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Developing functional requirements for a manufacturing systems analysis tool

Elisa Marie Bradshaw
Lehigh University

Bradshaw
(Married name Rebollo)
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DEVELOPING FUNCTIONAL REQUIREMENTS FOR A MANUFACTURING SYSTEMS ANALYSIS TOOL

by

Elisa Marie Bradshaw

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December 15, 1989

Date

Professor in Charge

IE Department Chairman

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This work is dedicated to my father, the late William Rebollo, and my mother Audrey Rebollo. A small payment toward the large debt owed for their love, support, and teaching.

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ABSTRACT

This thesis presents the functional requirements of an analysis tool for manufacturing-related systems. The term manufacturing-related is meant to encompass not only equipment or shop floor systems, but also the supporting entities such as order control or communication and their varied components, including humans.

Structured analysis techniques provide the basis for this study. These well-known methods have been used in the design and development of information systems for several decades. They are potentially one of the most useful tools for examination of manufacturing systems. Four case studies drawn from actual manufacturing analysis are developed as test cases.

Performance evaluation of the existing analysis tools and techniques reveal several problems with the current implementations which prevent wide-spread use. These include: restrictive and yet incomplete application methodologies, insufficient computer support, poor user interfaces, difficulties with model maintenance and integration, and rigid data structures.

Functional requirements for overcoming the barriers are presented. These are grouped by issue into the following areas: model structure and element

functionality, implementation support, and ease of use and maintenance control. Aside from addressing the problems mentioned above, the need for a true model and analysis capability is discussed. In addition, the specifications deal with necessary facilities such as: logic operators, interfaces to other analysis tools, and a rough-cut and development support mechanism.

The development of a general purpose manufacturing systems analysis tool would provide significant assistance to those responsible for the continued improvement and evolution of manufacturing.

INTRODUCTION

All systems have a life cycle. Analysis is critical to the development, maintenance, and death or phase-out portions of a system's life cycle.

Current manufacturing systems are composed of a variety of elements, several of which can and do exist as completely independent systems in their own right. But the increasing size, complexity, and level of integration present in manufacturing today present a difficult problem for the systems designers and engineers. No one analysis tool, or even small set of tools, are sufficient to the task of describing these systems and providing a base for analysis. And without analysis, how can new systems be developed and old systems be maintained and replaced?

The purpose of this thesis is to develop the functional requirements for a manufacturing systems analysis tool capable of handling the complexity of today's environment. The methodology presented is based upon structured analysis techniques and the requirements are generated by means of test case evaluations. The organization of this study is as follows.

Chapter one contains the problem definition and motivation as well as the approach used for the work.

Chapter two presents background on the most common forms of structured analysis and the systems designed to support the techniques. A brief explanation of development conventions and usage is also included.

Areas for technique and tool improvements are identified in chapter three. Representative manufacturing and related systems are presented as test cases for the analysis tool. These systems are drawn from authentic industrial analysis experience and include discussion of project sizes, methods, and goals. Problems resulting from both the methodologies and the support mechanisms are identified.

Based upon this study's findings, the functional requirements for a multi-purpose structured analysis tool suitable for manufacturing-related systems are developed in chapter four.

Chapter five closes this thesis with conclusions and identification of areas for future work.

CHAPTER 1

PROBLEM DEFINITION AND MOTIVATION

At the beginning of the industrial age, production and control were relatively simple and straightforward. Much of the manufacturing consisted of larger-scale versions of the quickly displaced cottage industries. As technology advanced, manufacturing became complex and more adaptive control methods were developed.

In today's environment, manufacturing and its many related support systems are highly complex and becoming more closely integrated through concepts and techniques such as Computer Integrated Manufactruing (CIM), Manufacturing Requirements Planning (MRP), and Just-In-Time (JIT). Certainly the elements out on the production floor have changed radically in recent times. Robots, automated guided vehichles (AGVs), automated storage and retrieval systems (ASRSs), and electronic identification systems have changed the complexion of manufacturing. Office and management systems now incorporate network, data base, and decision-support technologies. All of these new elements are combined with the many still-viable older implementations to create hybrid environments. And the most complex element, the human, finds his or her role changing at a rapid pace.

But as we integrate our islands of automation and functional departments, the lines which once gave definition to each system become blurred, and multi-dimensional super-systems are created. As these systems develop and grow, we find that the analytical tools we used to employ are incapable of "blurring the lines" as well. The management and control of these new systems becomes a critical issue and a need emerges for generalized but powerful tools.

In order to control a system it must be understood and fully described. Many tools for system description exist: general ledgers and balance sheets for financial system, organizational charts for corporate control systems, or blue prints for mechanical or structural systems. But what tools exist for manufacturing systems?

In fact, there are many: one or more for each <u>type</u> of system or sub-system: mathematical modeling and simulation for scheduling, process control charts or routings for operations, flow charts or decision trees for computer programs, procedural handbooks for human systems, etc., the list goes on. Each of these tools is designed to accomodate a specific type of system and to provide a specialized form of results. But what happens when a system containing several different sub-systems must be examined and the goal of the analysis can no longer be easily defined? Suddenly, these specialized tools can not support the analysis. A more generalized instrument is required.

APPROACH

Structured Analysis provides a basis for such a tool. Systems, specifically manufacturing systems for this thesis, have at least one consistent attribute: structure. Since this is the only major prerequisite for the use of structured analysis, the application is not unnecessarily restricted. However, several problems are encountered with the use of the tool as it currently exists today. Therefore, it is used in this study as a starting point.

In order to investigate the application of structured analysis to the manufacturing systems area, an implementation of the theory had to be chosen. Many different techniques exist, all enjoying varying levels of popularity and computerized support among different user bases. Two of the most widely-used are:

1. IDEF (the ICAM DEFinition language), developed by the Air Force ICAM (Integrated Computer-Aided Manufacturing program), which was designed for use by the military and DoD contractors, and

2. DFD (Data Flow Diagramming), most notably promoted by Yourdon and DeMarco as well as Gane and Sarson, which

enjoys a large civilian sector following.

For the purposes of this research the DFD approach was chosen over IDEF because the user base was larger and more computer support and tools were available. However, many of the conclusions and recommendations of this thesis apply equally to the IDEF modeling approach. A discussion of the DFD approach to structured analysis is presented in Chapter Two.

CHAPTER 2

STRUCTURED ANALYSIS

Structured analysis had its earliest roots in the information systems area, or data processing as it was commonly referred to back in the 1960s/1970s. Out of the turmoil created by the many individual styles of computer programming, came structured programming which greatly improved productivity and efficiency. This framework provided the beginnings for structured design and structured analysis techniques. All of these tools had concepts in common: top-down approaches, modularity, and a focus on data flow.

Structured analysis soon became an accepted standard as part of the information systems development process. As computers and their related information systems proliferated, so did the techniques used to analyze and design them. Eventually, the high level of computerization lead to the concept that almost any system could be modeled as an information system. Thus, applications began appearing in areas other than data processing.

The structured analysis methodology provided a systematic approach to the collection, organization, and review of information. Although there has been some augmentation of the original principles, the basic method focuses on information flow and transformation.

THE DFD APPROACH

As is the case with many of the strucured analysis techniques, Data Flow Diagramming (DFD) relies upon two tools: diagrams and data dictionaries. The diagrams are used to graphically show data flow through a system. The data dictionary is used to store information about all of the data elements within the system under study.

Although a few software tools support both diagramming and dictionary functions, most of the time these are separate elements. Data dictionaries are frequently created and maintained by one or more of the project team members using a data base package. Because the dictionary contains detailed information on all of the system elements at the most elementary level, the dictionaries are usually large and may vary greatly in appearance from system to system.

DFD diagrams are developed in a top-down, hierarchical manner. The first level shows the system to be examined and how it is related to other systems present in the organization. This is refered to as the context diagram. All subsequent diagrams provide views of the system with greater levels of detail but less breadth.

DEVELOPMENT CONVENTIONS AND USAGE

The diagrams contain four element types as defined below.

Process: This represents a manipulation point during data flow. Examples include, but are not restricted to: creation, addition, deletion, alteration. These are usually drawn as circles or or rounded-edged rectangles.

External Entity: This signifies a logical area which interacts through data transmission or reception with the function being diagrammed. This element is not a part of the function explained by the diagram and it is depicted as a square.

Data Store: This indicates a logical store of data and they are usually external. Examples include electronic storage devices and filing cabinets. These are customarily shown as rectangles, usually with the right-hand side open.

Data Flows: These delineate the paths of data between processes, external entities, and data stores and are represented by lines.

In creating these diagrams, the methodology dictates that no one diagram should contain more than five to seven processes in order to keep the drawings manageable. Each diagram is numbered to indicate its level of detail depth.

Examples of this convention can be found on Figures 1 and 2.

The DFD diagram in Figure 1 is numbered 0 and is labeled as the context. Within the diagram, the process numbered 2 is shown to be the system under examination through the use of a boundary line. Figure 2 shows a diagram numbered 2 and labeled as the explosion of process 2. This is a "blow-up" or more detailed view of the element shown in Figure 1, Diagram 0. This process of increasing detail is continued until the lowest level data elements are depicted. The diagram numbered 0 is considered the only Level 0 drawing. The subsequent Level 1 contains all of the diagrams numbered 1, 2, 3, etc.. Level 2 diagrams would contain labels such as 1.1, 1.4, 4.3, and 5.5. Level 3 would contain 1.1.4, 1.4.3, etc.. The periods between the numbers assists in identifying the levels.

The integrity of the graphical representation is enforced through the requirement that all lower-level diagrams reflect the same relationships and data flows as the previous level. Therefore, if a data flow is shown to enter a process on a Level 3 diagram, the Level 4 diagram of the process must also show the data flow.

