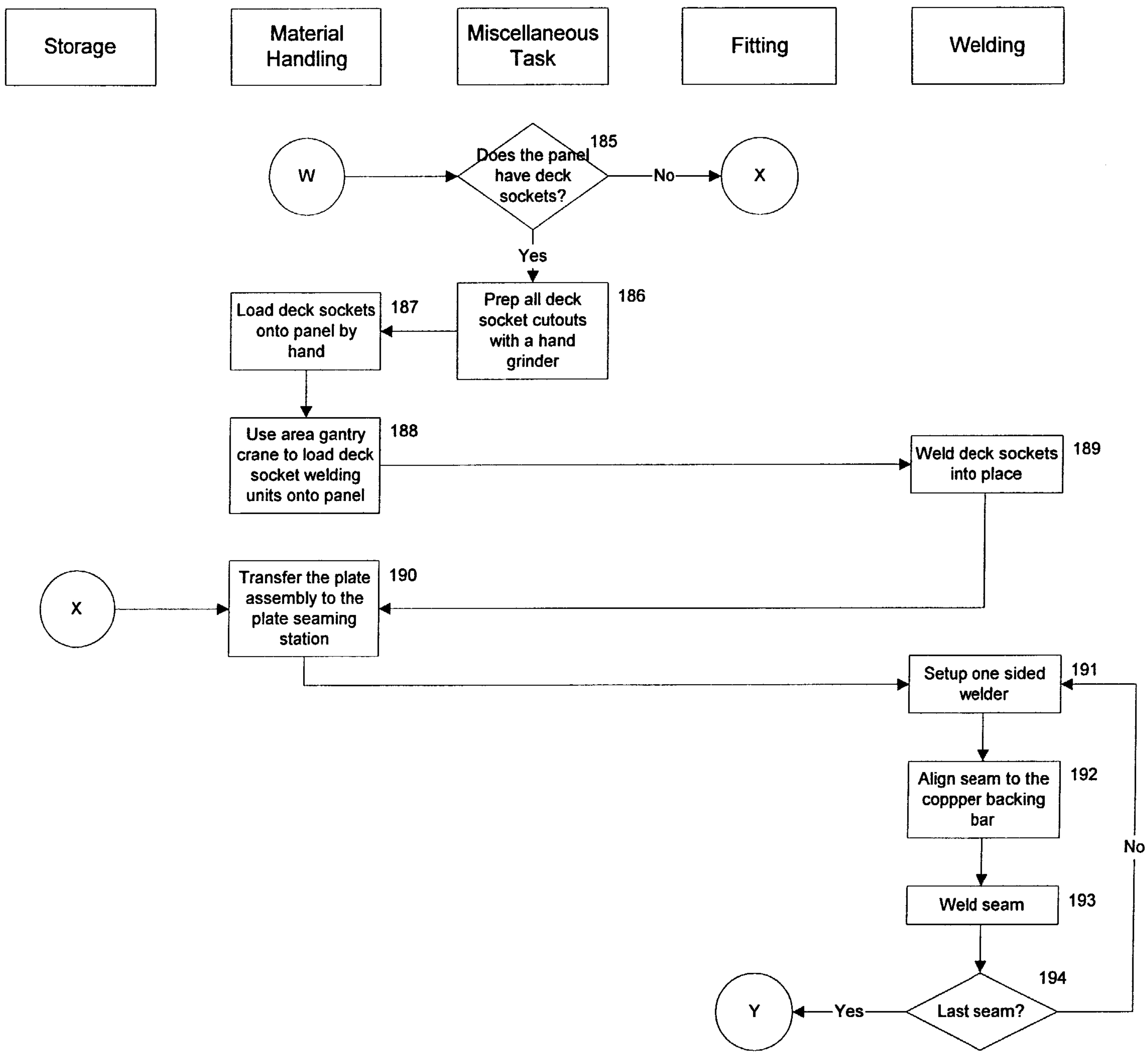
NASSCO Stage of Construction 2 - Steel Subassembly 'As-Is' Process Flowchart



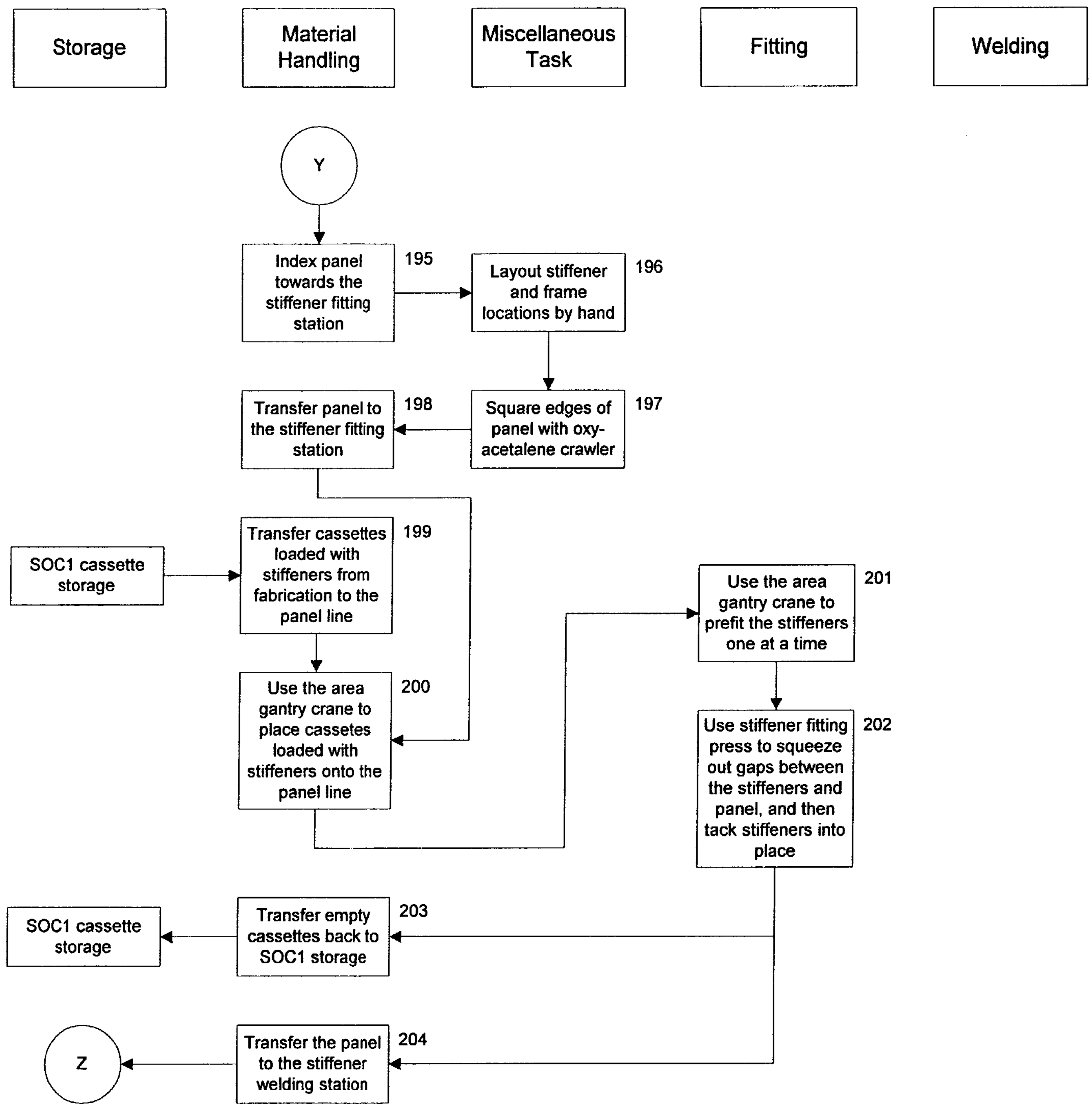
NASSCO Panel Line - 'As-Is' Process Flowchart



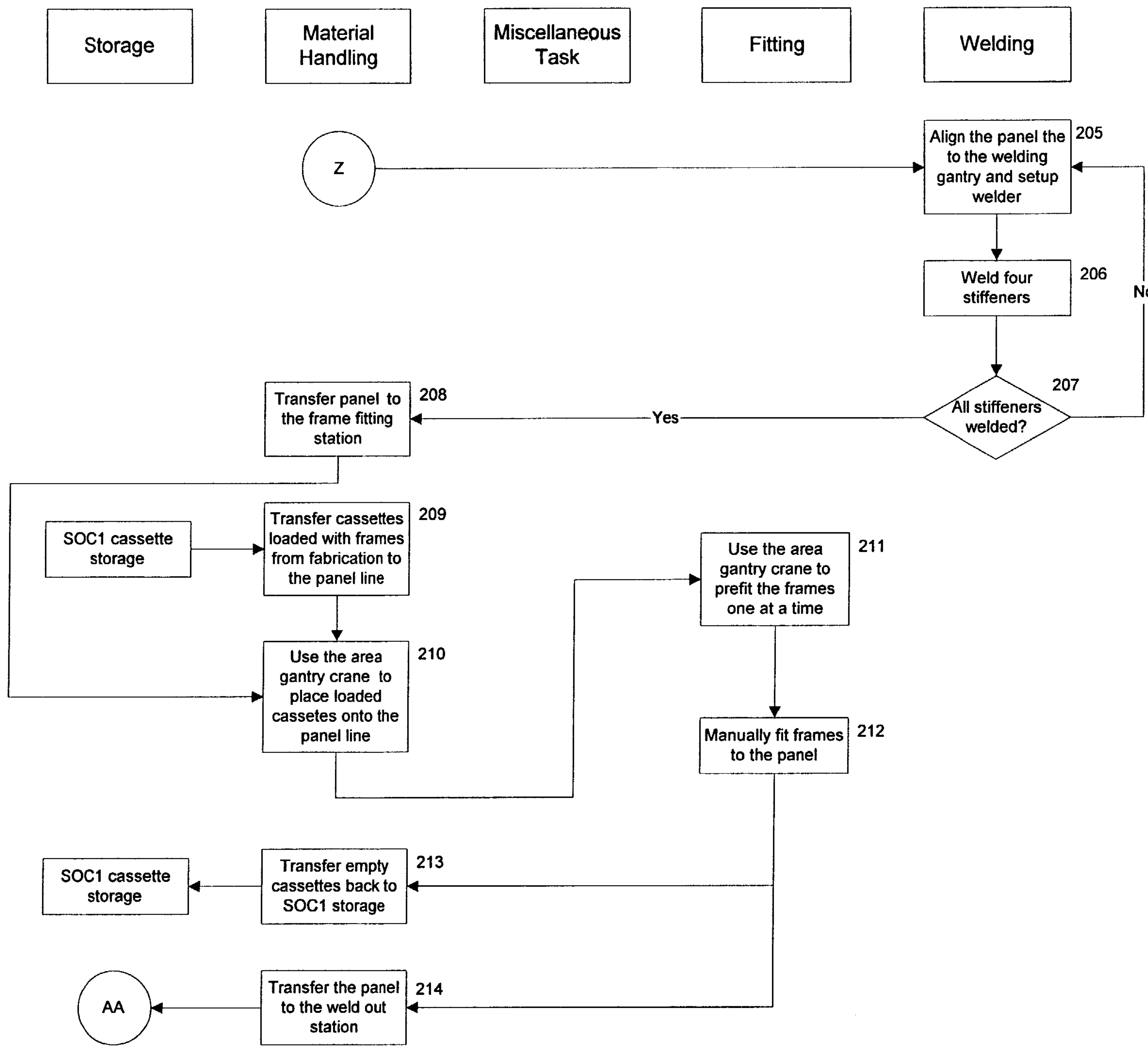
NASSCO Panel Line - 'As-Is' Process Flowchart



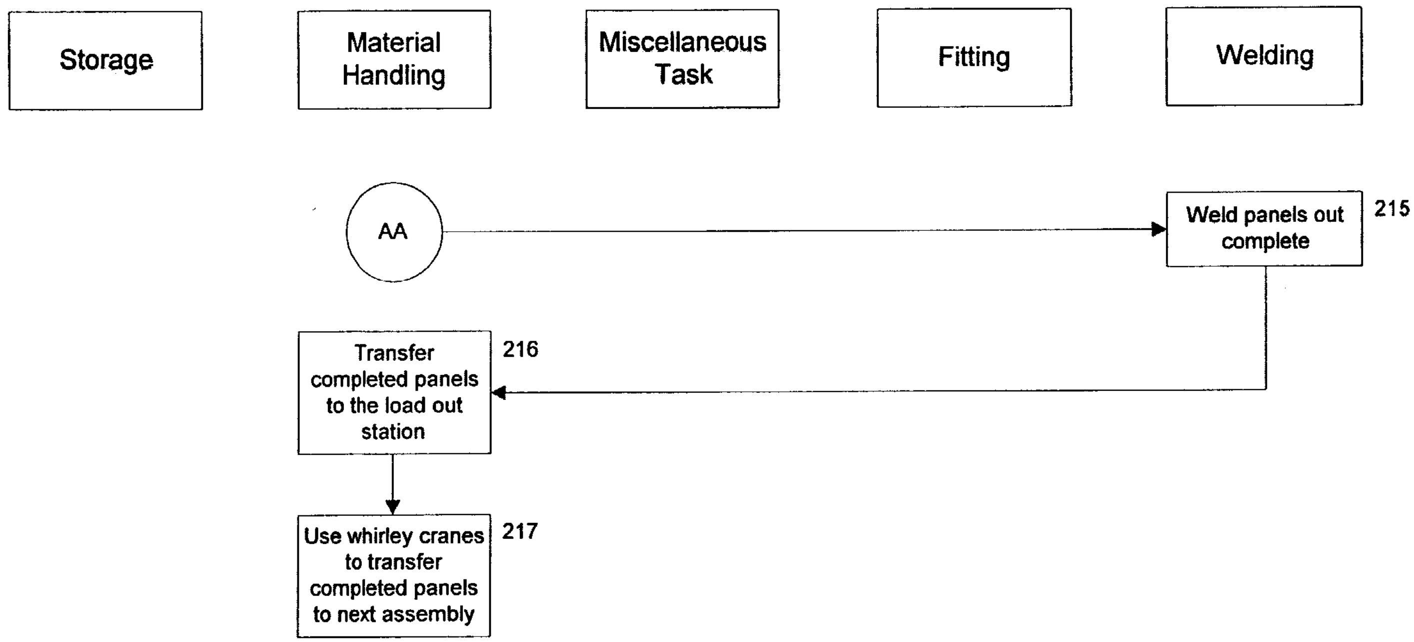
NASSCO Panel Line - 'As-Is' Process Flowchart



NASSCO Panel Line - 'As-Is' Process Flowchart



NASSCO Panel Line - 'As-Is' Process Flowchart



NASSCO Steel Fabrication and Subassembly 'As-Is' Process Flowchart Supplement

The intent of this supplement is to define the logic which should be used in the simulation model. The numbered items below directly correspond to the individual flowchart items for the 'As-Is' process flowchart.

1. The 507 crane will pick plates from piles within the steel yard and stage them next to the T1 transfer car. The T1 transfer car will index over to be within reach of the 507 crane. The 507 crane will then transfer the staged plates one at a time to the T1 transfer car. The 507 crane requires one operator and the T1 transfer car is operated by one of the Prime Line workers.
2. The T1 transfer car indexes back in-line with and becomes part of the wheelabrator incoming conveyor. The transfer car and the incoming conveyor are operated manually by one of the workers.
3. Stock within reach of the Pico crane is retrieved by that crane and staged for delivery to the wheelabrator. A forktruck performs this operation if the Pico crane is down or if the material is out of the crane's reach. In either case, an operator is required.
4. There is a quick sort of the profile raw stock by length.
5. Place the material greater than 31' in length in its own stack.
6. Place the material less than 31' in length in its own stack.
7. Use a forktruck to transfer the stacks of profile material from the profile steel yard to the wheelabrator incoming material staging area. If the raw material is 51' in length, a special spreader bar must be used to transfer the material.
8. Within the wheelabrator incoming material staging area, use a forktruck to orient and place the profile material onto the wheelabrator incoming conveyor. The number of profiles loaded at the same time (i.e. side-by-side) will vary from seven pieces for flatbar and four pieces for all other profiles.
9. Feed the material by conveyor through the wheelabrator for processing. The first process is a shot blast to remove any mill scale. The second process is a painting operation where a primer coat is applied to the material. One to two workers are required to operate the conveyors and the wheelabrator. An additional worker is stationed at the exit point of the wheelabrator to hand label all outgoing pieces of material.
10. Profile material is sent straight through to the end of the wheelabrator conveyor system where it is removed from the conveyor by forktruck.
11. Plates are transferred from the wheelabrator outgoing conveyor to the C2 collocator car via a turntable.
12. Plates for T-beam manufacture are logically separated from all other plates.
13. Plates scheduled for the flame planer or the CM300 machines are sorted out from the rest.
14. Plates scheduled for the CNC burn machines in the 2000 crane bay are stored in piles within the C2 collocator lane.
15. The 2000 crane is used to remove any scrap and remnant material from the CNC burn machine tables. the 2000 crane will then place this material into centrally located dumpsters within the 2000 crane bay. The dumpsters are periodically emptied by an outside contractor.
16. The 2000 crane will transfer plates from C2 collocator lane storage to the CNC burn machine table. This operation may require some plate shuffling.
17. Sometimes multiple (i.e. mirrored plates) will be processed on the burn machines. There needs to be a check for mirrored plates at this point in the logic. Please see the additional write up on the 2000 crane operations.
18. Same as #16.
19. This task consists of downloading the NC program and loading the plates onto the cutting table.
20. Using the marking heads on the CNC burn machines, layout lines are marked on the plate.
21. Detail pieces are cut from the plate stock.
22. Some of the plates require a manual bevel operation after cutting on the CNC burn tables.
23. Is there an open manual bevel station?
24. No open manual bevel station, therefore transfer piece to manual bevel staging.
25. Transfer plate to the manual bevel station.
26. Determine bevel requirements and setup required equipment.
27. Perform manual bevel operations.

28. Is the piece going directly to next assembly?
29. Next assembly not ready, store the piece in a local storage location.
30. Is the plate going to the panel line?
31. Use the 2000 crane to transfer the plate from to the panel line transfer car.
32. Is the detail piece greater than 18 ft in length? If so, do not use forktrucks for transport.
33. Is the plate going to subassembly?
34. Transfer plates less than 18 ft in length to the subassembly kitting area.
35. Transfer plates less than 18 ft in length to their SOC3 next assembly location.
36. If the plates are greater than 18 ft, are they going to subassembly or to assembly?
37. Using the collocator system, transfer plates to predefined staging piles in the C1 collocator lane.
38. Plates greater than 18 ft in length which are not going to either the panel line, subassembly, or Table 1 are delivered to the next assembly location by trailer.
39. Flatbar stock output from the wheelabrator is loaded into cassettes and then transported to staging area by a log carrier.
40. Same as #39.
41. Same as #41.
42. Is the flatbar going to be processed by the ironworker?
43. Transfer a cassette load of flatbar material from staging to the ironworker staging area.
44. Seize one of the 5 ton overhead cranes from the subassembly area to aide in material handling at the ironworker.
45. Read the manufacturing shop order and setup equipment to perform the task.
46. Process flatbar. Processing time to be a function of the number of cuts.
47. Mark and label each individual piece.
48. Flatbar stock is to be processed on Table 10, use the carrier to transport raw stock in cassettes from the staging area to Table 10.
49. The 507 crane is used to transfer incoming flatbar material from the cassettes to the Table 10 workarea.
50. Workers refer to manufacturing plans and then layout, mark, and label parts to be cut from the flatbar stock.
51. Are the pieces to be cut from the large shear?
52. Pieces are manually cut from raw stock using hand held cutting torches on Table 10.
53. Pieces are to be cut on the large shear, and are therefore loaded onto to pallets for transport to the large shear staging area.
54. Forktrucks transport flatbar material loaded on pallets from Table 10 to the large shear staging area.
55. A gantry crane at the large shear is used to move stock from the staging area to the large shear input table.
56. Parts are processed on the large shear. Cycle time is a function of the number of cuts.
57. Completed parts are stacked onto pallets on the output side of the large shear.
58. Do the sheared parts require beveling?
59. Using a forktruck, transport a pallet load of completed parts from the output side of the large shear to the small parts manual bevel staging area.
60. Review the beveling instructions on the manufacturing plan, setup material and equipment to perform the manual beveling operation.
61. Perform the manual beveling operation.
62. Stack beveled pieces onto a pallet.
63. Transfer pallet of beveled pieces to a manual deburr station.
64. Manually deburr parts.
65. Stack the deburred parts onto a pallet.
66. Using a forktruck, transfer the pallet of deburred parts to storage.
67. Are the non-flatbar profiles exiting the wheelabrator greater than 31 ft in length?
68. Non-flatbar profiles greater than 31 ft in length are loaded into cassettes as they exit the wheelabrator. A forktruck is used for material handling.
69. Non-flatbar profiles less than 31 ft in length are loaded onto carrier blocks as they exit the wheelabrator. A forktruck is used for material handling.
70. A log carrier is used to transport non-flatbar profiles loaded in cassettes or on carrier blocks from the output side of the wheelabrator to the profile staging area.

71. A log carrier is used to transport non-flatbar profiles loaded in cassettes or on carrier blocks from the profile staging area to the profile fabrication staging area.
72. Is the raw stock greater than 31 ft in length.?
73. Raw stock is greater than 31 ft in length and therefore, the long load bar must be installed on the 600 crane.
74. The 600 crane is used to transfer profile raw stock from the staging area to the layout and burn tables.
75. Workers layout, mark and label detail parts on the pieces of profile raw stock.
76. Workers use hand torches to cut detail pieces from the profile raw stock.
77. Are the completed profile parts greater than 31 ft in length?
78. Completed parts are greater than 31 ft in length and therefore, require that the long load bar be installed on the crane.
79. Is there a cassette or pallet available for the outgoing profile parts?
80. If no cassettes or pallets are available, use the 600 crane to transfer the completed profile parts from the layout and burn tables to the outgoing staging area.
81. Use the 600 crane to load completed profile parts onto cassettes and or pallets. Parts are sorted by part number and next assembly.
82. Are the completed profile parts going directly to the next assembly area?
83. Next assembly area is not ready for the completed profile parts, therefore, they are transported to storage by forktruck or log carrier.
84. Profile parts are transported directly to the next assembly location from profile fabrication by either forktruck or log carrier.
85. Is T-beam fabrication area ready to accept the T-beam material (plates) exiting the wheelabrator?
86. Fabrication is not ready for the just primed T-beam material, therefore, transfer this material to a predefined storage location in the C2 collocator lane.
87. Is the flange material for a T-beam greater than 14" wide?
88. Flange material for T-beams greater than 14" wide is stripped from plate using the CM100. Raw material for this operation is stored in the C2 collocator lane. The 2000 crane transfers this material from the C2 storage location onto a trailer.
89. Trailer loads of material are transported from the 2000 crane bay to the CM100. A forktruck is required for this operation.
90. The 590 crane is used to transfer T-beam flange material from the trailer to the CM100 table.
91. Workers refer to the manufacturing plan and setup the material and machine accordingly at the CM100.
92. The CM100 is used to strip T-beam flanges from plate stock.
93. The 590 crane is used to transfer T-beam flanges from the CM100 table to Table 10.
94. Workers manually fit the flanges to webs on Table 10.
95. A T-beam's flange and web are welded together using gravity welders.
96. Freshly completed and cooled T-beam welds (web to flange) are stripe coated with paint to prevent rusting.
97. Flange material for T-beams less than 14" wide is stripped from plate using the flame planer. Raw material for this operation is stored in the C2 collocator lane. The 2000 crane transfers this material from the C2 storage location onto the T2 transfer car.
98. Material is transported via the T2 transfer car the flame planer input conveyor.
99. Workers refer to the manufacturing plan, and setup the material and machine.
100. The flame planer is used to strip T-beam flanges from plate material. The processing time is a function of the feedrate and the length of cut.
101. Stripped T-beam flanges are transferred from the flame planer output conveyor onto the T3 transfer car. The material is then transferred from T3 to the T-beam welder input conveyor.
102. T-beams are processed through the T-beam welder.
103. T-beams exiting the T-beam welder are loaded onto carrier blocks using a local 5 ton gantry crane.
104. A log carrier transfers a load of T-beams on carrier blocks from the T-beam welder.
105. Has the blank T-beam been processed through the wheelabrator?
106. Non-primed T-beams are transported by log carrier to the wheelabrator input staging area.
107. Forktrucks are used to transfer blank T-beams from the wheelabrator input staging area to the input conveyor.

108. T-beams are processed through the wheelabrator.
109. A forktruck is used to transfer primed T-beams from the wheelabrator output conveyor and loaded onto carrier blocks.
110. A log carrier is used to transfer loads of T-beams from the wheelabrator output area to the blacksmith area.
111. A gantry crane is used to load T-beams from onto the bulldozer or frame bender.
112. The bulldozer or frame bender is used to straighten the T-beams.
113. Processed T-beams are loaded onto carrier blocks.
114. A log carrier is used to transfer processed T-beams to Table 10.
115. Using the 600 crane, transfer staged T-beams onto Table 10.
116. Manually layout and mark a T-beam.
117. Using a hand torch manually make all cutouts on a T-beam.
118. Use the 600 crane to transfer cut T-beam from Table 10 to the carrier blocks.
119. Using the log carrier, transfer loads of cut T-beams from Table 10 to the profile staging area.
120. Are plates coming from the 2000 crane bay going to the flame planer?
121. Using T2 transfer plates from the 2000 crane bay to the flame planer input conveyor.
122. Worker refers to manufacturing plan to setup material and machine.
123. Process plate across the flame planer. Process time is a function of the feedrate and the length of cut.
124. Is the processed material going from the flame planer to subassembly or to Table 1 SOC3?
125. Using the collocator system (T3 and C1), transfer material from the flame planer to a predefined storage location in the C1 collocator lane.
126. Parts coming off of the flame planer, which are not going to Table 1 or to subassembly, are loaded onto trailers and transported out of the system.
127. Plates are transferred from the 2000 crane to the small parts fabrication input conveyor using the T2 transfer car.
128. The local gantry crane is used to load raw stock onto the CM300 burn table.
129. Worker refers to manufacturing plan to setup material and machine.
130. The CM300 is used to fabricate detail parts.
131. The machine operator manually labels each cut part on the CM300.
132. The machine operator manually removes small parts from the CM300 table and stacks them onto pallets. The area crane is used to remove the heavier pieces.
133. The machine operator uses the area crane to transfer scrap material to the scrap bin.
134. Pallets of completed small parts are transferred to next assembly or storage by forktrucks.
135. Material for subassemblies is delivered to the paneling area from one of three sources. Plates greater than 18 feet long are transported from storage locations in the C2 collocator lane. The Table 1 cranes, collocator car, transfer cars, and shop cranes are used to transport this material into the area. Long profiles are delivered to the area in cassettes and / or carrier blocks by the log carrier. Plates and profiles less than 18 feet in length are delivered in a kits from the subassembly kitting area.
136. If there is not sufficient open floorspace for a given subassembly, place its material in the paneling staging area.
137. Laydown the material in an open space in preparation for paneling.
138. Shop cranes are used to remove completed panels from the workarea. They are transported to the far east end of the shop and loaded onto trailers. The trailers are then transported to the designated area in SOC3.
139. A fitter is assigned to the job and he/she performs all of the required tasks to fit the panel plates together.
140. The welder uses a local crane to position the subarc welding unit onto the panel. He/she then sets up the welding unit to perform the job.
141. The subarc welding unit is used to butt weld panel seams. The process time is a function of the feedrate and weld length.
142. The paneling process requires welding on both sides of the panel.
143. Shop cranes are used to flip the panel over.
144. The welder repeats the setup process for the subarc welding unit.
145. The subarc welding unit is used to butt weld panel seams. The process time is a function of the feedrate and weld length.

146. Are there additional parts to install on the panel?
147. Panels are transported to the line heating area in the east end of the shop using the shop gantry cranes.
148. Completed panels are loaded onto trailers with the shop cranes. The trailers are then transported to the designated area in SOC3.
149. Are the additional parts for the panel to be installed in the subassembly workcells?
150. A fitter is assigned to the job and he/she performs all of the required tasks to fit the detail pieces of a subassembly. A portion of this operation requires assistance from the area cranes.
151. A welder(s) is assigned to the job and he/she performs all of the required tasks to weld the subassembly. Welding time is a function of the method used and the total weld footage.
152. Sometimes there are more detail pieces to fit onto the subassembly after the completion of a welding operation. If this is the case, repeat the fit and weld cycle.
153. Subassemblies that are distorted from the welding process must be processed through the line heating area.
154. Material for subassemblies is delivered to the subassembly workcells from one of three sources. Plates greater than 18 feet long are transported from storage locations in the C2 collocator lane. The Table 1 cranes, collocator car, transfer cars, and shop cranes are used to transport this material into the area. Long profiles are delivered to the area in cassettes and / or carrier blocks by the log carrier. Plates and profiles less than 18 feet in length are delivered in a kits from the subassembly kitting area.
155. If there is not sufficient open floorspace for a given subassembly, place its material in the subassembly workcell staging area.
156. Laydown the material in an open space within the defined subassembly workcell.
157. Subassemblies are transported to the line heating area in the east end of the shop using the shop gantry cranes.
158. Completed subassemblies are transported to the designated area in SOC3. The smaller subassemblies are transported out of the area by forktruck. The larger subassemblies are loaded onto trailers in the east end of the shop with the area gantry cranes. The trailers are then transported to the designated area in SOC3.
159. A fitter is assigned to the job and he/she performs all of the required tasks to fit the detail pieces of a subassembly. A portion of this operation requires assistance from the area cranes.
160. A welder(s) is assigned to the job and he/she performs all of the required tasks to weld the subassembly. Welding time is a function of the method used and the total weld footage.
161. Sometimes there are more detail pieces to fit onto the subassembly after the completion of a welding operation. If this is the case, repeat the fit and weld cycle.
162. Subassemblies that are distorted from the welding process must be processed through the line heating area.
163. Material for subassemblies is delivered to the pre-subassembly area from the subassembly kitting area.
164. If there is not sufficient open tablespace for a given subassembly, place its material in the pre-subassembly staging area.
165. Laydown the material in an open space on the pre-subassembly worktables.
166. Completed subassemblies are loaded onto to pallets and then transported by forktruck to the designated area in SOC3.
167. A fitter is assigned to the job and he/she performs all of the required tasks to fit the detail pieces of a subassembly. A portion of this operation requires assistance from the area jib cranes.
168. A welder(s) is assigned to the job and he/she performs all of the required tasks to weld the subassembly. Welding time is a function of the method used and the total weld footage.
169. Sometimes there are more detail pieces to fit onto the subassembly after the completion of a welding operation. If this is the case, repeat the fit and weld cycle.
170. Are the completed subassemblies going into larger subassemblies in the paneling area?
171. Are the completed subassemblies going into larger subassemblies in the subassembly workcells?
172. The area gantry cranes are used to transport subassemblies from the line heating staging area to the line heating acorn table.
173. Completed subassemblies are transported to the designated area in SOC3. The smaller subassemblies are transported out of the area by forktruck. The larger subassemblies are loaded

onto trailers in the east end of the shop with the area gantry cranes. The trailers are then transported to the designated area in SOC3.

174. Distortions in subassemblies are corrected with the line heating process.
175. A panel line worker coordinates with the 2000 crane operator on the sequence and orientation of plates for the panel line. The crane operator retrieves plates and places them on the T4 transfer car.
176. A worker takes a hand held grinder and removes any slag from the plate edges.
177. The transfer is indexed over and aligned with the beginning of the panel line.
178. The first plate in the panel is simply indexed onto the panel line. Subsequent plates are aligned with previous plates in a panel by using the transfer car to shift the plate back and forth.
179. First plate in the panel is indexed directly to the panel line.
180. Subsequent plates are aligned to the panel using the transfer car. Workers tack both ends of the seam to hold the plates together while indexing to the plate fitting station.
181. The panel assembly is moved down the line (off of the transfer car) using the panel line drive system.
182. Twin magnet beds are used to fair the surfaces of the new plate with the panel assembly.
183. Repeat for above process for additional plates.
184. Plate fitting is complete. Use the panel line drive system to transfer the plate to the next station on the line.
185. Several of the RO/RO vessel blocks have deck sockets. If so, deck sockets are installed prior to seaming.
186. Using a hand grinder, workers remove sharp edges from the deck socket cutouts.
187. Workers manually carry deck sockets from a storage bin and distribute them on the panel as required.
188. Special welding units are lifted onto the panel with panel line's gantry crane.
189. Deck sockets are welded using the special welding equipment.
190. The panel is moved to the next station on the line.
191. The copper backing bar is cleaned and fluxed ready for the next seam.
192. The panel is aligned over the copper backing bar using the panel line's drive system, plate pushers, and adjustable magnets..
193. The seam is welded using the one sided welder.
194. If there are more seams, repeat the above process.
195. Using the panel line drive system, the panel is transferred to the next station on the line.
196. Two workers manually layout the stiffener and frame locations on the panel.
197. A portable oxy-acetalene torch unit is used to square the edges of the panel.
198. Using the panel line drive system, the panel is transferred to the next station on the line.
199. Cassettes loaded with stiffeners are transferred from SOC1 storage locations and delivered to the far west end of the panel line.
200. The panel line gantry crane will pick up the loaded cassettes and place them on top of the related panel in the stiffener fitting station.
201. The panel line gantry crane is used to place the stiffeners from the cassette onto the panel one at a time. The stiffeners are prefit using simple fitting aides to hold them in an upright position.
202. A stiffener fitting press is used to squeeze out any gaps between the stiffener and the panel. The stiffeners are then tacked into position. The press can service up to two stiffeners at a time.
203. Empty cassettes are removed from the line by the area gantry crane.
204. Using the panel line drive system, the panel is transferred to the next station on the line.
205. The panel must be aligned with the stiffener welding gantry. The gantry has some skewing capability which assists with this operation.
206. Both sides of up to four stiffeners are welded simultaneously.
207. If more stiffeners remain to be welded, repeat the above process.
208. Using the panel line drive system, the panel is transferred to the next station on the line.
209. Cassettes loaded with frames are transferred from SOC1 storage locations and delivered to the far west end of the panel line.
210. The panel line gantry crane will pick up the loaded cassettes and place them on top of the related panel in the frame fitting station.
211. The panel line gantry crane is used to place the frames into position one at a time.
212. Fitters manually complete the frame fitting operation.

213. Empty cassettes are removed from the line by the area gantry crane.
214. Using the panel line drive system, the panel is transferred to the next station on the line.
215. Welders are assigned to the panel and welding of the panel is completed.
216. Using the panel line drive system, the panel is transferred to the load out station. This is the last station on the line.
217. The yard whirley cranes will transfer completed panels from the load out station to the next assembly area.