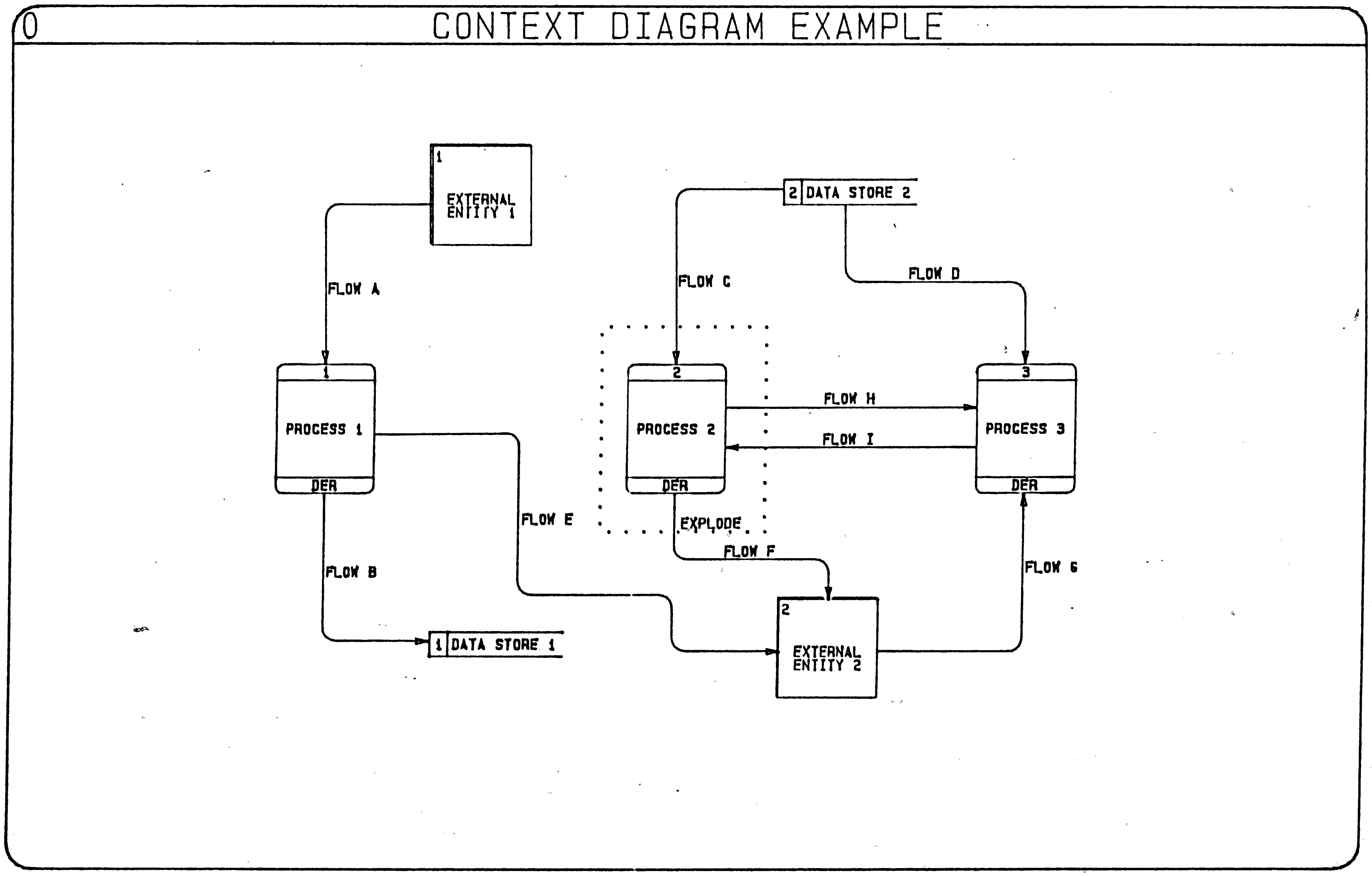

0
CONTEXT DIAGRAM EXAMPLE
1
EXTERNAL ENTITY 1
2 DATA STORE 2
FLOW A
FLOW C
FLOW D
1
PROCESS 1
DER
2
PROCESS 2
DER
3
PROCESS 3
DER
FLOW H
FLOW I
FLOW E
EXPLODE
FLOW F
FLOW B
FLOW G
1 DATA STORE 1
2
EXTERNAL ENTITY 2

Figure 1

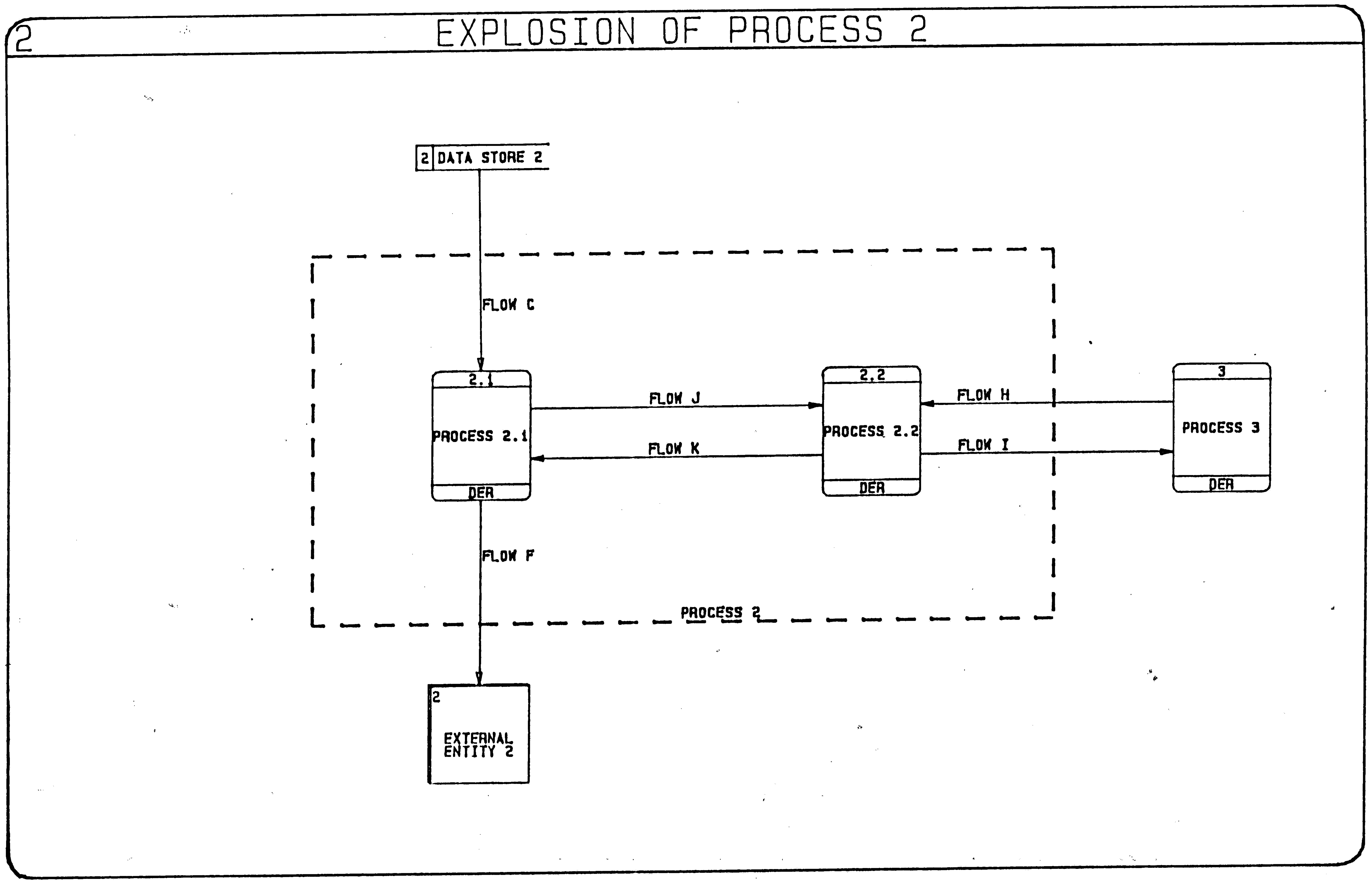

2
EXPLOSION OF PROCESS 2
2 DATA STORE 2
FLOW C
2.1
PROCESS 2.1
DER
FLOW J
FLOW K
2.2
PROCESS 2.2
DER
FLOW H
FLOW I
3
PROCESS 3
DER
FLOW F
PROCESS 2
2
EXTERNAL ENTITY 2

Figure 2

CHAPTER 3

MANUFACTURING SYSTEMS TEST CASES

In this chapter, four cases are presented as tests for structured analysis-based techniques in the modeling of manufacturing systems. The sizes of the companies and the projects themselves range from relatively small to very large.

The cases themselves are abridged; a brief description of each company, project, and model is included. In this chapter, the drawings presented are limited primarily to level one and two diagrams and are used to document the modeling difficulties discussed for each case. The bulk of the DFD diagrams generated for each case study and examples from the data dictionaries are provided in the appendix for reference. The test cases were abbreviated in order to highlight and provide context for the problems encountered, while not over-burdening the thesis with extraneous information.

Each case study presented includes the following information: Company Description, Project Purpose and Scope, Project Approach and Results, Model Size (as measured by the number of elements in the final model), a brief High Level Model Description, and Modeling Problems Encountered. The problems highlighted in this chapter are most-often specific to the individual models and are best described using text and the diagrams. Additional problems of a more general or global nature are presented in Chapter 4.

Test Case One

DoD Manufacturer's Shop Floor Control System

Company Description:

A mid-sized Department of Defense (DoD) heavy equipment and vehicle contractor.

Project Purpose and Scope:

The goal of the systems analysis was two-fold. The first objective was to document the existing operation of the shop floor and warehousing functions. The second objective was to develop an architecture and migration path toward a new data collection and manipulation system.

Project Approach and Results:

Two teams were assembled to for this project. One consisted of six university personnel and the other was made up of approximately ten company people. The two teams worked together, each supplying its own area of expertise and exchanging knowledge with the other. The university team provided the techniques and skills necessary for the analysis, while the company people provided the guidance, focus, and access to information necessary.

One of the university team members acted as systems administrator and database coordinator. Once the data collection began, this became a full-time requirement. The analysis lasted three full months with each university member participating full-time and the company members working half-time.

Significant among the findings of the analysis was an error checking and correction time factor rate of over 50% for the labor tracking data collection process. This prompted a new system requirement for automated labor tracking.

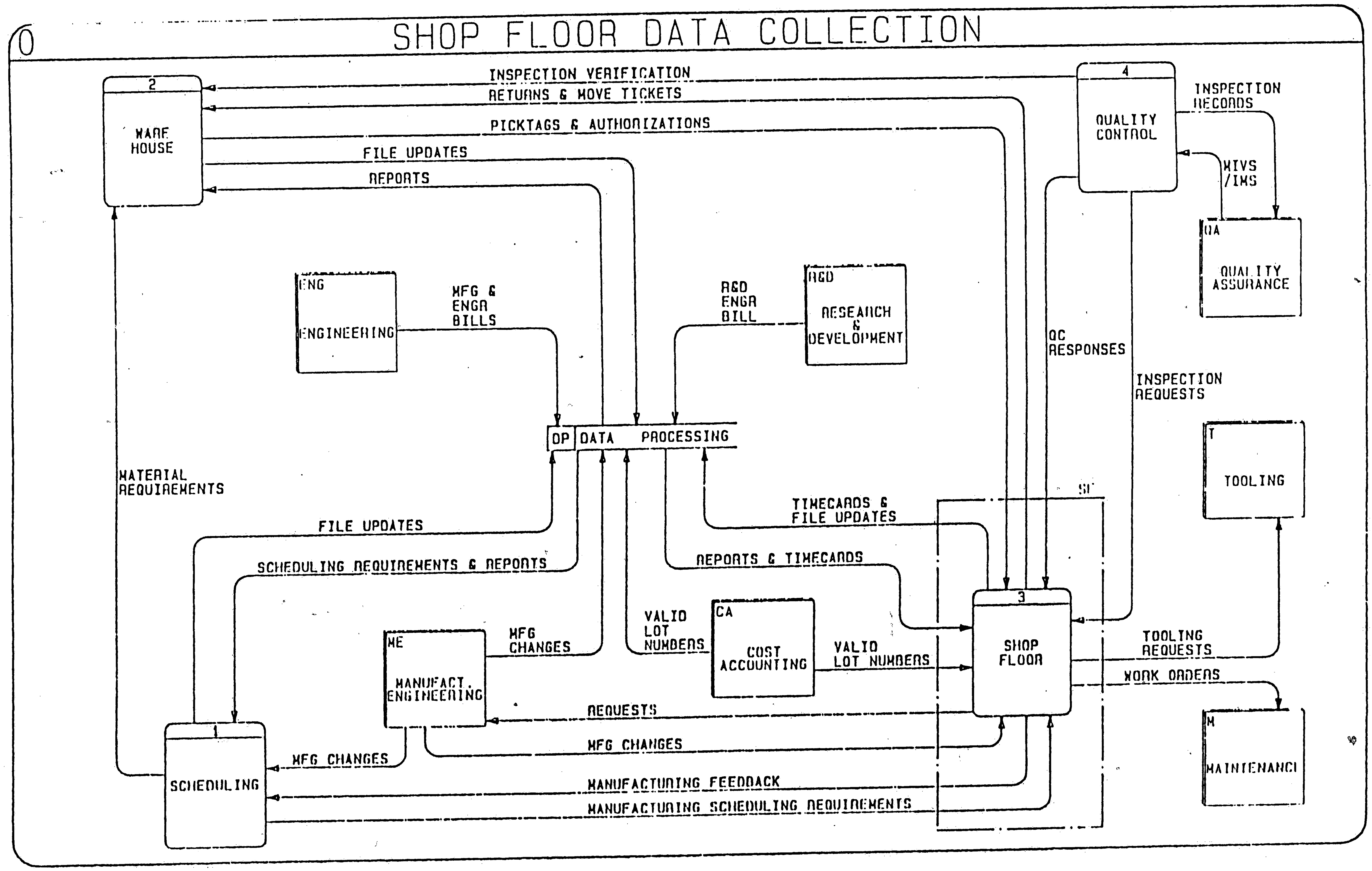
In addition, it was found that the labor and material tracking information paths were parallel enough to allow a single system to track both functions.