APPENDIX E
DETAILED PERFORMANCE STATISTICS FOR PROFILE FABRICATION AND PANEL LINE MODELS

DETAILED PERFORMANCE STATISTICS FOR THE "BASELINE" PROFILE FABRICATION AREA MODEL

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\ProfNew.MOD
Date: May/11/1998   Time: 07:48:03 AM

PROFILE LAYOUT CREW = 3
PROFILE BURN CREW = 5
T BEAM FIT CREW = 1
FLATBAR LAYOUT CREW = 3
FLATBAR BURN CREW = 6
T BEAM WELD CREW = 2
T BEAM PAINT CREW = 1

Scenario : Model Parameters
Replication : 1 of 1
Simulation Time : 840 hr

PCBLOCK ARRIVALS = 2 PER 8HR
FB CBLOCK ARRIVALS = 1 PER 8HR
T CBLOCK ARRIVALS = 1 PER 8HR

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Roller Table Position 1	743	1	41	1081.380049	0.99454	1	1	99.45
Roller Table Position 2	722	1	41	1051.378415	0.995072	1	1	99.51
Roller Table Position 3	598	1	40	891.214700	0.99355	1	1	99.36
Roller Table Position 4	667	1	41	970.739585	0.994511	1	1	99.45
Roller Table Position 5	729	1	41	1060.079439	0.993673	1	1	99.37
Roller Table Position 6	612.0202333	1	42	868.170595	0.992973	1	1	99.30
Roller Table Position 7	729	1	42	1035.386571	0.994198	1	1	99.42
Roller Table Position 8	612	1	41	889.208951	0.992853	1	1	99.29
Roller Table Position 9	688	1	42	975.945595	0.992968	1	1	99.30
Roller Table Position 10	674	1	41	979.816195	0.993384	1	1	99.34
Roller Table Position 11	633	1	42	897.380048	0.992363	1	1	99.24
Roller Table Position 12	660	1	41	959.265049	0.993178	1	1	99.32
Roller Table Position 13	688	1	44	930.211045	0.991504	1	1	99.15
Roller Table Position 14	612.0167333	1	41	889.986537	0.993694	1	1	99.37
Roller Table Position 15	729	1	43	1009.198767	0.992125	1	1	99.21
Roller Table Position 16	688	1	44	921.402068	0.982115	1	1	98.21
Roller Table Position 17	557.0031167	1	42	788.094905	0.990419	1	1	99.04
Roller Table Position 18	667	1	44	890.687045	0.979266	1	1	97.93
Roller Table Position 19	722	1	44	976.940273	0.992275	1	1	99.23
Roller Table Position 20	687	1	40	1022.057950	0.991808	1	1	99.18
Table10 Position 1	487	1	23	449.292174	0.353652	1	1	35.37
Table10 Position 2	446	1	22	387.831227	0.318845	1	0	31.88
Table10 Position 3	487	1	22	507.090409	0.381793	1	0	38.18
Table10 Position 4	439	1	22	366.604864	0.3062	1	0	30.62
Table10 Position 5	439	1	22	346.999500	0.289825	1	0	28.98
Table10 Position 6	439	1	22	355.193455	0.296669	1	0	29.67
Table10 Position 7	432	1	22	360.496409	0.305977	1	1	30.60
Table10 Position 8	487	1	22	484.015364	0.36442	1	1	36.44

Table10 Position 9	453	1	22	373.751182	0.302521	1	1	30.25
Flatbar Area Position 1	425	1	70	172.161486	0.4726	1	0	47.26
Flatbar Area Position 2	487	1	70	229.980114	0.550945	1	0	55.09
Flatbar Area Position 3	425	1	70	180.611186	0.495795	1	0	49.58
Flatbar Area Position 4	425	1	69	164.297928	0.444571	1	0	44.46
Flatbar Area Position 5	432	1	69	168.496710	0.448544	1	0	44.85
Flatbar Area Position 6	487	1	69	226.488522	0.534829	1	0	53.48
Flatbar Area Position 7	439	1	69	175.574087	0.459932	1	0	45.99
Flatbar Area Position 8	432	1	69	178.660797	0.475602	1	0	47.56
Flatbar Area Position 9	425	1	69	158.905594	0.42998	1	0	43.00
Profile Skip Tub	826	25	683	752.504012	10.3705	25	8	41.48
Table10 Skip Tub	826	25	199	2678.293412	10.7542	25	24	43.02
Flatbar Skip Tub	771	25	244	2184.198102	11.5206	25	19	46.08
ProfileIn	833	999999	1600	15205.614383	486.774	913	901	0.05
PTABLETBEAMIN	425	999999	0	0.000000	0	0	0	0.00
ProfileStorage	425	999999	100	9.570240	0.0375304	2	0	0.00
ProfileStorage2	425	999999	41	0.000000	0	1	0	0.00
ProfileOut	833	999999	2890	614.901443	35.5555	129	93	0.00
FlatbarOut	826	999999	895	1769.725418	31.9593	96	20	0.00
RTBeamOut	425	999999	199	5.144236	0.0401452	6	0	0.00
TBeamOut	757	999999	195	853.171318	3.66289	18	3	0.00
FlatbarIn	487	999999	624	107.146226	2.28813	18	0	0.00
FlatbarStorage	425	999999	50	1.000000	0.00196078	1	0	0.00
FlatbarStorage2	425	999999	15	0.000000	0	1	0	0.00
TBeamIn	833	999999	300	14646.599960	87.9148	164	162	0.01
TBeamStorage	425	999999	50	5.497740	0.0107799	1	0	0.00
TBeamStorage2	425	999999	23	0.000000	0	1	0	0.00
FrameBender	425	999999	0	0.000000	0	0	0	0.00
Bulldozer	425	1	0	0.000000	0	0	0	0.00
Bulldozer2	425	1	0	0.000000	0	0	0	0.00
OutgoingPileForProfile	425	999999	0	0.000000	0	0	0	0.00
ScrapBinOut1	425	25	27	1.600000	0.00169412	1	0	0.01
ScrapBinOut3	425	25	7	2.241000	0.000615176	1	0	0.00
ScrapBinOut2	425	25	9	2.619000	0.000924353	1	0	0.00
ScrapOut	425	999999	43	0.000000	0	1	0	0.00
Table	425	1	0	0.000000	0	0	0	0.00
Table2	425	1	0	0.000000	0	0	0	0.00
ShearStaging	549	999999	15	826.269667	0.376261	1	1	0.00
Shear	425	1	359	11.834582	0.166612	1	1	16.66
IronWorkerStaging	432	999999	11	368.727273	0.156481	1	0	0.00
IronWorker	425	1	176	21.818182	0.150588	1	0	15.06
BevelStation	425	1	250	5.000000	0.0490196	1	0	4.90
DeburrStation	425	1	1662	1.999198	0.130301	1	1	13.03
Bldg2OutStaging	487	999999	1661	46.731479	2.65643	25	11	0.00
GeneralStorage	750	999999	66	1544.918121	2.26588	5	1	0.00

FlatbarToShear	826	999999	380	1458.996897	11.1868	27	5	0.00
FlatbarToBevel	439	999999	10	206.380400	0.0783525	2	0	0.00
FlatbarToDeburr	480	999999	57	106.658333	0.211095	1	1	0.00
BevelToDeburr	432	999999	10	101.819100	0.0392821	1	0	0.00
IronWorkerOut	819	999999	630	908.406786	11.6462	30	5	0.00
ShearOut	805	999999	1056	637.512711	13.9382	32	6	0.00
BevelOut	432	999999	250	96.983600	0.935413	25	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Profile Skip Tub	826	3.75	96.11	0.14	0.00
Table10 Skip Tub	826	2.65	97.29	0.06	0.00
Flatbar Skip Tub	771	3.16	96.78	0.06	0.00
ProfileIn	833	0.14	99.86	0.00	0.00
PTABLETBEAMIN	425	100.00	0.00	0.00	0.00
ProfileStorage	425	97.87	2.13	0.00	0.00
ProfileStorage2	425	100.00	0.00	0.00	0.00
ProfileOut	833	2.26	97.74	0.00	0.00
FlatbarOut	826	1.83	98.17	0.00	0.00
RTBeamOut	425	97.64	2.36	0.00	0.00
TBeamOut	757	7.72	92.28	0.00	0.00
FlatbarIn	487	50.39	49.61	0.00	0.00
FlatbarStorage	425	99.80	0.20	0.00	0.00
FlatbarStorage2	425	100.00	0.00	0.00	0.00
TBeamIn	833	1.08	98.92	0.00	0.00
TBeamStorage	425	98.92	1.08	0.00	0.00
TBeamStorage2	425	100.00	0.00	0.00	0.00
FrameBender	425	100.00	0.00	0.00	0.00
OutgoingPileForProfile	425	100.00	0.00	0.00	0.00
ScrapBinOut1	425	99.83	0.17	0.00	0.00
ScrapBinOut3	425	99.94	0.06	0.00	0.00
ScrapBinOut2	425	99.91	0.09	0.00	0.00
ScrapOut	425	100.00	0.00	0.00	0.00
ShearStaging	549	62.37	37.63	0.00	0.00
IronWorkerStaging	432	84.35	15.65	0.00	0.00
Bldg2OutStaging	487	76.02	23.98	0.00	0.00
GeneralStorage	750	10.60	89.40	0.00	0.00
FlatbarToShear	826	1.76	98.24	0.00	0.00
FlatbarToBevel	439	92.22	7.78	0.00	0.00
FlatbarToDeburr	480	78.89	21.11	0.00	0.00

BevelToDeburr	432	96.07	3.93	0.00	|	0.00
IronWorkerOut	819	4.45	95.55	0.00	|	0.00
ShearOut	805	9.70	90.30	0.00	|	0.00
BevelOut	432	93.62	6.38	0.00	|	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down
Roller Table Position 1	743	24.26	0.00	0.55	75.19	0.00	0.00
Roller Table Position 2	722	25.28	0.00	0.49	74.23	0.00	0.00
Roller Table Position 3	598	29.52	0.00	0.64	69.81	0.03	0.00
Roller Table Position 4	667	27.24	0.00	0.55	72.21	0.00	0.00
Roller Table Position 5	729	24.78	0.00	0.63	74.58	0.00	0.00
Roller Table Position 6	612.0202333	29.65	0.00	0.70	69.65	0.00	0.00
Roller Table Position 7	729	26.70	0.00	0.58	72.72	0.00	0.00
Roller Table Position 8	612	29.56	0.00	0.71	69.73	0.00	0.00
Roller Table Position 9	688	25.83	0.00	0.70	73.47	0.00	0.00
Roller Table Position 10	674	26.41	0.00	0.66	72.93	0.00	0.00
Roller Table Position 11	633	29.86	0.00	0.76	69.34	0.03	0.00
Roller Table Position 12	660	28.56	0.00	0.68	70.76	0.00	0.00
Roller Table Position 13	688	25.89	0.00	0.85	73.21	0.05	0.00
Roller Table Position 14	612.0167333	30.13	0.00	0.63	69.24	0.00	0.00
Roller Table Position 15	729	24.71	0.00	0.79	74.50	0.00	0.00
Roller Table Position 16	688	25.55	0.00	1.79	72.64	0.02	0.00
Roller Table Position 17	557.0031167	30.98	0.00	0.96	68.06	0.00	0.00
Roller Table Position 18	667	26.42	0.00	2.07	71.43	0.07	0.00
Roller Table Position 19	722	24.23	0.00	0.77	75.00	0.00	0.00
Roller Table Position 20	687	26.27	0.00	0.82	72.91	0.00	0.00
Table10 Position 1	487	15.66	0.00	64.63	19.70	0.00	0.00
Table10 Position 2	446	17.12	0.00	68.12	14.77	0.00	0.00
Table10 Position 3	487	15.68	0.00	61.82	22.50	0.00	0.00
Table10 Position 4	439	17.40	0.00	69.38	13.22	0.00	0.00
Table10 Position 5	439	17.38	0.00	71.02	11.60	0.00	0.00
Table10 Position 6	439	17.16	0.00	70.33	12.51	0.00	0.00
Table10 Position 7	432	17.84	0.00	69.40	12.76	0.00	0.00
Table10 Position 8	487	16.05	0.00	63.56	20.40	0.00	0.00
Table10 Position 9	453	16.22	0.00	69.75	14.03	0.00	0.00
Flatbar Area Position 1	425	26.46	0.00	52.74	20.80	0.00	0.00
Flatbar Area Position 2	487	24.15	0.00	44.91	30.94	0.00	0.00
Flatbar Area Position 3	425	26.40	0.00	50.42	23.18	0.00	0.00
Flatbar Area Position 4	425	23.54	0.00	55.54	20.92	0.00	0.00
Flatbar Area Position 5	432	23.72	0.00	55.15	21.13	0.00	0.00

Flatbar Area Position 6	487	22.65	0.00	46.52	30.82	0.01	0.00
Flatbar Area Position 7	439	23.76	0.00	54.01	22.15	0.07	0.00
Flatbar Area Position 8	432	26.39	0.00	52.44	21.15	0.02	0.00
Flatbar Area Position 9	425	22.02	0.00	57.00	20.97	0.00	0.00
Bulldozer	425	0.00	0.00	100.00	0.00	0.00	0.00
Bulldozer2	425	0.00	0.00	100.00	0.00	0.00	0.00
Table	425	0.00	0.00	100.00	0.00	0.00	0.00
Table2	425	0.00	0.00	100.00	0.00	0.00	0.00
Shear	425	16.66	0.00	83.34	0.00	0.00	0.00
IronWorker	425	15.06	0.00	84.94	0.00	0.00	0.00
BevelStation	425	4.90	0.00	95.10	0.00	0.00	0.00
DeburrStation	425	13.03	0.00	86.97	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
PLayoutCrew.1	1	427.2607	300	77.929133	4.119380	4.416923	0.00	96.40
PLayoutCrew.2	1	427.4926	302	77.529911	4.091842	4.188946	0.00	96.44
PLayoutCrew.3	1	427.49495	295	78.644190	4.059893	4.493360	0.00	95.47
PLayoutCrew	3	1282.24825	897	78.029887	4.090591	4.360310	0.00	96.10
PBurnCrew.1	1	426.7109167	185	132.610670	3.987212	2.381000	0.00	99.06
PBurnCrew.2	1	426.6133833	194	126.389634	3.878500	2.271778	0.00	99.09
PBurnCrew.3	1	426.29275	187	131.041439	3.538522	1.718484	0.00	98.70
PBurnCrew.4	1	426.6019	183	133.602639	3.843005	2.415138	0.00	98.60
PBurnCrew.5	1	426.69665	190	128.768863	3.558693	2.277800	0.00	98.51
PBurnCrew	5	2132.9156	939	130.428838	3.761087	2.204497	0.00	98.79
TFittingCrew	1	426.2099667	216	54.883981	3.197118	2.515820	0.00	49.22
TWeldingCrew.1	1	425.74545	138	55.217391	3.375551	3.084940	0.00	31.65
TWeldingCrew.2	1	425.1822	71	58.773803	3.154282	2.604116	0.00	17.24
TWeldingCrew	2	850.92765	209	56.425550	3.300383	2.910464	0.00	24.45
TPaintCrew	1	426.38895	201	24.253731	3.629881	3.205269	0.00	21.91
FLayoutCrew.1	1	425.13315	221	60.135747	1.548220	0.932375	0.00	53.45
FLayoutCrew.2	1	425.0857	210	60.142857	1.503684	0.537400	0.00	50.77
FLayoutCrew.3	1	425.04755	203	61.477833	1.368712	0.634623	0.00	50.04
FLayoutCrew	3	1275.2664	634	60.567823	1.475969	0.706097	0.00	51.42
FBurnCrew.1	1	425.15465	109	73.211009	1.656578	1.480057	0.00	31.99
FBurnCrew.2	1	425.0437	73	81.643836	1.538425	1.234121	0.00	23.81
FBurnCrew.3	1	425.02415	45	78.666667	1.610844	1.081910	0.00	14.17
FBurnCrew.4	1	425.0437	23	61.739130	1.723087	0.825646	0.00	5.72
FBurnCrew.5	1	425	2	40.000000	0.520000	0.038519	0.00	0.32

FBurnCrew.6	1	425	0	0.000000	0.000000	0.000000	0.00	0.00
FBurnCrew	6	2550.2662	252	75.317460	1.611234	1.065698	0.00	12.67
Carrier	1	425	279	2.778387	0.432907	0.412219	0.00	3.51
Crane 600	1	425.04135	5041	0.758810	0.239388	0.307754	0.00	19.73
Crane 590	1	425	2347	1.648099	0.203770	0.386285	0.00	17.05
Truck	1	425	43	2.917628	0.917628	0.000000	0.00	0.65
Forktruck	1	425	158	3.252696	1.312753	0.788225	0.00	2.83
ShearCrane	1	425	359	2.309000	0.175000	0.419610	0.00	3.50

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
PLayoutCrew.1	427.2607	91.20	5.21	0.90	2.70	0.00
PLayoutCrew.2	427.4926	91.28	5.15	0.91	2.65	0.00
PLayoutCrew.3	427.49495	90.45	5.02	0.88	3.66	0.00
PLayoutCrew	1282.24825	90.98	5.13	0.90	3.00	0.00
PBurnCrew.1	426.7109167	95.82	3.24	0.26	0.68	0.00
PBurnCrew.2	426.6133833	95.79	3.30	0.24	0.67	0.00
PBurnCrew.3	426.29275	95.81	2.89	0.21	1.09	0.00
PBurnCrew.4	426.6019	95.52	3.08	0.27	1.13	0.00
PBurnCrew.5	426.69665	95.56	2.95	0.27	1.22	0.00
PBurnCrew	2132.9156	95.70	3.09	0.25	0.96	0.00
TFittingCrew	426.2099667	46.36	2.86	0.88	49.90	0.00
TWeldingCrew.1	425.74545	29.83	1.82	1.82	66.52	0.00
TWeldingCrew.2	425.1822	16.36	0.88	0.88	81.89	0.00
TWeldingCrew	850.92765	23.10	1.35	1.35	74.20	0.00
TPaintCrew	426.38895	19.06	2.85	0.33	77.77	0.00
FLayoutCrew.1	425.13315	52.10	1.35	0.23	46.31	0.00
FLayoutCrew.2	425.0857	49.52	1.25	0.13	49.10	0.00
FLayoutCrew.3	425.04755	48.94	1.10	0.15	49.81	0.00
FLayoutCrew	1275.2664	50.19	1.23	0.17	48.41	0.00
FBurnCrew.1	425.15465	31.28	0.71	0.71	67.30	0.00
FBurnCrew.2	425.0437	23.37	0.44	0.44	75.75	0.00
FBurnCrew.3	425.02415	13.88	0.28	0.28	85.55	0.00
FBurnCrew.4	425.0437	5.57	0.16	0.16	94.12	0.00
FBurnCrew.5	425	0.31	0.00	0.00	99.68	0.00
FBurnCrew.6	425	0.00	0.00	0.00	100.00	0.00
FBurnCrew	2550.2662	12.40	0.27	0.27	87.07	0.00
Carrier	425	3.04	0.47	0.24	96.24	0.00
Crane 600	425.04135	15.00	4.73	0.78	79.49	0.00
Crane 590	425	15.17	1.88	0.98	81.97	0.00

Truck	425	0.49	0.15	0.00	99.35	0.00
Forktruck	425	2.02	0.81	0.56	96.61	0.00
ShearCrane	425	3.25	0.25	0.63	95.87	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
CBlock	ProfileStorage	110
CBlock	FlatbarStorage	56
CBlock	TBeamStorage	56

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
Profile	2838	1010	15388.231333	18.122112	1236.055733	512.355690	13621.697798
Flatbar	1240	50	2576.029293	25.162192	2244.170659	205.827070	100.869372
TBeam	215	7	13552.164093	18.279381	1434.985791	956.098028	11142.800893
RTBeam	0	166	-	-	-	-	-
Scrap	718	8	687.545173	9.328521	678.216652	0.000000	0.000000
Scrap2	225	19	2025.767818	12.049920	2013.717898	0.000000	0.000000
Scrap3	175	24	2379.510806	5.252629	2374.258177	0.000000	0.000000
CarrierBlock	0	0	-	-	-	-	-
nothing	0	0	-	-	-	-	-
CBlock	200	0	8.072270	8.072270	0.000000	0.000000	0.000000
ScrapBin	0	0	-	-	-	-	-
SFlatbar	3565	102	2132.571927	13.388283	1923.331307	22.023562	173.828774

ENTITY STATES BY PERCENTAGE

Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
Profile	0.12	8.03	3.33	88.52
Flatbar	0.98	87.12	7.99	3.92
TBeam	0.13	10.59	7.05	82.22

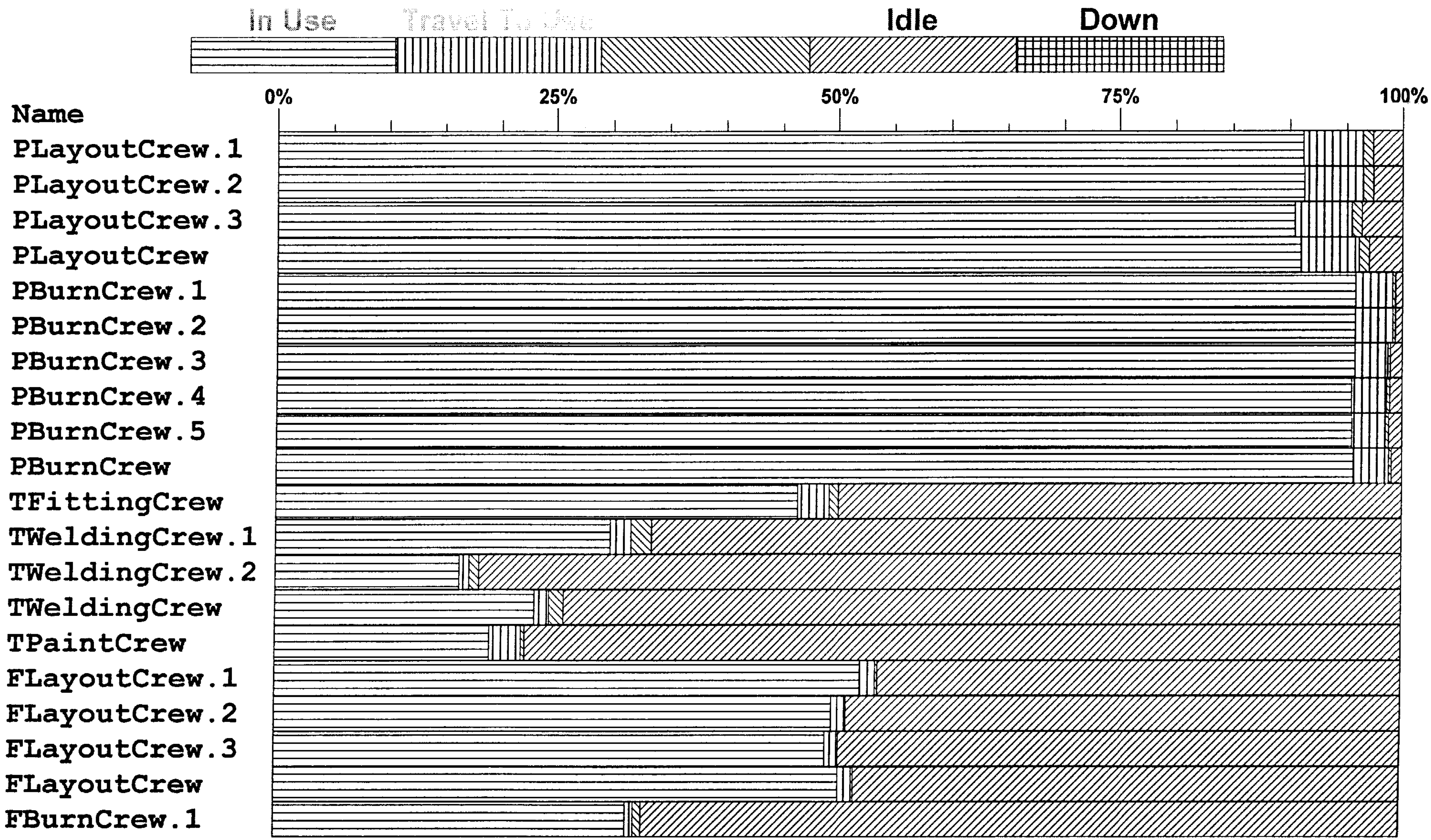
Scrap	1.36	98.64	0.00	0.00
Scrap2	0.59	99.41	0.00	0.00
Scrap3	0.22	99.78	0.00	0.00
CBlock	100.00	0.00	0.00	0.00
SFlatbar	0.63	90.19	1.03	8.15

VARIABLES

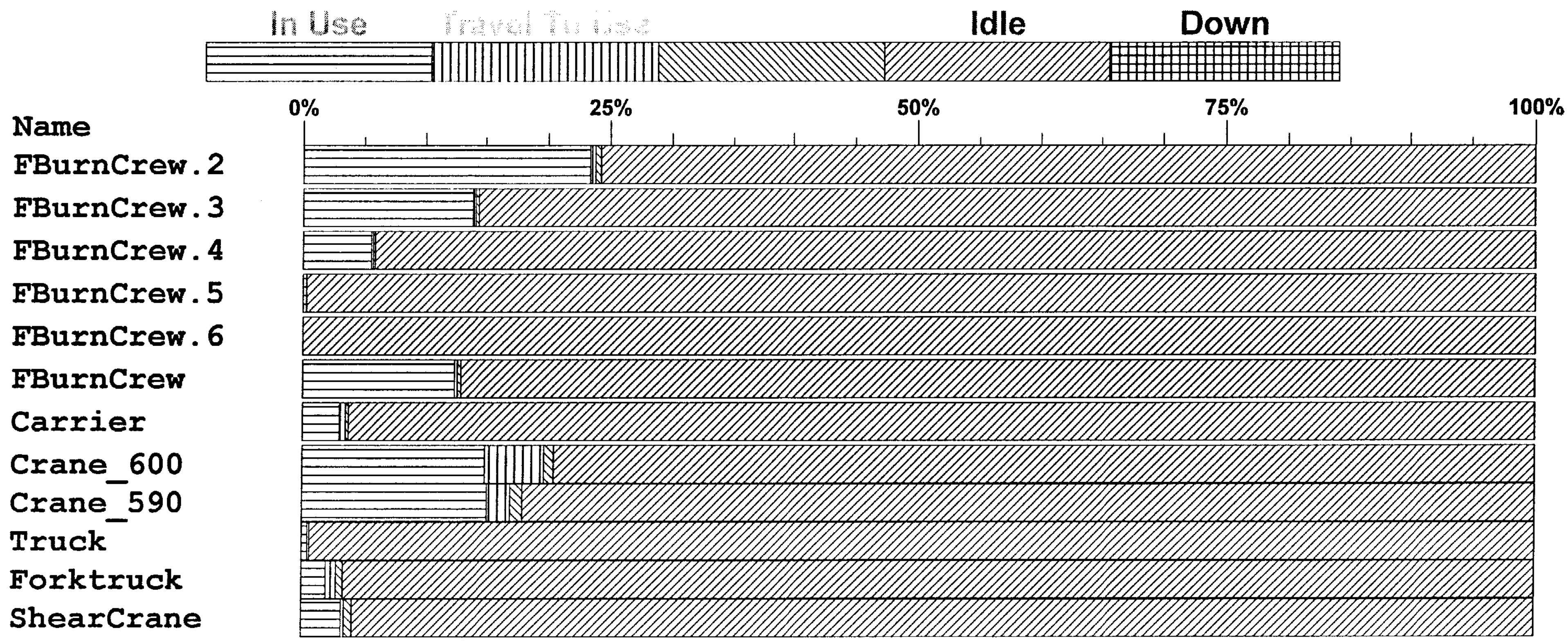
Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v TotalProfilesArrived	699	67.940635	0	699	699	362.64
v TotalFlatbarsArrived	624	76.031046	0	624	624	339.653
v TotalTBeamsArrived	138	344.018029	0	138	138	71.3464
v TotalProfilesProcessed	683	69.522054	0	683	683	346.533
v TotalFlatbarsProcessed	244	194.394381	0	244	244	135.434
v TotalTBeamsProcessed	134	354.070679	0	134	134	67.8743
v TotalProfilesProduced	2890	16.432067	0	2890	2890	1466.39
v TotalFlatbarsProduced	2556	18.591288	0	2556	2556	1215.39
v TotalTBeamsProduced	195	243.624949	0	195	195	104.197
v PBatchSize	100	470.401000	0	16	16	15.8476
v FBatchSize	50	940.800000	0	16	16	15.8476
v TBatchSize	50	940.800000	0	6	6	5.94286
v Counter	0	0.000000	0	0	0	0
v PScrap	683	69.530981	0	683	683	346.398
v FScrap	244	194.432279	0	244	244	135.376
v TScrap	199	238.434317	0	199	199	106.745
v PPerUnit	101	465.743564	0	10	6	4.7238
v FPerUnit	53	887.547170	0	11	4	4.01905
v TPerUnit	50	940.800000	0	3	1	1.44762
v PPerUnitBatch	0	0.000000	0	0	0	0
v FPerUnitBatch	0	0.000000	0	0	0	0
v TPerUnitBatch	0	0.000000	0	0	0	0
v PTotal	0	0.000000	0	0	0	0
v FTotal	0	0.000000	0	0	0	0
v TTotal	0	0.000000	0	0	0	0
v TotalFToShear	380	125.023555	0	380	380	201.556
v TotalShearProduced	1661	28.608870	0	1661	1661	717.878
v Count	0	0.000000	0	0	0	0
v ProfileWIP	740	64.177708	0	658	658	341.961
v TBeamWIP	153	310.290771	0	123	123	63.2189
v FlatBarWIP	647	73.328243	0	601	601	327.536
v ProfileFlowTime	41	1139.069537	0	4069.85	1157.79	977.595

v	TBeamFlowTime	15	3136.982200	0	3625.86	476.293	412.39
v	FlatBarFlowTime	23	2042.633913	0	4306.18	1333.59	1736.7

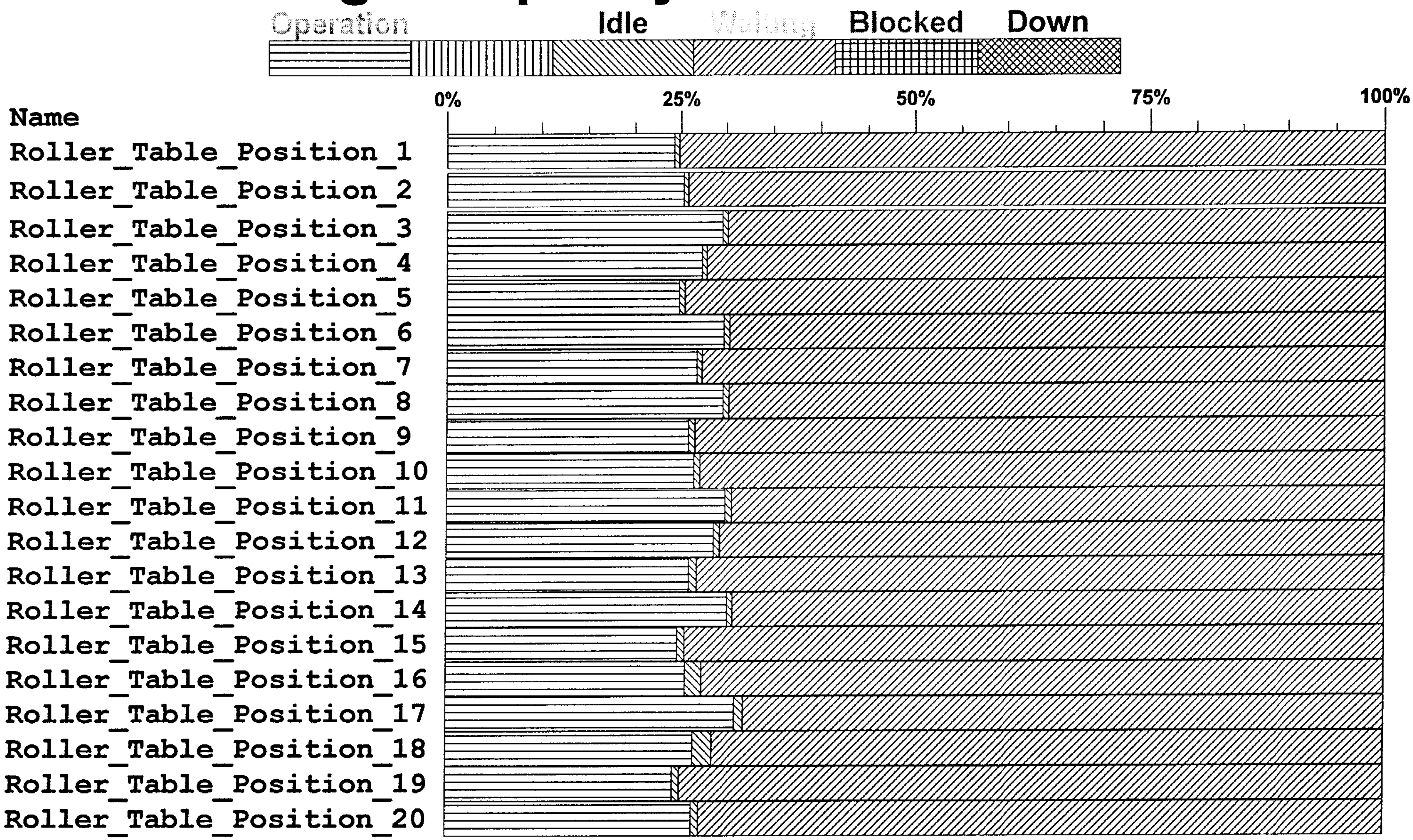
Resource States



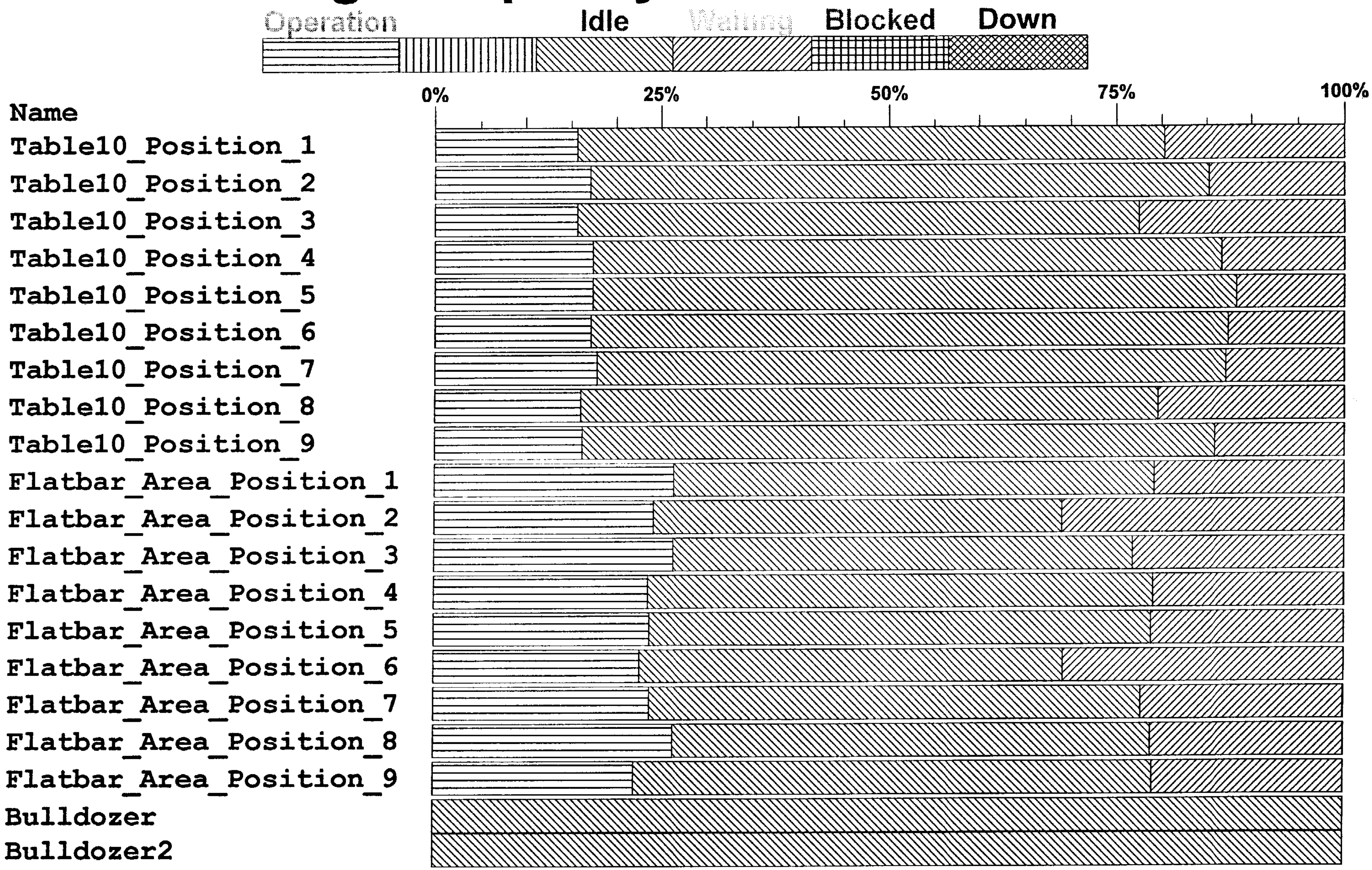
Resource States



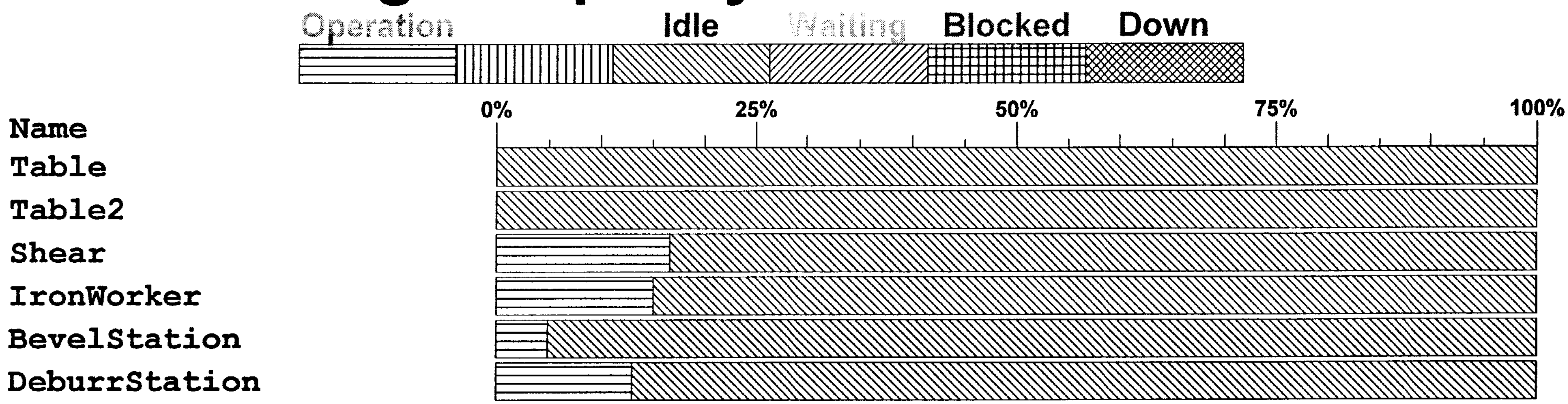
Single Capacity Location States



Single Capacity Location States



Single Capacity Location States



DETAILED PERFORMANCE STATISTICS FOR THE "HIGH OUTPUT - INCREASED MANNING" PROFILE FABRICATION AREA MODEL

PROFILE LAYOUT = 20
PROFILE BURN = 20
TBEAM FIT = 9
FLATBAR LAYOUT = 9
FLATBAR BURN = 9
TBEAM WELD = 9
T BEAM PAINT = 9
P CBLOCK ARRIVALS = 2 PER 8HR
FB CBLOCK ARRIVALS = 1 PER 8HR
T CBLOCK ARRIVALS = 1 PER 8HR

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\ProfNew.MOD
Date: May/11/1998 Time: 09:05:27 AM

Scenario : Model Parameters
Replication : 1 of 1
Simulation Time : 840 hr

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Roller Table Position 1	577	1	94	316.784596	0.860131	1	1	86.01
Roller Table Position 2	652	1	95	362.827137	0.881099	1	1	88.11
Roller Table Position 3	432	1	95	256.771347	0.941099	1	1	94.11
Roller Table Position 4	432.0189	1	95	255.825926	0.937593	1	1	93.76
Roller Table Position 5	432	1	95	254.640589	0.933289	1	1	93.33
Roller Table Position 6	432	1	95	251.206463	0.920703	1	1	92.07
Roller Table Position 7	439	1	95	255.990695	0.923277	1	1	92.33
Roller Table Position 8	439	1	95	263.152168	0.949106	1	1	94.91
Roller Table Position 9	487	1	95	292.524979	0.951057	1	0	95.11
Roller Table Position 10	439	1	95	260.690021	0.940226	1	1	94.02
Roller Table Position 11	432	1	94	254.217021	0.921929	1	1	92.19
Roller Table Position 12	425.0008333	1	92	253.275272	0.913776	1	1	91.38
Roller Table Position 13	425	1	92	242.111391	0.8735	1	1	87.35
Roller Table Position 14	432	1	92	248.448674	0.881839	1	1	88.18
Roller Table Position 15	439	1	93	249.389613	0.880533	1	1	88.05
Roller Table Position 16	494	1	93	286.973086	0.900422	1	1	90.04
Roller Table Position 17	439.0146667	1	93	251.167355	0.88678	1	1	88.68
Roller Table Position 18	439	1	93	249.304935	0.880234	1	1	88.02
Roller Table Position 19	439.0128333	1	92	254.529348	0.888991	1	1	88.90
Roller Table Position 20	432	1	92	254.660772	0.903889	1	1	90.39
Table10 Position 1	439	1	42	214.057190	0.341321	1	0	34.13
Table10 Position 2	439	1	42	226.072095	0.360479	1	0	36.05
Table10 Position 3	487	1	42	305.303714	0.438835	1	0	43.88
Table10 Position 4	425	1	41	220.500049	0.354529	1	0	35.45
Table10 Position 5	425	1	41	218.827098	0.35184	1	0	35.18
Table10 Position 6	425	1	41	217.618122	0.349896	1	0	34.99
Table10 Position 7	432	1	41	231.590902	0.366328	1	0	36.63
Table10 Position 8	432	1	41	232.783341	0.368214	1	0	36.82

Table10 Position 9	432	1	41	221.599927	0.350525	1	0	35.05
Flatbar Area Position 1	425	1	77	107.887234	0.325777	1	0	32.58
Flatbar Area Position 2	425	1	77	110.619078	0.334026	1	0	33.40
Flatbar Area Position 3	432	1	77	118.096013	0.350825	1	0	35.08
Flatbar Area Position 4	425	1	77	104.450909	0.315401	1	0	31.54
Flatbar Area Position 5	425	1	76	113.433066	0.338075	1	0	33.81
Flatbar Area Position 6	425	1	76	97.927974	0.291864	1	0	29.19
Flatbar Area Position 7	425	1	76	109.274724	0.325682	1	0	32.57
Flatbar Area Position 8	425	1	76	106.748355	0.318152	1	0	31.82
Flatbar Area Position 9	425	1	76	108.590671	0.323643	1	0	32.36
Profile Skip Tub	833	25	1565	450.832828	14.1167	25	15	56.47
Table10 Skip Tub	826	25	372	1944.070425	14.5923	25	22	58.37
Flatbar Skip Tub	812	25	291	2001.026340	11.9519	25	16	47.81
ProfileIn	833	999999	1600	939.913193	30.0893	100	23	0.00
PTABLETBEAMIN	425	999999	0	0.000000	0	0	0	0.00
ProfileStorage	425	999999	100	9.522100	0.0373416	2	0	0.00
ProfileStorage2	425	999999	98	0.000000	0	1	0	0.00
ProfileOut	819	999999	6232	274.281869	34.7848	145	28	0.00
FlatbarOut	833	999999	1224	1218.648355	29.8444	100	12	0.00
RTBeamOut	439	999999	372	28.005960	0.395528	11	0	0.00
TBeamOut	819	999999	372	612.021763	4.63313	18	8	0.00
FlatbarIn	425	999999	688	62.732340	1.69254	16	0	0.00
FlatbarStorage	425	999999	50	1.077220	0.0021122	1	0	0.00
FlatbarStorage2	425	999999	20	0.000000	0	1	0	0.00
TBeamIn	625	999999	300	438.803813	3.51043	13	2	0.00
TBeamStorage	425	999999	50	5.449600	0.0106855	1	0	0.00
TBeamStorage2	425	999999	49	0.000000	0	1	0	0.00
FrameBender	425	999999	0	0.000000	0	0	0	0.00
Bulldozer	425	1	0	0.000000	0	0	0	0.00
Bulldozer2	425	1	0	0.000000	0	0	0	0.00
OutgoingPileForProfile	425	999999	0	0.000000	0	0	0	0.00
ScrapBinOut1	425	25	62	1.600000	0.0038902	1	0	0.02
ScrapBinOut3	425	25	14	2.367000	0.00129953	1	0	0.01
ScrapBinOut2	425	25	11	2.619000	0.00112976	1	0	0.00
ScrapOut	425	999999	87	0.000000	0	1	0	0.00
Table	425	1	0	0.000000	0	0	0	0.00
Table2	425	1	0	0.000000	0	0	0	0.00
ShearStaging	494	999999	15	632.257667	0.319968	1	0	0.00
Shear	425	1	375	12.213333	0.179608	1	0	17.96
IronWorkerStaging	425	999999	7	295.714286	0.0811765	1	0	0.00
IronWorker	425	1	112	19.714286	0.0865882	1	0	8.66
BevelStation	425	1	175	5.000000	0.0343137	1	0	3.43
DeburrStation	425	1	1475	2.000000	0.115686	1	0	11.57
Bldg2OutStaging	432	999999	1475	26.050492	1.48243	25	0	0.00
GeneralStorage	770	999999	59	1863.423203	2.3797	5	4	0.00

FlatbarToShear	778	999999	397	1603.830327	13.6401	27	22	0.00
FlatbarToBevel	487	999999	7	651.428571	0.156057	1	0	0.00
FlatbarToDeburr	432	999999	52	57.617000	0.11559	1	0	0.00
BevelToDeburr	425	999999	7	57.439714	0.0157678	1	0	0.00
IronWorkerOut	819	999999	368	2206.488500	16.524	28	18	0.00
ShearOut	729	999999	1132	369.606171	9.56548	34	7	0.00
BevelOut	487	999999	175	255.345143	1.52927	25	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Profile Skip Tub	833	3.14	96.14	0.72	0.00
Table10 Skip Tub	826	2.56	96.38	1.06	0.00
Flatbar Skip Tub	812	3.38	96.37	0.25	0.00
ProfileIn	833	0.24	99.76	0.00	0.00
PTABLETBEAMIN	425	100.00	0.00	0.00	0.00
ProfileStorage	425	97.88	2.12	0.00	0.00
ProfileStorage2	425	100.00	0.00	0.00	0.00
ProfileOut	819	1.93	98.07	0.00	0.00
FlatbarOut	833	0.65	99.35	0.00	0.00
RTBeamOut	439	84.29	15.71	0.00	0.00
TBeamOut	819	5.18	94.82	0.00	0.00
FlatbarIn	425	66.81	33.19	0.00	0.00
FlatbarStorage	425	99.79	0.21	0.00	0.00
FlatbarStorage2	425	100.00	0.00	0.00	0.00
TBeamIn	625	29.18	70.82	0.00	0.00
TBeamStorage	425	98.93	1.07	0.00	0.00
TBeamStorage2	425	100.00	0.00	0.00	0.00
FrameBender	425	100.00	0.00	0.00	0.00
OutgoingPileForProfile	425	100.00	0.00	0.00	0.00
ScrapBinOut1	425	99.61	0.39	0.00	0.00
ScrapBinOut3	425	99.87	0.13	0.00	0.00
ScrapBinOut2	425	99.89	0.11	0.00	0.00
ScrapOut	425	100.00	0.00	0.00	0.00
ShearStaging	494	68.00	32.00	0.00	0.00
IronWorkerStaging	425	91.88	8.12	0.00	0.00
Bldg2OutStaging	432	87.12	12.88	0.00	0.00
GeneralStorage	770	16.09	83.91	0.00	0.00
FlatbarToShear	778	2.16	97.84	0.00	0.00
FlatbarToBevel	487	84.39	15.61	0.00	0.00
FlatbarToDeburr	432	88.44	11.56	0.00	0.00

BevelToDeburr	425	98.42	1.58	0.00	0.00
IronWorkerOut	819	4.40	95.60	0.00	0.00
ShearOut	729	17.31	82.69	0.00	0.00
BevelOut	487	84.35	15.65	0.00	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down
Roller Table Position 1	577	65.33	0.00	13.99	18.89	1.80	0.00
Roller Table Position 2	652	57.72	0.00	11.89	29.13	1.26	0.00
Roller Table Position 3	432	86.09	0.00	5.89	6.04	1.97	0.00
Roller Table Position 4	432.0189	86.02	0.00	6.24	5.55	2.19	0.00
Roller Table Position 5	432	86.25	0.00	6.67	6.76	0.32	0.00
Roller Table Position 6	432	85.91	0.00	7.93	6.00	0.16	0.00
Roller Table Position 7	439	84.91	0.00	7.67	7.17	0.25	0.00
Roller Table Position 8	439	86.37	0.00	5.09	8.41	0.13	0.00
Roller Table Position 9	487	77.08	0.00	4.89	17.81	0.22	0.00
Roller Table Position 10	439	85.21	0.00	5.98	8.58	0.23	0.00
Roller Table Position 11	432	84.97	0.00	7.81	7.22	0.00	0.00
Roller Table Position 12	425.0008333	85.07	0.00	8.62	6.06	0.24	0.00
Roller Table Position 13	425	81.90	0.00	12.65	5.41	0.04	0.00
Roller Table Position 14	432	80.93	0.00	11.82	6.93	0.32	0.00
Roller Table Position 15	439	78.75	0.00	11.95	8.86	0.45	0.00
Roller Table Position 16	494	69.86	0.00	9.96	19.93	0.24	0.00
Roller Table Position 17	439.0146667	78.93	0.00	11.32	9.33	0.42	0.00
Roller Table Position 18	439	79.23	0.00	11.98	8.20	0.60	0.00
Roller Table Position 19	439.0128333	81.11	0.00	11.10	7.63	0.16	0.00
Roller Table Position 20	432	81.55	0.00	9.61	6.96	1.88	0.00
Table10 Position 1	439	32.75	0.00	65.87	1.38	0.00	0.00
Table10 Position 2	439	32.74	0.00	63.95	3.31	0.00	0.00
Table10 Position 3	487	29.47	0.00	56.12	14.41	0.00	0.00
Table10 Position 4	425	33.06	0.00	64.55	2.39	0.00	0.00
Table10 Position 5	425	33.04	0.00	64.82	2.14	0.00	0.00
Table10 Position 6	425	33.02	0.00	65.01	1.97	0.00	0.00
Table10 Position 7	432	32.58	0.00	63.37	4.06	0.00	0.00
Table10 Position 8	432	32.52	0.00	63.18	4.30	0.00	0.00
Table10 Position 9	432	32.52	0.00	64.95	2.53	0.00	0.00
Flatbar Area Position 1	425	28.78	0.00	67.42	3.71	0.09	0.00
Flatbar Area Position 2	425	29.61	0.00	66.60	3.53	0.26	0.00
Flatbar Area Position 3	432	29.58	0.00	64.92	5.37	0.13	0.00
Flatbar Area Position 4	425	28.87	0.00	68.46	2.47	0.19	0.00
Flatbar Area Position 5	425	30.75	0.00	66.19	2.87	0.19	0.00

Flatbar Area Position 6	425	26.79	0.00	70.81	2.39	0.00	0.00
Flatbar Area Position 7	425	29.88	0.00	67.43	2.69	0.00	0.00
Flatbar Area Position 8	425	28.97	0.00	68.18	2.64	0.21	0.00
Flatbar Area Position 9	425	28.98	0.00	67.64	3.02	0.37	0.00
Bulldozer	425	0.00	0.00	100.00	0.00	0.00	0.00
Bulldozer2	425	0.00	0.00	100.00	0.00	0.00	0.00
Table	425	0.00	0.00	100.00	0.00	0.00	0.00
Table2	425	0.00	0.00	100.00	0.00	0.00	0.00
Shear	425	17.96	0.00	82.04	0.00	0.00	0.00
IronWorker	425	8.66	0.00	91.34	0.00	0.00	0.00
BevelStation	425	3.43	0.00	96.57	0.00	0.00	0.00
DeburrStation	425	11.57	0.00	88.43	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
PLayoutCrew.1	1	426.2326833	239	73.155766	4.584921	4.135079	0.00	72.65
PLayoutCrew.2	1	426.1024167	228	72.747404	4.385917	3.971500	0.00	68.82
PLayoutCrew.3	1	426.0416167	211	74.546957	4.494373	4.020283	0.00	65.26
PLayoutCrew.4	1	426.1252167	207	71.178237	4.511841	4.008373	0.00	61.28
PLayoutCrew.5	1	425.6947667	182	77.032967	4.454335	3.897543	0.00	58.06
PLayoutCrew.6	1	425.7530833	157	76.942675	4.480490	3.843918	0.00	50.04
PLayoutCrew.7	1	425.6001667	138	80.797101	4.755130	4.001268	0.00	46.23
PLayoutCrew.8	1	425.5461333	127	82.992126	4.761165	3.952078	0.00	43.65
PLayoutCrew.9	1	425.496	114	80.350877	4.512842	3.674743	0.00	37.89
PLayoutCrew.10	1	425.4100667	101	84.851485	4.319676	3.469346	0.00	35.30
PLayoutCrew.11	1	425.29715	83	90.240964	4.570690	3.522367	0.00	30.86
PLayoutCrew.12	1	425	65	96.153846	4.336862	3.097758	0.00	25.62
PLayoutCrew.13	1	425.0595833	44	89.545455	4.824818	3.032743	0.00	16.28
PLayoutCrew.14	1	425.0982833	33	93.939394	5.120879	2.864220	0.00	12.82
PLayoutCrew.15	1	425	20	106.500000	4.099400	1.782348	0.00	8.67
PLayoutCrew.16	1	425	15	104.000000	4.632267	1.694732	0.00	6.39
PLayoutCrew.17	1	425	12	110.833333	4.690250	1.481132	0.00	5.44
PLayoutCrew.18	1	425	7	105.714286	4.844571	1.027636	0.00	3.03
PLayoutCrew.19	1	425	4	120.000000	3.867000	0.515600	0.00	1.94
PLayoutCrew.20	1	425	4	120.000000	5.108750	0.681167	0.00	1.96
PLayoutCrew	20	8508.457167	1991	79.133068	4.532101	3.602578	0.00	32.63
PBurnCrew.1	1	426.1504333	166	126.325301	3.168030	2.875332	0.00	84.08
PBurnCrew.2	1	425.9996333	156	129.685212	3.041898	2.729017	0.00	81.02
PBurnCrew.3	1	426.1389	146	137.465753	3.277932	2.976282	0.00	80.39

PBurnCrew.4	1	426.0916167	157	121.345134	2.864000	2.528000	0.00	76.29
PBurnCrew.5	1	426.0014167	154	119.126649	2.792609	2.547643	0.00	73.48
PBurnCrew.6	1	425.5994333	134	130.292418	2.713836	2.361390	0.00	69.80
PBurnCrew.7	1	425.9218333	131	126.943366	2.841130	2.481253	0.00	66.53
PBurnCrew.8	1	425.7196	125	127.579880	2.713256	2.371727	0.00	63.76
PBurnCrew.9	1	425.6540667	122	127.131148	2.875573	2.511063	0.00	62.13
PBurnCrew.10	1	425.4192167	108	138.653306	2.759306	2.365119	0.00	59.83
PBurnCrew.11	1	425.697	111	135.140586	2.675712	2.233113	0.00	59.89
PBurnCrew.12	1	425.7059	102	138.486745	3.512549	2.821102	0.00	56.71
PBurnCrew.13	1	425.5893833	102	126.679794	2.795447	2.285167	0.00	51.73
PBurnCrew.14	1	425.5352667	92	135.405207	2.981076	2.405781	0.00	49.86
PBurnCrew.15	1	425.3157	86	132.179442	2.215163	1.747743	0.00	45.29
PBurnCrew.16	1	425.4170167	72	133.202472	2.751750	2.153543	0.00	38.35
PBurnCrew.17	1	425.3747833	65	129.501985	2.865831	2.093022	0.00	33.71
PBurnCrew.18	1	425.1307667	40	155.250000	2.012225	1.298210	0.00	24.66
PBurnCrew.19	1	425.0120667	23	177.391304	1.450087	0.741156	0.00	16.13
PBurnCrew.20	1	425.0604333	16	181.875000	2.262375	0.861857	0.00	11.55
PBurnCrew	20	8512.534467	2108	131.057353	2.857379	2.395855	0.00	55.28
TFittingCrew.1	1	425.1630667	115	57.913043	2.792635	2.277681	0.00	27.37
TFittingCrew.2	1	425.2777	95	56.842105	2.774684	2.178471	0.00	22.20
TFittingCrew.3	1	425.2808	62	55.161290	2.849435	2.007557	0.00	14.10
TFittingCrew.4	1	425.0534833	42	58.571429	2.860048	1.766500	0.00	10.12
TFittingCrew.5	1	425.0639833	30	58.000000	2.958200	1.584750	0.00	7.17
TFittingCrew.6	1	425.0547667	23	60.000000	2.844625	1.393286	0.00	5.68
TFittingCrew.7	1	425	9	60.000000	2.790222	0.717486	0.00	2.22
TFittingCrew.8	1	425	7	60.000000	2.894429	0.613970	0.00	1.73
TFittingCrew.9	1	425	5	60.000000	3.295200	0.531484	0.00	1.24
TFittingCrew	9	3825.8938	388	57.525773	2.828794	1.769133	0.00	10.20
TWeldingCrew.1	1	425.5987	118	56.440678	3.058550	3.033273	0.00	27.52
TWeldingCrew.2	1	425.24045	93	57.419355	3.295860	2.736741	0.00	22.13
TWeldingCrew.3	1	425.3039167	64	55.312500	3.353766	2.555250	0.00	14.71
TWeldingCrew.4	1	425.209	44	55.909091	3.253133	2.184940	0.00	10.22
TWeldingCrew.5	1	425.0911	29	57.931034	3.452138	1.962980	0.00	6.98
TWeldingCrew.6	1	425.0422167	25	57.600000	3.262240	1.631120	0.00	5.97
TWeldingCrew.7	1	425	8	60.000000	3.302500	0.777059	0.00	1.99
TWeldingCrew.8	1	425	7	60.000000	4.056000	0.860364	0.00	1.76
TWeldingCrew.9	1	425	5	60.000000	4.185800	0.675129	0.00	1.26
TWeldingCrew	9	3826.485383	393	56.793893	3.262581	2.216093	0.00	10.28
TPaintCrew.1	1	426.6702	87	24.137931	2.114636	3.814192	0.00	8.93
TPaintCrew.2	1	426.3428833	81	24.074074	1.890074	3.098962	0.00	8.22
TPaintCrew.3	1	426.6461333	70	23.928571	2.058486	3.798769	0.00	7.11
TPaintCrew.4	1	426.2815167	62	23.387097	1.874952	2.957346	0.00	6.12
TPaintCrew.5	1	425.9025667	42	22.619048	1.536952	2.082846	0.00	3.97
TPaintCrew.6	1	425.7824833	31	22.580645	1.591903	1.805731	0.00	2.93
TPaintCrew.7	1	425.2582	9	25.000000	1.988000	0.595846	0.00	0.95

TPaintCrew.8	1	425.2217167	8	21.875000	1.662875	0.511654	0.00	0.74
TPaintCrew.9	1	425.0311333	3	25.000000	0.622667	0.071846	0.00	0.30
TPaintCrew	9	3833.136833	393	23.664122	1.894642	2.081910	0.00	4.37
FLayoutCrew.1	1	425.0184667	131	60.916031	0.984214	0.895361	0.00	31.80
FLayoutCrew.2	1	425.0382167	124	61.451613	1.013976	0.917759	0.00	30.37
FLayoutCrew.3	1	425.00265	108	61.944444	0.863306	0.790144	0.00	26.60
FLayoutCrew.4	1	425.0011333	86	61.046512	1.090988	0.919853	0.00	20.96
FLayoutCrew.5	1	425	63	61.190476	1.136492	0.862639	0.00	15.40
FLayoutCrew.6	1	425	49	61.224490	1.094041	0.765829	0.00	11.97
FLayoutCrew.7	1	425	44	61.704545	1.048909	0.699273	0.00	10.83
FLayoutCrew.8	1	425	44	61.704545	0.986523	0.667800	0.00	10.82
FLayoutCrew.9	1	425	43	61.744186	1.062581	0.702938	0.00	10.59
FLayoutCrew	9	3825.060467	692	61.387283	1.014717	0.826099	0.00	18.82
FBurnCrew.1	1	425.02415	85	74.823529	1.556306	1.296922	0.00	25.46
FBurnCrew.2	1	425.0173333	61	80.000000	1.441557	1.113101	0.00	19.48
FBurnCrew.3	1	425	49	81.224490	1.288122	0.928206	0.00	15.86
FBurnCrew.4	1	425	39	86.153846	1.574077	0.990145	0.00	13.42
FBurnCrew.5	1	425	29	95.862069	1.720966	0.978588	0.00	11.10
FBurnCrew.6	1	425.02415	18	97.777778	1.370722	0.601780	0.00	7.00
FBurnCrew.7	1	425.0358	11	94.545455	1.800727	0.550222	0.00	4.16
FBurnCrew.8	1	425	3	113.333333	2.007667	0.215107	0.00	1.36
FBurnCrew.9	1	425	0	0.000000	0.000000	0.000000	0.00	0.00
FBurnCrew	9	3825.101433	295	83.050847	1.508949	0.902921	0.00	10.87
Carrier	1	425	367	2.869338	0.435807	0.499427	0.00	4.76
Crane 600	1	425.0985333	10864	0.755617	0.240224	0.356570	0.00	42.42
Crane 590	1	425.0083833	2983	1.644542	0.197347	0.434998	0.00	21.55
Truck	1	425	87	2.831989	0.831989	0.000000	0.00	1.25
Forktruck	1	425	140	3.308229	1.375657	0.784922	0.00	2.57
ShearCrane	1	425	375	2.309000	0.175000	0.420823	0.00	3.65

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
PLayoutCrew.1	426.2326833	68.37	4.28	4.28	23.06	0.00
PLayoutCrew.2	426.1024167	64.88	3.95	3.95	27.23	0.00
PLayoutCrew.3	426.0416167	61.53	3.73	3.73	31.01	0.00
PLayoutCrew.4	426.1252167	57.63	3.65	3.65	35.07	0.00
PLayoutCrew.5	425.6947667	54.89	3.17	3.17	38.76	0.00
PLayoutCrew.6	425.7530833	47.29	2.75	2.75	47.20	0.00
PLayoutCrew.7	425.6001667	43.66	2.57	2.57	51.20	0.00
PLayoutCrew.8	425.5461333	41.28	2.37	2.37	53.98	0.00

PLayoutCrew.9	425.496	35.88	2.02	2.02	60.09	0.00
PLayoutCrew.10	425.4100667	33.58	1.73	1.73	62.97	0.00
PLayoutCrew.11	425.29715	29.35	1.50	1.50	67.64	0.00
PLayoutCrew.12	425	24.51	1.11	1.11	73.28	0.00
PLayoutCrew.13	425.0595833	15.45	0.83	0.83	82.89	0.00
PLayoutCrew.14	425.0982833	12.15	0.66	0.66	86.52	0.00
PLayoutCrew.15	425	8.35	0.32	0.32	91.00	0.00
PLayoutCrew.16	425	6.12	0.27	0.27	93.34	0.00
PLayoutCrew.17	425	5.22	0.22	0.22	94.34	0.00
PLayoutCrew.18	425	2.90	0.13	0.13	96.83	0.00
PLayoutCrew.19	425	1.88	0.06	0.06	98.00	0.00
PLayoutCrew.20	425	1.88	0.08	0.08	97.96	0.00
PLayoutCrew	8508.457167	30.86	1.77	1.77	65.59	0.00
PBurnCrew.1	426.1504333	82.01	2.07	2.07	13.85	0.00
PBurnCrew.2	425.9996333	79.15	1.87	1.87	17.11	0.00
PBurnCrew.3	426.1389	78.50	1.90	1.90	17.71	0.00
PBurnCrew.4	426.0916167	74.52	1.77	1.77	21.94	0.00
PBurnCrew.5	426.0014167	71.77	1.70	1.70	24.82	0.00
PBurnCrew.6	425.5994333	68.37	1.42	1.42	28.78	0.00
PBurnCrew.7	425.9218333	65.07	1.46	1.46	32.01	0.00
PBurnCrew.8	425.7196	62.43	1.33	1.33	34.91	0.00
PBurnCrew.9	425.6540667	60.73	1.40	1.40	36.48	0.00
PBurnCrew.10	425.4192167	58.67	1.17	1.17	39.00	0.00
PBurnCrew.11	425.697	58.73	1.16	1.16	38.94	0.00
PBurnCrew.12	425.7059	55.30	1.40	1.40	41.89	0.00
PBurnCrew.13	425.5893833	50.60	1.13	1.13	47.14	0.00
PBurnCrew.14	425.5352667	48.79	1.07	1.07	49.06	0.00
PBurnCrew.15	425.3157	44.55	0.75	0.75	53.96	0.00
PBurnCrew.16	425.4170167	37.57	0.78	0.78	60.87	0.00
PBurnCrew.17	425.3747833	32.98	0.73	0.73	65.56	0.00
PBurnCrew.18	425.1307667	24.35	0.32	0.32	75.02	0.00
PBurnCrew.19	425.0120667	16.00	0.13	0.13	83.74	0.00
PBurnCrew.20	425.0604333	11.41	0.14	0.14	88.31	0.00
PBurnCrew	8512.534467	54.09	1.18	1.18	43.54	0.00
TFittingCrew.1	425.1630667	26.11	1.26	1.26	71.37	0.00
TFittingCrew.2	425.2777	21.16	1.03	1.03	76.77	0.00
TFittingCrew.3	425.2808	13.40	0.69	0.69	85.21	0.00
TFittingCrew.4	425.0534833	9.65	0.47	0.47	89.41	0.00
TFittingCrew.5	425.0639833	6.82	0.35	0.35	92.48	0.00
TFittingCrew.6	425.0547667	5.41	0.27	0.27	94.05	0.00
TFittingCrew.7	425	2.12	0.10	0.10	97.69	0.00
TFittingCrew.8	425	1.65	0.08	0.08	98.19	0.00
TFittingCrew.9	425	1.18	0.06	0.06	98.69	0.00
TFittingCrew	3825.8938	9.72	0.48	0.48	89.32	0.00
TWeldingCrew.1	425.5987	26.08	1.44	1.44	71.04	0.00

TWeldingCrew.2	425.24045	20.93	1.20	1.20	76.67	0.00
TWeldingCrew.3	425.3039167	13.87	0.84	0.84	84.45	0.00
TWeldingCrew.4	425.209	9.64	0.57	0.57	89.21	0.00
TWeldingCrew.5	425.0911	6.59	0.39	0.39	92.63	0.00
TWeldingCrew.6	425.0422167	5.65	0.32	0.32	93.71	0.00
TWeldingCrew.7	425	1.88	0.10	0.10	97.91	0.00
TWeldingCrew.8	425	1.65	0.11	0.11	98.13	0.00
TWeldingCrew.9	425	1.18	0.08	0.08	98.66	0.00
TWeldingCrew	3826.485383	9.72	0.56	0.56	89.15	0.00
TPaintCrew.1	426.6702	8.20	0.73	0.39	90.68	0.00
TPaintCrew.2	426.3428833	7.62	0.60	0.31	91.46	0.00
TPaintCrew.3	426.6461333	6.54	0.56	0.39	92.51	0.00
TPaintCrew.4	426.2815167	5.67	0.45	0.30	93.58	0.00
TPaintCrew.5	425.9025667	3.72	0.25	0.21	95.82	0.00
TPaintCrew.6	425.7824833	2.74	0.19	0.18	96.88	0.00
TPaintCrew.7	425.2582	0.88	0.07	0.06	98.99	0.00
TPaintCrew.8	425.2217167	0.69	0.05	0.05	99.21	0.00
TPaintCrew.9	425.0311333	0.29	0.01	0.01	99.69	0.00
TPaintCrew	3833.136833	4.04	0.32	0.21	95.42	0.00
FLayoutCrew.1	425.0184667	31.29	0.51	0.51	67.70	0.00
FLayoutCrew.2	425.0382167	29.88	0.49	0.49	69.13	0.00
FLayoutCrew.3	425.00265	26.24	0.37	0.37	73.03	0.00
FLayoutCrew.4	425.0011333	20.59	0.37	0.37	78.68	0.00
FLayoutCrew.5	425	15.12	0.28	0.28	84.32	0.00
FLayoutCrew.6	425	11.76	0.21	0.21	87.81	0.00
FLayoutCrew.7	425	10.65	0.18	0.18	88.99	0.00
FLayoutCrew.8	425	10.65	0.17	0.17	89.01	0.00
FLayoutCrew.9	425	10.41	0.18	0.18	89.23	0.00
FLayoutCrew	3825.060467	18.51	0.31	0.31	80.88	0.00
FBurnCrew.1	425.02415	24.94	0.52	0.52	74.02	0.00
FBurnCrew.2	425.0173333	19.14	0.34	0.34	80.17	0.00
FBurnCrew.3	425	15.61	0.25	0.25	83.90	0.00
FBurnCrew.4	425	13.18	0.24	0.24	86.34	0.00
FBurnCrew.5	425	10.90	0.20	0.20	88.71	0.00
FBurnCrew.6	425.02415	6.90	0.10	0.10	92.90	0.00
FBurnCrew.7	425.0358	4.08	0.08	0.08	95.77	0.00
FBurnCrew.8	425	1.33	0.02	0.02	98.62	0.00
FBurnCrew.9	425	0.00	0.00	0.00	100.00	0.00
FBurnCrew	3825.101433	10.68	0.19	0.19	88.94	0.00
Carrier	425	4.13	0.63	0.45	94.79	0.00
Crane 600	425.0985333	32.18	10.23	1.17	56.41	0.00
Crane 590	425.0083833	19.24	2.31	1.00	77.45	0.00
Truck	425	0.97	0.28	0.00	98.75	0.00
Forktruck	425	1.82	0.76	0.51	96.92	0.00
ShearCrane	425	3.40	0.26	0.66	95.69	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
CBlock	ProfileStorage	110
CBlock	FlatbarStorage	56
CBlock	TBeamStorage	56

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
Profile	6302	63	1603.365435	33.947746	284.070794	462.945568	822.401327
Flatbar	1607	34	1846.109585	32.458892	1594.975633	162.604441	56.070619
TBeam	413	8	1808.298174	46.361794	513.900441	909.757906	338.278034
RTBeam	0	9	-	-	-	-	-
Scrap	1637	16	411.174563	12.690987	398.227567	0.000000	0.256009
Scrap2	275	16	1939.482007	17.364502	1922.117505	0.000000	0.000000
Scrap3	350	22	1799.912949	8.708220	1791.204729	0.000000	0.000000
CarrierBlock	0	0	-	-	-	-	-
nothing	0	0	-	-	-	-	-
CBlock	200	0	8.037210	8.037210	0.000000	0.000000	0.000000
ScrapBin	0	0	-	-	-	-	-
SFlatbar	2980	229	2320.442434	13.868828	2141.734469	21.846980	142.992158

ENTITY STATES BY PERCENTAGE

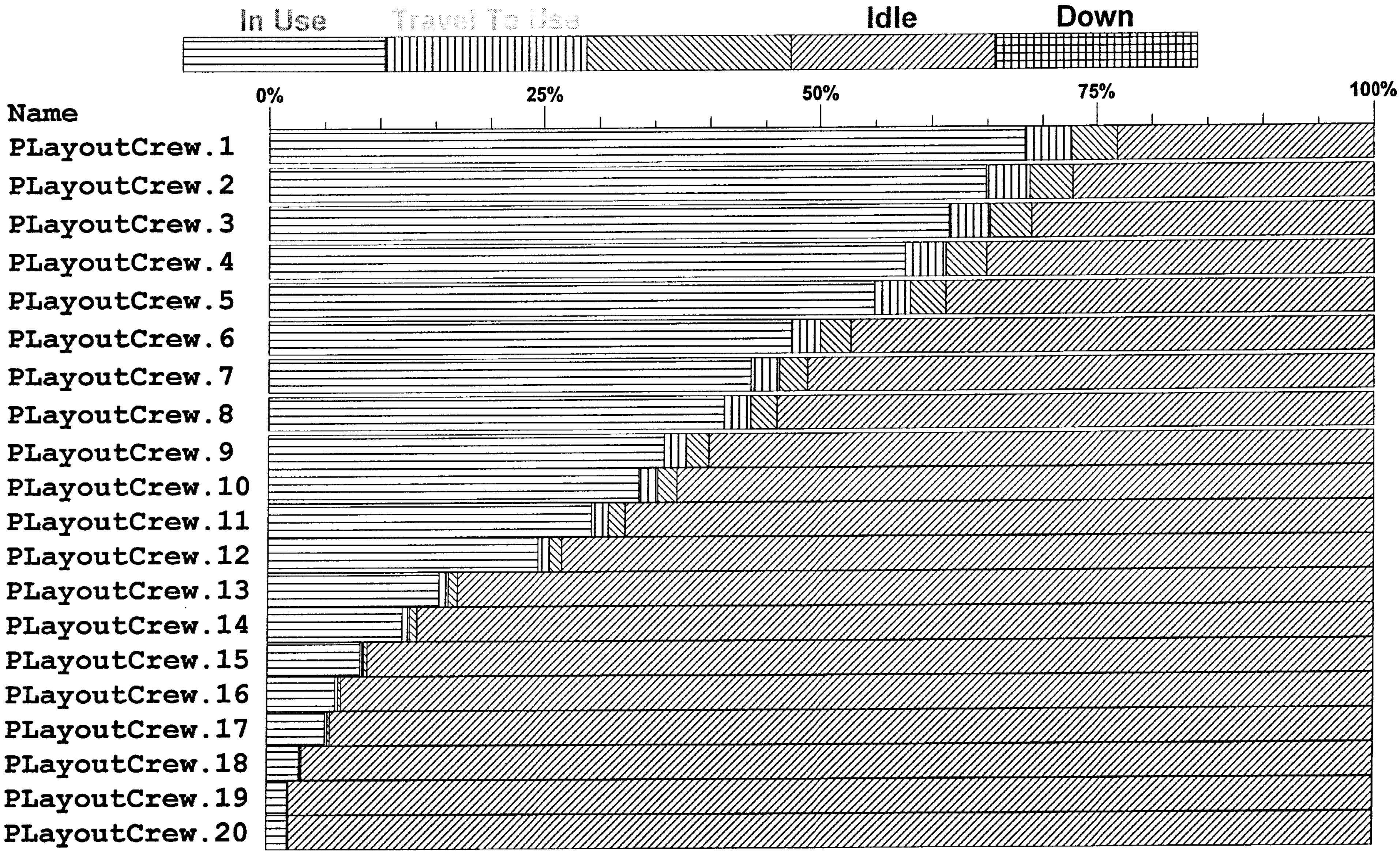
Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
Profile	2.12	17.72	28.87	51.29
Flatbar	1.76	86.40	8.81	3.04
TBeam	2.56	28.42	50.31	18.71
Scrap	3.09	96.85	0.00	0.06
Scrap2	0.90	99.10	0.00	0.00
Scrap3	0.48	99.52	0.00	0.00

CBlock	100.00	0.00	0.00	0.00
SFlatbar	0.60	92.30	0.94	6.16

VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v TotalProfilesArrived	1577	30.125497	0	1577	1577	815.512
v TotalFlatbarsArrived	688	68.728605	0	688	688	356.88
v TotalTBeamsArrived	298	158.780054	0	298	298	155.916
v TotalProfilesProcessed	1566	30.343257	0	1566	1566	801.98
v TotalFlatbarsProcessed	291	163.102292	0	291	291	145.405
v TotalTBeamsProcessed	291	162.146271	0	291	291	152.323
v TotalProfilesProduced	6232	7.625222	0	6232	6232	3232.6
v TotalFlatbarsProduced	2699	17.594279	0	2699	2699	1333.75
v TotalTBeamsProduced	372	127.452987	0	372	372	184.773
v PBatchSize	100	470.401000	0	16	16	15.8476
v FBatchSize	50	940.800000	0	16	16	15.8476
v TBatchSize	50	940.800000	0	6	6	5.94286
v Counter	0	0.000000	0	0	0	0
v PScrap	1565	30.358424	0	1565	1565	801.48
v FScrap	291	163.191302	0	291	291	145.297
v TScrap	372	126.868425	0	372	372	188.605
v PPerUnit	100	470.401000	0	10	3	4.53333
v FPerUnit	51	922.352941	0	10	5	4.21905
v TPerUnit	50	940.800000	0	3	3	1.59048
v PPerUnitBatch	0	0.000000	0	0	0	0
v FPerUnitBatch	0	0.000000	0	0	0	0
v TPerUnitBatch	0	0.000000	0	0	0	0
v PTotal	0	0.000000	0	0	0	0
v FTotal	0	0.000000	0	0	0	0
v TTotal	0	0.000000	0	0	0	0
v TotalFToShear	397	118.739108	0	397	397	210.025
v TotalShearProduced	1475	31.801881	0	1475	1475	736.309
v Count	0	0.000000	0	0	0	0
v ProfileWIP	1675	28.363528	0	1479	1479	764.934
v TBeamWIP	318	149.264959	0	279	278	146.913
v FlatBarWIP	737	64.159132	0	639	639	332.689
v ProfileFlowTime	98	483.669316	0	3731.47	162.305	303.958
v TBeamFlowTime	20	2373.312850	0	806.294	184.615	170.451
v FlatBarFlowTime	49	958.394857	0	4001.67	1306.71	875.085