Model Size:

Data Flow entries numbered over 250. One hundred processes were identified. Twenty-five data stores and ten external entities were mapped. Over 100 interviews were required to collect the data. Significant document review was also employed.

High Level Model Description:

As Figure 3, the context diagram shows, the shop floor was the primary focus of our analysis. Mid-way through the project, the warehousing function was included for



0
SHOP FLOOR DATA COLLECTION
2
WARE HOUSE
INSPECTION VERIFICATION
RETURNS & MOVE TICKETS
PICKTAGS & AUTHORIZATIONS
FILE UPDATES
REPORTS
4
QUALITY CONTROL
INSPECTION RECORDS
MIVS /IMS
QA
QUALITY ASSURANCE
ENG
ENGINEERING
MFG & ENGR BILLS
R&D ENGR BILL
R&D
RESEARCH & DEVELOPMENT
QC RESPONSES
INSPECTION REQUESTS
DP
DATA PROCESSING
T
TOOLING
MATERIAL REQUIREMENTS
FILE UPDATES
SCHEDULING REQUIREMENTS & REPORTS
TIMECARDS & FILE UPDATES
REPORTS & TIMECARDS
SF
VALID LOT NUMBERS
CA
COST ACCOUNTING
VALID LOT NUMBERS
3
SHOP FLOOR
TOOLING REQUESTS
WORK ORDERS
ME
MANUFACT. ENGINEERING
MFG CHANGES
REQUESTS
MFG CHANGES
M
MAINTENANCE
1
SCHEDULING
MFG CHANGES
MANUFACTURING FEEDBACK
MANUFACTURING SCHEDULING REQUIREMENTS

Figure 3

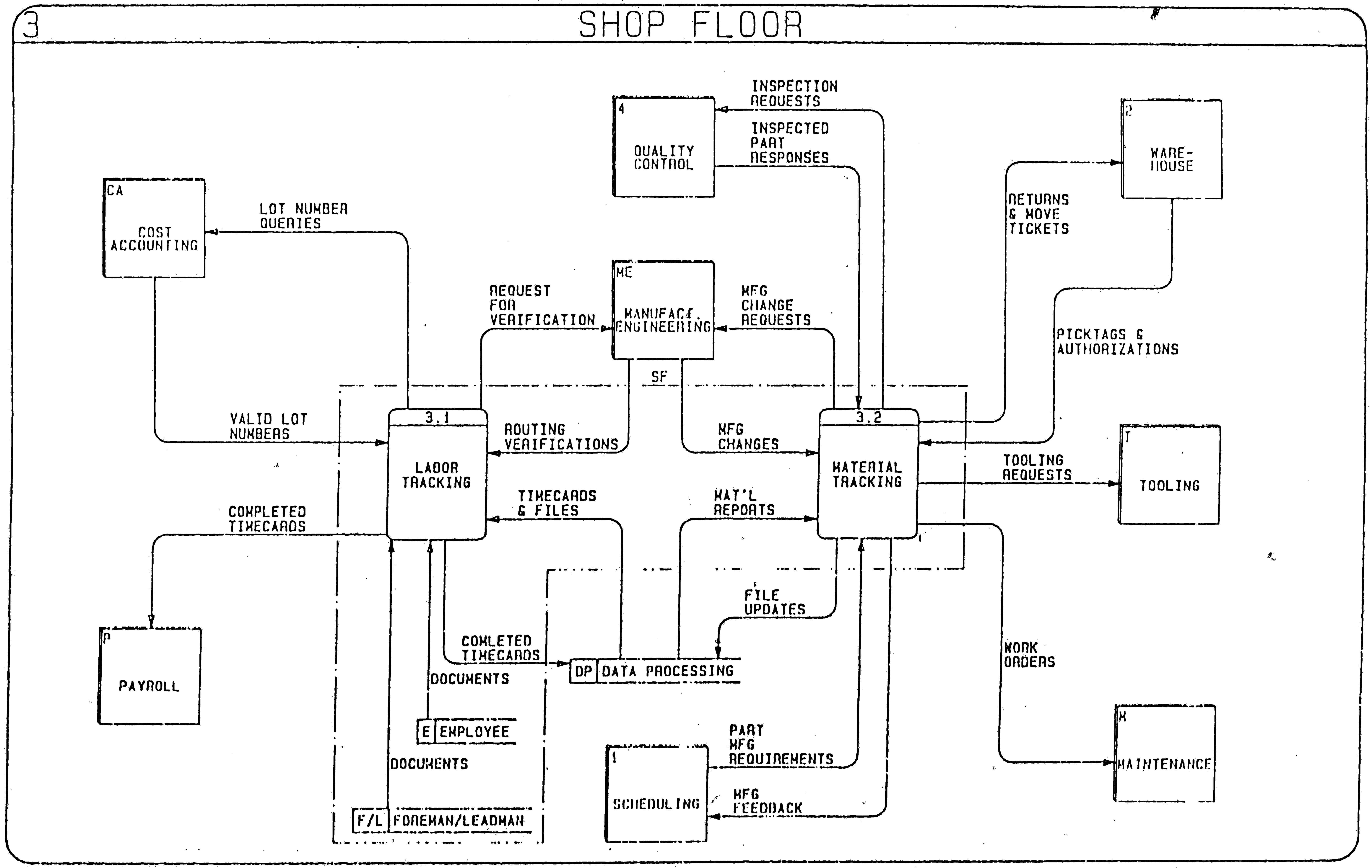

3
SHOP FLOOR
4
QUALITY CONTROL
INSPECTION REQUESTS
INSPECTED PART RESPONSES
2
WARE-HOUSE
CA
COST ACCOUNTING
LOT NUMBER QUERIES
RETURNS & MOVE TICKETS
ME
MANUFACT. ENGINEERING
REQUEST FOR VERIFICATION
MFG CHANGE REQUESTS
PICKTAGS & AUTHORIZATIONS
SF
3.1
LABOR TRACKING
3.2
MATERIAL TRACKING
VALID LOT NUMBERS
ROUTING VERIFICATIONS
MFG CHANGES
T
TOOLING
TOOLING REQUESTS
COMPLETED TIMECARDS
TIMECARDS & FILES
MAT'L REPORTS
FILE UPDATES
P
PAYROLL
COMLETED TIMECARDS
DP
DATA PROCESSING
WORK ORDERS
DOCUMENTS
E
EMPLOYEE
DOCUMENTS
1
SCHEDULING
PART MFG REQUIREMENTS
MFG FEEDBACK
M
MAINTENANCE
F/L
FOREMAN/LEADMAN

Figure 4

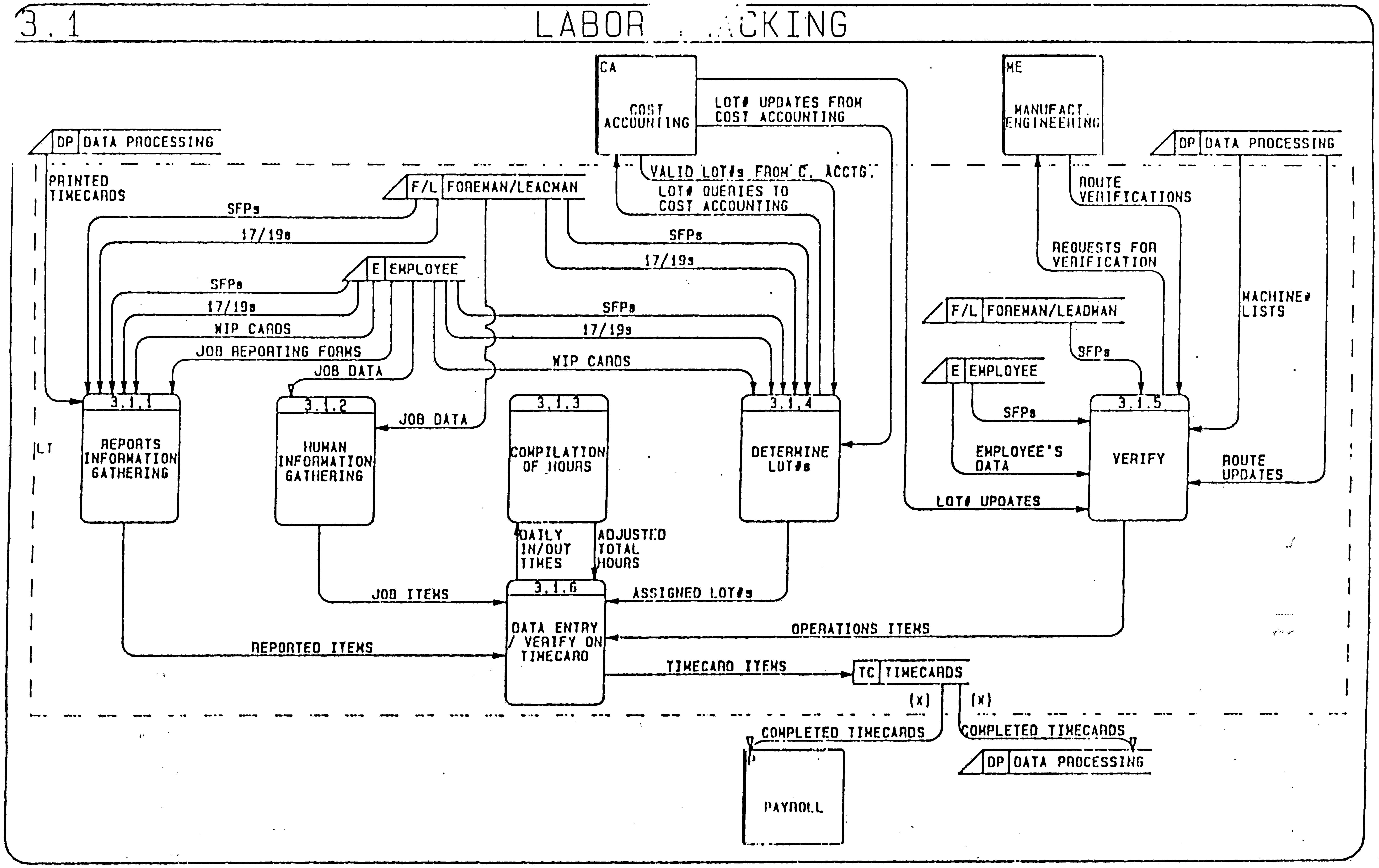
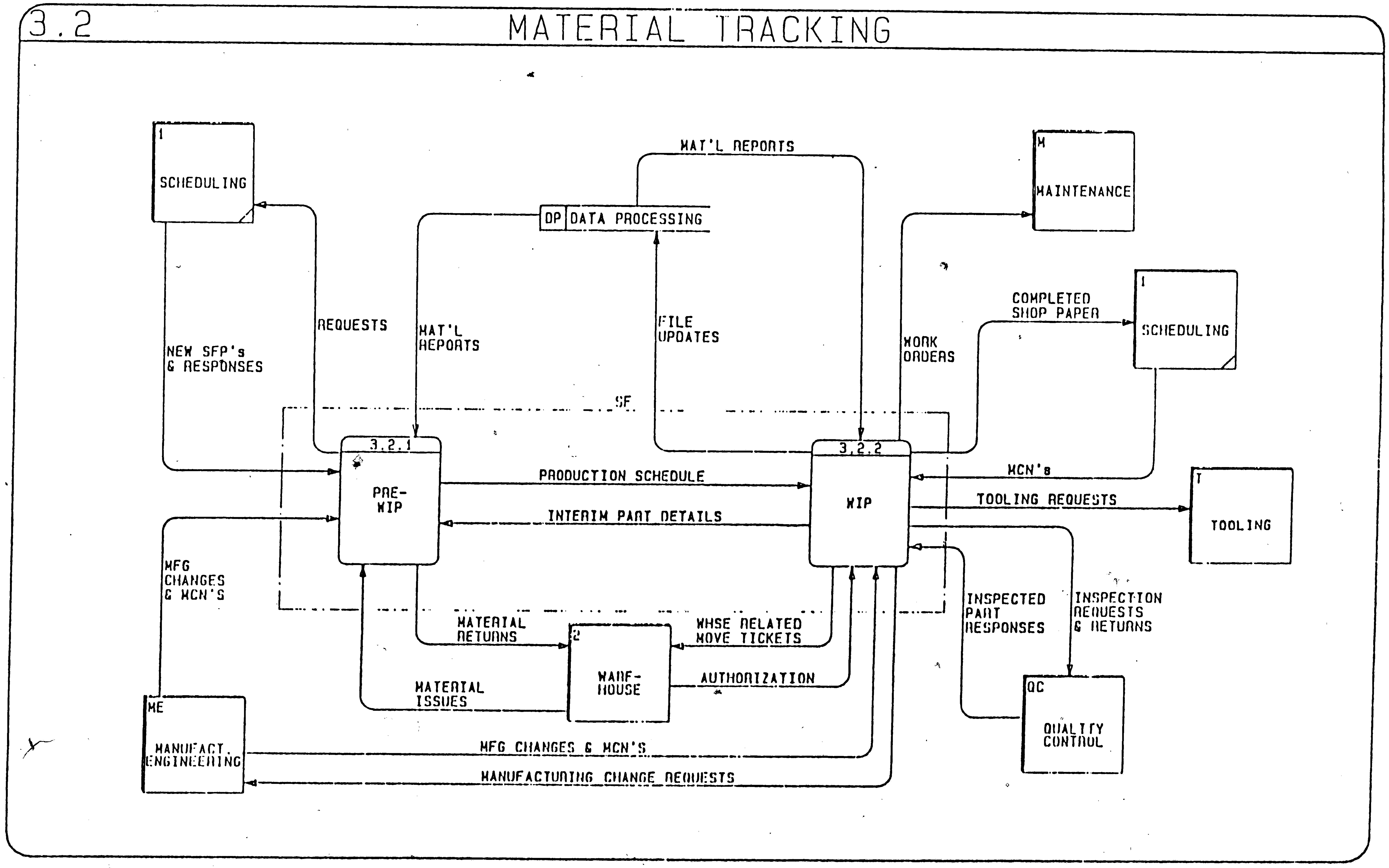

3.1
LABOR CKING
CA
COST ACCOUNTING
LOT# UPDATES FROM COST ACCOUNTING
ME
MANUFACT. ENGINEERING
DP DATA PROCESSING
PRINTED TIMECARDS
F/L FOREMAN/LEADMAN
VALID LOT#s FROM C. ACCTG.
LOT# QUERIES TO COST ACCOUNTING
ROUTE VERIFICATIONS
SFPs
17/19s
E EMPLOYEE
WIP CARDS
JOB REPORTING FORMS
JOB DATA
REQUESTS FOR VERIFICATION
MACHINE# LISTS
3.1.1
REPORTS INFORMATION GATHERING
3.1.2
HUMAN INFORMATION GATHERING
3.1.3
COMPILATION OF HOURS
3.1.4
DETERMINE LOT#s
3.1.5
VERIFY
LT
EMPLOYEE'S DATA
ROUTE UPDATES
LOT# UPDATES
DAILY IN/OUT TIMES
ADJUSTED TOTAL HOURS
3.1.6
DATA ENTRY / VERIFY ON TIMECARD
JOB ITEMS
ASSIGNED LOT#s
OPERATIONS ITEMS
REPORTED ITEMS
TIMECARD ITEMS
TC TIMECARDS
(x)
COMPLETED TIMECARDS
PAYROLL

Figure 5



3.2
MATERIAL TRACKING
1
SCHEDULING
MAT'L REPORTS
DP
DATA PROCESSING
M
MAINTENANCE
COMPLETED
SHOP PAPER
1
SCHEDULING
REQUESTS
MAT'L
REPORTS
FILE
UPDATES
WORK
ORDERS
NEW SFP's
& RESPONSES
SF
3.2.1
PRE-
WIP
3.2.2
WIP
PRODUCTION SCHEDULE
INTERIM PART DETAILS
MCN's
TOOLING REQUESTS
T
TOOLING
MFG
CHANGES
& MCN'S
MATERIAL
RETURNS
WHSE RELATED
MOVE TICKETS
2
WARE-
HOUSE
AUTHORIZATION
MATERIAL
ISSUES
INSPECTED
PART
RESPONSES
INSPECTION
REQUESTS
& RETURNS
QC
QUALITY
CONTROL
ME
MANUFACT.
ENGINEERING
MFG CHANGES & MCN'S
MANUFACTURING CHANGE REQUESTS

Figure 6

detailed study. The shop floor interacted regulary with many traditionally inter-related functions such as maintenance, quality control, scheduling, and the data processing group. In addition, there was frequent contact with cost accounting due to the contract-tracking requirements of DoD regulations.

In Figure 4, the level-one diagram labeled 3 - Shop Floor shows the decomposition of the system into logically almost independent labor and material tracking functions. The level-two diagrams, included in the Appendix, show the basic components of these processes. Although the two systems are triggered by many of the same events, the information flows of each are handled separately from one another.

Modeling Problems Encountered:

The need for a data structure flexible enough to handle a construct such as "human being" is necessary as seen in Figure 5. Neither a data store nor a process is as descriptive a structure as needed, even though humans are capable of performing the tasks assigned to the structures.

Allowance for multiple methods or process choices would be useful. An example is shown in Figure 5 where the data flow Completed Timecards goes to one of two places depending on certain known conditions. In the diagram, the symbol "*" is used to show a logical OR option, as advocated by some structured analysis techniques.

A closer connection between levels of data flow is required. As can be seen in comparing Figures 3, 4, and 6, the data flow name for the information passed between Shop Floor/Material Tracking and Manufacturing Engineering has different names (due to the differing levels of detail available) at each level. This connectivity is critical within the data dictionary.

Test Case Two

Food Producer's Production Scheduling System

Company Description:

A small, privately owned manufacturer of snack food products.

Project Purpose and Scope:

The focus for this project included all aspects of production scheduling. The goal was the documentation of the scheduling function and an analysis of weaknesses and strengths found therein. Based on the analysis, recommendation for improvement were to be made.

Project Approach and Results:

A small team consisting of two full-time university people and two part-time company people completed the basic system documentation after less than a month of data collection and revision. Because the analysis portion of the project required additional tools not integrated with the model, analysis required several more months of effort for one of the university members.

During the documentation of the system, it became evident that the scheduling function relied completely on one set of resources, with no back-up or fail-safe available. As a result, a computer-based scheduling assistant was developed and a previously high risk to the company was significantly reduced.

Model Size:

A small system consisting of 50 data flows and 25 processes was described. One data store and six external entities were included. Approximately 25 interviews occured during data collection and model verification. Work monitoring techniques were also used to collect information.

High Level Model Description:

Production scheduling is closely tied to the production planning, order control, shipping and production functions as shown in Figure 7. Although, it is not normally in direct communication with the order entry process, this process labeled 1.1 is the internal driver for the entire system, and therefore required careful examination. In addition to these processes, production scheduling works closely with the sales/marketing group, the purchasing entity, and shipping, as well as large customers. Diagrams 1.1 through 1.7, located in the Appendix, depict the workings