Resource States



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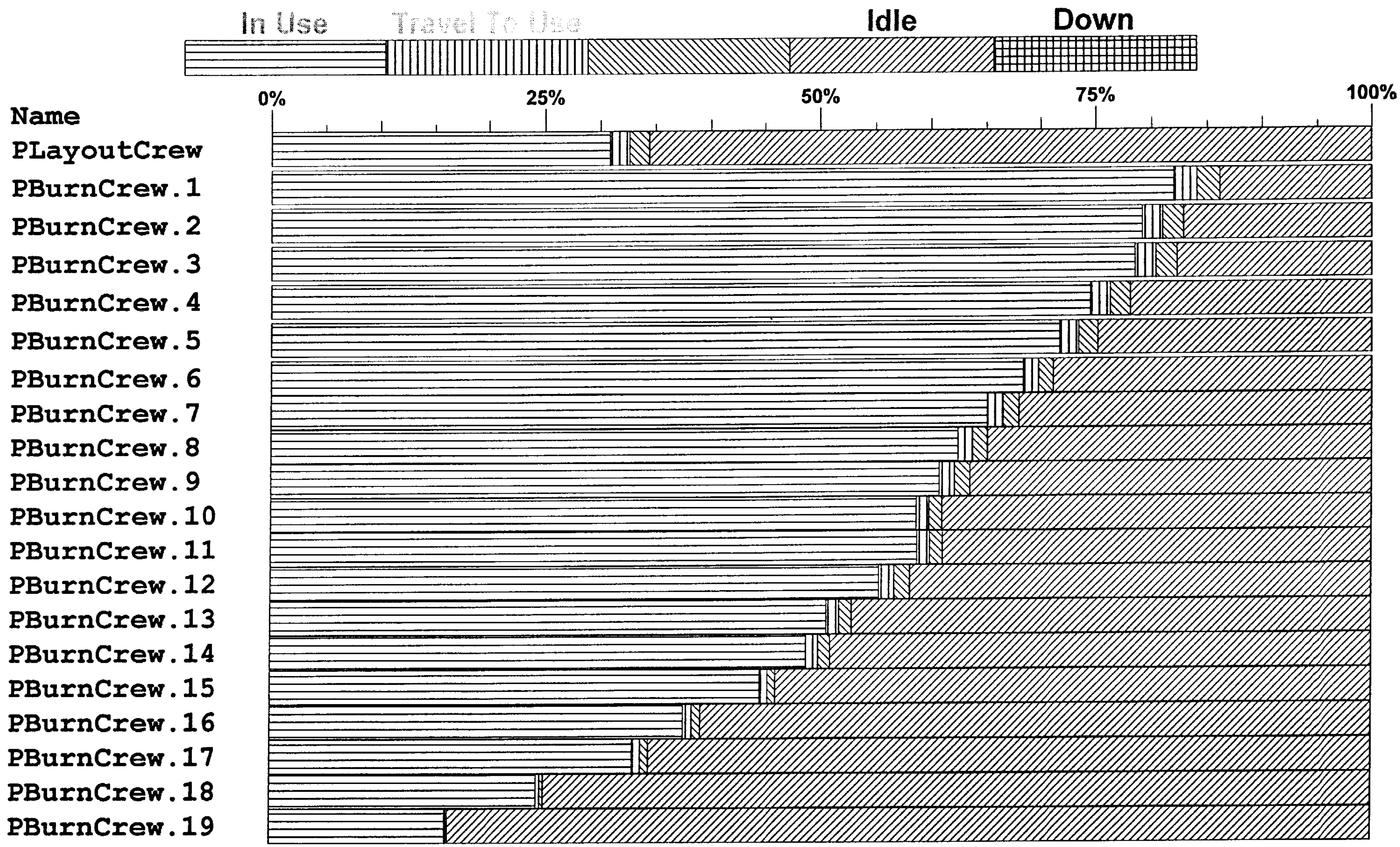

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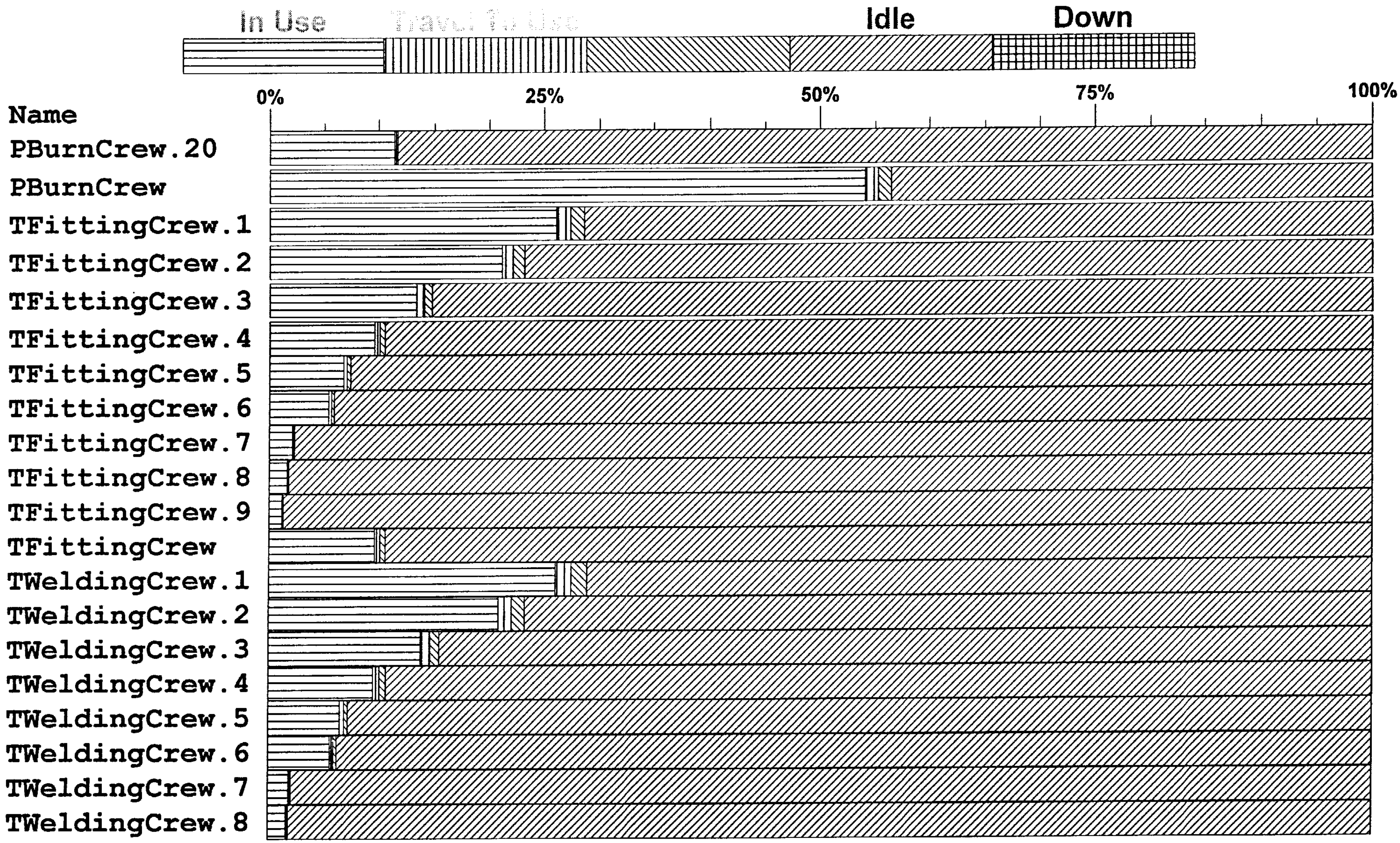
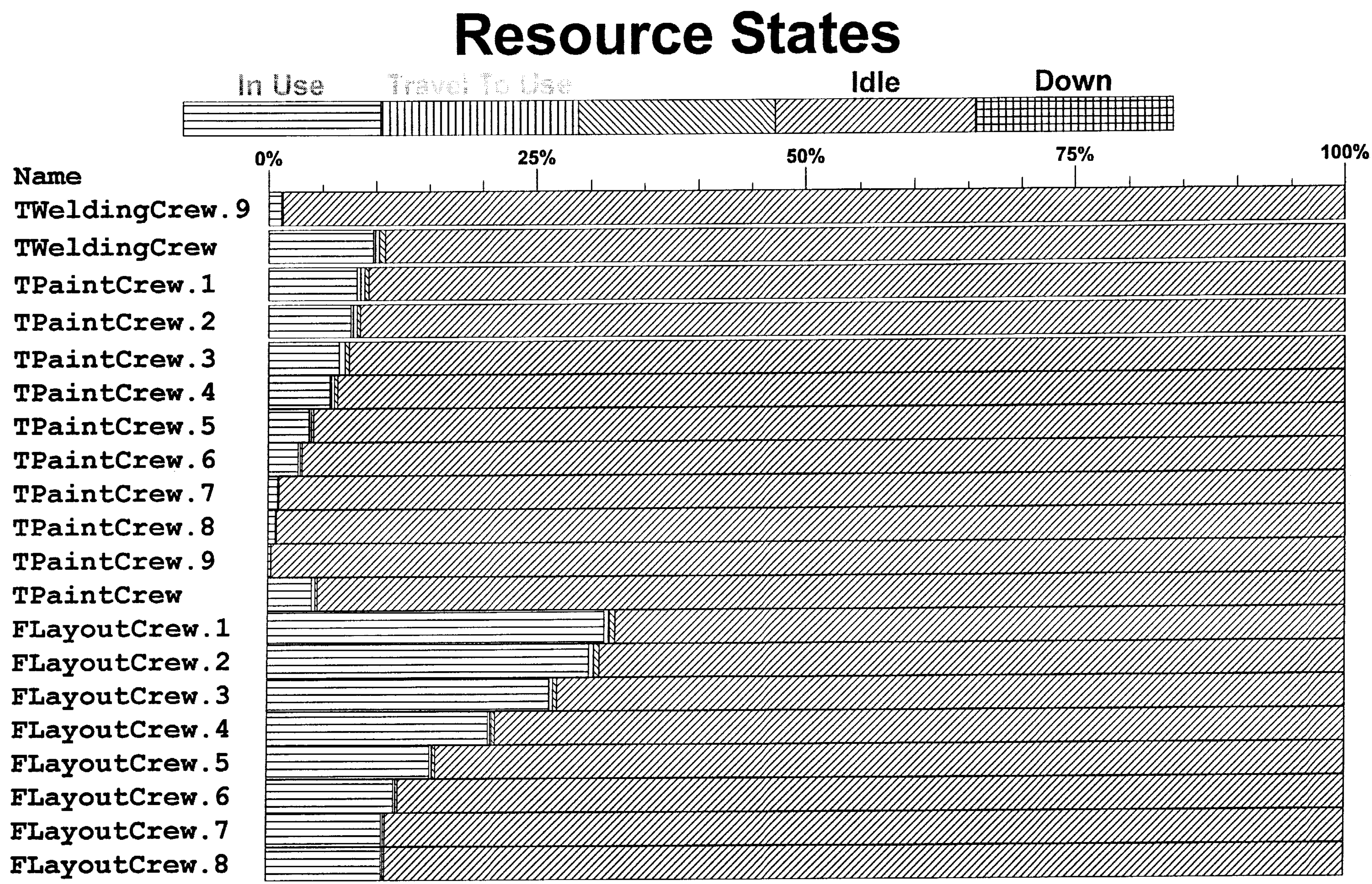
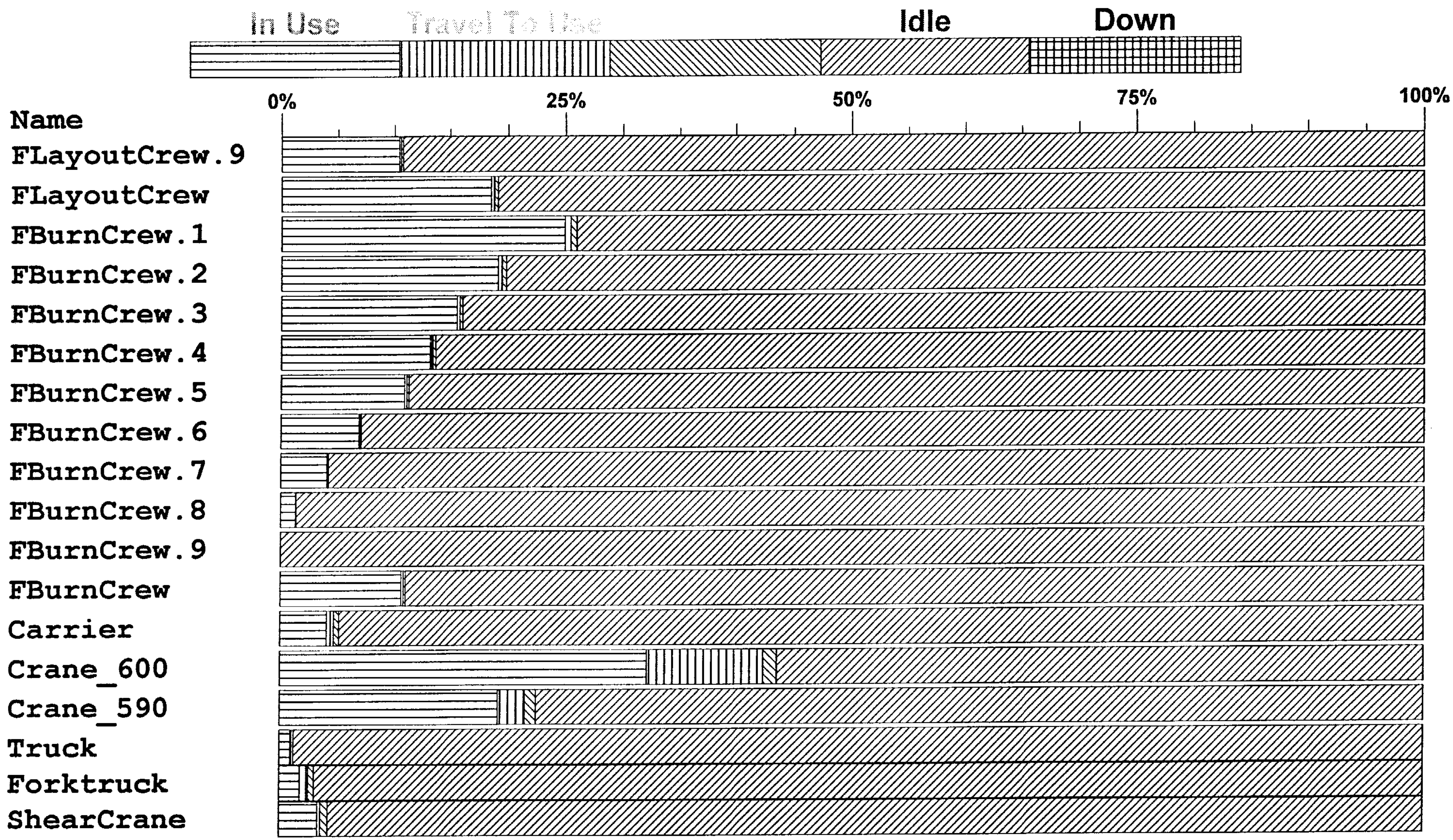


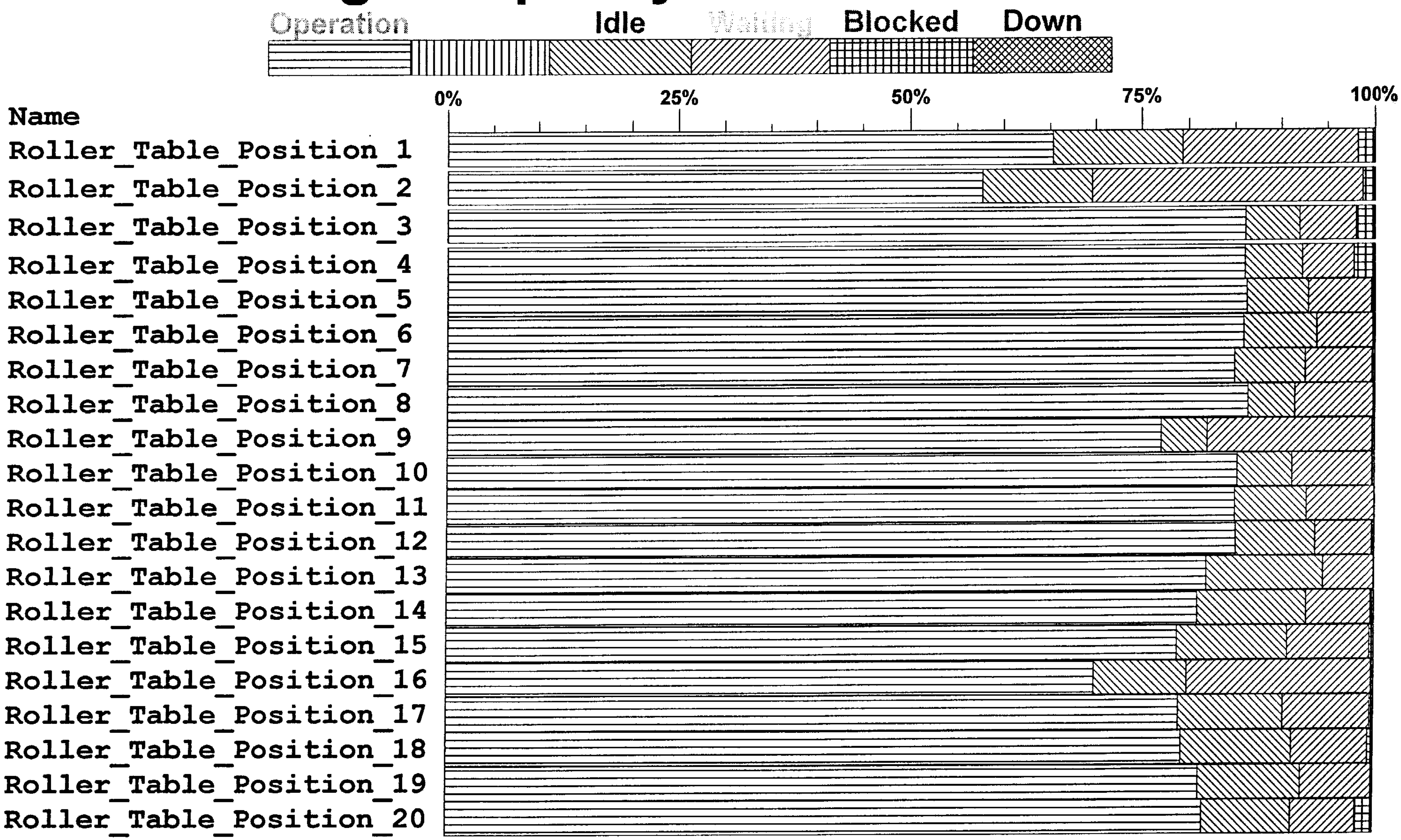


Resource States
In Use
Travel To Use
Idle
Down
0%
25%
50%
75%
100%
Name
TWeldingCrew.9
TWeldingCrew
TPaintCrew.1
TPaintCrew.2
TPaintCrew.3
TPaintCrew.4
TPaintCrew.5
TPaintCrew.6
TPaintCrew.7
TPaintCrew.8
TPaintCrew.9
TPaintCrew
FLayoutCrew.1
FLayoutCrew.2
FLayoutCrew.3
FLayoutCrew.4
FLayoutCrew.5
FLayoutCrew.6
FLayoutCrew.7
FLayoutCrew.8

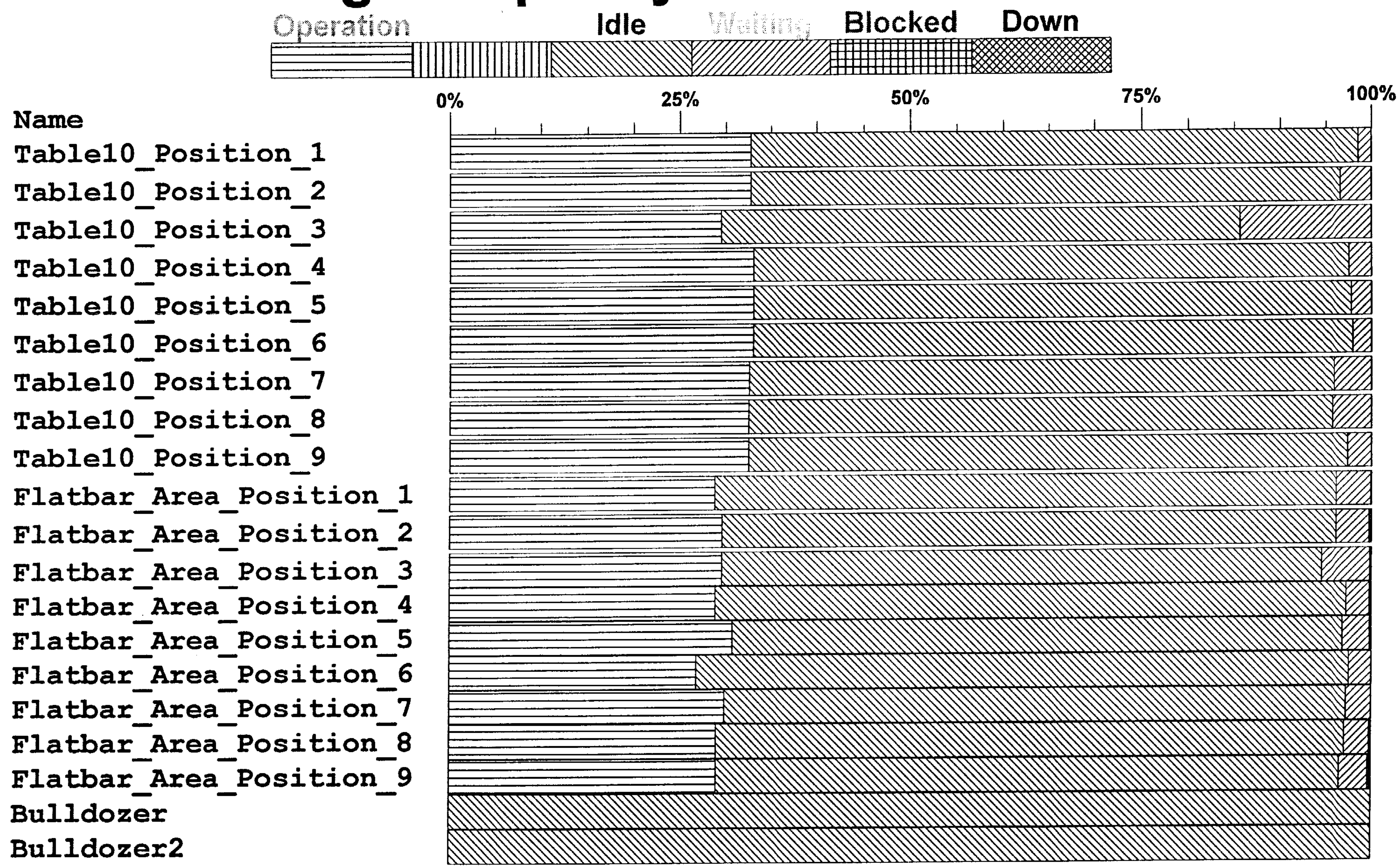
Resource States



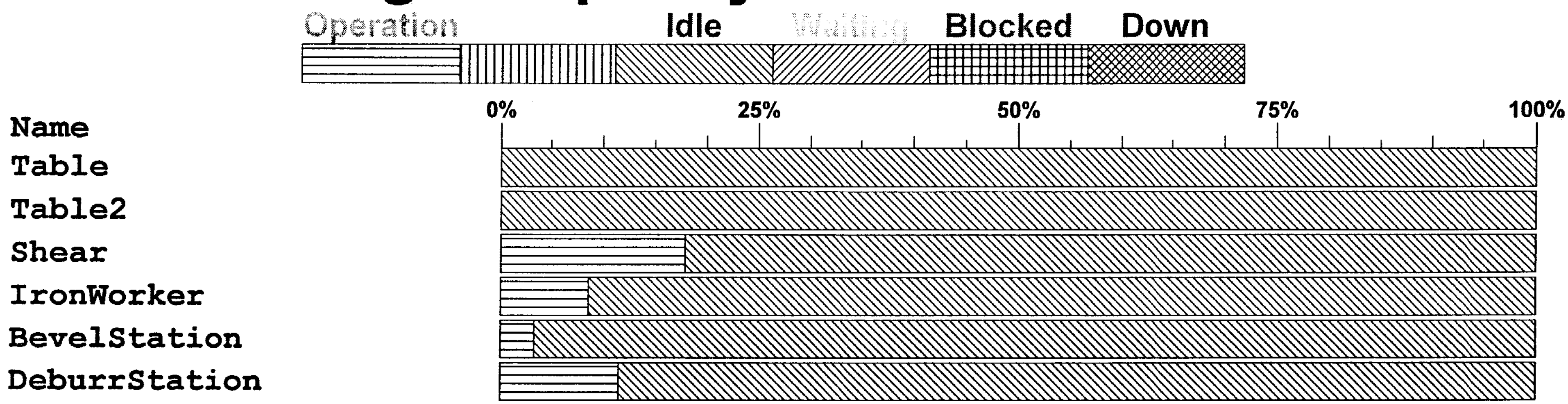
Single Capacity Location States



Single Capacity Location States



Single Capacity Location States



DETAILED PERFORMANCE STATISTICS FOR THE "HIGH OUTPUT - INCREASED MANNING AND MATERIAL" PROFILE FABRICATION AREA MODEL

DETAILED PERFORMANCE STATISTICS FOR THE "HIGH OUTPUT" PANEL LINE MODEL

DK Socket Fitters = 2
DK Socket Welders = 4
Stiffener Fitters = 4
Web Fitters = 6
Web Welders (Sta 9) = 8
Web Welders (Sta 10) = 8
DK Socket Fit Time = 0
DK Socket Weld Time = 0
Gantry Crane Wait = 0
#2 DK Socket Weld Time = 0
Hold Time = 0

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\jeff.MOD
Date: May/19/1998   Time: 02:46:00 PM

No DK Sockets

Scenario   : Model Parameters
Replication   : 1 of 1
Warmup Time   : 96 hr
Simulation Time : 840 hr

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Sta1 Plate Fitting	744	5	282	536.515535	3.38928	5	2	67.79
Sta2 Deck Sockets	744	1	57	783.157895	1	1	1	100.00
Sta3 One Sided Welding	357	1	57	375.789474 6.25	1	1	1	100.00
Sta4 Manual Layout	357	1	56	182.667946	0.477563	1	1	47.76
Sta5 Stiffener Fitting	371	1	56	363.190786	0.913688	1	1	91.37
Sta6 Stiffener Welding	357	1	56	273.995393	0.716328	1	1	71.63
Sta7 Web Fitting 1	357	1	55	201.445709	0.517251	1	0	51.73
Sta8 Web Fitting 2	357	1	56	185.386768	0.484671	1	0	48.47
Sta9 Weld Out 1	405	1	57	365.619404	0.857626	1	1	85.76
Sta10 Weld Out 2	357	1	56	321.161018	0.839637	1	1	83.96
Sta11 Load Out	357	1	55	0.000000	0	1	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Sta1 Plate Fitting	744	0.00	70.64	29.36	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down

Sta2 Deck Sockets	744	0.00	0.00	0.00	7.65	92.35	0.00
Sta3 One Sided Welding	357	99.68	0.00	0.00	0.32	0.00	0.00
Sta4 Manual Layout	357	46.62	0.00	52.24	0.24	0.90	0.00
Sta5 Stiffener Fitting	371	80.17	0.00	8.63	11.20	0.00	0.00
Sta6 Stiffener Welding	357	71.24	0.00	28.37	0.39	0.00	0.00
Sta7 Web Fitting 1	357	47.34	0.00	48.27	4.39	0.00	0.00
Sta8 Web Fitting 2	357	47.93	0.00	51.53	0.54	0.00	0.00
Sta9 Weld Out 1	405	73.34	0.00	14.24	12.42	0.00	0.00
Sta10 Weld Out 2	357	83.22	0.00	16.04	0.74	0.00	0.00
Sta11 Load Out	357	0.00	0.00	100.00	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
crane500	1	357	228	44.971430	0.039700	0.000000	0.00	47.91
Sta1 Plate Fitters.1	1	357	845	19.362324	0.097031	0.054921	0.00	76.76
Sta1 Plate Fitters.2	1	357	845	19.362324	0.097031	0.054921	0.00	76.76
Sta1 Plate Fitters	2	714	1690	19.362324	0.097031	0.054921	0.00	76.76
Sta2 Deck Socket Welders.1	1	357	56	0.000000	0.541000	0.388410	0.00	0.14
Sta2 Deck Socket Welders.2	1	357	56	0.000000	0.541000	0.388410	0.00	0.14
Sta2 Deck Socket Welders.3	1	357	56	0.000000	0.541000	0.388410	0.00	0.14
Sta2 Deck Socket Welders.4	1	357	56	0.000000	0.541000	0.388410	0.00	0.14
Sta2 Deck Socket Welders	4	1428	224	0.000000	0.541000	0.388410	0.00	0.14
Sta2 Deck Socket Fitters.1	1	357.01025	56	0.000000	0.541000	0.395346	0.00	0.14
Sta2 Deck Socket Fitters.2	1	357.01025	56	0.000000	0.541000	0.395346	0.00	0.14
Sta2 Deck Socket Fitters	2	714.0205	112	0.000000	0.541000	0.395346	0.00	0.14
Sta3 OSW Operator.1	1	357.2222	78	273.582077	0.606000	0.472680	0.00	99.78
Sta3 OSW Operator.2	1	357.2222	78	273.582077	0.606000	0.472680	0.00	99.78
Sta3 OSW Operator	2	714.4444	156	273.582077	0.606000	0.472680	0.00	99.78
Sta4 Layout Person.1	1	357.1651833	66	151.163212	0.901000	0.675750	0.00	46.83
Sta4 Layout Person.2	1	357.1651833	66	151.163212	0.901000	0.675750	0.00	46.83
Sta4 Layout Person	2	714.3303667	132	151.163212	0.901000	0.675750	0.00	46.83
Sta5 Stiffener Fitter.1	1	357.3363167	72	247.598500	1.187000	0.909191	0.00	83.54
Sta5 Stiffener Fitter.2	1	357.3363167	72	247.598500	1.187000	0.909191	0.00	83.54
Sta5 Stiffener Fitter.3	1	357.3363167	72	247.598500	1.187000	0.909191	0.00	83.54
Sta5 Stiffener Fitter.4	1	357.3363167	72	247.598500	1.187000	0.909191	0.00	83.54
Sta5 Stiffener Fitter	4	1429.345267	288	247.598500	1.187000	0.909191	0.00	83.54
Sta6 DartIV Operator.1	1	357.4329333	72	211.600750	1.528000	1.170383	0.00	71.55
Sta6 DartIV Operator.2	1	357.4329333	72	211.600750	1.528000	1.170383	0.00	71.55
Sta6 DartIV Operator	2	714.8658667	144	211.600750	1.528000	1.170383	0.00	71.55

Sta7 Web Fitter.1	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter.2	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter.3	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter.4	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter.5	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter.6	1	357.6558833	131	155.471962	1.513015	1.592155	0.00	95.83
Sta7 Web Fitter	6	2145.9353	786	155.471962	1.513015	1.592155	0.00	95.83
Sta9 Welder.1	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.2	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.3	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.4	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.5	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.6	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.7	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder.8	1	357.8131333	75	237.004573	2.467307	1.933268	0.00	83.66
Sta9 Welder	8	2862.505067	600	237.004573	2.467307	1.933268	0.00	83.66
Sta10 Welder.1	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.2	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.3	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.4	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.5	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.6	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.7	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder.8	1	357.85335	72	246.952903	2.839000	2.174553	0.00	83.76
Sta10 Welder	8	2862.8268	576	246.952903	2.839000	2.174553	0.00	83.76
forktruck	1	357	111	0.475090	0.475288	0.000000	0.00	0.49
One Sided Welder	1	357	78	274.615385	0.000000	0.000000	0.00	100.00
PL415 Stiffener Press	1	357	72	248.696444	0.073592	0.055585	0.00	83.62
DartIV Welder	1	357	72	213.038014	0.070493	0.053245	0.00	71.63
Spider Gantry No1	1	405	76	274.143079	0.072427	0.056583	0.00	85.76
Spider Gantry No2	1	357	72	249.719569	0.072333	0.054415	0.00	83.96
Transfer car	1	550.01315	557	39.652131	0.110590	1.028212	0.00	67.11

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
crane500	357	47.87	0.04	0.00	52.09	0.00
Sta1 Plate Fitters.1	357	76.38	0.38	0.16	23.07	0.00
Sta1 Plate Fitters.2	357	76.38	0.38	0.16	23.07	0.00
Sta1 Plate Fitters	714	76.38	0.38	0.16	23.07	0.00
Sta2 Deck Socket Welders.1	357	0.00	0.14	0.14	99.72	0.00

Sta2 Deck Socket Welders.2	357	0.00	0.14	0.14	99.72	0.00
Sta2 Deck Socket Welders.3	357	0.00	0.14	0.14	99.72	0.00
Sta2 Deck Socket Welders.4	357	0.00	0.14	0.14	99.72	0.00
Sta2 Deck Socket Welders	1428	0.00	0.14	0.14	99.72	0.00
Sta2 Deck Socket Fitters.1	357.01025	0.00	0.14	0.14	99.71	0.00
Sta2 Deck Socket Fitters.2	357.01025	0.00	0.14	0.14	99.71	0.00
Sta2 Deck Socket Fitters	714.0205	0.00	0.14	0.14	99.71	0.00
Sta3 OSW Operator.1	357.2222	99.56	0.22	0.22	0.00	0.00
Sta3 OSW Operator.2	357.2222	99.56	0.22	0.22	0.00	0.00
Sta3 OSW Operator	714.4444	99.56	0.22	0.22	0.00	0.00
Sta4 Layout Person.1	357.1651833	46.56	0.28	0.28	52.89	0.00
Sta4 Layout Person.2	357.1651833	46.56	0.28	0.28	52.89	0.00
Sta4 Layout Person	714.3303667	46.56	0.28	0.28	52.89	0.00
Sta5 Stiffener Fitter.1	357.3363167	83.15	0.39	0.40	16.06	0.00
Sta5 Stiffener Fitter.2	357.3363167	83.15	0.39	0.40	16.06	0.00
Sta5 Stiffener Fitter.3	357.3363167	83.15	0.39	0.40	16.06	0.00
Sta5 Stiffener Fitter.4	357.3363167	83.15	0.39	0.40	16.06	0.00
Sta5 Stiffener Fitter	1429.345267	83.15	0.39	0.40	16.06	0.00
Sta6 DartIV Operator.1	357.4329333	71.04	0.51	0.51	27.94	0.00
Sta6 DartIV Operator.2	357.4329333	71.04	0.51	0.51	27.94	0.00
Sta6 DartIV Operator	714.8658667	71.04	0.51	0.51	27.94	0.00
Sta7 Web Fitter.1	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter.2	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter.3	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter.4	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter.5	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter.6	357.6558833	94.91	0.92	0.82	3.36	0.00
Sta7 Web Fitter	2145.9353	94.91	0.92	0.82	3.36	0.00
Sta9 Welder.1	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.2	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.3	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.4	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.5	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.6	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.7	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder.8	357.8131333	82.80	0.86	0.87	15.47	0.00
Sta9 Welder	2862.505067	82.80	0.86	0.87	15.47	0.00
Sta10 Welder.1	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.2	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.3	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.4	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.5	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.6	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.7	357.85335	82.81	0.95	0.95	15.28	0.00
Sta10 Welder.8	357.85335	82.81	0.95	0.95	15.28	0.00

Sta10 Welder	2862.8268	82.81	0.95	0.95	15.28	0.00
forktruck	357	0.25	0.25	0.00	99.51	0.00
One Sided Welder	357	100.00	0.00	0.00	0.00	0.00
PL415 Stiffener Press	357	83.60	0.02	0.02	16.36	0.00
DartIV Welder	357	71.61	0.02	0.02	28.34	0.00
Spider Gantry No1	405	85.74	0.02	0.02	14.22	0.00
Spider Gantry No2	357	83.94	0.02	0.02	16.01	0.00
Transfer car	550.01315	66.93	0.19	0.74	32.15	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
profile	profile staging original	0
plate cut	plate transfer car1	0
deck sockets	deck socket staging original	0
web	Web Staging	0

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
profile	55	65	14381.656982	46.710618	0.000000	0.000000	14334.946364
plate cut	275	38	5817.978684	32.120193	475.807949	4351.872764	958.177778
Ent panel line	55	7	5339.904855	0.000000	124.302345	4292.672764	922.929745
deck sockets	56	0	0.992000	0.992000	0.000000	0.000000	0.000000
web	55	1	373.545800	6.779582	366.766218	0.000000	0.000000

ENTITY STATES BY PERCENTAGE

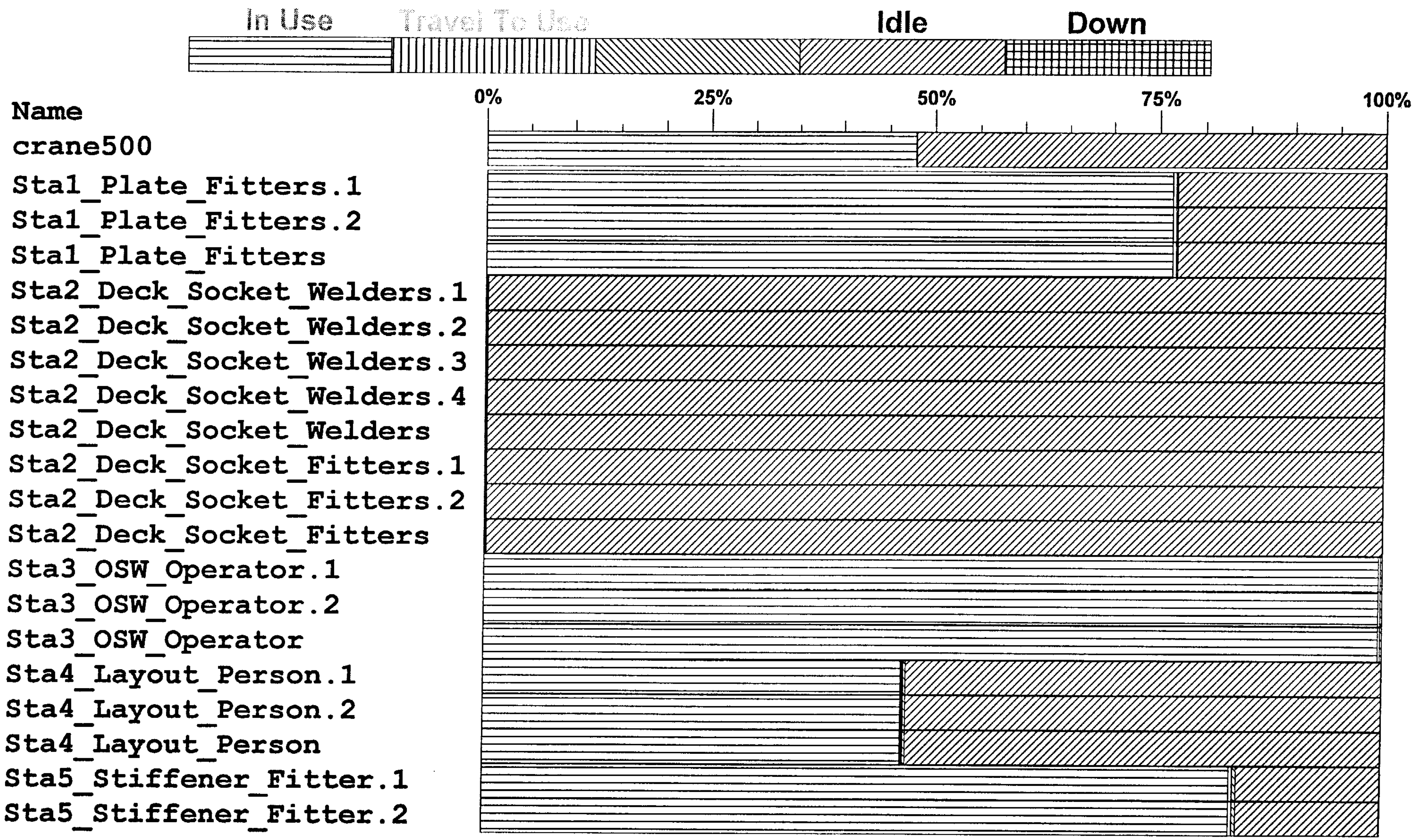
Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
profile	0.32	0.00	0.00	99.68
plate cut	0.55	8.18	74.80	16.47
Ent panel line	0.00	2.33	80.39	17.28
deck sockets	100.00	0.00	0.00	0.00

web	1.81	98.19	0.00	0.00

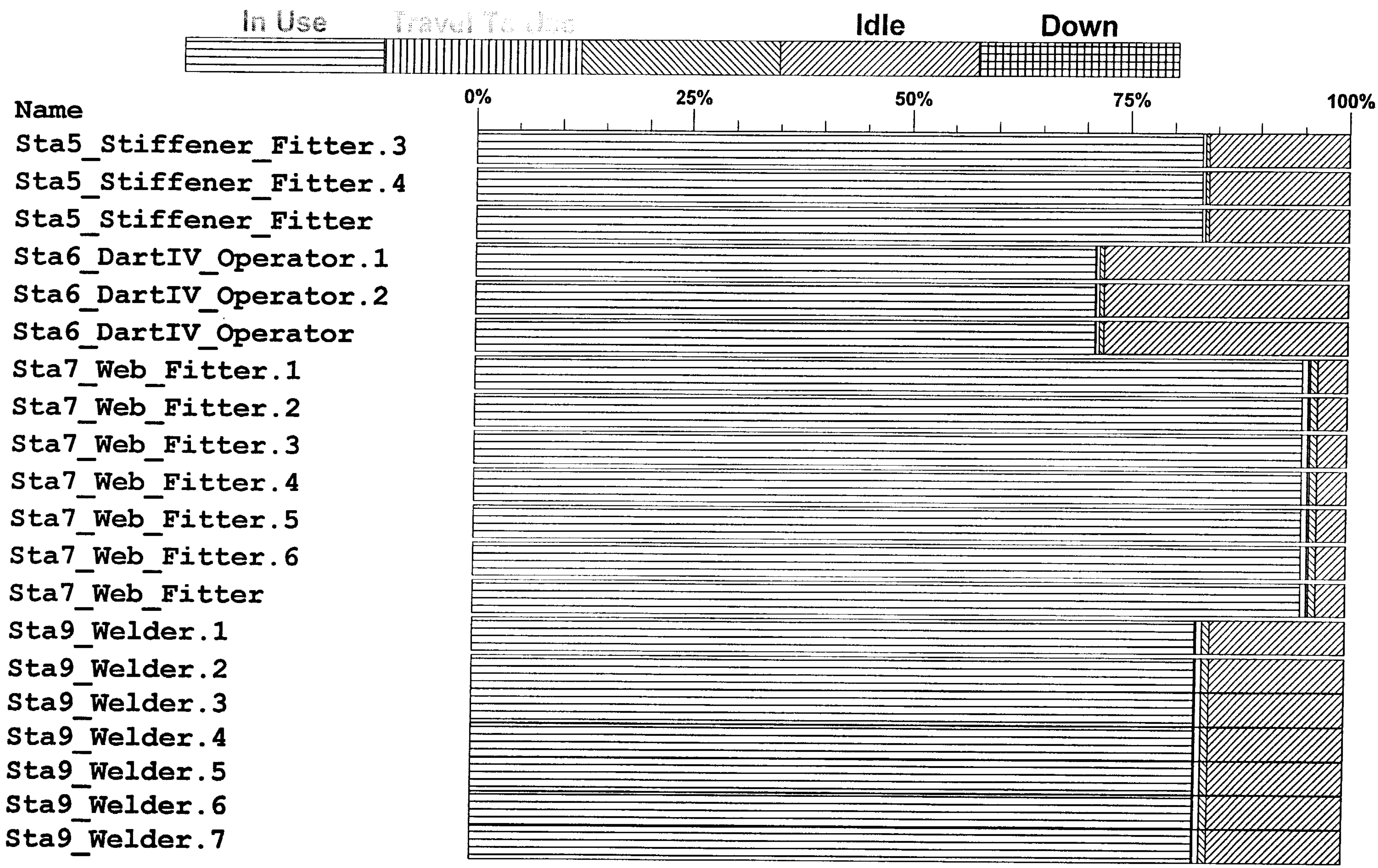
VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v NoofPanels completed	55	756.772291	5	60	60	32.4059
v total time	55	756.772291	26.4362	52.9235	27.1237	34.747
v cycle time	55	756.772291	6.14656	10.3467	6.14656	6.85593
v nof stiffners	55	754.988945	144	1024	1024	586.633
v nof webs	55	751.650109	42	372	372	209.901
v total footage	166	251.289470	22200	232300	232300	128159
v nof plates	277	150.548032	60	337	337	199.296
v nof panels per shift	55	756.772291	0.773193	1.30154	1.30154	1.18063
v PanelWIP	110	378.386145	7	8	7	7.06888

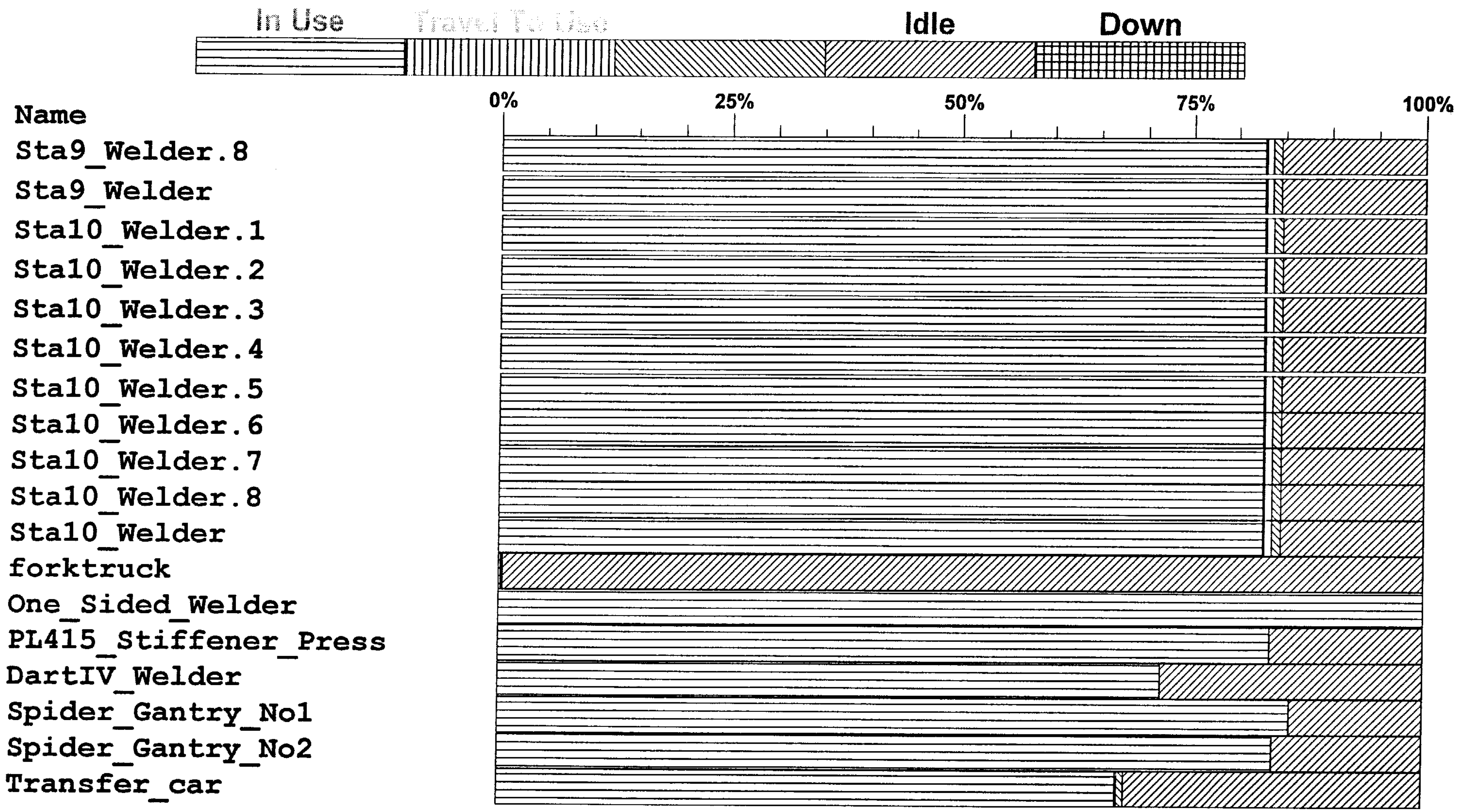
Resource States



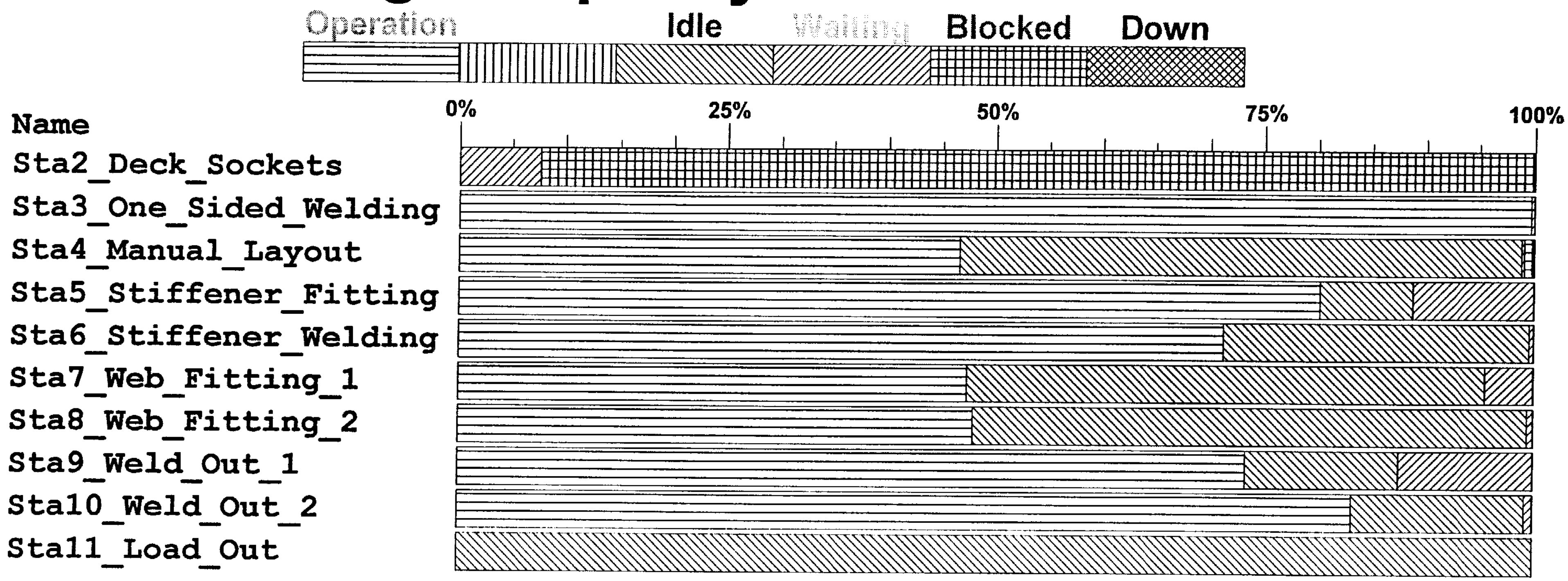
Resource States



Resource States



Single Capacity Location States



DETAILED PERFORMANCE STATISTICS FOR THE "MOST LIKELY OPERATING CONDITION" PANEL LINE MODEL

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\jeff.MOD
Date: May/19/1998   Time: 02:49:32 PM
NO DK SOCKETS

Scenario : Model Parameters
Replication : 1 of 1
Warmup Time : 96 hr
Simulation Time : 840 hr

DK SOCKET FITTERS = 2
DK SOCKET WELDERS = 4
STIFFENER FITTERS = 4
WEB FITTERS = 6
WEB WELDERS (STA9) = 8
WEB WELDERS (STA10) = 8
DK SOCKET FIT TIME = 0
DK SOCKET WELD TIME = 0
GANTRY CRANE WAIT = 0
#2 DECK SOCKET WELD TIME = 0
HOLD TIME = 40

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Sta1 Plate Fitting	744	5	214	508.660794	2.43847	5	4	48.77
Sta2 Deck Sockets	357	1	42	1.082000	0.00212157	1	0	0.21
Sta3 One Sided Welding	357	1	43	384.127744	0.771125	1	0	77.11
Sta4 Manual Layout	357	1	43	178.120023	0.357571	1	1	35.76
Sta5 Stiffener Fitting	357	1	43	323.386256	0.649188	1	0	64.92
Sta6 Stiffener Welding	357	1	44	268.326955	0.551185	1	1	55.12
Sta7 Web Fitting 1	357	1	43	186.317744	0.374027	1	0	37.40
Sta8 Web Fitting 2	357	1	43	184.684349	0.370748	1	1	37.07
Sta9 Weld Out 1	357	1	43	324.837465	0.652101	1	0	65.21
Sta10 Weld Out 2	357	1	44	316.075523	0.649268	1	1	64.93
Sta11 Load Out	357	1	43	0.000000	0	1	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Sta1 Plate Fitting	744	6.91	93.07	0.02	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down

Sta2 Deck Sockets	357	0.00	0.00	99.79	0.21	0.00	0.00
Sta3 One Sided Welding	357	76.97	0.00	22.89	0.15	0.00	0.00
Sta4 Manual Layout	357	35.58	0.00	64.24	0.18	0.00	0.00
Sta5 Stiffener Fitting	357	64.66	0.00	35.08	0.26	0.00	0.00
Sta6 Stiffener Welding	357	54.81	0.00	44.88	0.31	0.00	0.00
Sta7 Web Fitting 1	357	37.04	0.00	62.60	0.37	0.00	0.00
Sta8 Web Fitting 2	357	36.56	0.00	62.93	0.52	0.00	0.00
Sta9 Weld Out 1	357	64.72	0.00	34.79	0.49	0.00	0.00
Sta10 Weld Out 2	357	64.36	0.00	35.07	0.57	0.00	0.00
Sta11 Load Out	357	0.00	0.00	100.00	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
crane500	1	357	176	45.041239	0.039131	0.000000	0.00	37.04
Sta1 Plate Fitters.1	1	357	658	19.256596	0.101799	0.047545	0.00	59.47
Sta1 Plate Fitters.2	1	357	658	19.256596	0.101799	0.047545	0.00	59.47
Sta1 Plate Fitters	2	714	1316	19.256596	0.101799	0.047545	0.00	59.47
Sta2 Deck Socket Welders.1	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Welders.2	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Welders.3	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Welders.4	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Welders	4	1428	168	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Fitters.1	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Fitters.2	1	357	42	0.000000	0.541000	0.355031	0.00	0.11
Sta2 Deck Socket Fitters	2	714	84	0.000000	0.541000	0.355031	0.00	0.11
Sta3 OSW Operator.1	1	357.1717	60	274.593450	0.606000	0.443415	0.00	77.05
Sta3 OSW Operator.2	1	357.1717	60	274.593450	0.606000	0.443415	0.00	77.05
Sta3 OSW Operator	2	714.3434	120	274.593450	0.606000	0.443415	0.00	77.05
Sta4 Layout Person.1	1	357.0750833	47	162.059872	0.901000	0.613725	0.00	35.75
Sta4 Layout Person.2	1	357.0750833	47	162.059872	0.901000	0.613725	0.00	35.75
Sta4 Layout Person	2	714.1501667	94	162.059872	0.901000	0.613725	0.00	35.75
Sta5 Stiffener Fitter.1	1	357.3363167	60	230.504433	1.187000	0.868537	0.00	64.83
Sta5 Stiffener Fitter.2	1	357.3363167	60	230.504433	1.187000	0.868537	0.00	64.83
Sta5 Stiffener Fitter.3	1	357.3363167	60	230.504433	1.187000	0.868537	0.00	64.83
Sta5 Stiffener Fitter.4	1	357.3363167	60	230.504433	1.187000	0.868537	0.00	64.83
Sta5 Stiffener Fitter	4	1429.345267	240	230.504433	1.187000	0.868537	0.00	64.83
Sta6 DartIV Operator.1	1	357.2292	52	225.547269	1.528000	1.073730	0.00	55.08
Sta6 DartIV Operator.2	1	357.2292	52	225.547269	1.528000	1.073730	0.00	55.08
Sta6 DartIV Operator	2	714.4584	104	225.547269	1.528000	1.073730	0.00	55.08

Sta7 Web Fitter.1	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter.2	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter.3	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter.4	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter.5	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter.6	1	357.5689	103	152.741427	1.693786	1.570579	0.00	74.14
Sta7 Web Fitter	6	2145.4134	618	152.741427	1.693786	1.570579	0.00	74.14
Sta9 Welder.1	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.2	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.3	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.4	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.5	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.6	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.7	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder.8	1	357.7023833	60	230.362500	2.479000	1.813902	0.00	65.08
Sta9 Welder	8	2861.619067	480	230.362500	2.479000	1.813902	0.00	65.08
Sta10 Welder.1	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.2	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.3	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.4	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.5	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.6	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.7	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder.8	1	357.5204833	54	254.756593	2.839000	2.017184	0.00	64.83
Sta10 Welder	8	2860.163867	432	254.756593	2.839000	2.017184	0.00	64.83
forktruck	1	357	84	0.475000	0.475000	0.000000	0.00	0.37
One Sided Welder	1	357	60	275.189350	0.103932	0.076561	0.00	77.11
PL415 Stiffener Press	1	357	60	231.605150	0.067627	0.049817	0.00	64.89
DartIV Welder	1	357	52	226.970635	0.076725	0.052878	0.00	55.12
Spider Gantry No1	1	357	60	232.732283	0.069051	0.050866	0.00	65.21
Spider Gantry No2	1	357	54	257.468963	0.075453	0.052618	0.00	64.93
Transfer car	1	357	429	9.125734	0.000000	0.995209	0.00	18.28

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
crane500	357	37.01	0.03	0.00	62.96	0.00
Sta1 Plate Fitters.1	357	59.15	0.31	0.10	40.43	0.00
Sta1 Plate Fitters.2	357	59.15	0.31	0.10	40.43	0.00
Sta1 Plate Fitters	714	59.15	0.31	0.10	40.43	0.00
Sta2 Deck Socket Welders.1	357	0.00	0.11	0.11	99.79	0.00

Sta2 Deck Socket Welders.2	357	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Welders.3	357	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Welders.4	357	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Welders	1428	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Fitters.1	357	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Fitters.2	357	0.00	0.11	0.11	99.79	0.00
Sta2 Deck Socket Fitters	714	0.00	0.11	0.11	99.79	0.00
Sta3 OSW Operator.1	357.1717	76.88	0.17	0.17	22.78	0.00
Sta3 OSW Operator.2	357.1717	76.88	0.17	0.17	22.78	0.00
Sta3 OSW Operator	714.3434	76.88	0.17	0.17	22.78	0.00
Sta4 Layout Person.1	357.0750833	35.55	0.20	0.20	64.05	0.00
Sta4 Layout Person.2	357.0750833	35.55	0.20	0.20	64.05	0.00
Sta4 Layout Person	714.1501667	35.55	0.20	0.20	64.05	0.00
Sta5 Stiffener Fitter.1	357.3363167	64.51	0.33	0.33	34.83	0.00
Sta5 Stiffener Fitter.2	357.3363167	64.51	0.33	0.33	34.83	0.00
Sta5 Stiffener Fitter.3	357.3363167	64.51	0.33	0.33	34.83	0.00
Sta5 Stiffener Fitter.4	357.3363167	64.51	0.33	0.33	34.83	0.00
Sta5 Stiffener Fitter	1429.345267	64.51	0.33	0.33	34.83	0.00
Sta6 DartIV Operator.1	357.2292	54.72	0.36	0.37	44.55	0.00
Sta6 DartIV Operator.2	357.2292	54.72	0.36	0.37	44.55	0.00
Sta6 DartIV Operator	714.4584	54.72	0.36	0.37	44.55	0.00
Sta7 Web Fitter.1	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter.2	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter.3	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter.4	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter.5	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter.6	357.5689	73.33	0.81	0.78	25.07	0.00
Sta7 Web Fitter	2145.4134	73.33	0.81	0.78	25.07	0.00
Sta9 Welder.1	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.2	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.3	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.4	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.5	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.6	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.7	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder.8	357.7023833	64.40	0.68	0.69	34.22	0.00
Sta9 Welder	2861.619067	64.40	0.68	0.69	34.22	0.00
Sta10 Welder.1	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.2	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.3	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.4	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.5	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.6	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.7	357.5204833	64.13	0.70	0.71	34.45	0.00
Sta10 Welder.8	357.5204833	64.13	0.70	0.71	34.45	0.00

Sta10 Welder	2860.163867	64.13	0.70	0.71	34.45	0.00
forktruck	357	0.19	0.19	0.00	99.63	0.00
One Sided Welder	357	77.08	0.03	0.03	22.86	0.00
PL415 Stiffener Press	357	64.88	0.02	0.02	35.09	0.00
DartIV Welder	357	55.10	0.02	0.02	44.86	0.00
Spider Gantry No1	357	65.19	0.02	0.02	34.77	0.00
Spider Gantry No2	357	64.91	0.02	0.02	35.05	0.00
Transfer car	357	18.28	0.00	1.09	80.63	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
profile	profile staging original	0
plate cut	plate transfer car1	0
deck sockets	deck socket staging original	0
web	Web Staging	0

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
profile	42	51	14508.915310	1.359429	0.000000	0.000000	14507.555881
plate cut	215	25	4864.955726	21.758651	527.291377	4315.905698	0.000000
Ent panel line	43	4	4231.986930	0.000000	15.281233	4216.705698	0.000000
deck sockets	42	1	984.553190	0.992000	0.000000	0.000000	983.561190
web	43	1	536.975860	0.041000	536.934860	0.000000	0.000000

ENTITY STATES BY PERCENTAGE

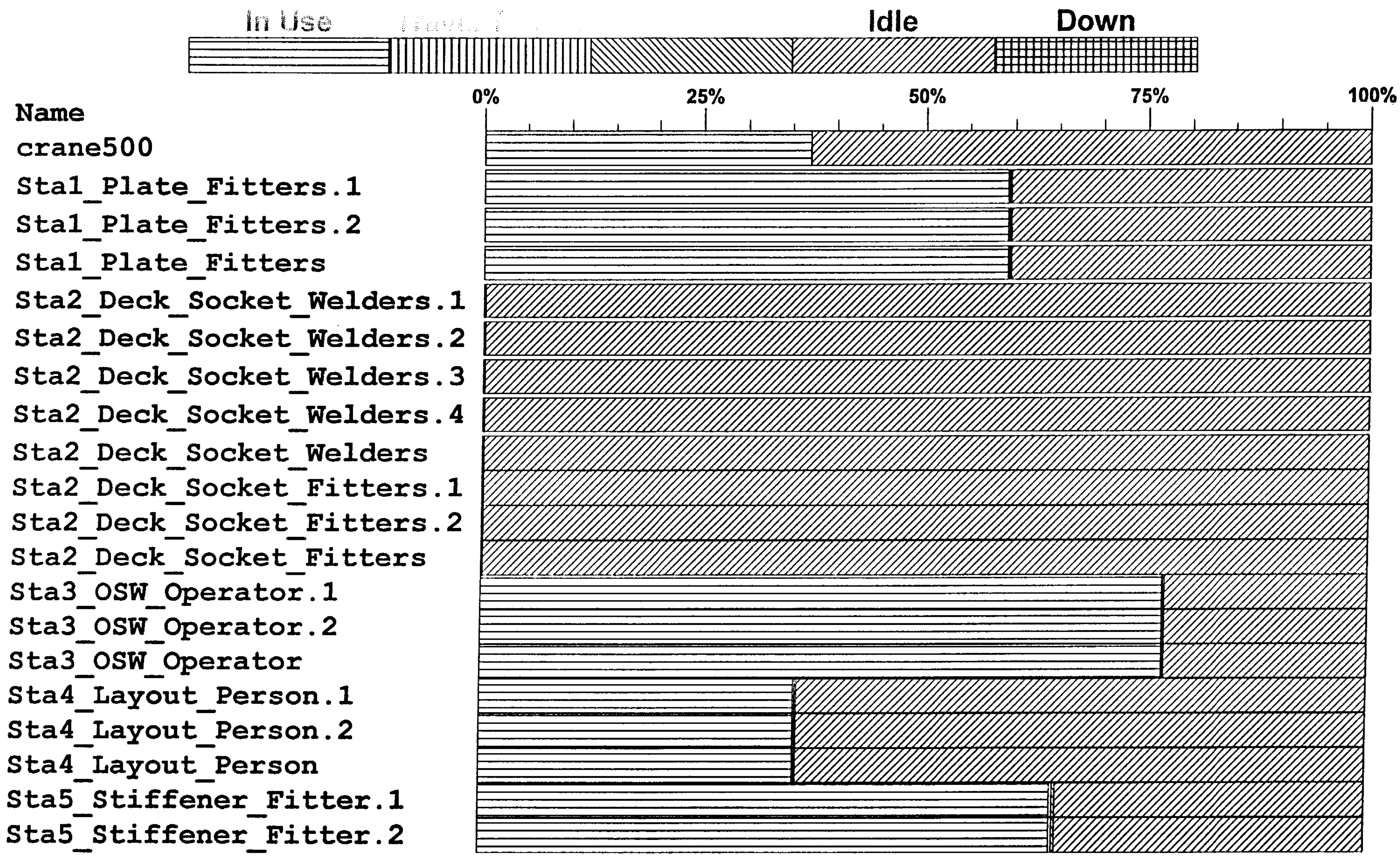
Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
profile	0.01	0.00	0.00	99.99
plate cut	0.45	10.84	88.71	0.00
Ent panel line	0.00	0.36	99.64	0.00
deck sockets	0.10	0.00	0.00	99.90

web	0.01	99.99	0.00	0.00

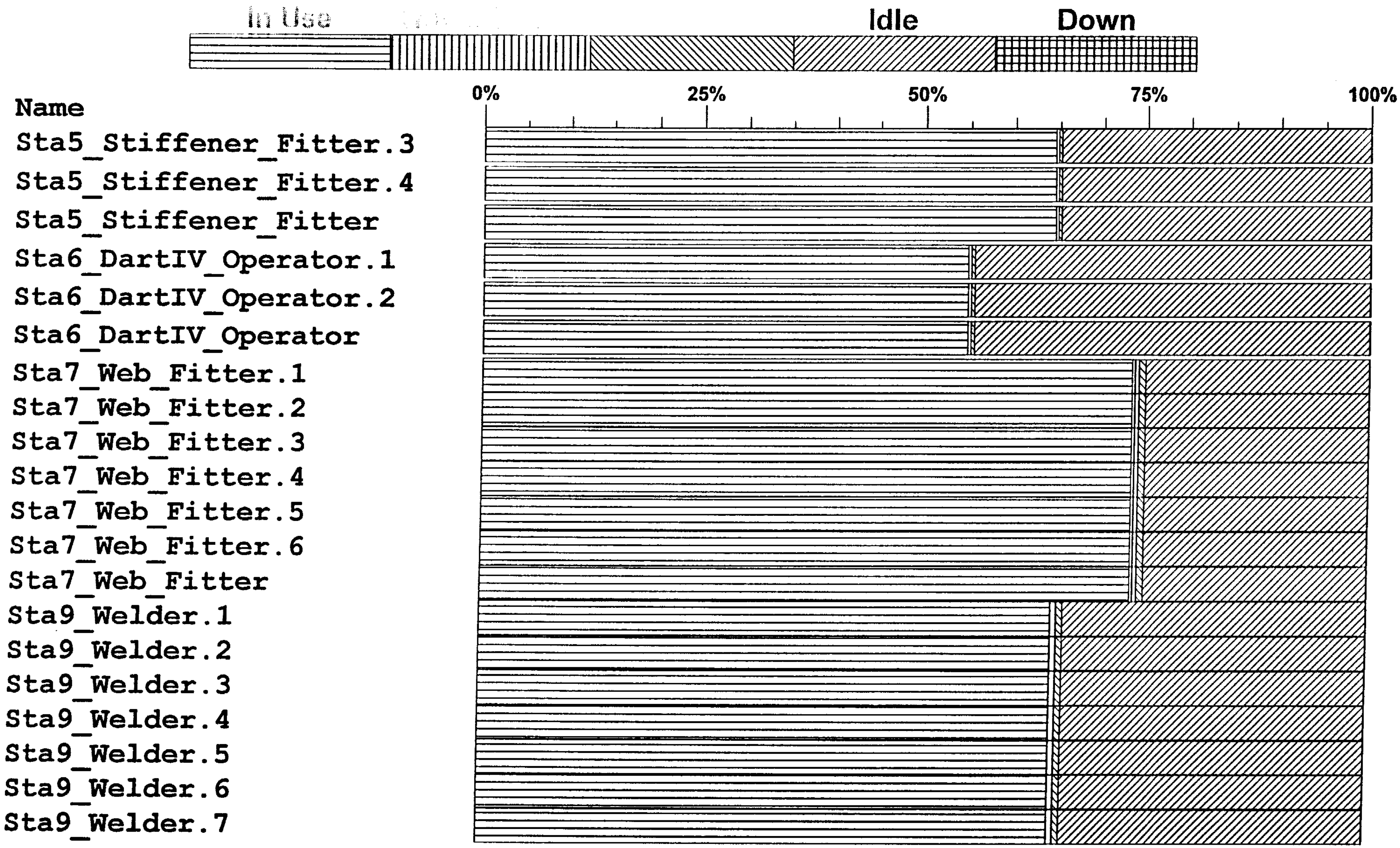
VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v NoofPanels completed	43	964.975256	3	46	46	24.8457
v total time	43	964.975256	23.5969	49.327	23.6019	29.7832
v cycle time	43	964.975256	7.9955	13.966	7.9955	9.00432
v nof stiffners	42	985.231333	112	784	784	449.359
v nof webs	43	964.602395	30	288	288	161.32
v total footage	129	323.052473	15700	179100	179100	98267.4
v nof plates	213	195.774742	41	254	254	148.177
v nof panels per shift	43	964.975256	0.57282	1.00056	1.00056	0.903372
v PanelWIP	85	488.163953	4	5	4	4.30203

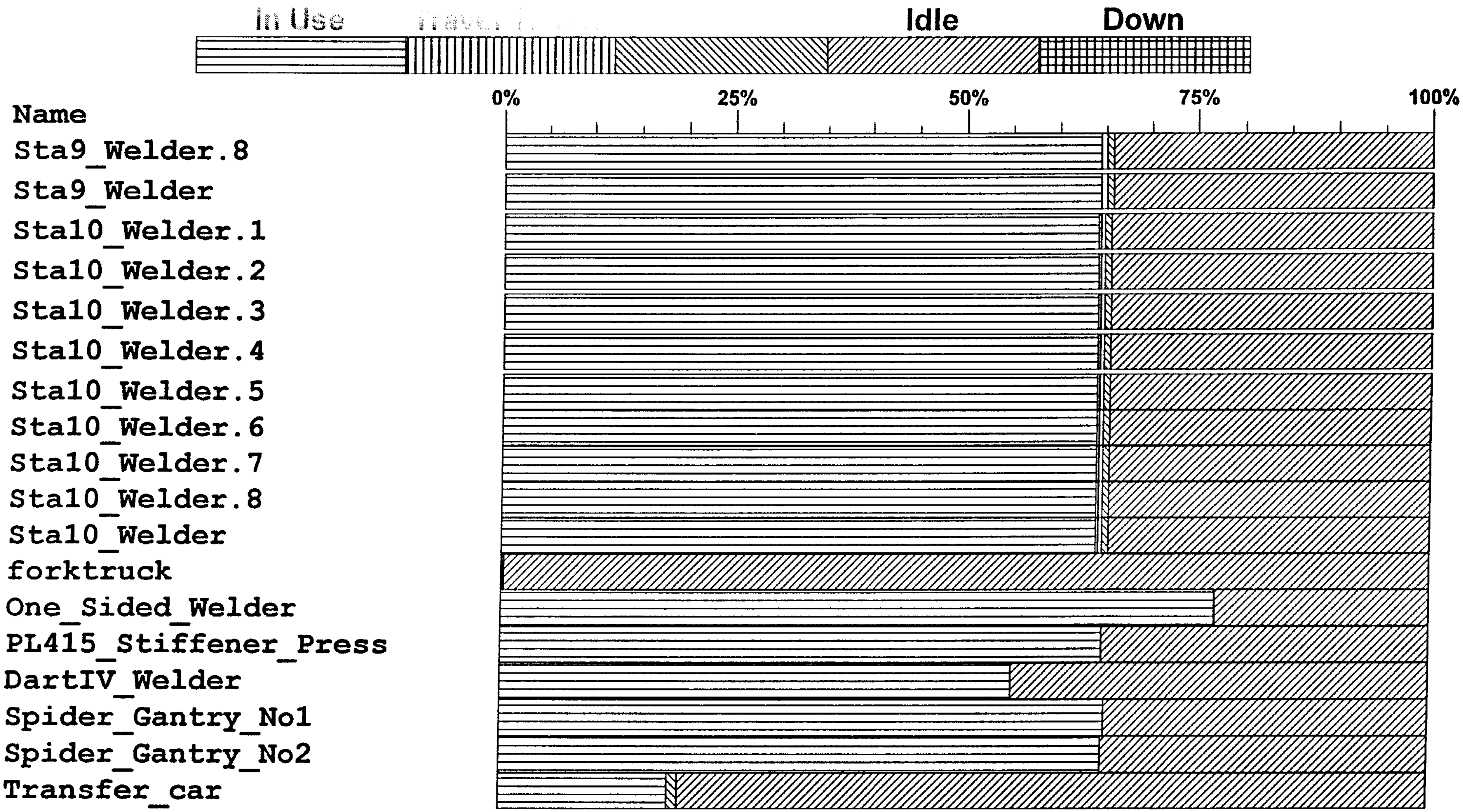
Resource States



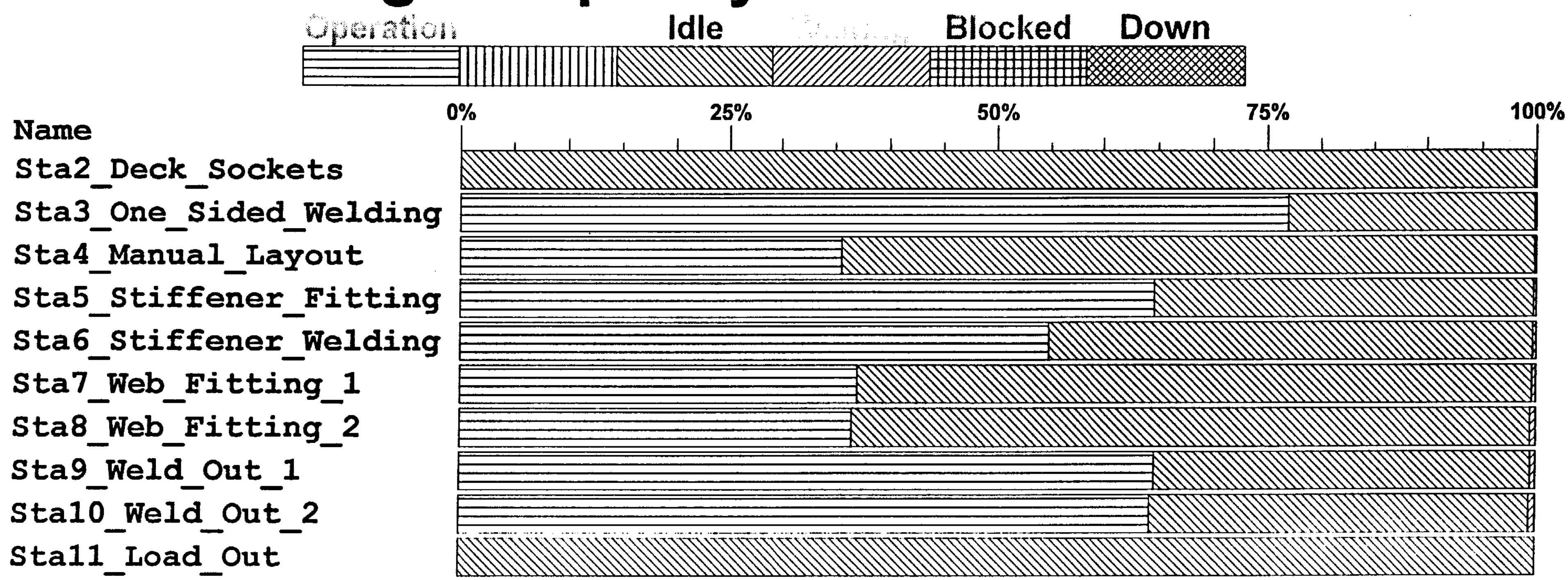
Resource States



Resource States



Single Capacity Location States



PROFILE LAYOUT = 20
PROFILE BURN = 20
T BEAM FIT = 9
FLATBAR LAYOUT = 9
FLATBAR BURN = 9
TBEAM WELD = 9
TBEAM PAINT = 9
PCBLOCK ARRIVALS = 2 PER 8HR
FB CBLOCK ARRIVALS = 6 PER 8HR
T CBLOCK ARRIVALS = 4 PER 8HR