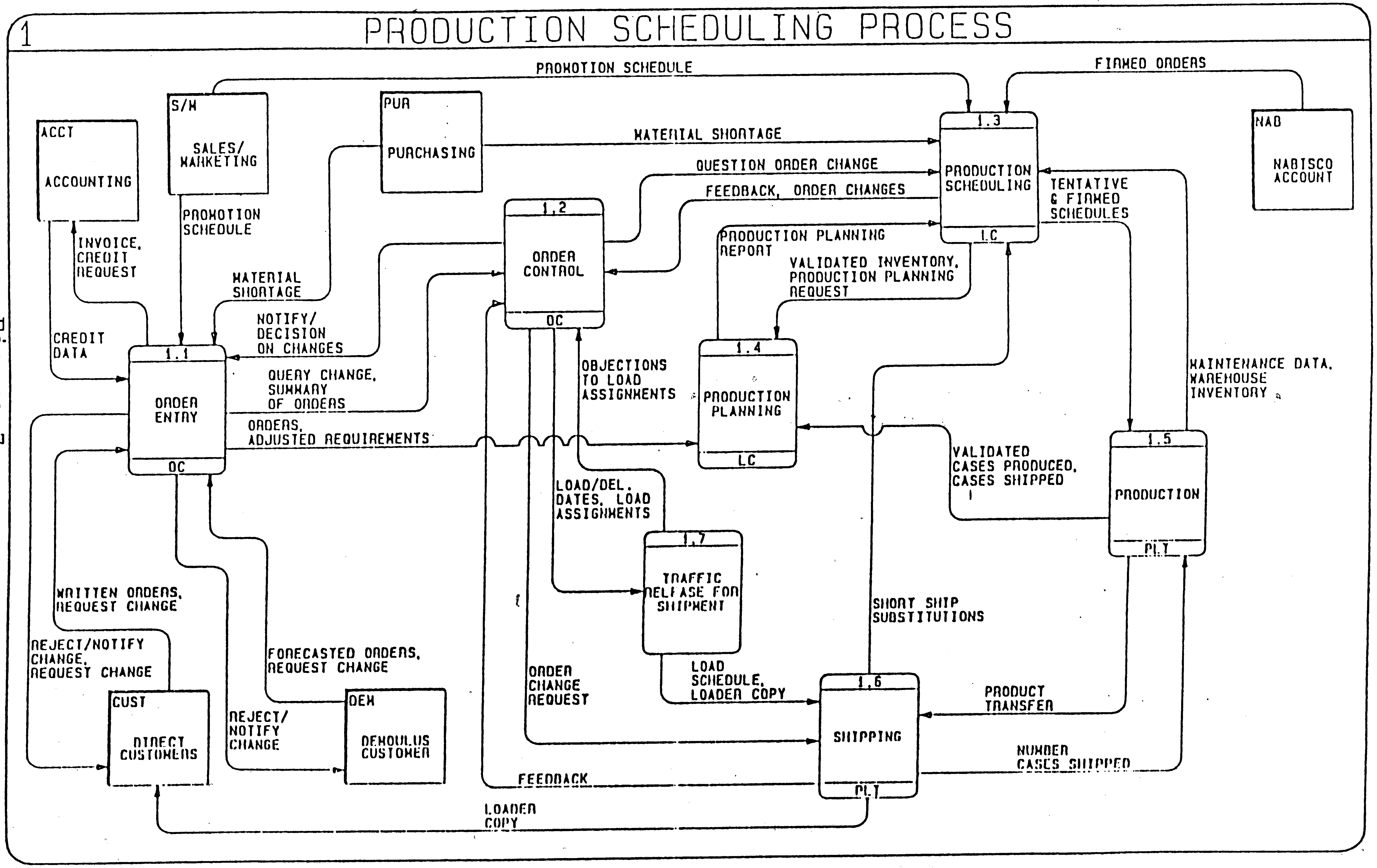

1
PRODUCTION SCHEDULING PROCESS
PROMOTION SCHEDULE
FIRMED ORDERS
S/M
SALES/
MARKETING
PUR
PURCHASING
ACCT
ACCOUNTING
NAB
NABISCO
ACCOUNT
MATERIAL SHORTAGE
1.3
PRODUCTION
SCHEDULING
LC
QUESTION ORDER CHANGE
FEEDBACK, ORDER CHANGES
TENTATIVE
& FIRMED
SCHEDULES
PROMOTION
SCHEDULE
INVOICE,
CREDIT
REQUEST
MATERIAL
SHORTAGE
1.2
ORDER
CONTROL
OC
PRODUCTION PLANNING
REPORT
VALIDATED INVENTORY,
PRODUCTION PLANNING
REQUEST
CREDIT
DATA
NOTIFY/
DECISION
ON CHANGES
1.1
ORDER
ENTRY
OC
QUERY CHANGE,
SUMMARY
OF ORDERS
ORDERS,
ADJUSTED REQUIREMENTS
OBJECTIONS
TO LOAD
ASSIGNMENTS
1.4
PRODUCTION
PLANNING
LC
MAINTENANCE DATA,
WAREHOUSE
INVENTORY
VALIDATED
CASES PRODUCED,
CASES SHIPPED
1.5
PRODUCTION
PLT
LOAD/DEL.
DATES, LOAD
ASSIGNMENTS
1.7
TRAFFIC
RELEASE FOR
SHIPMENT
WRITTEN ORDERS,
REQUEST CHANGE
SHORT SHIP
SUBSTITUTIONS
REJECT/NOTIFY
CHANGE,
REQUEST CHANGE
FORECASTED ORDERS,
REQUEST CHANGE
ORDER
CHANGE
REQUEST
LOAD
SCHEDULE,
LOADER COPY
1.6
SHIPPING
PLT
PRODUCT
TRANSFER
CUST
DIRECT
CUSTOMERS
REJECT/
NOTIFY
CHANGE
DEM
DEMOULUS
CUSTOMER
NUMBER
CASES SHIPPED
FEEDBACK
LOADER
COPY

Figure 7

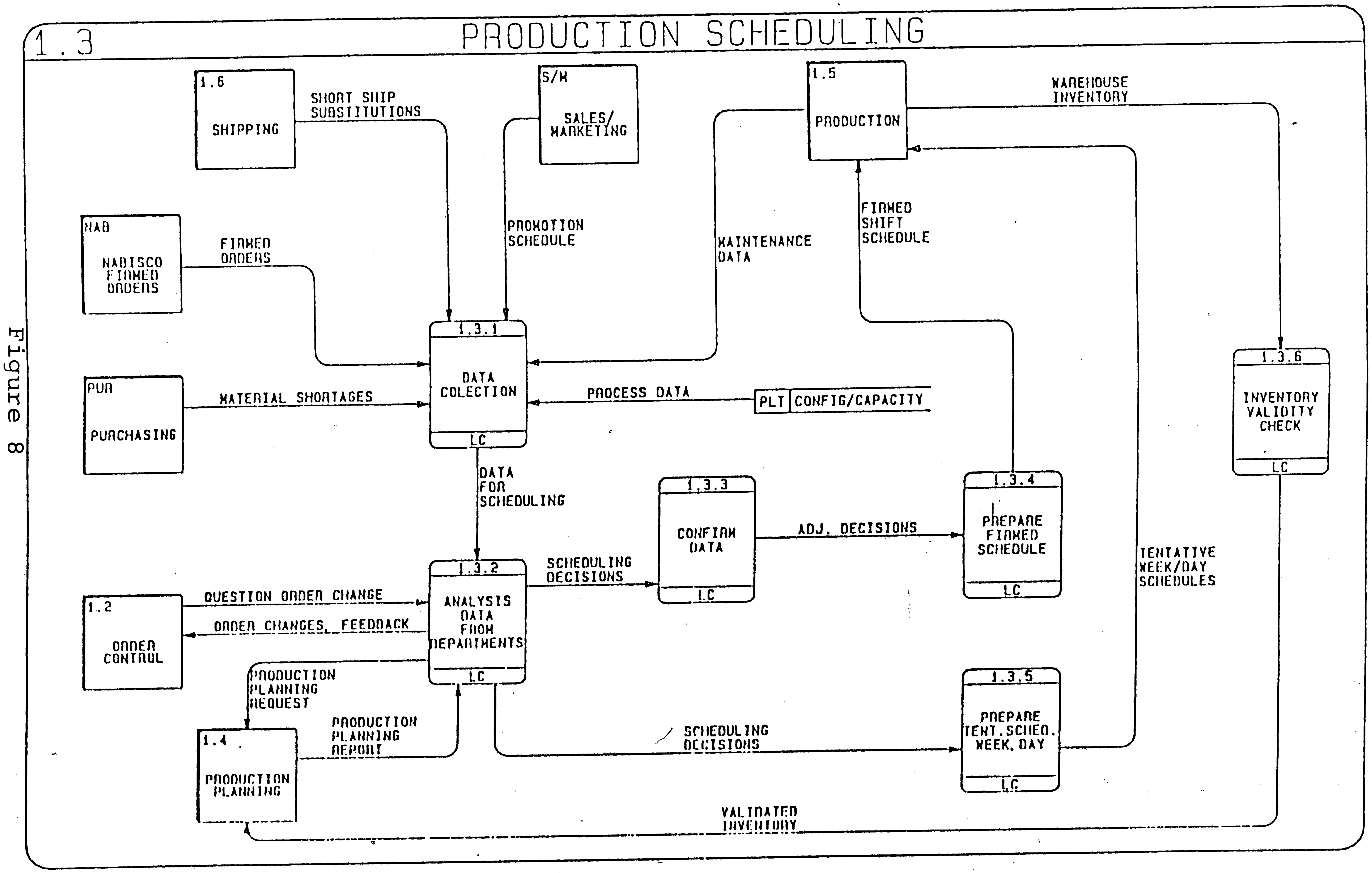

1.3
PRODUCTION SCHEDULING
1.6
SHIPPING
SHORT SHIP SUBSTITUTIONS
S/M
SALES/ MARKETING
1.5
PRODUCTION
WAREHOUSE INVENTORY
NAB
NABISCO FIRMED ORDERS
FIRMED ORDERS
PROMOTION SCHEDULE
MAINTENANCE DATA
FIRMED SHIFT SCHEDULE
1.3.1
DATA COLECTION
LC
PUR
PURCHASING
MATERIAL SHORTAGES
PROCESS DATA
PLT
CONFIG/CAPACITY
1.3.6
INVENTORY VALIDITY CHECK
LC
DATA FOR SCHEDULING
1.3.3
CONFIRM DATA
LC
ADJ. DECISIONS
1.3.4
PREPARE FIRMED SCHEDULE
LC
TENTATIVE WEEK/DAY SCHEDULES
1.3.2
ANALYSIS DATA FROM DEPARTMENTS
LC
SCHEDULING DECISIONS
1.2
ORDER CONTROL
QUESTION ORDER CHANGE
ORDER CHANGES, FEEDBACK
PRODUCTION PLANNING REQUEST
1.4
PRODUCTION PLANNING
PRODUCTION PLANNING REPORT
SCHEDULING DECISIONS
1.3.5
PREPARE TENT. SCHED. WEEK, DAY
LC
VALIDATED INVENTORY

Figure 8
28

of the inter-related processes.

Modeling Problems Encountered:

The artificial structure imposed upon the system under examination by the "no more than seven data elements per diagram" convention can produce great confusion about the true nature of that system. Figure 7 shows several more data elements than it normally should, but to divide the elements randomly to accomodate the page size would falsely alter the system structure.

Interfaces with other, more task-specific analysis tools should be possible. Depicted in Figure 8, the process labeled 1.3.4, Prepare Firmed Schedule, is best further explained through the use of a spreadsheet program, but no link to the structured analysis tool exists. As a result of this problem, model integration between the structured model and the spreadsheet model became a major issue.

Test Case Three

Computer Manufacturer's Production Communications Systems

Company Description:

A mid-to-large size manufacturer of personal and mini computer systems.

Project Purpose and Scope:

The goal of this analysis was to investigate the feasibility of a common manufacturing communication and networking standard. The standard was to be implemented for the production floor and related functions by multiple plants within a division. Each plant however, manufactured different products and posessed varying levels of technological sophistication.

Project Approach and Results:

Because multiple plants were involved but time constraints did not permit detailed analysis of each one, it was decided that the two plants at either end of the technology spectrum would be modeled. It was reasoned that if the architecture could support these two environments, that the remaining plants could also adopt the architecture.

Based on this approach, three teams were developed. A three-person team of full-time university personnel worked on-site at each of the plants for intensive one-week data collection periods. One team of company personnel from each plant provided location support and high-level information. Following the data collection, an eight week period of data analysis ensued. Approximately four of the weeks were spent on model creation and structured analysis.