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\ProfNew.MOD
Date: May/11/1998   Time: 10:57:33 AM

Scenario : Model Parameters
Replication : 1 of 1
Simulation Time : 840 hr

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Roller Table Position 1	425	1	85	292.684212	0.975614	1	1	97.56
Roller Table Position 2	425	1	85	293.119247	0.977064	1	1	97.71
Roller Table Position 3	473	1	86	323.315930	0.979745	1	1	97.97
Roller Table Position 4	425	1	86	289.961942	0.977911	1	1	97.79
Roller Table Position 5	487	1	88	287.628136	0.866231	1	1	86.62
Roller Table Position 6	446	1	88	297.268250	0.977564	1	1	97.76
Roller Table Position 7	439	1	88	292.483943	0.977167	1	1	97.72
Roller Table Position 8	432	1	88	288.009489	0.97781	1	1	97.78
Roller Table Position 9	549	1	85	341.252059	0.880584	1	1	88.06
Roller Table Position 10	425	1	88	282.552716	0.975084	1	1	97.51
Roller Table Position 11	439	1	90	280.829633	0.959555	1	1	95.96
Roller Table Position 12	480	1	85	291.731906	0.861014	1	1	86.10
Roller Table Position 13	487	1	87	328.147552	0.977031	1	1	97.70
Roller Table Position 14	432	1	87	283.909816	0.952938	1	1	95.29
Roller Table Position 15	425	1	87	284.325931	0.970053	1	1	97.01
Roller Table Position 16	446	1	87	299.681103	0.9743	1	1	97.43
Roller Table Position 17	439.0125333	1	88	287.473057	0.960399	1	1	96.04
Roller Table Position 18	446	1	88	291.091705	0.957252	1	1	95.73
Roller Table Position 19	480	1	87	322.930287	0.975519	1	1	97.55
Roller Table Position 20	508	1	88	334.337102	0.965278	1	1	96.53
Table10 Position 1	432.0009667	1	113	217.668088	0.948937	1	1	94.89
Table10 Position 2	425.02505	1	112	216.185625	0.949465	1	1	94.95
Table10 Position 3	549	1	112	283.029429	0.962334	1	1	96.23
Table10 Position 4	494	1	110	257.488073	0.95559	1	1	95.56
Table10 Position 5	494	1	111	255.859018	0.958176	1	1	95.82
Table10 Position 6	425.0114167	1	112	215.729473	0.947492	1	1	94.75
Table10 Position 7	425	1	109	222.703394	0.951948	1	1	95.19
Table10 Position 8	432	1	110	223.737327	0.949503	1	1	94.95

Table10 Position 9	494	1	110	255.556391	0.948421	1	1	94.84
Flatbar Area Position 1	439	1	271	88.299727	0.908475	1	1	90.85
Flatbar Area Position 2	501	1	268	100.185377	0.893203	1	1	89.32
Flatbar Area Position 3	432.0112667	1	256	93.076184	0.919247	1	1	91.92
Flatbar Area Position 4	487	1	269	87.017978	0.80109	1	1	80.11
Flatbar Area Position 5	487.00245	1	273	97.291623	0.908983	1	1	90.90
Flatbar Area Position 6	446.03395	1	263	91.559027	0.899783	1	1	89.98
Flatbar Area Position 7	487.0286167	1	272	87.332478	0.812903	1	1	81.29
Flatbar Area Position 8	487.0070167	1	283	83.082799	0.804658	1	1	80.47
Flatbar Area Position 9	487	1	271	86.053878	0.798104	1	1	79.81
Profile Skip Tub	826	25	981	595.090481	11.7793	25	6	47.12
Table10 Skip Tub	812	25	1056	555.414526	12.0385	25	6	48.15
Flatbar Skip Tub	833	25	912	730.586225	13.3312	25	12	53.32
ProfileIn	833	999999	1600	10256.962574	328.354	624	616	0.03
PTABLETBEAMIN	425	999999	0	0.000000	0	0	0	0.00
ProfileStorage	425	999999	100	40.846220	0.160181	2	0	0.00
ProfileStorage2	425	999999	61	0.000000	0	1	0	0.00
ProfileOut	826	999999	4074	381.154031	31.3322	129	12	0.00
FlatbarOut	833	999999	3083	625.171366	38.5635	153	5	0.00
RTBeamOut	812	999999	1057	2124.169778	46.0847	87	58	0.00
TBeamOut	819	999999	990	208.890841	4.20842	18	8	0.00
FlatbarIn	833	999999	3728	7336.556470	547.233	1350	1302	0.05
FlatbarStorage	425	999999	300	12.343843	0.145222	6	0	0.00
FlatbarStorage2	425	999999	55	0.000000	0	1	0	0.00
TBeamIn	833	999999	1200	9660.393908	231.942	456	443	0.02
TBeamStorage	425	999999	200	32.450720	0.254515	4	0	0.00
TBeamStorage2	425	999999	120	0.000000	0	1	0	0.00
FrameBender	425	999999	0	0.000000	0	0	0	0.00
Bulldozer	425	1	0	0.000000	0	0	0	0.00
Bulldozer2	425	1	0	0.000000	0	0	0	0.00
OutgoingPileForProfile	425	999999	0	0.000000	0	0	0	0.00
ScrapBinOut1	425	25	39	1.600000	0.00244706	1	0	0.01
ScrapBinOut3	425	25	42	2.241000	0.00369106	1	0	0.01
ScrapBinOut2	425	25	36	2.827889	0.00399231	1	0	0.02
ScrapOut	425	999999	117	0.000000	0	1	0	0.00
Table	425	1	0	0.000000	0	0	0	0.00
Table2	425	1	0	0.000000	0	0	0	0.00
ShearStaging	826	999999	60	794.060467	0.961332	2	1	0.00
Shear	425.0441833	1	1481	13.546968	0.786705	1	1	78.67
IronWorkerStaging	729	999999	67	1561.894328	2.39248	9	2	0.00
IronWorker	425	1	1043	19.980662	0.817248	1	1	81.72
BevelStation	425	1	800	5.000000	0.156863	1	0	15.69
DeburrStation	425	1	8412	1.999791	0.659696	1	1	65.97
Bldg2OutStaging	708	999999	8411	57.567139	11.3982	31	11	0.00
GeneralStorage	771.0353	999999	336	328.075536	2.3828	5	1	0.00

FlatbarToShear	826	999999	1505	461.136130	14.0034	27	5	0.00
FlatbarToBevel	508	999999	32	282.594031	0.296687	2	0	0.00
FlatbarToDeburr	639	999999	306	111.252552	0.887931	2	2	0.00
BevelToDeburr	432	999999	32	73.285031	0.0904753	1	0	0.00
IronWorkerOut	833	999999	3455	165.551464	11.4442	34	5	0.00
ShearOut	833	999999	5001	128.460796	12.8538	32	1	0.00
BevelOut	501	999999	800	114.290063	3.04165	25	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Profile Skip Tub	826	3.49	96.14	0.37	0.00
Table10 Skip Tub	812	2.11	97.52	0.37	0.00
Flatbar Skip Tub	833	2.40	97.04	0.56	0.00
ProfileIn	833	0.20	99.80	0.00	0.00
PTABLETBEAMIN	425	100.00	0.00	0.00	0.00
ProfileStorage	425	91.74	8.26	0.00	0.00
ProfileStorage2	425	100.00	0.00	0.00	0.00
ProfileOut	826	2.56	97.44	0.00	0.00
FlatbarOut	833	0.91	99.09	0.00	0.00
RTBeamOut	812	3.79	96.21	0.00	0.00
TBeamOut	819	9.21	90.79	0.00	0.00
FlatbarIn	833	0.13	99.87	0.00	0.00
FlatbarStorage	425	95.39	4.61	0.00	0.00
FlatbarStorage2	425	100.00	0.00	0.00	0.00
TBeamIn	833	0.59	99.41	0.00	0.00
TBeamStorage	425	92.79	7.21	0.00	0.00
TBeamStorage2	425	100.00	0.00	0.00	0.00
FrameBender	425	100.00	0.00	0.00	0.00
OutgoingPileForProfile	425	100.00	0.00	0.00	0.00
ScrapBinOut1	425	99.76	0.24	0.00	0.00
ScrapBinOut3	425	99.63	0.37	0.00	0.00
ScrapBinOut2	425	99.60	0.40	0.00	0.00
ScrapOut	425	100.00	0.00	0.00	0.00
ShearStaging	826	10.98	89.02	0.00	0.00
IronWorkerStaging	729	11.22	88.78	0.00	0.00
Bldg2OutStaging	708	20.66	79.34	0.00	0.00
GeneralStorage	771.0353	11.36	88.64	0.00	0.00
FlatbarToShear	826	1.14	98.86	0.00	0.00
FlatbarToBevel	508	71.00	29.00	0.00	0.00
FlatbarToDeburr	639	27.11	72.89	0.00	0.00

BevelToDeburr	432	90.95	9.05	0.00	|	0.00
IronWorkerOut	833	1.48	98.52	0.00	|	0.00
ShearOut	833	2.43	97.57	0.00	|	0.00
BevelOut	501	71.86	28.14	0.00	|	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down
Roller Table Position 1	425	92.64	0.00	2.44	4.92	0.00	0.00
Roller Table Position 2	425	93.07	0.00	2.29	4.38	0.25	0.00
Roller Table Position 3	473	83.35	0.00	2.03	14.14	0.49	0.00
Roller Table Position 4	425	92.72	0.00	2.21	4.69	0.38	0.00
Roller Table Position 5	487	81.20	0.00	13.38	5.38	0.04	0.00
Roller Table Position 6	446	88.39	0.00	2.24	9.27	0.10	0.00
Roller Table Position 7	439	90.07	0.00	2.28	7.61	0.03	0.00
Roller Table Position 8	432	91.60	0.00	2.22	6.08	0.10	0.00
Roller Table Position 9	549	71.70	0.00	11.94	16.21	0.15	0.00
Roller Table Position 10	425	92.92	0.00	2.49	4.48	0.10	0.00
Roller Table Position 11	439	89.41	0.00	4.04	6.54	0.00	0.00
Roller Table Position 12	480	81.79	0.00	13.90	4.27	0.03	0.00
Roller Table Position 13	487	80.78	0.00	2.30	16.75	0.17	0.00
Roller Table Position 14	432	90.50	0.00	4.71	4.77	0.02	0.00
Roller Table Position 15	425	92.04	0.00	2.99	4.92	0.04	0.00
Roller Table Position 16	446	87.73	0.00	2.57	9.66	0.05	0.00
Roller Table Position 17	439.0125333	89.18	0.00	3.96	6.79	0.07	0.00
Roller Table Position 18	446	87.78	0.00	4.27	7.80	0.14	0.00
Roller Table Position 19	480	81.69	0.00	2.45	15.82	0.04	0.00
Roller Table Position 20	508	76.79	0.00	3.47	19.34	0.40	0.00
Table10 Position 1	432.0009667	89.43	0.00	5.11	5.46	0.00	0.00
Table10 Position 2	425.02505	89.81	0.00	5.05	5.14	0.00	0.00
Table10 Position 3	549	69.41	0.00	3.77	26.82	0.00	0.00
Table10 Position 4	494	76.20	0.00	4.44	19.36	0.00	0.00
Table10 Position 5	494	76.23	0.00	4.18	19.59	0.00	0.00
Table10 Position 6	425.0114167	89.76	0.00	5.25	4.99	0.00	0.00
Table10 Position 7	425	87.84	0.00	4.81	7.36	0.00	0.00
Table10 Position 8	432	86.64	0.00	5.05	8.31	0.00	0.00
Table10 Position 9	494	75.83	0.00	5.16	19.01	0.00	0.00
Flatbar Area Position 1	439	79.01	0.00	9.15	11.79	0.05	0.00
Flatbar Area Position 2	501	69.52	0.00	10.68	19.64	0.16	0.00
Flatbar Area Position 3	432.0112667	78.73	0.00	8.08	13.10	0.09	0.00
Flatbar Area Position 4	487	71.73	0.00	19.89	8.32	0.06	0.00
Flatbar Area Position 5	487.00245	71.19	0.00	9.10	19.54	0.17	0.00

Flatbar Area Position 6	446.03395	77.14	0.00	10.02	12.78	0.07	0.00
Flatbar Area Position 7	487.0286167	71.77	0.00	18.71	9.29	0.23	0.00
Flatbar Area Position 8	487.0070167	72.57	0.00	19.53	7.77	0.13	0.00
Flatbar Area Position 9	487	71.75	0.00	20.19	7.86	0.20	0.00
Bulldozer	425	0.00	0.00	100.00	0.00	0.00	0.00
Bulldozer2	425	0.00	0.00	100.00	0.00	0.00	0.00
Table	425	0.00	0.00	100.00	0.00	0.00	0.00
Table2	425	0.00	0.00	100.00	0.00	0.00	0.00
Shear	425.0441833	78.67	0.00	21.33	0.00	0.00	0.00
IronWorker	425	81.72	0.00	18.28	0.00	0.00	0.00
BevelStation	425	15.69	0.00	84.31	0.00	0.00	0.00
DeburrStation	425	65.97	0.00	34.03	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
PLayoutCrew.1	1	427.0234667	249	75.442936	5.044328	4.585753	0.00	78.24
PLayoutCrew.2	1	426.5666833	236	74.957627	4.579504	4.125050	0.00	73.34
PLayoutCrew.3	1	426.6214833	224	73.480607	4.646581	4.219096	0.00	68.42
PLayoutCrew.4	1	426.1467	197	78.140650	4.391106	3.898830	0.00	63.61
PLayoutCrew.5	1	425.7150167	174	78.612736	4.535582	4.013990	0.00	56.69
PLayoutCrew.6	1	425.6770167	172	72.151163	4.713285	4.094369	0.00	51.76
PLayoutCrew.7	1	425.7144833	144	76.388889	4.380708	3.710718	0.00	45.53
PLayoutCrew.8	1	425.9600333	127	78.031496	4.662921	3.870529	0.00	41.09
PLayoutCrew.9	1	425.6414333	95	76.842105	4.615726	3.623917	0.00	30.30
PLayoutCrew.10	1	425.5292	84	76.428571	4.665429	3.562691	0.00	26.68
PLayoutCrew.11	1	425.7638167	69	75.942029	4.655000	3.381000	0.00	21.77
PLayoutCrew.12	1	425.1811	43	78.139535	4.249795	2.710014	0.00	13.90
PLayoutCrew.13	1	425.02805	25	84.000000	3.894040	1.908843	0.00	8.62
PLayoutCrew.14	1	425.1002	14	89.285714	4.125357	1.443875	0.00	5.13
PLayoutCrew.15	1	425	8	106.250000	3.654500	0.859882	0.00	3.45
PLayoutCrew.16	1	425	5	64.000000	3.795600	0.612194	0.00	1.33
PLayoutCrew.17	1	425	2	85.000000	7.134500	0.509607	0.00	0.72
PLayoutCrew.18	1	425	1	50.000000	7.149000	0.264778	0.00	0.22
PLayoutCrew.19	1	425	1	50.000000	7.015000	0.259815	0.00	0.22
PLayoutCrew.20	1	425	1	50.000000	6.932000	0.256741	0.00	0.22
PLayoutCrew	20	8511.668683	1871	76.155677	4.616923	3.630203	0.00	29.60
PBurnCrew.1	1	426.2077333	144	156.724653	3.144306	2.777791	0.00	90.02
PBurnCrew.2	1	426.2304333	145	153.779883	3.023738	2.657224	0.00	88.91
PBurnCrew.3	1	426.2649833	142	152.745810	2.879761	2.539913	0.00	86.40

PBurnCrew.4	1	426.28975	135	156.056919	2.860125	2.542333	0.00	83.89
PBurnCrew.5	1	425.8279167	132	157.965061	2.352371	2.056377	0.00	82.83
PBurnCrew.6	1	425.8510833	128	158.203125	2.690062	2.496532	0.00	80.61
PBurnCrew.7	1	425.9002833	125	162.240000	2.763544	2.382366	0.00	80.71
PBurnCrew.8	1	426.13515	117	163.303470	2.973855	2.503173	0.00	76.09
PBurnCrew.9	1	425.9827833	116	160.516905	2.738621	2.318832	0.00	74.09
PBurnCrew.10	1	426.1393	121	150.307793	3.157793	2.709879	0.00	72.63
PBurnCrew.11	1	425.8141833	107	162.651019	2.832879	2.349752	0.00	69.31
PBurnCrew.12	1	425.68545	104	166.439471	3.134663	2.608040	0.00	69.05
PBurnCrew.13	1	425.8121	99	171.998545	2.779404	2.274058	0.00	67.73
PBurnCrew.14	1	425.6405667	96	169.669865	2.621320	2.154814	0.00	64.78
PBurnCrew.15	1	426.0361333	95	156.509768	3.550800	2.858695	0.00	59.49
PBurnCrew.16	1	425.66645	82	159.301305	2.786037	2.196683	0.00	52.04
PBurnCrew.17	1	425.8013833	68	162.162294	2.720103	2.010511	0.00	43.89
PBurnCrew.18	1	425.5161333	49	165.306122	2.783735	1.868534	0.00	32.26
PBurnCrew.19	1	425.2622833	33	166.363636	2.428848	1.406175	0.00	21.83
PBurnCrew.20	1	425.0093333	15	118.000000	2.315000	0.846951	0.00	7.08
PBurnCrew	20	8517.073433	2053	159.409069	2.869841	2.386890	0.00	65.20
TFittingCrew.1	1	425.61145	270	57.299148	2.812070	2.574564	0.00	63.57
TFittingCrew.2	1	425.66405	233	58.197425	3.015801	2.747988	0.00	55.88
TFittingCrew.3	1	425.4810667	218	57.247706	2.744384	2.463197	0.00	51.24
TFittingCrew.4	1	425.3424	164	57.073171	2.587250	2.233205	0.00	38.34
TFittingCrew.5	1	425.2097	105	57.142857	2.781352	2.229328	0.00	24.66
TFittingCrew.6	1	425	27	60.000000	2.696370	1.373623	0.00	6.64
TFittingCrew.7	1	425	12	60.000000	2.817000	0.889579	0.00	2.96
TFittingCrew.8	1	425	9	60.000000	3.821222	0.982600	0.00	2.25
TFittingCrew.9	1	425	2	60.000000	4.372000	0.312286	0.00	0.50
TFittingCrew	9	3827.308667	1040	57.568048	2.814270	2.308408	0.00	27.35
TWeldingCrew.1	1	425.8309167	271	56.217033	2.975661	3.066175	0.00	62.78
TWeldingCrew.2	1	426.1512167	243	56.188691	3.331639	3.318041	0.00	56.58
TWeldingCrew.3	1	425.5822833	215	57.906028	3.350014	3.244857	0.00	51.59
TWeldingCrew.4	1	425.4785333	162	56.435833	2.985525	3.100353	0.00	37.71
TWeldingCrew.5	1	425.4119833	106	56.603774	3.976896	3.345643	0.00	25.16
TWeldingCrew.6	1	425.1368667	35	56.571429	2.801629	1.751018	0.00	8.15
TWeldingCrew.7	1	425.0724167	13	55.384615	3.685154	1.228385	0.00	3.01
TWeldingCrew.8	1	425	8	60.000000	4.698625	1.105559	0.00	2.03
TWeldingCrew.9	1	425	1	60.000000	2.533000	0.093815	0.00	0.25
TWeldingCrew	9	3828.664217	1054	56.661356	3.252101	2.937741	0.00	27.49
TPaintCrew.1	1	426.5644	234	24.183406	1.528645	3.610154	0.00	23.51
TPaintCrew.2	1	426.559	193	24.740933	1.386768	3.594192	0.00	19.71
TPaintCrew.3	1	426.3903167	152	24.176566	1.014645	3.208423	0.00	14.97
TPaintCrew.4	1	426.1704	143	24.475524	1.175007	2.700923	0.00	14.34
TPaintCrew.5	1	426.0269167	121	24.607810	1.004975	2.369808	0.00	12.12
TPaintCrew.6	1	425.8959667	126	24.206349	1.160548	2.067615	0.00	12.51
TPaintCrew.7	1	425.2910833	33	24.242424	1.119091	0.671731	0.00	3.28

TPaintCrew.8	1	425.0738	14	23.214286	1.002000	0.170308	0.00	1.33
TPaintCrew.9	1	425.0413167	1	25.000000	2.479000	0.095346	0.00	0.11
TPaintCrew	9	3833.0132	1017	24.371976	1.247796	2.054278	0.00	11.33
FLayoutCrew.1	1	425.38055	465	46.126875	1.046598	1.111114	0.00	85.95
FLayoutCrew.2	1	425.2070333	444	46.705523	1.039705	1.109685	0.00	83.09
FLayoutCrew.3	1	425.3541	418	47.516156	1.126830	1.163000	0.00	79.67
FLayoutCrew.4	1	425.3227833	370	48.859700	0.953027	0.968736	0.00	72.22
FLayoutCrew.5	1	425.2750333	320	50.765625	0.975794	1.010419	0.00	64.89
FLayoutCrew.6	1	425.2778167	251	51.812749	0.902976	0.899393	0.00	51.85
FLayoutCrew.7	1	425.1135	170	55.936471	0.747359	0.770006	0.00	37.78
FLayoutCrew.8	1	425.1241667	88	58.125000	0.855034	0.744980	0.00	20.35
FLayoutCrew.9	1	425	21	65.714286	0.967333	0.483667	0.00	5.49
FLayoutCrew	9	3827.054983	2547	49.226655	0.994669	1.016613	0.00	55.71
FBurnCrew.1	1	425.70935	292	60.909897	1.612483	1.623603	0.00	71.47
FBurnCrew.2	1	425.5169667	241	61.093685	1.631382	1.585335	0.00	59.21
FBurnCrew.3	1	425.3889	189	61.887926	1.526233	1.534351	0.00	46.96
FBurnCrew.4	1	425.3026333	135	65.333333	1.539640	1.424429	0.00	35.38
FBurnCrew.5	1	425.1278	83	70.361446	1.703145	1.385892	0.00	23.45
FBurnCrew.6	1	425.0955333	34	71.764706	1.695882	0.977288	0.00	9.79
FBurnCrew.7	1	425	9	82.222222	1.163333	0.317273	0.00	2.94
FBurnCrew.8	1	425	0	0.000000	0.000000	0.000000	0.00	0.00
FBurnCrew.9	1	425	0	0.000000	0.000000	0.000000	0.00	0.00
FBurnCrew	9	3827.141183	983	63.119111	1.596898	1.404243	0.00	27.70
Carrier	1	425	836	2.980105	0.617500	0.546431	0.00	11.79
Crane 600	1	425.1255167	9989	0.785194	0.283236	0.518838	0.00	41.84
Crane 590	1	425.19415	8952	1.649164	0.192049	0.382035	0.00	64.61
Truck	1	425	117	3.143641	1.143641	0.000000	0.00	1.97
Forktruck	1	425.2395667	766	3.178279	1.210995	0.877724	0.00	13.19
ShearCrane	1	425.06295	1481	2.309000	0.175000	0.442824	0.00	14.42

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
PLayoutCrew.1	427.0234667	73.32	4.92	4.92	16.84	0.00
PLayoutCrew.2	426.5666833	69.12	4.22	4.22	22.44	0.00
PLayoutCrew.3	426.6214833	64.30	4.12	4.12	27.46	0.00
PLayoutCrew.4	426.1467	60.21	3.40	3.40	32.99	0.00
PLayoutCrew.5	425.7150167	53.55	3.14	3.14	40.16	0.00
PLayoutCrew.6	425.6770167	48.59	3.17	3.17	45.06	0.00
PLayoutCrew.7	425.7144833	43.06	2.47	2.47	52.00	0.00
PLayoutCrew.8	425.9600333	38.78	2.32	2.32	56.59	0.00

PLayoutCrew.9	425.6414333	28.58	1.72	1.72	67.98	0.00
PLayoutCrew.10	425.5292	25.15	1.53	1.53	71.78	0.00
PLayoutCrew.11	425.7638167	20.51	1.26	1.26	76.97	0.00
PLayoutCrew.12	425.1811	13.17	0.73	0.73	85.36	0.00
PLayoutCrew.13	425.02805	8.23	0.38	0.38	91.00	0.00
PLayoutCrew.14	425.1002	4.90	0.23	0.23	94.65	0.00
PLayoutCrew.15	425	3.33	0.11	0.11	96.44	0.00
PLayoutCrew.16	425	1.25	0.07	0.07	98.60	0.00
PLayoutCrew.17	425	0.67	0.06	0.06	99.22	0.00
PLayoutCrew.18	425	0.20	0.03	0.03	99.75	0.00
PLayoutCrew.19	425	0.20	0.03	0.03	99.75	0.00
PLayoutCrew.20	425	0.20	0.03	0.03	99.75	0.00
PLayoutCrew	8511.668683	27.90	1.70	1.70	68.70	0.00
PBurnCrew.1	426.2077333	88.25	1.77	1.77	8.21	0.00
PBurnCrew.2	426.2304333	87.19	1.71	1.71	9.38	0.00
PBurnCrew.3	426.2649833	84.81	1.60	1.60	12.00	0.00
PBurnCrew.4	426.28975	82.37	1.52	1.52	14.59	0.00
PBurnCrew.5	425.8279167	81.61	1.22	1.22	15.96	0.00
PBurnCrew.6	425.8510833	79.25	1.36	1.36	18.03	0.00
PBurnCrew.7	425.9002833	79.36	1.35	1.35	17.94	0.00
PBurnCrew.8	426.13515	74.73	1.36	1.36	22.55	0.00
PBurnCrew.9	425.9827833	72.85	1.24	1.24	24.66	0.00
PBurnCrew.10	426.1393	71.13	1.49	1.49	25.88	0.00
PBurnCrew.11	425.8141833	68.12	1.19	1.19	29.51	0.00
PBurnCrew.12	425.68545	67.77	1.28	1.28	29.68	0.00
PBurnCrew.13	425.8121	66.65	1.08	1.08	31.20	0.00
PBurnCrew.14	425.6405667	63.78	1.00	1.00	34.23	0.00
PBurnCrew.15	426.0361333	58.17	1.32	1.32	39.19	0.00
PBurnCrew.16	425.66645	51.15	0.89	0.89	47.06	0.00
PBurnCrew.17	425.8013833	43.16	0.72	0.72	55.39	0.00
PBurnCrew.18	425.5161333	31.73	0.53	0.53	67.21	0.00
PBurnCrew.19	425.2622833	21.52	0.31	0.31	77.86	0.00
PBurnCrew.20	425.0093333	6.94	0.14	0.14	92.79	0.00
PBurnCrew	8517.073433	64.04	1.15	1.15	33.65	0.00
TFittingCrew.1	425.61145	60.58	2.98	2.98	33.45	0.00
TFittingCrew.2	425.66405	53.09	2.79	2.79	41.33	0.00
TFittingCrew.3	425.4810667	48.89	2.35	2.35	46.41	0.00
TFittingCrew.4	425.3424	36.68	1.66	1.66	60.00	0.00
TFittingCrew.5	425.2097	23.52	1.14	1.14	74.19	0.00
TFittingCrew.6	425	6.35	0.29	0.29	93.08	0.00
TFittingCrew.7	425	2.82	0.13	0.13	96.91	0.00
TFittingCrew.8	425	2.12	0.13	0.13	97.61	0.00
TFittingCrew.9	425	0.47	0.03	0.03	99.46	0.00
TFittingCrew	3827.308667	26.07	1.28	1.28	71.37	0.00
TWeldingCrew.1	425.8309167	59.63	3.16	3.16	34.06	0.00

TWeldingCrew.2	426.1512167	53.40	3.18	3.18	40.24	0.00
TWeldingCrew.3	425.5822833	48.76	2.83	2.83	45.58	0.00
TWeldingCrew.4	425.4785333	35.81	1.89	1.89	60.40	0.00
TWeldingCrew.5	425.4119833	23.51	1.65	1.65	73.19	0.00
TWeldingCrew.6	425.1368667	7.76	0.38	0.38	91.47	0.00
TWeldingCrew.7	425.0724167	2.82	0.19	0.19	96.80	0.00
TWeldingCrew.8	425	1.88	0.15	0.15	97.82	0.00
TWeldingCrew.9	425	0.24	0.01	0.01	99.74	0.00
TWeldingCrew	3828.664217	26.00	1.49	1.49	71.01	0.00
TPaintCrew.1	426.5644	22.11	1.40	0.37	76.13	0.00
TPaintCrew.2	426.559	18.66	1.05	0.37	79.93	0.00
TPaintCrew.3	426.3903167	14.36	0.60	0.33	84.71	0.00
TPaintCrew.4	426.1704	13.69	0.66	0.27	85.38	0.00
TPaintCrew.5	426.0269167	11.65	0.48	0.24	87.63	0.00
TPaintCrew.6	425.8959667	11.94	0.57	0.21	87.28	0.00
TPaintCrew.7	425.2910833	3.14	0.14	0.07	96.65	0.00
TPaintCrew.8	425.0738	1.27	0.06	0.02	98.65	0.00
TPaintCrew.9	425.0413167	0.10	0.01	0.01	99.88	0.00
TPaintCrew	3833.0132	10.78	0.55	0.21	88.46	0.00
FLayoutCrew.1	425.38055	84.04	1.91	1.91	12.15	0.00
FLayoutCrew.2	425.2070333	81.28	1.81	1.81	15.10	0.00
FLayoutCrew.3	425.3541	77.82	1.85	1.85	18.48	0.00
FLayoutCrew.4	425.3227833	70.84	1.38	1.38	26.40	0.00
FLayoutCrew.5	425.2750333	63.66	1.23	1.23	33.88	0.00
FLayoutCrew.6	425.2778167	50.97	0.89	0.89	47.26	0.00
FLayoutCrew.7	425.1135	37.28	0.50	0.50	61.72	0.00
FLayoutCrew.8	425.1241667	20.05	0.29	0.29	79.36	0.00
FLayoutCrew.9	425	5.41	0.08	0.08	94.43	0.00
FLayoutCrew	3827.054983	54.60	1.10	1.10	43.19	0.00
FBurnCrew.1	425.70935	69.63	1.84	1.84	26.68	0.00
FBurnCrew.2	425.5169667	57.67	1.54	1.54	39.25	0.00
FBurnCrew.3	425.3889	45.83	1.13	1.13	51.91	0.00
FBurnCrew.4	425.3026333	34.56	0.82	0.82	63.80	0.00
FBurnCrew.5	425.1278	22.90	0.55	0.55	76.00	0.00
FBurnCrew.6	425.0955333	9.57	0.23	0.23	89.98	0.00
FBurnCrew.7	425	2.90	0.04	0.04	97.02	0.00
FBurnCrew.8	425	0.00	0.00	0.00	100.00	0.00
FBurnCrew.9	425	0.00	0.00	0.00	100.00	0.00
FBurnCrew	3827.141183	27.02	0.68	0.68	71.61	0.00
Carrier	425	9.77	2.02	0.59	87.61	0.00
Crane 600	425.1255167	30.75	11.10	2.93	55.22	0.00
Crane 590	425.19415	57.87	6.74	1.72	33.67	0.00
Truck	425	1.44	0.52	0.00	98.03	0.00
Forktruck	425.2395667	9.54	3.65	2.52	84.29	0.00
ShearCrane	425.06295	13.41	1.02	2.61	82.96	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
CBlock	ProfileStorage	110
CBlock	FlatbarStorage	336
CBlock	TBeamStorage	224

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
Profile	4123	631	10476.720978	38.898463	387.967461	410.154065	9639.700989
Flatbar	4608	1346	7314.005296	73.407934	677.152189	220.302370	6343.142802
TBeam	1102	75	10352.120356	38.694982	197.916079	972.309606	9143.199689
RTBeam	0	459	-	-	-	-	-
Scrap	1092	6	524.091607	10.452898	513.638709	0.000000	0.000000
Scrap2	900	12	705.859780	13.911968	691.947812	0.000000	0.000000
Scrap3	1050	7	548.327615	10.810085	537.517530	0.000000	0.000000
CarrierBlock	0	0	-	-	-	-	-
nothing	0	0	-	-	-	-	-
CBlock	600	2	25.755150	25.755150	0.000000	0.000000	0.000000
ScrapBin	0	0	-	-	-	-	-
SFlatbar	17885	124	976.320200	65.126582	468.085436	24.032541	419.075641

ENTITY STATES BY PERCENTAGE

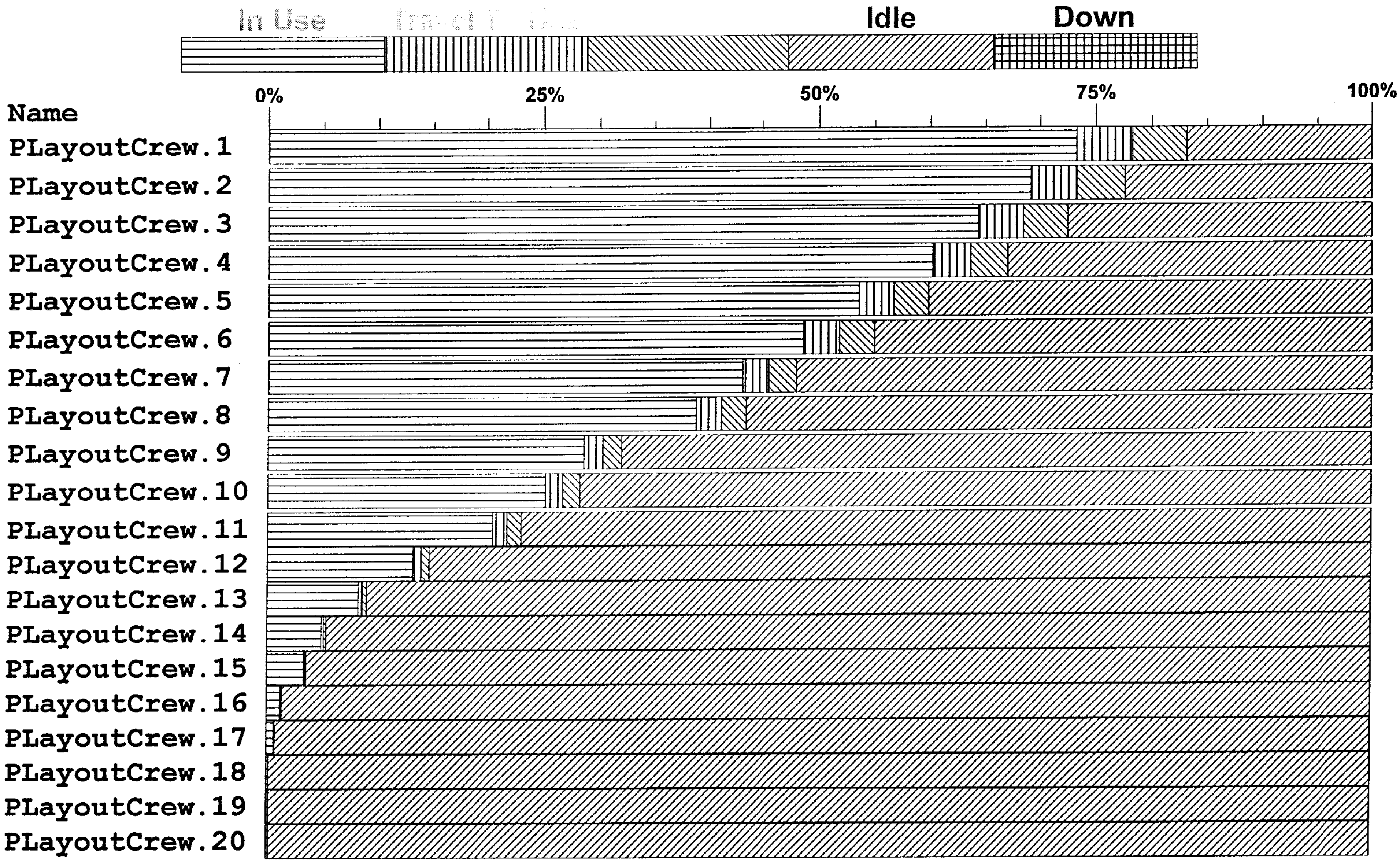
Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
Profile	0.37	3.70	3.91	92.01
Flatbar	1.00	9.26	3.01	86.73
TBeam	0.37	1.91	9.39	88.32
Scrap	1.99	98.01	0.00	0.00
Scrap2	1.97	98.03	0.00	0.00
Scrap3	1.97	98.03	0.00	0.00

CBlock	100.00	0.00	0.00	0.00
SFlatbar	6.67	47.94	2.46	42.92

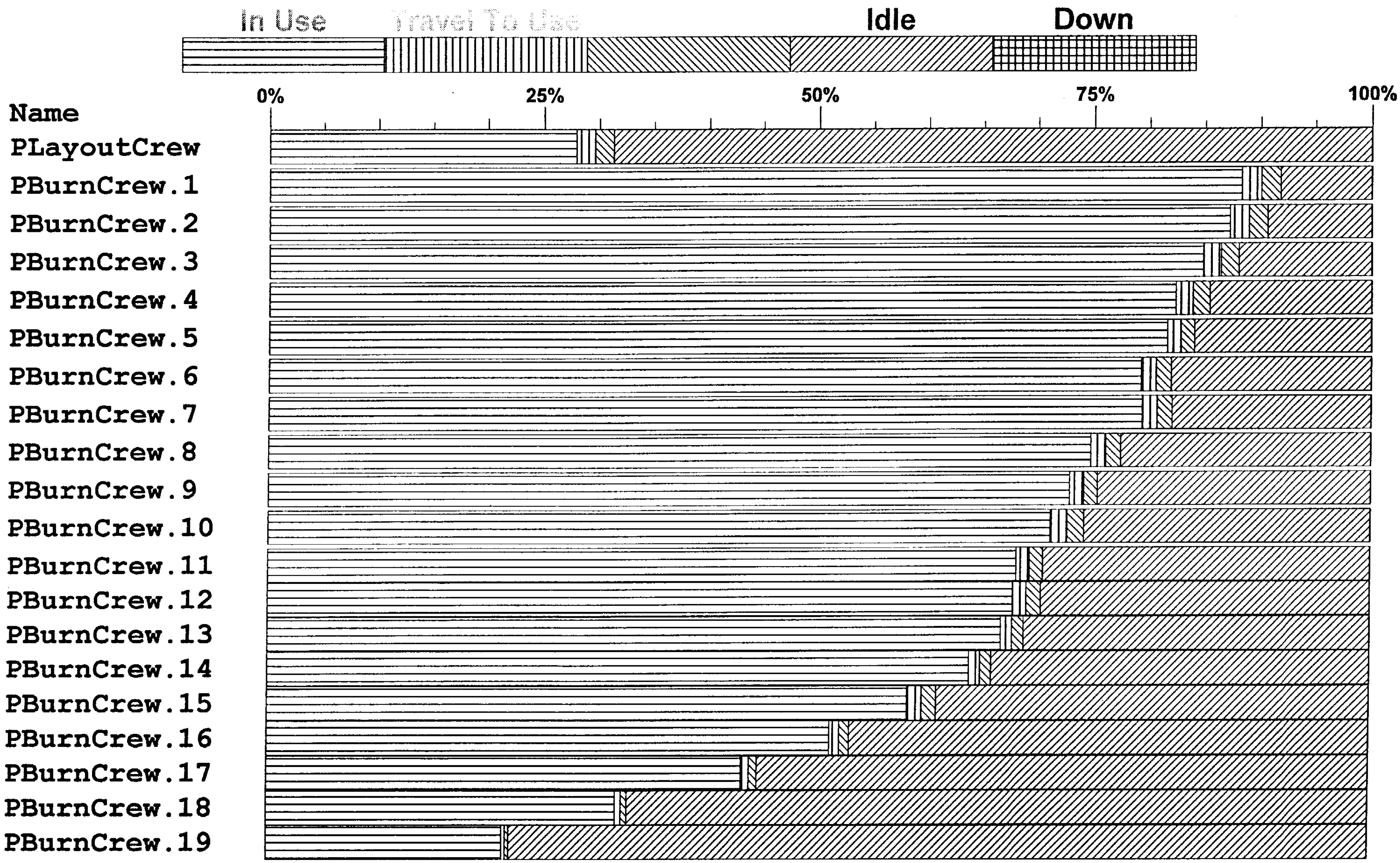
VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v TotalProfilesArrived	984	48.239792	0	984	984	518.744
v TotalFlatbarsArrived	2426	19.585580	0	2426	2426	1386.59
v TotalTBeamsArrived	757	62.731407	0	757	757	403.461
v TotalProfilesProcessed	981	48.402087	0	981	981	510.878
v TotalFlatbarsProcessed	912	52.059214	0	912	912	519.75
v TotalTBeamsProcessed	741	64.126588	0	741	741	392.388
v TotalProfilesProduced	4074	11.655812	0	4074	4074	2094.02
v TotalFlatbarsProduced	11494	4.134310	0	11494	11494	5713.43
v TotalTBeamsProduced	990	47.996470	0	990	990	501.87
v PBatchSize	100	470.401000	0	16	16	15.8476
v FBatchSize	300	156.800000	0	16	16	15.8476
v TBatchSize	200	235.200000	0	6	6	5.94286
v Counter	0	0.000000	0	0	0	0
v PScrap	981	48.406429	0	981	981	510.651
v FScrap	912	52.067229	0	912	912	519.493
v TScrap	1056	45.000699	0	1056	1056	554.799
v PPerUnit	100	470.401000	0	9	3	4.1238
v FPerUnit	305	154.229508	0	11	3	4.26667
v TPerUnit	200	235.200000	0	3	2	1.6
v PPerUnitBatch	0	0.000000	0	0	0	0
v FPerUnitBatch	0	0.000000	0	0	0	0
v TPerUnitBatch	0	0.000000	0	0	0	0
v PTotal	0	0.000000	0	0	0	0
v FTotal	0	0.000000	0	0	0	0
v TTotal	0	0.000000	0	0	0	0
v TotalFToShear	1505	31.568660	0	1505	1505	858.858
v TotalShearProduced	8411	5.649715	0	8411	8411	4139.16
v Count	0	0.000000	0	0	0	0
v ProfileWIP	1045	45.424837	0	923	923	487.414
v TBeamWIP	812	58.482358	0	702	702	372.723
v FlatBarWIP	2546	18.662458	0	2306	2306	1326.4
v ProfileFlowTime	61	775.257787	0	3537.66	164.081	281.329
v TBeamFlowTime	55	863.032873	0	3518.94	127.096	237.382
v FlatBarFlowTime	120	394.281208	0	7186.5	3188.89	2773.25

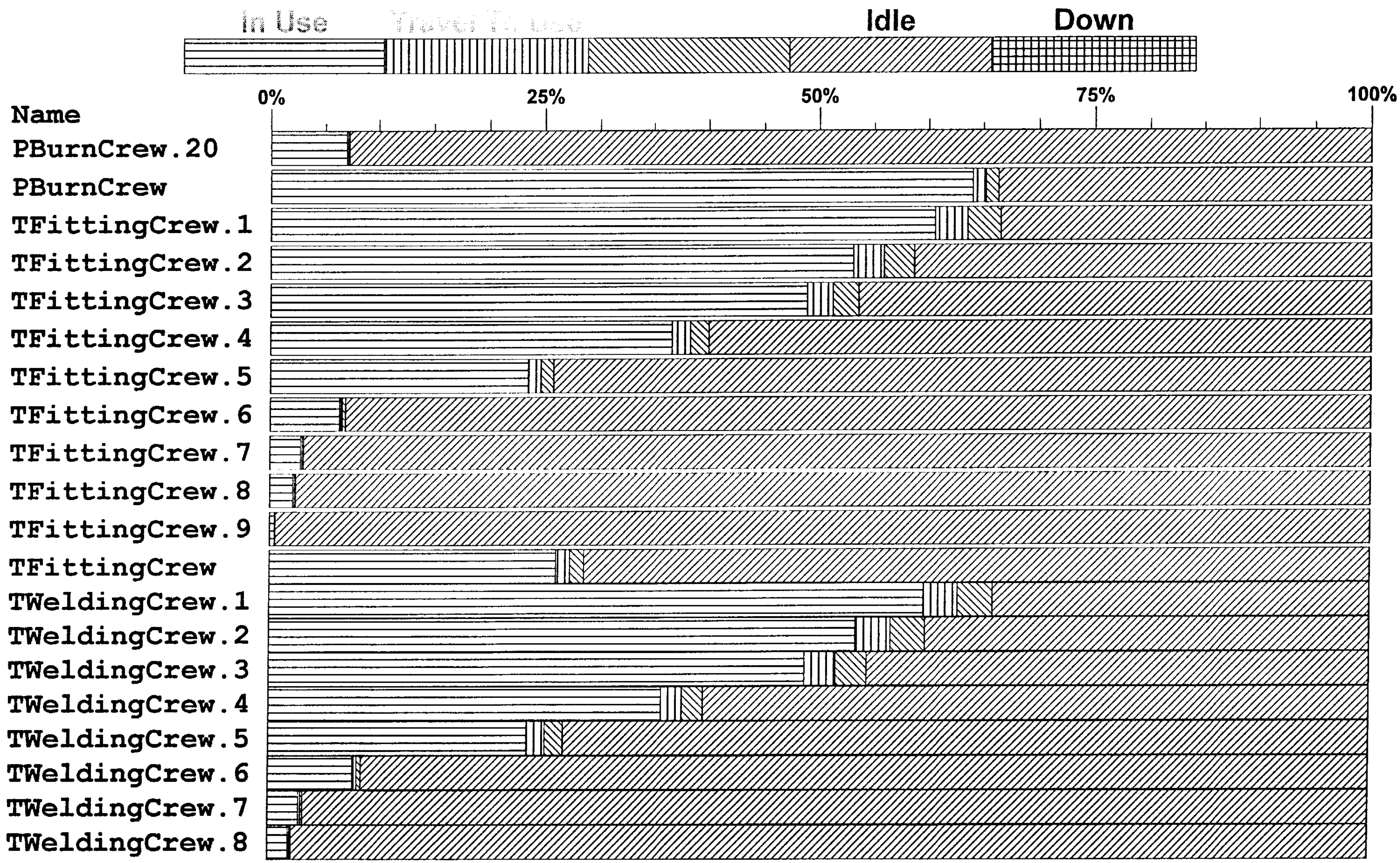
Resource States



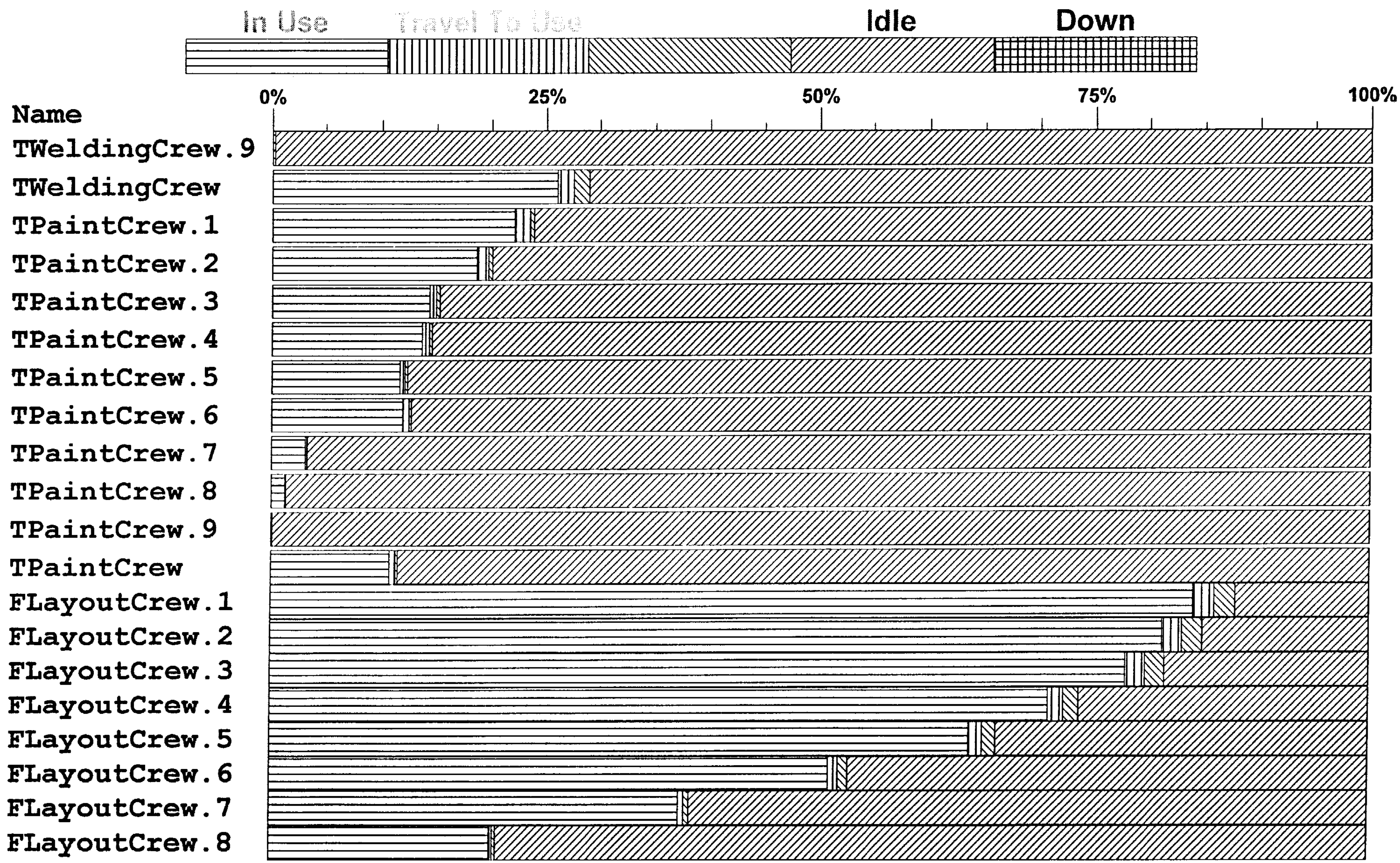
Resource States



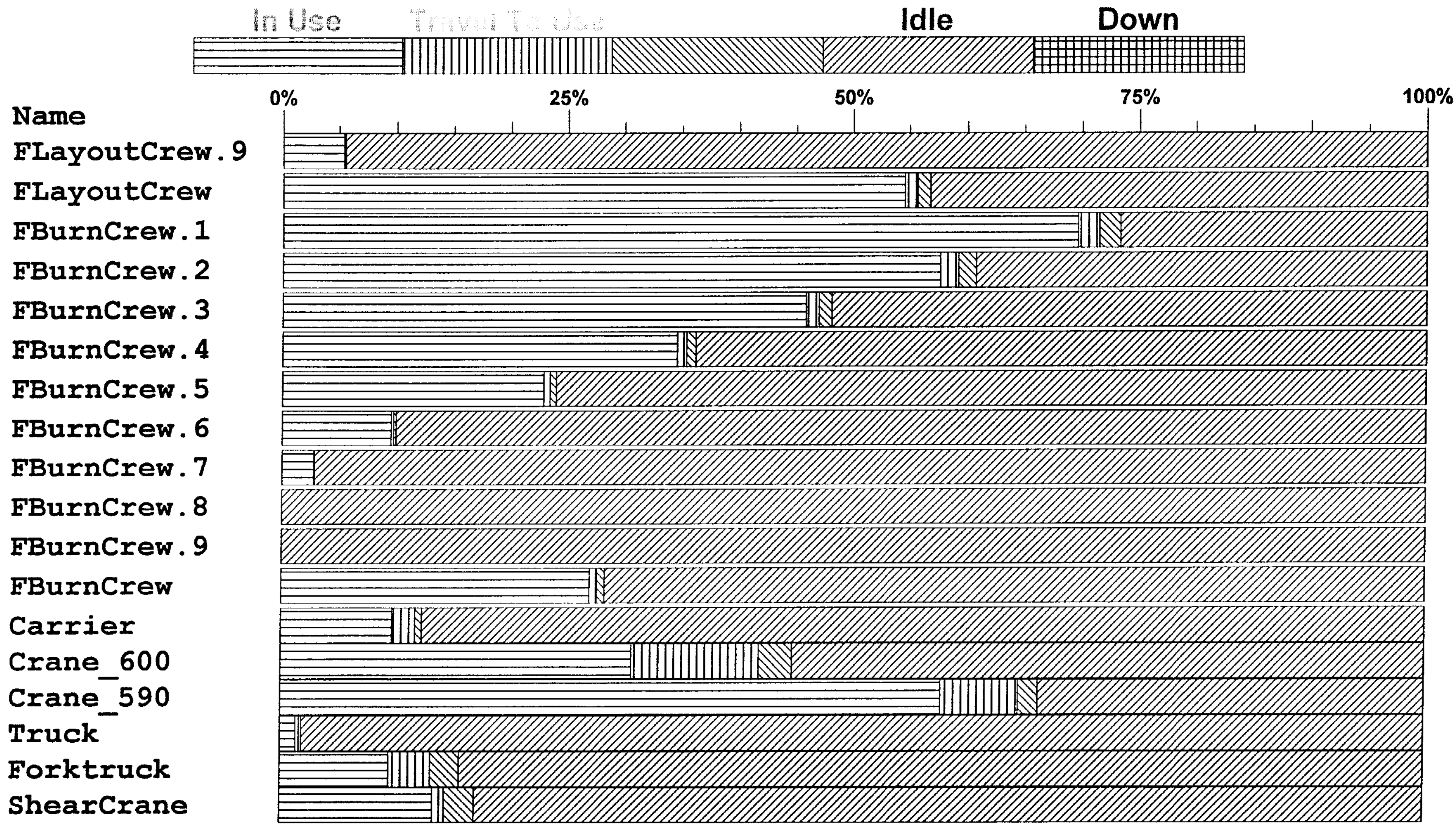
Resource States



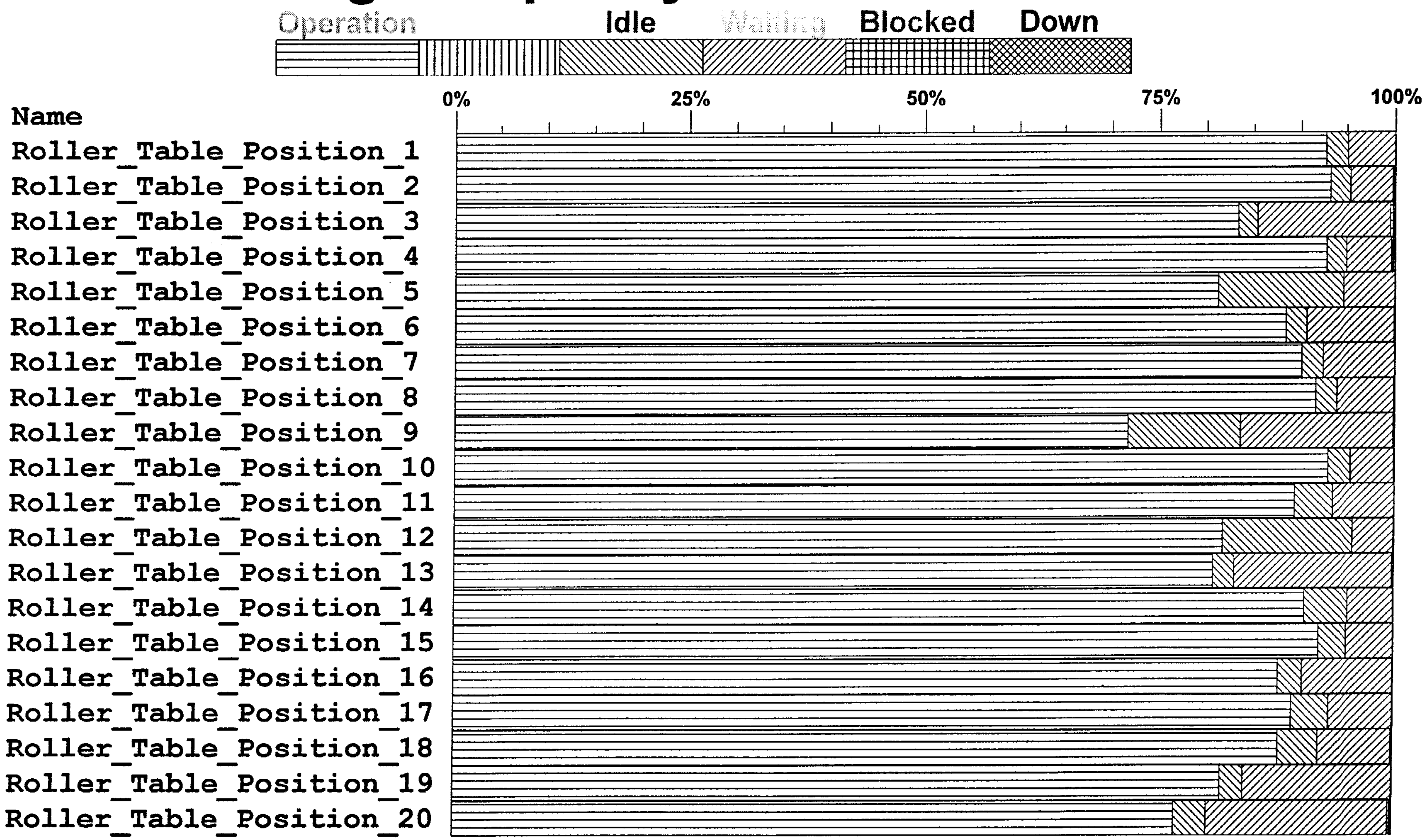
Resource States



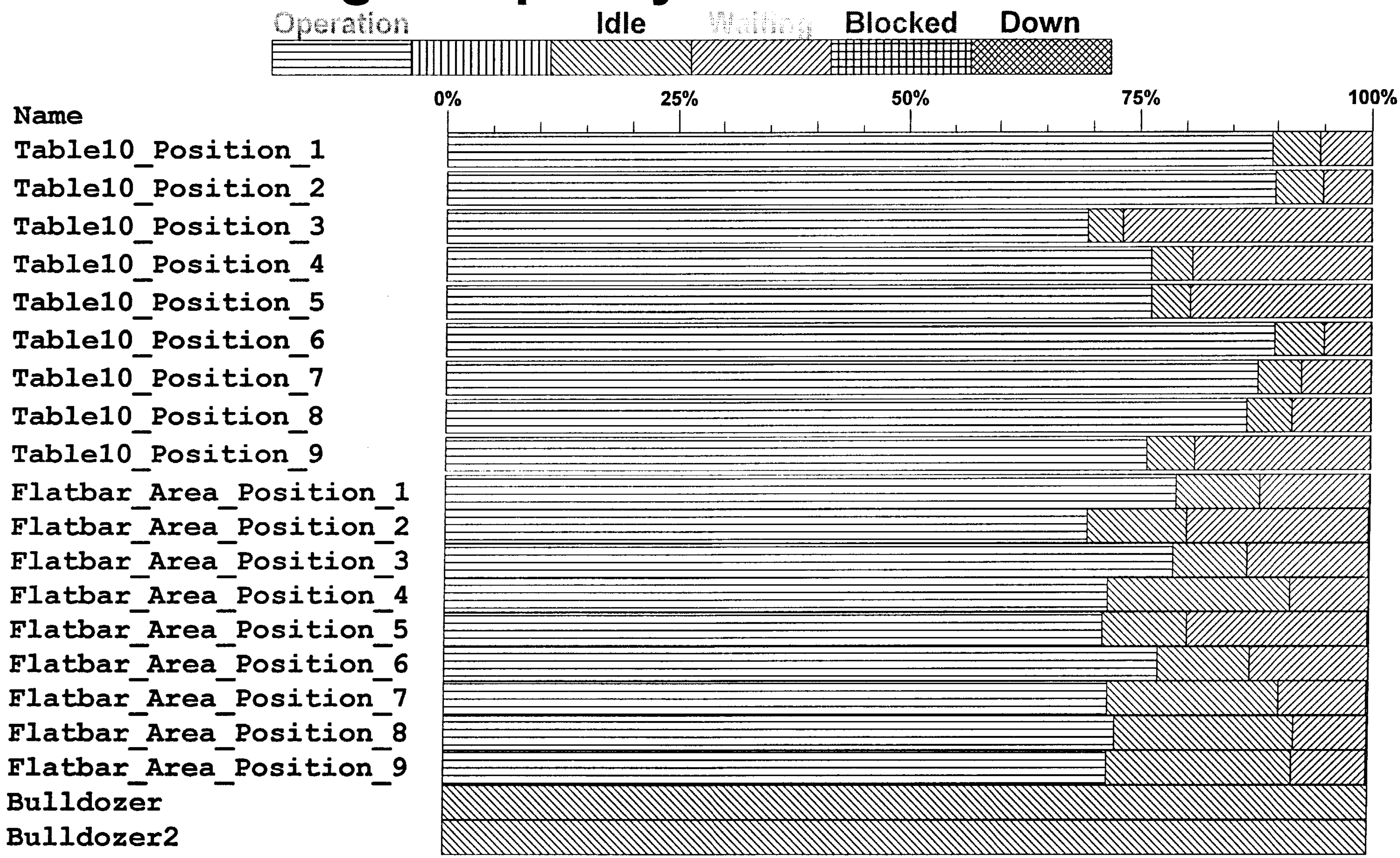
Resource States



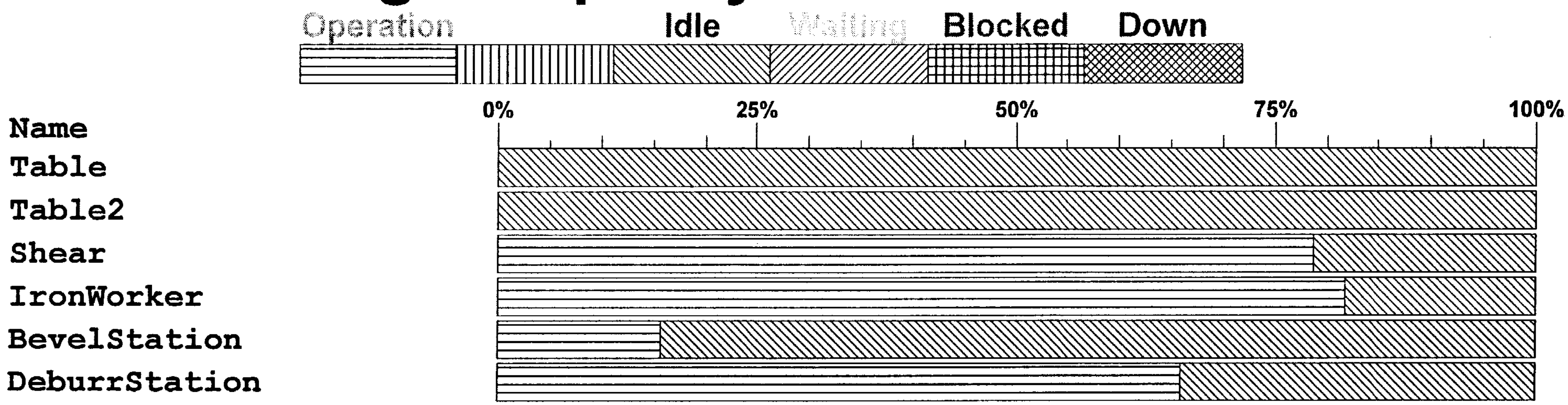
Single Capacity Location States



Single Capacity Location States



Single Capacity Location States



DETAILED PERFORMANCE STATISTICS FOR THE "MOST LIKELY OPERATING CONDITION" PROFILE FABRICATION AREA MODEL

PROFILE LAYOUT = 7
PROFILE BURN = 17
TBEAM FIT = 3
FB LAYOUT = 6
FB BURN = 3
TBEAM WELD = 3
T BEAM PAINT = 2

General Report
Output from C:\ProMod4\models\Simulation Models\Latest AsIs\ProfNew.MOD
Date: May/11/1998   Time: 03:14:56 PM

Scenario   : Model Parameters
Replication   : 1 of 1
Simulation Time : 840 hr

PCBLOCK ARRIVALS = 2 PER 8HR
FBBLOCK ARRIVALS = 6 PER 8HR
T CBLOCK ARRIVALS = 4 PER 8HR

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents	Current Contents	% Util
Roller Table Position 1	453	1	94	275.439681	0.952588	1	1	95.26
Roller Table Position 2	549	1	92	316.901620	0.885093	1	1	88.51
Roller Table Position 3	487	1	93	308.805086	0.98285	1	1	98.28
Roller Table Position 4	425.0036167	1	90	278.218589	0.98194	1	1	98.19
Roller Table Position 5	432	1	89	285.528831	0.980404	1	1	98.04
Roller Table Position 6	446	1	92	285.583152	0.981825	1	1	98.18
Roller Table Position 7	439.0065667	1	94	271.096734	0.967453	1	1	96.75
Roller Table Position 8	480	1	91	310.903813	0.98237	1	1	98.24
Roller Table Position 9	425	1	90	278.604056	0.983308	1	1	98.33
Roller Table Position 10	446	1	90	291.910956	0.981763	1	1	98.18
Roller Table Position 11	432.0055667	1	90	282.132522	0.979614	1	1	97.96
Roller Table Position 12	425	1	90	277.773922	0.980379	1	1	98.04
Roller Table Position 13	439	1	92	280.688413	0.980385	1	1	98.04
Roller Table Position 14	446	1	92	280.443913	0.964157	1	1	96.42
Roller Table Position 15	446	1	92	280.087239	0.962931	1	1	96.29
Roller Table Position 16	432	1	93	271.575688	0.974404	1	1	97.44
Roller Table Position 17	494	1	89	326.724258	0.981055	1	1	98.11
Roller Table Position 18	494	1	90	318.038178	0.965703	1	1	96.57
Roller Table Position 19	432.0095167	1	92	271.011826	0.961904	1	1	96.19
Roller Table Position 20	446	1	89	293.683730	0.976751	1	1	97.68
Table10 Position 1	446	1	111	228.158045	0.946395	1	1	94.64
Table10 Position 2	446.0105167	1	109	232.479477	0.946923	1	1	94.69
Table10 Position 3	439	1	110	225.689145	0.942514	1	1	94.25
Table10 Position 4	501	1	110	259.812000	0.950743	1	1	95.07
Table10 Position 5	425	1	109	223.084661	0.953578	1	1	95.36
Table10 Position 6	432	1	110	225.418373	0.956637	1	1	95.66
Table10 Position 7	446	1	109	232.596009	0.94742	1	1	94.74
Table10 Position 8	446.0147	1	109	236.590266	0.963658	1	1	96.37

Table10 Position 9	480	1	109	253.222963	0.958379	1	1	95.84
Flatbar Area Position 1	446.0087333	1	215	117.267781	0.942155	1	1	94.22
Flatbar Area Position 2	549.0212667	1	214	146.925636	0.954489	1	1	95.45
Flatbar Area Position 3	508.0083833	1	209	138.940780	0.952695	1	1	95.27
Flatbar Area Position 4	508	1	224	125.687509	0.923688	1	1	92.37
Flatbar Area Position 5	501	1	245	116.081861	0.94611	1	1	94.61
Flatbar Area Position 6	501	1	237	117.311941	0.924915	1	1	92.49
Flatbar Area Position 7	563	1	230	137.982670	0.939491	1	1	93.95
Flatbar Area Position 8	508	1	217	133.375373	0.949556	1	1	94.96
Flatbar Area Position 9	460.0183667	1	228	112.608886	0.93021	1	1	93.02
Profile Skip Tub	826	25	1028	491.447076	10.1939	25	3	40.78
Table10 Skip Tub	826	25	1023	556.353187	11.484	25	23	45.94
Flatbar Skip Tub	833	25	790	760.478995	12.0204	25	15	48.08
ProfileIn	833	999999	1600	9533.152069	305.183	586	564	0.03
PTABLETBEAMIN	425	999999	0	0.000000	0	0	0	0.00
ProfileStorage	425	999999	100	40.983200	0.160718	2	0	0.00
ProfileStorage2	425	999999	63	0.000000	0	1	0	0.00
ProfileOut	826	999999	3779	507.028425	38.6614	129	57	0.00
FlatbarOut	778	999999	3063	507.628388	33.309	128	34	0.00
RTBeamOut	826	999999	1023	861.048979	17.7735	44	37	0.00
TBeamOut	826	999999	977	226.496020	4.46502	18	5	0.00
FlatbarIn	833	999999	3712	11981.357554	889.852	1719	1693	0.09
FlatbarStorage	425	999999	300	12.386803	0.145727	6	0	0.00
FlatbarStorage2	425.0073833	999999	49	0.000000	0	1	0	0.00
TBeamIn	833	999999	1200	8955.644671	215.021	424	412	0.02
TBeamStorage	425	999999	200	32.587700	0.25559	4	0	0.00
TBeamStorage2	432	999999	126	0.000000	0	1	0	0.00
FrameBender	425	999999	0	0.000000	0	0	0	0.00
Bulldozer	425	1	0	0.000000	0	0	0	0.00
Bulldozer2	425	1	0	0.000000	0	0	0	0.00
OutgoingPileForProfile	425	999999	0	0.000000	0	0	0	0.00
ScrapBinOut1	425	25	41	1.600000	0.00257255	1	0	0.01
ScrapBinOut3	425	25	40	2.241000	0.00351529	1	0	0.01
ScrapBinOut2	425	25	31	2.619000	0.00318388	1	0	0.01
ScrapOut	425	999999	112	0.000000	0	1	0	0.00
Table	425	1	0	0.000000	0	0	0	0.00
Table2	425	1	0	0.000000	0	0	0	0.00
ShearStaging	736	999999	48	922.657708	1.00289	2	1	0.00
Shear	425.0276833	1	1199	15.411059	0.724575	1	1	72.46
IronWorkerStaging	812	999999	68	2696.691735	3.76386	9	5	0.00
IronWorker	425	1	1009	22.619944	0.89504	1	1	89.50
BevelStation	425	1	1200	5.000000	0.235294	1	0	23.53
DeburrStation	425	1	8375	2.000000	0.656863	1	0	65.69
Bldg2OutStaging	647	999999	8375	41.789406	9.01562	34	0	0.00
GeneralStorage	633	999999	335	255.489967	2.25353	5	0	0.00

FlatbarToShear	826	999999	1220	500.972852	12.3323	27	20	0.00
FlatbarToBevel	460	999999	48	171.190208	0.297722	2	0	0.00
FlatbarToDeburr	619	999999	287	105.536840	0.815538	2	0	0.00
BevelToDeburr	439	999999	48	86.220042	0.157121	1	0	0.00
IronWorkerOut	826	999999	3796	178.743837	13.6907	32	21	0.00
ShearOut	833	999999	4617	133.734325	12.354	32	17	0.00
BevelOut	460	999999	1200	85.889167	3.73431	25	0	0.00

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location Name	Scheduled Hours	% Empty	% Partially Occupied	% Full	% Down
Profile Skip Tub	826	2.89	96.83	0.28	0.00
Table10 Skip Tub	826	3.11	96.57	0.32	0.00
Flatbar Skip Tub	833	2.38	97.18	0.44	0.00
ProfileIn	833	0.20	99.80	0.00	0.00
PTABLETBEAMIN	425	100.00	0.00	0.00	0.00
ProfileStorage	425	91.71	8.29	0.00	0.00
ProfileStorage2	425	100.00	0.00	0.00	0.00
ProfileOut	826	2.23	97.77	0.00	0.00
FlatbarOut	778	1.07	98.93	0.00	0.00
RTBeamOut	826	3.89	96.11	0.00	0.00
TBeamOut	826	7.22	92.78	0.00	0.00
FlatbarIn	833	0.23	99.77	0.00	0.00
FlatbarStorage	425	95.35	4.65	0.00	0.00
FlatbarStorage2	425.0073833	100.00	0.00	0.00	0.00
TBeamIn	833	0.61	99.39	0.00	0.00
TBeamStorage	425	92.76	7.24	0.00	0.00
TBeamStorage2	432	100.00	0.00	0.00	0.00
FrameBender	425	100.00	0.00	0.00	0.00
OutgoingPileForProfile	425	100.00	0.00	0.00	0.00
ScrapBinOut1	425	99.74	0.26	0.00	0.00
ScrapBinOut3	425	99.65	0.35	0.00	0.00
ScrapBinOut2	425	99.68	0.32	0.00	0.00
ScrapOut	425	100.00	0.00	0.00	0.00
ShearStaging	736	10.50	89.50	0.00	0.00
IronWorkerStaging	812	5.71	94.29	0.00	0.00
Bldg2OutStaging	647	22.76	77.24	0.00	0.00
GeneralStorage	633	14.14	85.86	0.00	0.00
FlatbarToShear	826	1.18	98.82	0.00	0.00
FlatbarToBevel	460	71.39	28.61	0.00	0.00
FlatbarToDeburr	619	27.89	72.11	0.00	0.00

BevelToDeburr	439	84.29	15.71	0.00	|	0.00
IronWorkerOut	826	4.60	95.40	0.00	|	0.00
ShearOut	833	2.31	97.69	0.00	|	0.00
BevelOut	460	71.04	28.96	0.00	|	0.00

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location Name	Scheduled Hours	% Operation	% Setup	% Idle	% Waiting	% Blocked	% Down
Roller Table Position 1	453	81.39	0.00	4.74	13.84	0.04	0.00
Roller Table Position 2	549	68.16	0.00	11.49	20.31	0.04	0.00
Roller Table Position 3	487	79.37	0.00	1.72	18.92	0.00	0.00
Roller Table Position 4	425.0036167	87.81	0.00	1.81	10.38	0.00	0.00
Roller Table Position 5	432	88.14	0.00	1.96	9.87	0.03	0.00
Roller Table Position 6	446	85.51	0.00	1.82	12.55	0.12	0.00
Roller Table Position 7	439.0065667	85.33	0.00	3.25	11.40	0.02	0.00
Roller Table Position 8	480	79.03	0.00	1.76	19.17	0.04	0.00
Roller Table Position 9	425	90.01	0.00	1.67	8.32	0.00	0.00
Roller Table Position 10	446	84.84	0.00	1.82	13.32	0.02	0.00
Roller Table Position 11	432.0055667	87.18	0.00	2.04	10.64	0.14	0.00
Roller Table Position 12	425	90.12	0.00	1.96	7.86	0.05	0.00
Roller Table Position 13	439	86.44	0.00	1.96	11.47	0.13	0.00
Roller Table Position 14	446	84.87	0.00	3.58	11.49	0.05	0.00
Roller Table Position 15	446	83.56	0.00	3.71	12.59	0.15	0.00
Roller Table Position 16	432	86.95	0.00	2.56	10.44	0.05	0.00
Roller Table Position 17	494	76.44	0.00	1.89	21.52	0.14	0.00
Roller Table Position 18	494	76.13	0.00	3.43	20.32	0.12	0.00
Roller Table Position 19	432.0095167	87.60	0.00	3.81	8.43	0.16	0.00
Roller Table Position 20	446	84.52	0.00	2.32	13.13	0.03	0.00
Table10 Position 1	446	84.53	0.00	5.36	10.11	0.00	0.00
Table10 Position 2	446.0105167	83.79	0.00	5.31	10.90	0.00	0.00
Table10 Position 3	439	85.21	0.00	5.75	9.04	0.00	0.00
Table10 Position 4	501	74.65	0.00	4.93	20.43	0.00	0.00
Table10 Position 5	425	87.63	0.00	4.64	7.72	0.00	0.00
Table10 Position 6	432	86.61	0.00	4.34	9.05	0.00	0.00
Table10 Position 7	446	83.37	0.00	5.26	11.37	0.00	0.00
Table10 Position 8	446.0147	83.61	0.00	3.63	12.76	0.00	0.00
Table10 Position 9	480	77.60	0.00	4.16	18.23	0.00	0.00
Flatbar Area Position 1	446.0087333	73.88	0.00	5.78	20.24	0.10	0.00
Flatbar Area Position 2	549.0212667	60.19	0.00	4.55	35.26	0.00	0.00
Flatbar Area Position 3	508.0083833	64.54	0.00	4.73	30.73	0.00	0.00
Flatbar Area Position 4	508	64.78	0.00	7.63	27.44	0.15	0.00
Flatbar Area Position 5	501	67.90	0.00	5.39	26.61	0.10	0.00