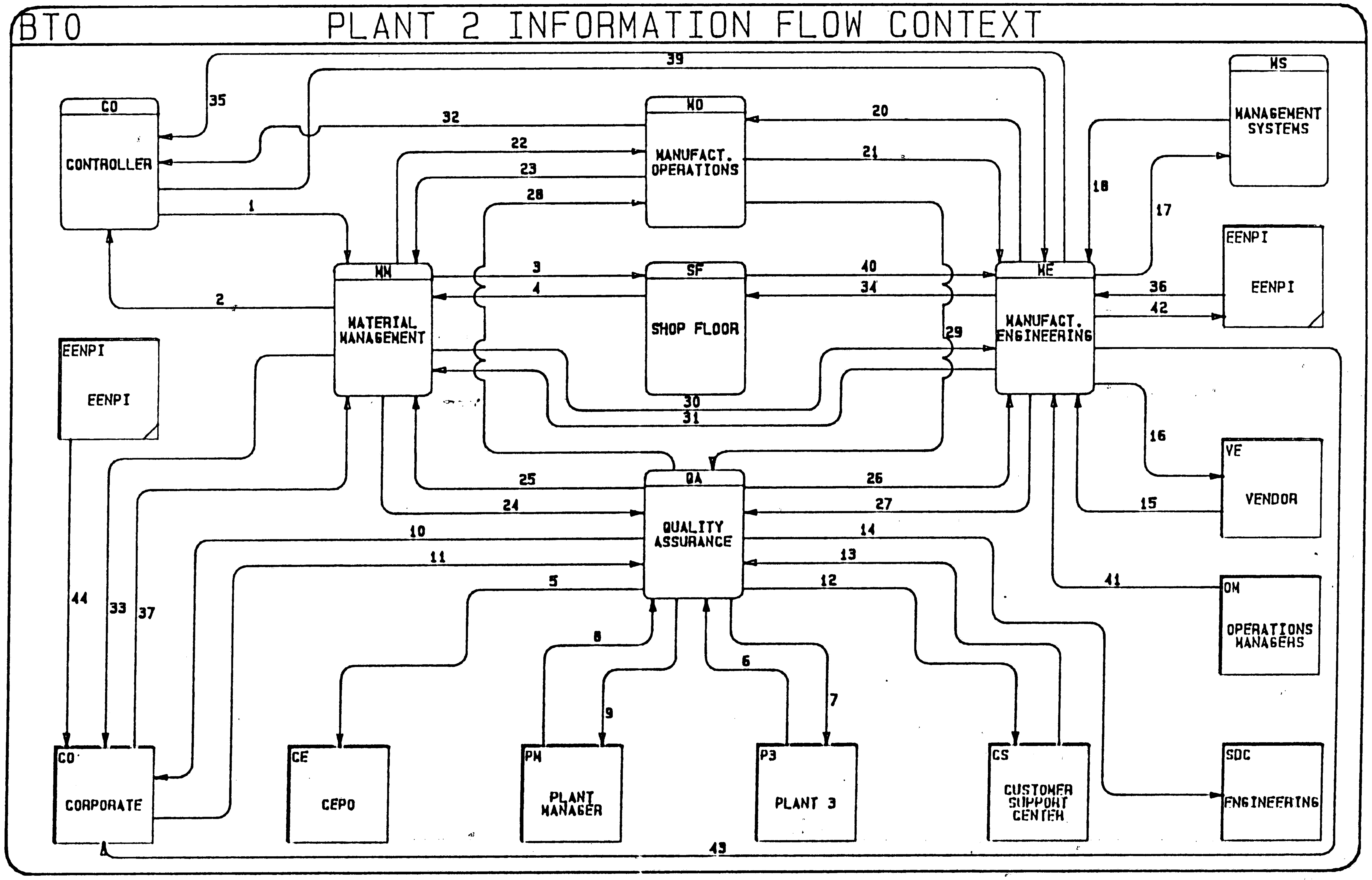
Model Size:

The completed model contained over 150 data flows and over 60 distinct processes. Four external entities were included in the model. Between 50 and 75 interviews were performed during the data collection phase. Review of existing protocols and systems was also utilized.

High Level Model Description:

Although the plants were considerably different from one another from product and manufacturing technology aspects, their methods of operation and overall functionality were similar. Some similarities were to be expected given the fact that they were plant within the same division of a corporation, but these resemblences quickly dissipated beyond the highest model level.

Figures 9 and 10, BF0 and BT0, are the context diagram



BTO
PLANT 2 INFORMATION FLOW CONTEXT
CO
CONTROLLER
MO
MANUFACT. OPERATIONS
MS
MANAGEMENT SYSTEMS
MM
MATERIAL MANAGEMENT
SF
SHOP FLOOR
ME
MANUFACT. ENGINEERING
EENPI
EENPI
EENPI
EENPI
QA
QUALITY ASSURANCE
VE
VENDOR
OM
OPERATIONS MANAGERS
CO
CORPORATE
CE
CEPO
PM
PLANT MANAGER
P3
PLANT 3
CS
CUSTOMER SUPPORT CENTER
SDC
ENGINEERING
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
20
21
22
23
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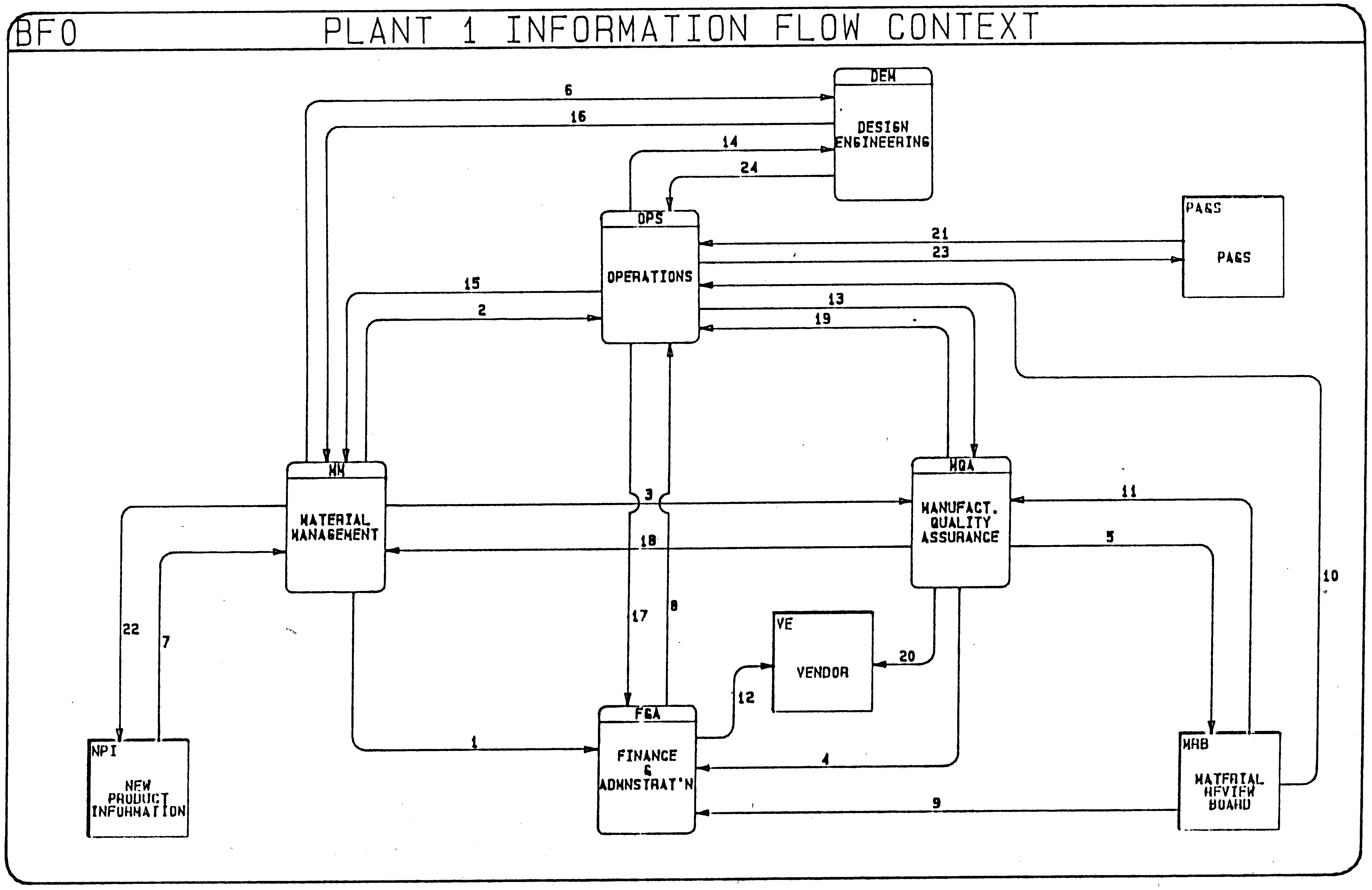
42
43
44

Figure 9


BFO
PLANT 1 INFORMATION FLOW CONTEXT
DEW
DESIGN ENGINEERING
OPS
OPERATIONS
PA&S
PA&S
MM
MATERIAL MANAGEMENT
MQA
MANUFACT. QUALITY ASSURANCE
VE
VENDOR
F&A
FINANCE & ADMNSTRAT'N
NPI
NEW PRODUCT INFORMATION
MRB
MATERIAL REVIEW BOARD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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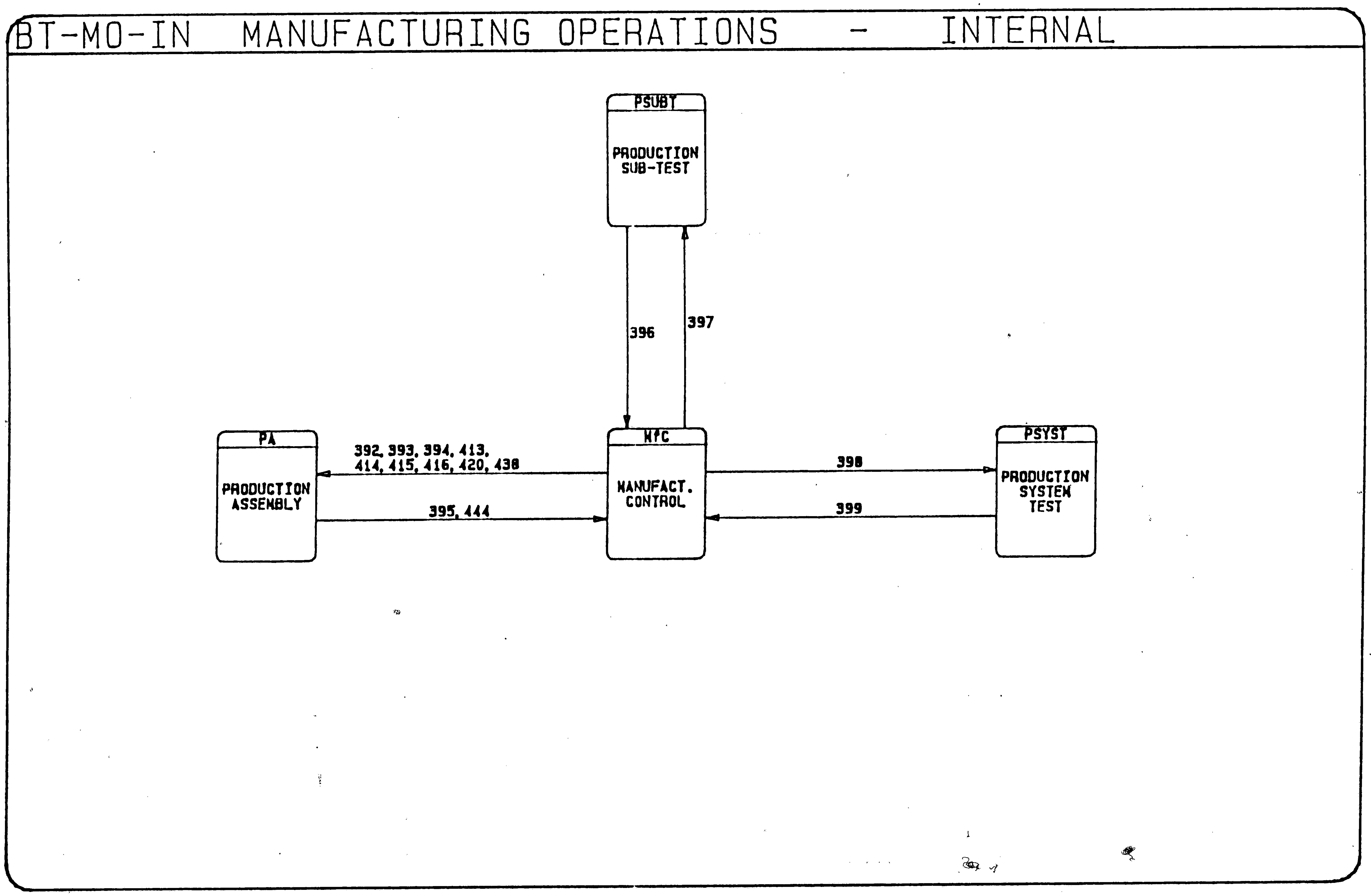
21
22
23
24