Flatbar Area Position 6	501	65.60	0.00	7.51	26.90	0.00	0.00
Flatbar Area Position 7	563	59.67	0.00	6.05	34.23	0.04	0.00
Flatbar Area Position 8	508	65.99	0.00	5.04	28.96	0.00	0.00
Flatbar Area Position 9	460.0183667	72.39	0.00	6.98	20.61	0.02	0.00
Bulldozer	425	0.00	0.00	100.00	0.00	0.00	0.00
Bulldozer2	425	0.00	0.00	100.00	0.00	0.00	0.00
Table	425	0.00	0.00	100.00	0.00	0.00	0.00
Table2	425	0.00	0.00	100.00	0.00	0.00	0.00
Shear	425.0276833	72.46	0.00	27.54	0.00	0.00	0.00
IronWorker	425	89.50	0.00	10.50	0.00	0.00	0.00
BevelStation	425	23.53	0.00	76.47	0.00	0.00	0.00
DeburrStation	425	65.69	0.00	34.31	0.00	0.00	0.00

RESOURCES

Resource Name	Units	Scheduled Hours	Number Of Times Used	Average Minutes Per Usage	Average Minutes Travel To Use	Average Minutes Travel To Park	% Blocked In Travel	% Util
PLayoutCrew.1	1	427.0412167	308	69.329575	4.348016	3.716178	0.00	88.63
PLayoutCrew.2	1	427.00735	290	71.684148	4.756405	4.443271	0.00	86.60
PLayoutCrew.3	1	426.4813667	299	67.277201	4.431209	4.073427	0.00	83.84
PLayoutCrew.4	1	426.6936833	284	69.104680	4.530343	4.081508	0.00	81.72
PLayoutCrew.5	1	426.6055833	266	72.177677	4.383398	3.935576	0.00	79.61
PLayoutCrew.6	1	426.6173	264	70.027784	4.402123	3.965064	0.00	76.83
PLayoutCrew.7	1	426.27515	244	68.838143	4.526715	3.655308	0.00	70.08
PLayoutCrew	7	2986.72165	1955	69.752751	4.482284	3.993551	0.00	81.05
PBurnCrew.1	1	425.9434667	162	141.197969	2.808883	2.382718	0.00	91.28
PBurnCrew.2	1	425.9895167	151	150.425755	3.015238	2.459317	0.00	90.65
PBurnCrew.3	1	426.2712	150	149.819900	2.887533	2.561043	0.00	89.56
PBurnCrew.4	1	426.1085667	145	150.025952	3.004772	2.626491	0.00	86.79
PBurnCrew.5	1	426.4497167	150	146.351947	3.105599	2.756209	0.00	87.64
PBurnCrew.6	1	425.7713	143	149.796930	2.772636	2.490171	0.00	85.40
PBurnCrew.7	1	425.8666333	144	149.768354	2.612951	2.175184	0.00	85.88
PBurnCrew.8	1	425.8871833	144	142.767396	2.762194	2.435210	0.00	82.01
PBurnCrew.9	1	425.7375667	135	152.833785	2.591222	2.210394	0.00	82.14
PBurnCrew.10	1	426.4464167	141	132.051936	3.279972	2.723797	0.00	74.58
PBurnCrew.11	1	426.03565	122	151.179025	2.942270	2.596812	0.00	73.56
PBurnCrew.12	1	426.0427167	120	141.500000	3.237273	2.710696	0.00	67.96
PBurnCrew.13	1	425.7144667	114	141.315789	2.659278	2.346653	0.00	64.27
PBurnCrew.14	1	425.3841333	95	151.894737	2.596611	2.128754	0.00	57.50
PBurnCrew.15	1	425.3922167	82	171.585366	2.505768	1.896981	0.00	55.93
PBurnCrew.16	1	425.7702167	64	163.593750	3.365985	2.544759	0.00	41.84

PBurnCrew.17	1	425.5537333	55	150.000000	3.648564	2.477420	0.00	33.10
PBurnCrew	17	7240.3647	2117	148.001764	2.903915	2.455197	0.00	73.54
TFittingCrew.1	1	425.9568667	355	56.620327	3.010880	2.500660	0.00	82.86
TFittingCrew.2	1	425.9561167	345	56.817241	3.120764	2.537267	0.00	80.93
TFittingCrew.3	1	426.0770167	342	56.602096	3.134020	2.669761	0.00	79.93
TFittingCrew	3	1277.99	1042	56.679540	3.087566	2.571184	0.00	81.24
TWeldingCrew.1	1	426.1444333	352	56.913369	3.266421	3.233468	0.00	82.87
TWeldingCrew.2	1	425.8762667	342	57.202734	2.915601	3.053618	0.00	80.47
TWeldingCrew.3	1	426.30235	342	56.444488	3.671743	3.470007	0.00	80.38
TWeldingCrew	3	1278.32305	1036	56.854108	3.284023	3.255141	0.00	81.24
TPaintCrew.1	1	426.37875	492	24.368626	3.598537	3.181731	0.00	53.79
TPaintCrew.2	1	426.4662667	507	24.556213	3.569694	3.383692	0.00	55.73
TPaintCrew	2	852.8450167	999	24.463828	3.583899	3.282712	0.00	54.76
FLayoutCrew.1	1	425.4579	411	53.446443	1.156223	0.968184	0.00	87.92
FLayoutCrew.2	1	425.4537833	399	53.542313	1.124741	1.030581	0.00	85.46
FLayoutCrew.3	1	425.3453	376	54.513141	1.080966	0.996793	0.00	81.91
FLayoutCrew.4	1	425.2455833	354	55.054887	1.079155	1.033121	0.00	77.89
FLayoutCrew.5	1	425.20435	320	54.529178	1.080556	1.056179	0.00	69.75
FLayoutCrew.6	1	425.3548667	262	55.539271	1.201198	1.036580	0.00	58.25
FLayoutCrew	6	2552.061783	2122	54.343482	1.118242	1.019172	0.00	76.86
FBurnCrew.1	1	425.663	301	71.239671	1.673536	1.525032	0.00	85.98
FBurnCrew.2	1	425.8457167	288	72.265375	1.637553	1.610556	0.00	83.35
FBurnCrew.3	1	425.53505	270	71.925926	1.517230	1.425272	0.00	77.71
FBurnCrew	3	1277.043767	859	71.799265	1.612165	1.525289	0.00	82.35
Carrier	1	425.0245167	838	2.988877	0.616768	0.550799	0.00	11.85
Crane 600	1	425.1966167	9744	0.786746	0.287479	0.500970	0.00	41.03
Crane 590	1	425.15435	8100	1.646995	0.203352	0.426406	0.00	58.76
Truck	1	425	112	3.110973	1.110973	0.000000	0.00	1.85
Forktruck	1	425.1601	766	3.079731	1.115329	0.854550	0.00	12.60
ShearCrane	1	425.0451667	1199	2.309000	0.175000	0.441169	0.00	11.68

RESOURCE STATES BY PERCENTAGE

Resource Name	Scheduled Hours	% In Use	% Travel To Use	% Travel To Park	% Idle	% Down
PLayoutCrew.1	427.0412167	83.34	5.29	2.86	8.51	0.00
PLayoutCrew.2	427.00735	81.14	5.46	3.45	9.95	0.00
PLayoutCrew.3	426.4813667	78.61	5.23	3.17	12.99	0.00
PLayoutCrew.4	426.6936833	76.66	5.06	3.11	15.17	0.00
PLayoutCrew.5	426.6055833	75.01	4.61	2.72	17.66	0.00
PLayoutCrew.6	426.6173	72.22	4.61	2.65	20.52	0.00
PLayoutCrew.7	426.27515	65.67	4.41	2.23	27.69	0.00

PLayoutCrew	2986.72165	76.10	4.95	2.88	16.07	0.00
PBurnCrew.1	425.9434667	89.50	1.78	1.62	7.09	0.00
PBurnCrew.2	425.9895167	88.87	1.78	1.58	7.77	0.00
PBurnCrew.3	426.2712	87.87	1.69	1.63	8.81	0.00
PBurnCrew.4	426.1085667	85.09	1.70	1.67	11.53	0.00
PBurnCrew.5	426.4497167	85.80	1.84	1.76	10.60	0.00
PBurnCrew.6	425.7713	83.85	1.55	1.54	13.06	0.00
PBurnCrew.7	425.8666333	84.40	1.47	1.35	12.78	0.00
PBurnCrew.8	425.8871833	80.45	1.56	1.54	16.45	0.00
PBurnCrew.9	425.7375667	80.77	1.37	1.34	16.52	0.00
PBurnCrew.10	426.4464167	72.77	1.81	1.68	23.74	0.00
PBurnCrew.11	426.03565	72.15	1.40	1.35	25.09	0.00
PBurnCrew.12	426.0427167	66.43	1.53	1.46	30.58	0.00
PBurnCrew.13	425.7144667	63.07	1.20	1.14	34.59	0.00
PBurnCrew.14	425.3841333	56.54	0.97	0.95	41.55	0.00
PBurnCrew.15	425.3922167	55.13	0.81	0.77	43.30	0.00
PBurnCrew.16	425.7702167	40.98	0.86	0.83	57.33	0.00
PBurnCrew.17	425.5537333	32.31	0.79	0.79	66.12	0.00
PBurnCrew	7240.3647	72.12	1.42	1.35	25.11	0.00
TFittingCrew.1	425.9568667	78.65	4.22	2.76	14.38	0.00
TFittingCrew.2	425.9561167	76.70	4.24	3.01	16.06	0.00
TFittingCrew.3	426.0770167	75.72	4.20	3.20	16.88	0.00
TFittingCrew	1277.99	77.02	4.22	2.99	15.77	0.00
TWeldingCrew.1	426.1444333	78.35	4.52	3.92	13.21	0.00
TWeldingCrew.2	425.8762667	76.56	3.91	3.13	16.39	0.00
TWeldingCrew.3	426.30235	75.47	4.91	3.76	15.86	0.00
TWeldingCrew	1278.32305	76.79	4.45	3.60	15.15	0.00
TPaintCrew.1	426.37875	46.87	6.92	0.32	45.89	0.00
TPaintCrew.2	426.4662667	48.66	7.07	0.34	43.93	0.00
TPaintCrew	852.8450167	47.76	7.00	0.33	44.91	0.00
FLayoutCrew.1	425.4579	86.05	1.87	1.12	10.97	0.00
FLayoutCrew.2	425.4537833	83.69	1.77	1.29	13.25	0.00
FLayoutCrew.3	425.3453	80.31	1.60	1.19	16.90	0.00
FLayoutCrew.4	425.2455833	76.38	1.50	1.14	20.98	0.00
FLayoutCrew.5	425.20435	68.40	1.36	1.13	29.12	0.00
FLayoutCrew.6	425.3548667	57.02	1.23	0.97	40.78	0.00
FLayoutCrew	2552.061783	75.31	1.55	1.14	22.00	0.00
FBurnCrew.1	425.663	83.96	2.02	0.94	13.08	0.00
FBurnCrew.2	425.8457167	81.46	1.89	1.01	15.65	0.00
FBurnCrew.3	425.53505	76.06	1.65	0.76	21.53	0.00
FBurnCrew	1277.043767	80.49	1.85	0.90	16.75	0.00
Carrier	425.0245167	9.82	2.03	0.59	87.56	0.00
Crane 600	425.1966167	30.05	10.98	3.22	55.75	0.00
Crane 590	425.15435	52.30	6.46	2.10	39.14	0.00
Truck	425	1.37	0.49	0.00	98.15	0.00

Forktruck	425.1601	9.25	3.35	2.43	84.98	0.00
ShearCrane	425.0451667	10.86	0.82	2.12	86.21	0.00

FAILED ARRIVALS

Entity Name	Location Name	Total Failed
CBlock	ProfileStorage	110
CBlock	FlatbarStorage	336
CBlock	TBeamStorage	224

ENTITY ACTIVITY

Entity Name	Total Exits	Current Quantity In System	Average Minutes In System	Average Minutes In Move Logic	Average Minutes Wait For Res, etc.	Average Minutes In Operation	Average Minutes Blocked
Profile	3785	629	9750.116521	20.660293	486.441894	395.785739	8847.228595
Flatbar	4278	1756	12131.355064	29.755174	695.453528	228.081048	11178.065314
TBeam	1098	51	8995.878367	36.019358	238.412751	931.486778	7789.959480
RTBeam	0	424	-	-	-	-	-
Scrap	1137	3	440.830055	7.262192	433.567863	0.000000	0.000000
Scrap2	775	15	724.340874	18.308977	706.031897	0.000000	0.000000
Scrap3	1000	23	499.624094	6.709440	492.914654	0.000000	0.000000
CarrierBlock	0	0	-	-	-	-	-
nothing	0	0	-	-	-	-	-
CBlock	600	5	25.846642	25.846642	0.000000	0.000000	0.000000
ScrapBin	0	0	-	-	-	-	-
SFlatbar	18285	41	1053.997520	16.248427	397.044845	23.990484	616.713764

ENTITY STATES BY PERCENTAGE

Entity Name	% In Move Logic	% Wait For Res, etc.	% In Operation	% Blocked
Profile	0.21	4.99	4.06	90.74
Flatbar	0.25	5.73	1.88	92.14
TBeam	0.40	2.65	10.35	86.59
Scrap	1.65	98.35	0.00	0.00

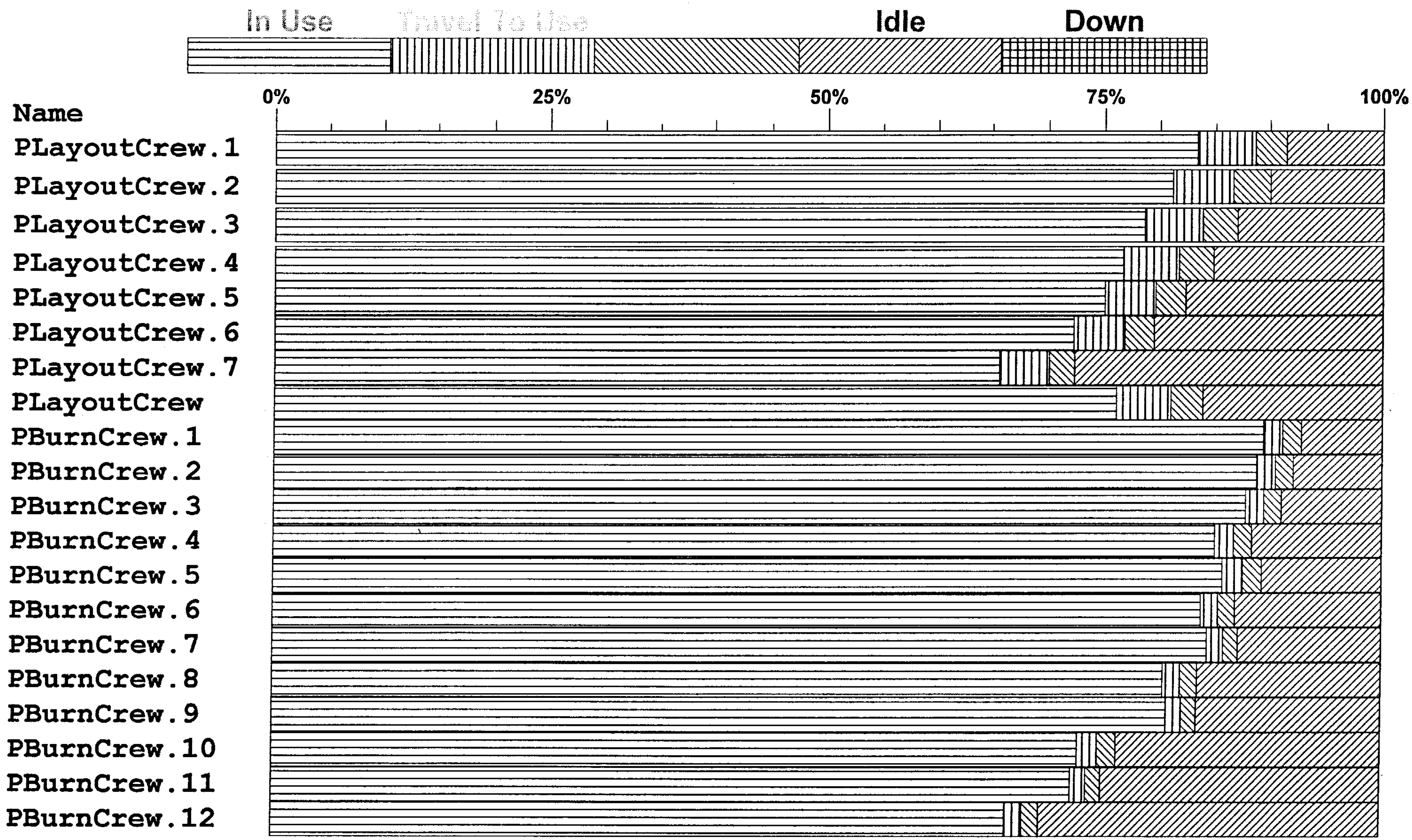
Scrap2	2.53	97.47	0.00	0.00
Scrap3	1.34	98.66	0.00	0.00
CBlock	100.00	0.00	0.00	0.00
SFlatbar	1.54	37.67	2.28	58.51

VARIABLES

Variable Name	Total Changes	Average Minutes Per Change	Minimum Value	Maximum Value	Current Value	Average Value
v TotalProfilesArrived	1036	45.840807	0	1036	1036	541.717
v TotalFlatbarsArrived	2019	23.535809	0	2019	2019	1093.93
v TotalTBeamsArrived	788	60.289123	0	788	788	420.238
v TotalProfilesProcessed	1028	46.205815	0	1028	1028	533.59
v TotalFlatbarsProcessed	790	60.060815	0	790	790	426.732
v TotalTBeamsProcessed	776	61.118832	0	776	776	409.09
v TotalProfilesProduced	3779	12.570866	0	3779	3779	1938.84
v TotalFlatbarsProduced	11438	4.153179	0	11438	11438	5699.78
v TotalTBeamsProduced	977	48.625969	0	977	977	500.143
v PBatchSize	100	470.401000	0	16	16	15.8476
v FBatchSize	300	156.800000	0	16	16	15.8476
v TBatchSize	200	235.200000	0	6	6	5.94286
v Counter	0	0.000000	0	0	0	0
v PScrap	1028	46.212784	0	1028	1028	533.425
v FScrap	790	60.085659	0	790	790	426.444
v TScrap	1023	46.365817	0	1023	1023	526.257
v PPerUnit	102	461.177451	0	12	4	4.74285
v FPerUnit	303	155.247525	0	11	6	4.8
v TPerUnit	200	235.200000	0	3	2	1.71429
v PPerUnitBatch	0	0.000000	0	0	0	0
v FPerUnitBatch	0	0.000000	0	0	0	0
v TPerUnitBatch	0	0.000000	0	0	0	0
v PTotal	0	0.000000	0	0	0	0
v FTotal	0	0.000000	0	0	0	0
v TTotal	0	0.000000	0	0	0	0
v TotalFToShear	1220	38.948317	0	1220	1220	658.867
v TotalShearProduced	8375	5.672127	0	8375	8375	4109.21
v Count	0	0.000000	0	0	0	0
v ProfileWIP	1099	43.213900	0	973	973	508.989
v TBeamWIP	837	56.759652	0	739	739	394.3
v FlatBarWIP	2145	22.153286	0	1893	1893	1029.01
v ProfileFlowTime	63	750.613429	0	3747.15	221.597	339.199
v TBeamFlowTime	49	964.209327	0	3564.74	267.798	232.168

v FlatBarFlowTime	126	376.189794	0	5369.88	1713.13	1696.17

Resource States



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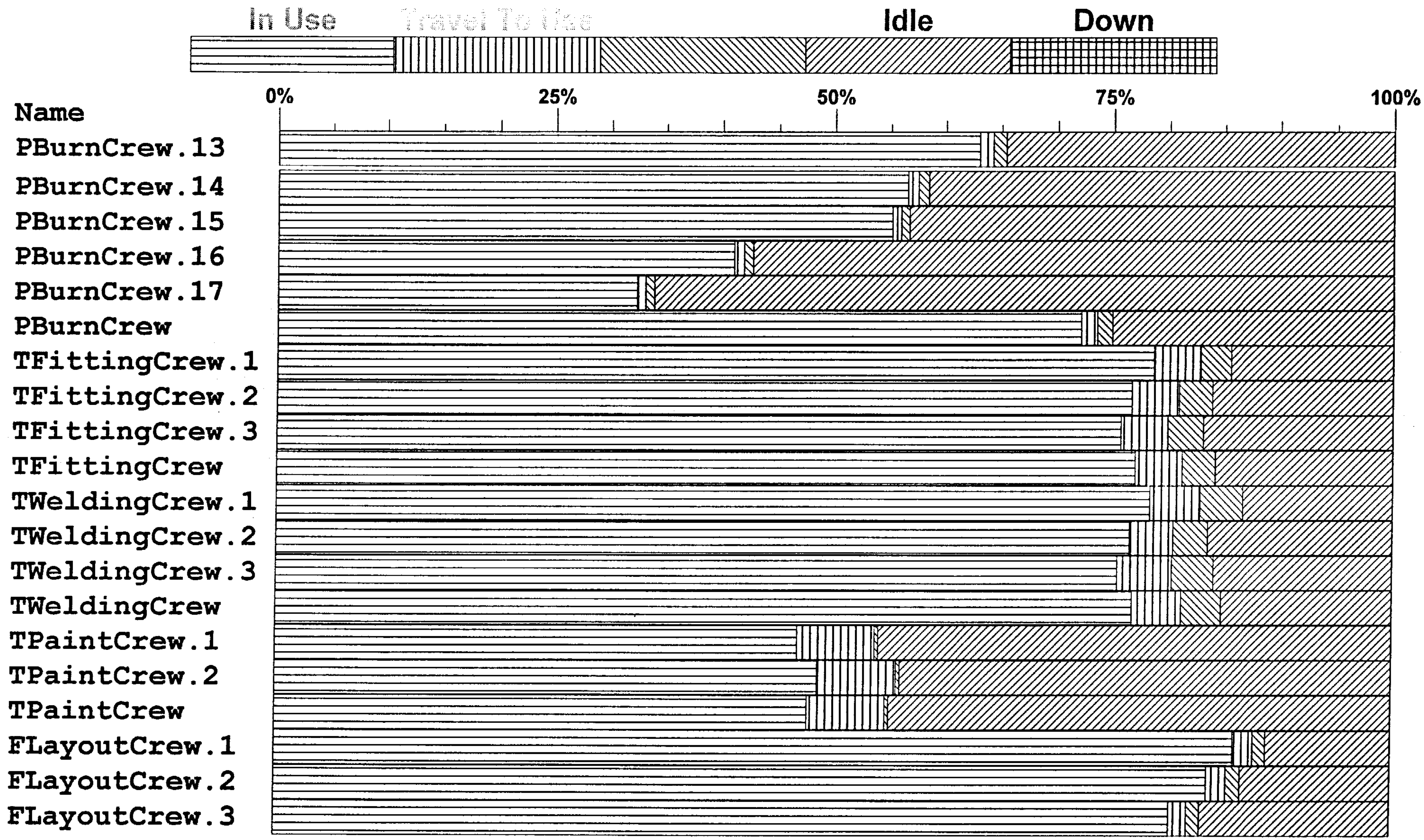

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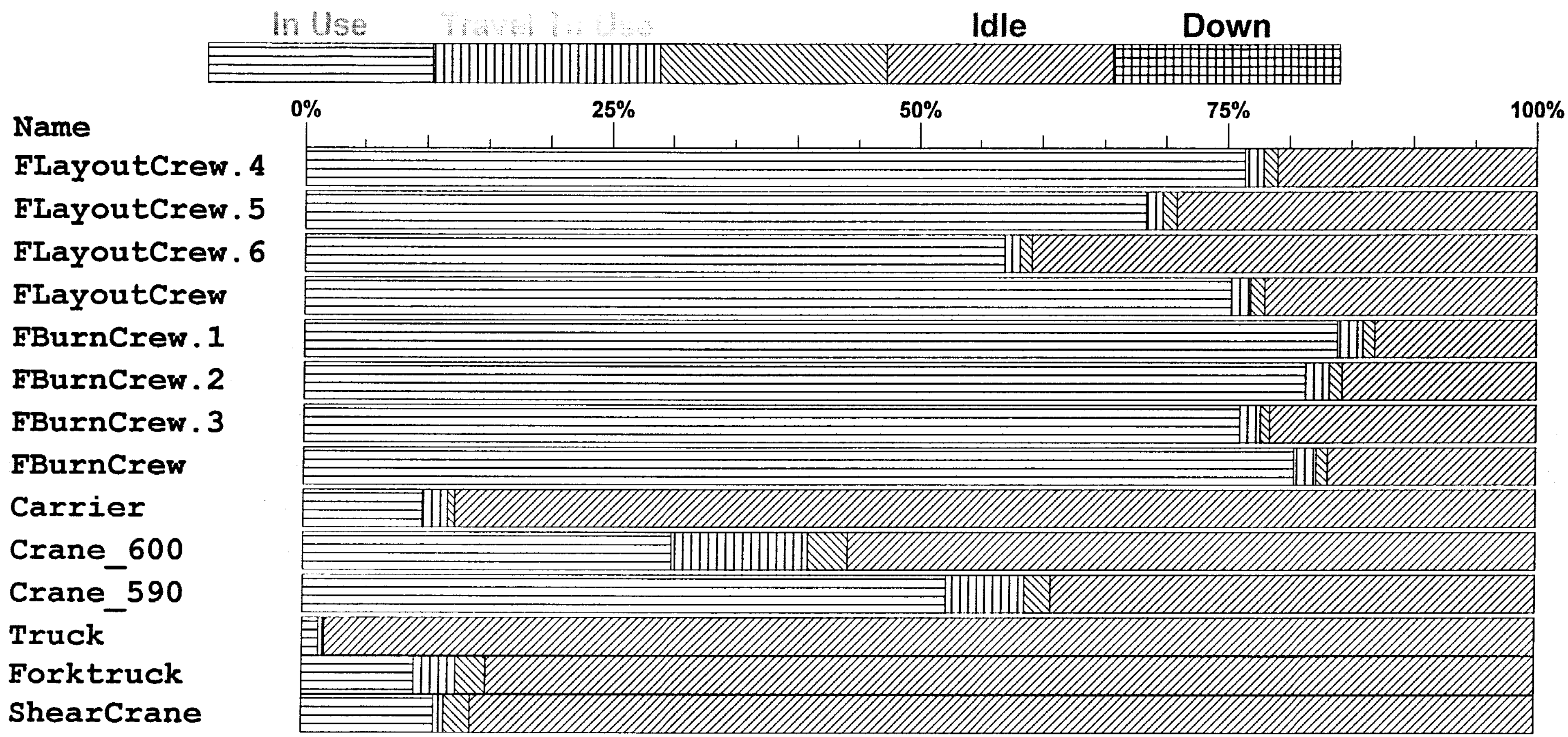

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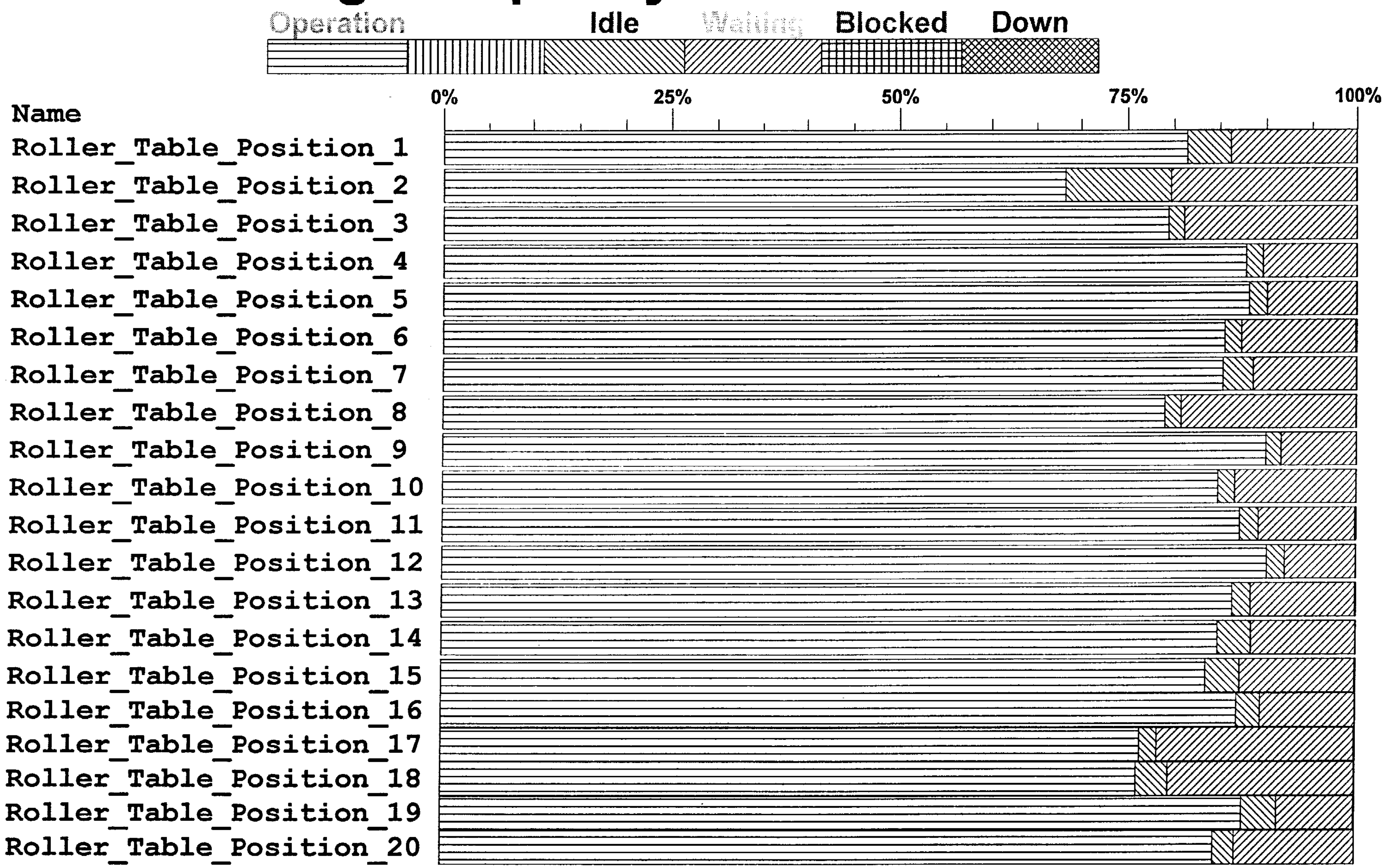

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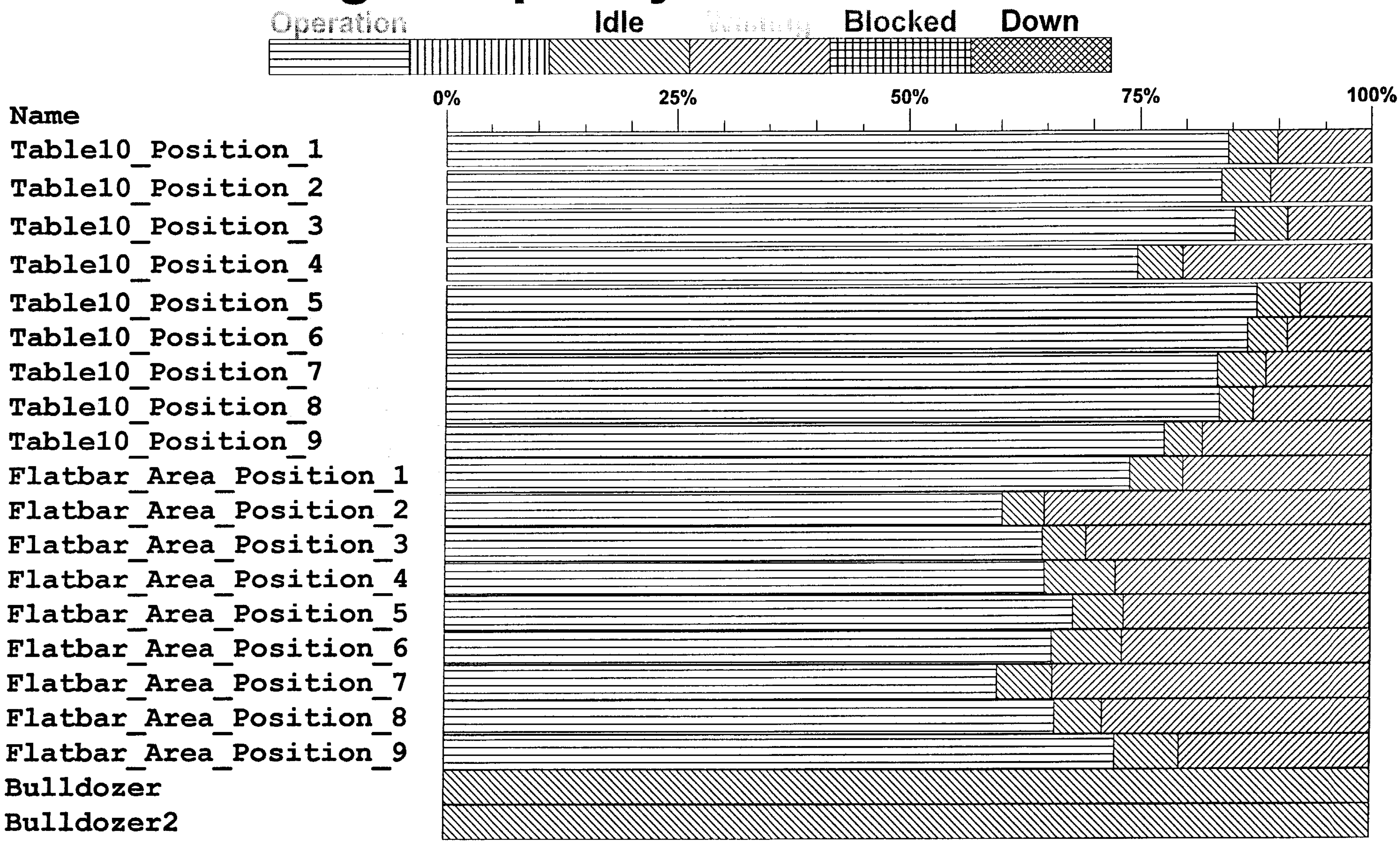

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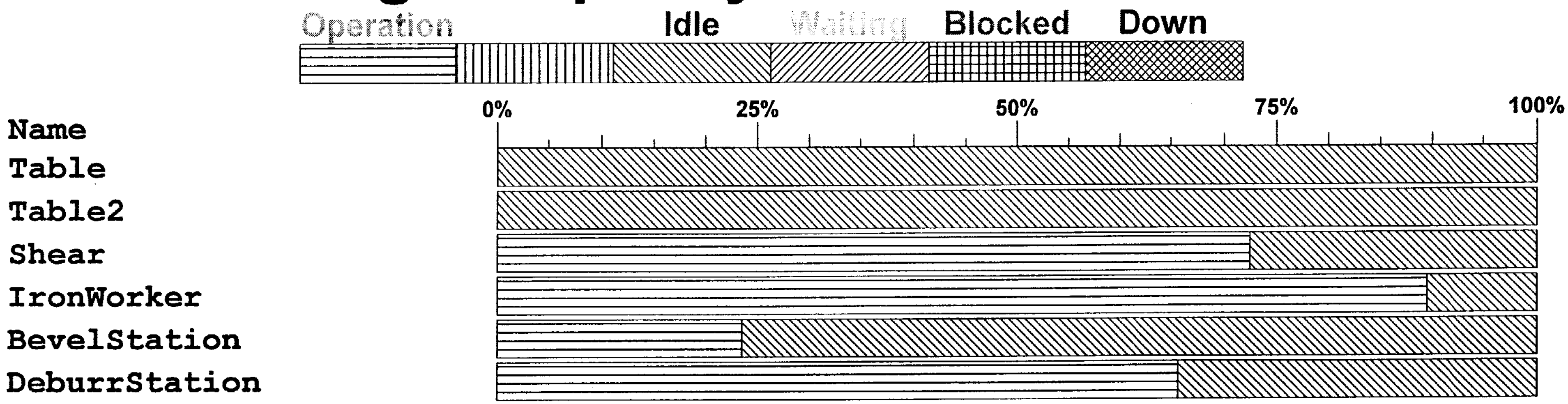

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