Figure 10



BT-MO-IN MANUFACTURING OPERATIONS - INTERNAL
PSUBT
PRODUCTION SUB-TEST
396
397
PA
PRODUCTION ASSEMBLY
392, 393, 394, 413, 414, 415, 416, 420, 438
395, 444
MFC
MANUFACT. CONTROL
398
399
PSYST
PRODUCTION SYSTEM TEST

Figure 11

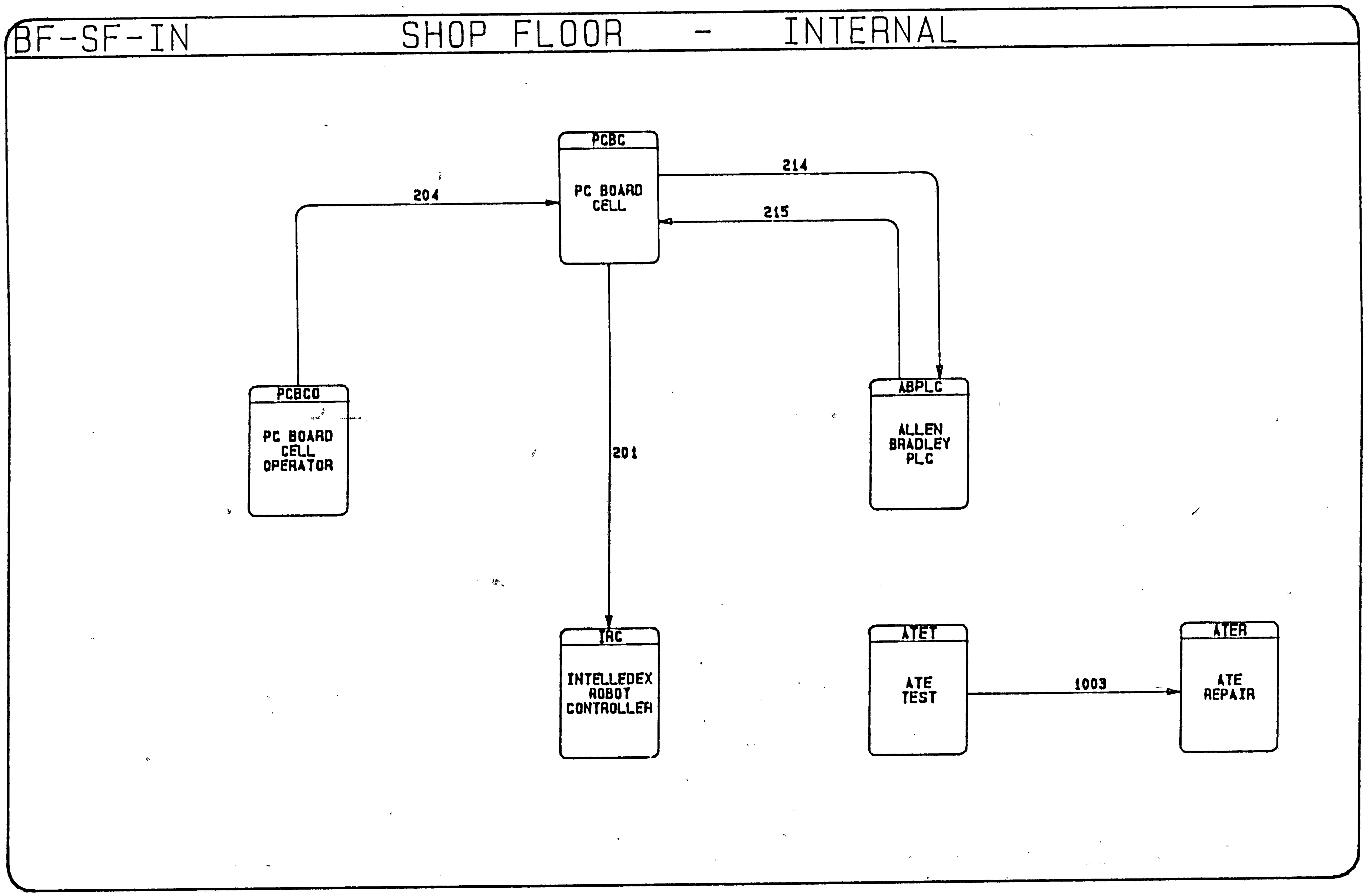

BF-SF-IN
SHOP FLOOR - INTERNAL
PCBC
PC BOARD CELL
PCBCO
PC BOARD CELL OPERATOR
ABPLC
ALLEN BRADLEY PLC
IRC
INTELLEDEX ROBOT CONTROLLER
ATET
ATE TEST
ATER
ATE REPAIR
204
214
215
201
1003

Figure 12

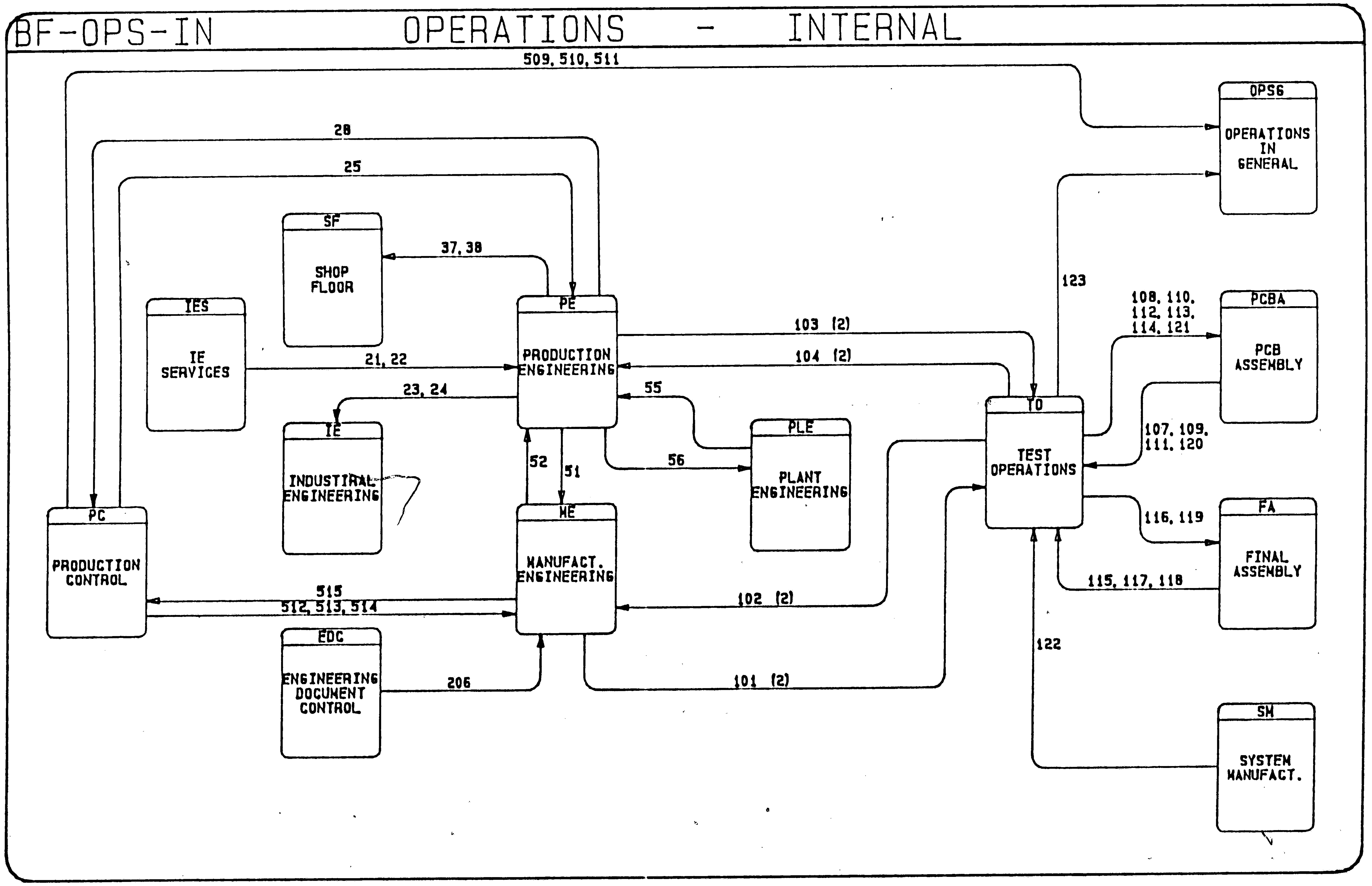

BF-OPS-IN OPERATIONS - INTERNAL
509, 510, 511
28
25
OPS6
OPERATIONS IN GENERAL
SF
SHOP FLOOR
37, 38
IES
IE SERVICES
21, 22
PE
PRODUCTION ENGINEERING
23, 24
IE
INDUSTRIAL ENGINEERING
55
56
PLE
PLANT ENGINEERING
52
51
ME
MANUFACT. ENGINEERING
PC
PRODUCTION CONTROL
515
512, 513, 514
EDC
ENGINEERING DOCUMENT CONTROL
206
103 (2)
104 (2)
102 (2)
101 (2)
123
TO
TEST OPERATIONS
108, 110, 112, 113, 114, 121
PCBA
PCB ASSEMBLY
107, 109, 111, 120
116, 119
FA
FINAL ASSEMBLY
115, 117, 118
122
SM
SYSTEM MANUFACT.

Figure 13

for the two plants. Here, the commonality can be easily recognized, particularly when it is noted that the operation function on BF0 is equivalent to the two separate functions denoted as manufacturing operations and manufacturing engineering on diagram BT0.

Examination of the level one diagrams, included in the Appendix, begins to highlight the differences between the two organizations. Much of the functionality is the same but the implementations are radically different. The functionality and implementations of the respective shop floors as shown in the diagrams designated by -SF-IN, are different as dictated by their product lines.

Modeling Problems Encountered:

Structured analysis techniques require that the physical and logical models be completely separated from one another. For this project, the two models had to be viewed more as two facets of the same stone and the analysis tool was not able to accomodate the need. This is evidenced in Figures 11 and 12, where physical names had to be assigned to what should have been logical entities in order to tie the diagrams to the other physical model.

As was the case in the previous study, the need for a link to other analysis tools existed. Figure 12 models an aspect of the system which required mathematical analysis of data loads and transmission frequencies. This requirement could not be met within the data dictionary and a separate tool had to be utilized, creating the need for further cross-model integrity checks.

A filtering capability for the over-all model as well as individual levels or sections would permit much greater usefulness of the model. Figure 13 presents a view of internal operations at one of the plants. Each functional group represented reported to one of a few divisional groups. The ability to highlight one or more groups for analysis would have eliminated the need for manual evaluations.

Test Case Four

Automotive Electronics Manufacturer's Parts Ordering And Control System

Company Description:

One of the "Big Three" United States automobile manufacturing sites. This plant is responsible for production of electrical and electronic control systems for the corporation's major assembly plants.

Project Purpose and Scope:

The goal of this study was to develop a detailed understanding and documentation of the production scheduling and purchased-material order control functions. This was necessary because a new plant was being built and the manufacturing philosophy was shifting to a Just-In-Time concept and it was felt that the current system could not support the shift. Development of a current model was accomplished in order to identify those components which required modification or replacement.

Project Approach and Results:

Two university people served as modelers, one full-time and one quarter-time. They were responsible for data collection, model development and analysis. The company provided no team as such, but provided access to the individuals performing the fuctions under analysis. The data collection lasted three weeks. The modeling and analysis were completed within six weeks.

The modeling effort showed the current system to be completely incompatible with the operating philosophy of the new plant. As a result, a newly-designed system was recommended and approved for the facility.

Model Size:

The model consisted of approximately 50 data flows and 25 processes. Six data stores and three external entities were included. Under 25 interviews were used to collect the data.

High Level Model Description:

As shown in the context diagram on Figure 14, the master production scheduling and material control functions were the focus of the examination. The level one diagram, Figure 15, of the scheduling functions illustrates the many phases of the process and the tremendous dependence on several different computing systems, modeled as data stores. The level one material control diagram, Figure 16, is oriented more toward the purchased parts cycle rather than the production parts.

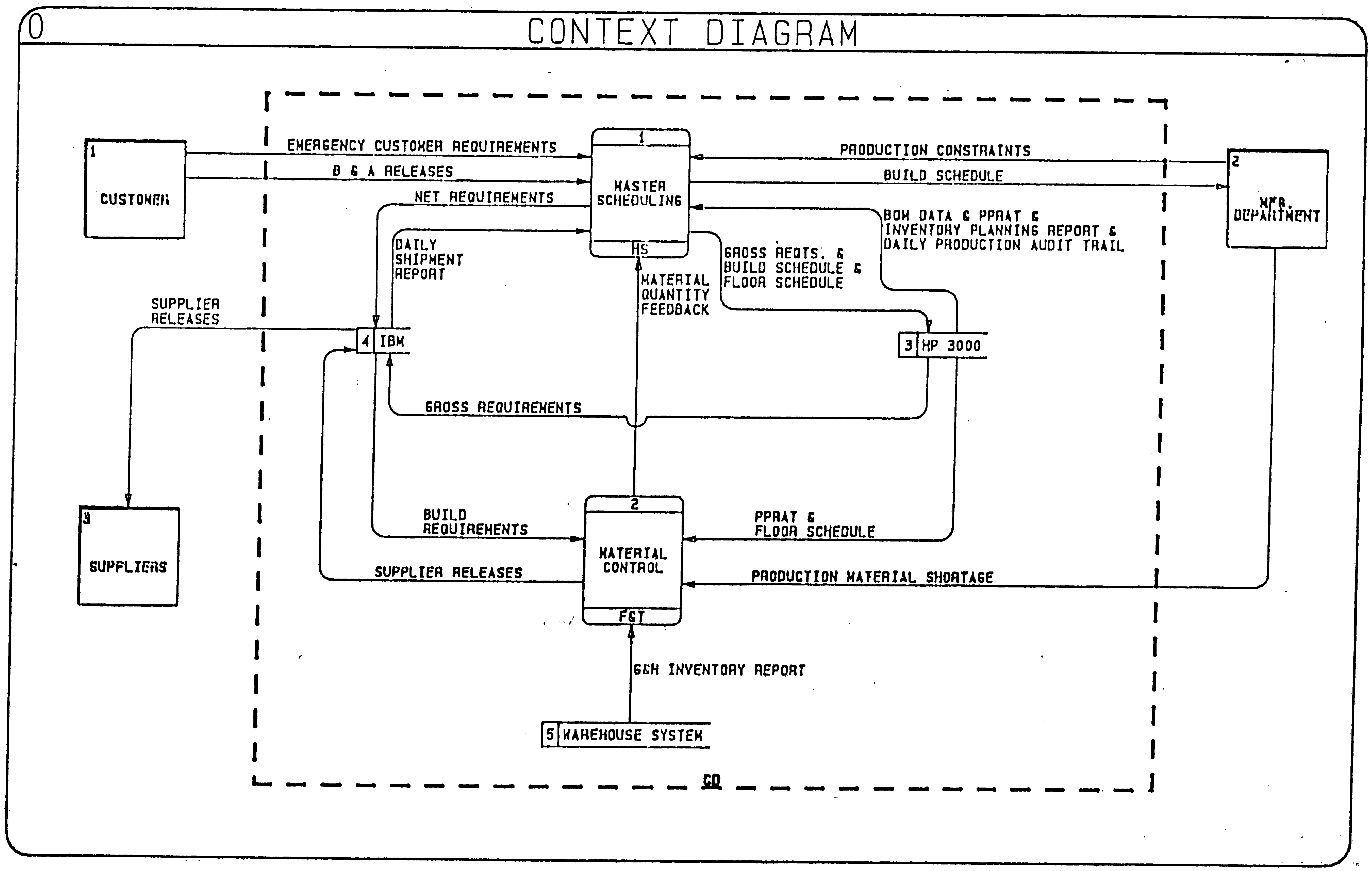

0
CONTEXT DIAGRAM
1 CUSTOMER
2 MFG. DEPARTMENT
3 SUPPLIERS
1 MASTER SCHEDULING
MS
2 MATERIAL CONTROL
FGT
4 IBM
3 HP 3000
5 WAREHOUSE SYSTEM
EMERGENCY CUSTOMER REQUIREMENTS
B & A RELEASES
NET REQUIREMENTS
PRODUCTION CONSTRAINTS
BUILD SCHEDULE
BOM DATA & PPRAT & INVENTORY PLANNING REPORT & DAILY PRODUCTION AUDIT TRAIL
DAILY SHIPMENT REPORT
MATERIAL QUANTITY FEEDBACK
GROSS REQTS. & BUILD SCHEDULE & FLOOR SCHEDULE
SUPPLIER RELEASES
GROSS REQUIREMENTS
BUILD REQUIREMENTS
PPRAT & FLOOR SCHEDULE
SUPPLIER RELEASES
PRODUCTION MATERIAL SHORTAGE
G&H INVENTORY REPORT
CD

Figure 14

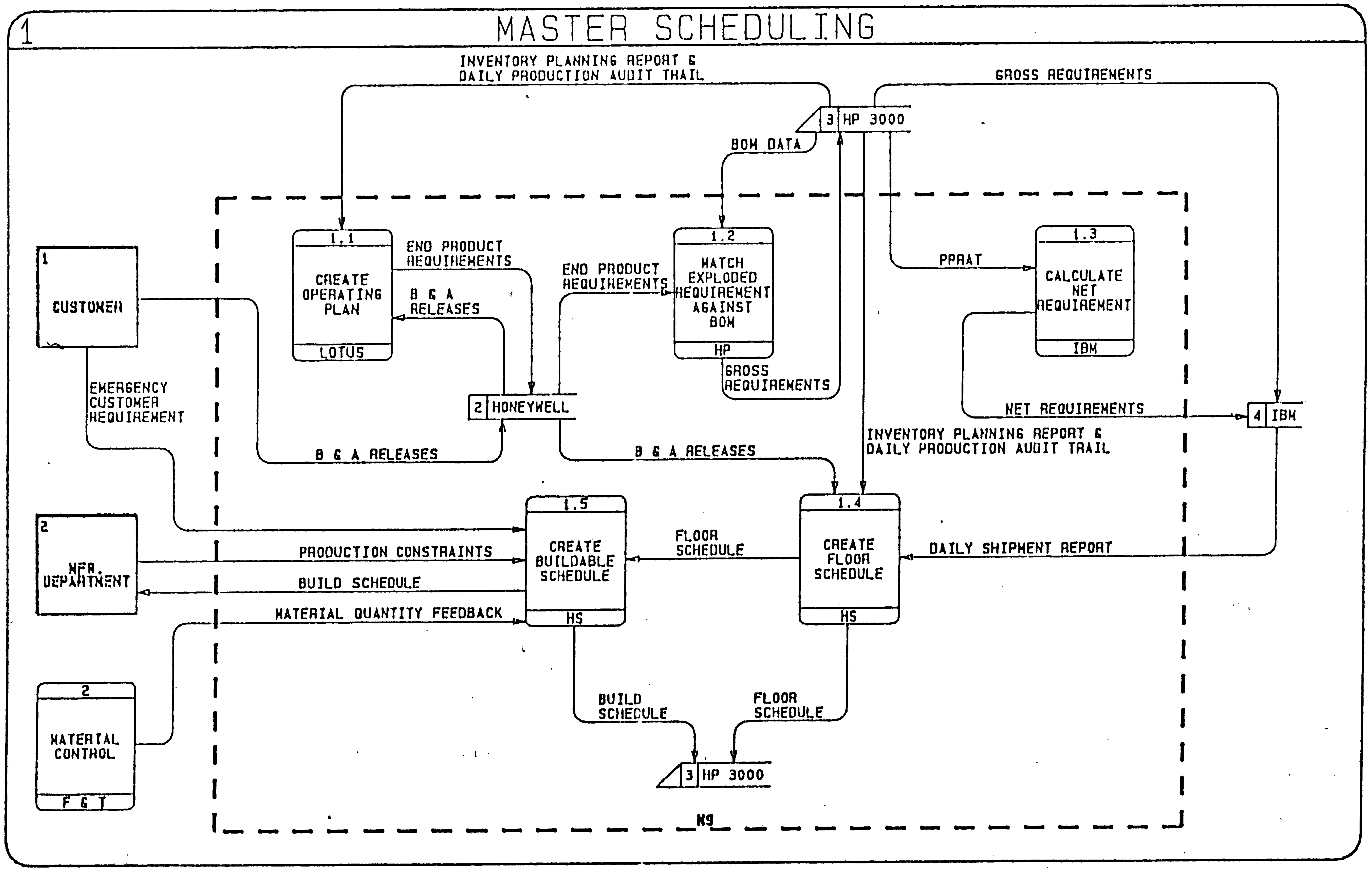

1 MASTER SCHEDULING
INVENTORY PLANNING REPORT & DAILY PRODUCTION AUDIT TRAIL
GROSS REQUIREMENTS
3 HP 3000
BOM DATA
1 CUSTOMER
1.1 CREATE OPERATING PLAN LOTUS
END PRODUCT REQUIREMENTS
B & A RELEASES
END PRODUCT REQUIREMENTS
1.2 MATCH EXPLODED REQUIREMENT AGAINST BOM HP
GROSS REQUIREMENTS
PPRAT
1.3 CALCULATE NET REQUIREMENT IBM
NET REQUIREMENTS
4 IBM
EMERGENCY CUSTOMER REQUIREMENT
2 HONEYWELL
B & A RELEASES
B & A RELEASES
INVENTORY PLANNING REPORT & DAILY PRODUCTION AUDIT TRAIL
2 MFG. DEPARTMENT
1.5 CREATE BUILDABLE SCHEDULE HS
FLOOR SCHEDULE
1.4 CREATE FLOOR SCHEDULE HS
DAILY SHIPMENT REPORT
PRODUCTION CONSTRAINTS
BUILD SCHEDULE
MATERIAL QUANTITY FEEDBACK
2 MATERIAL CONTROL F & T
BUILD SCHEDULE
FLOOR SCHEDULE
3 HP 3000
NS

Figure 15

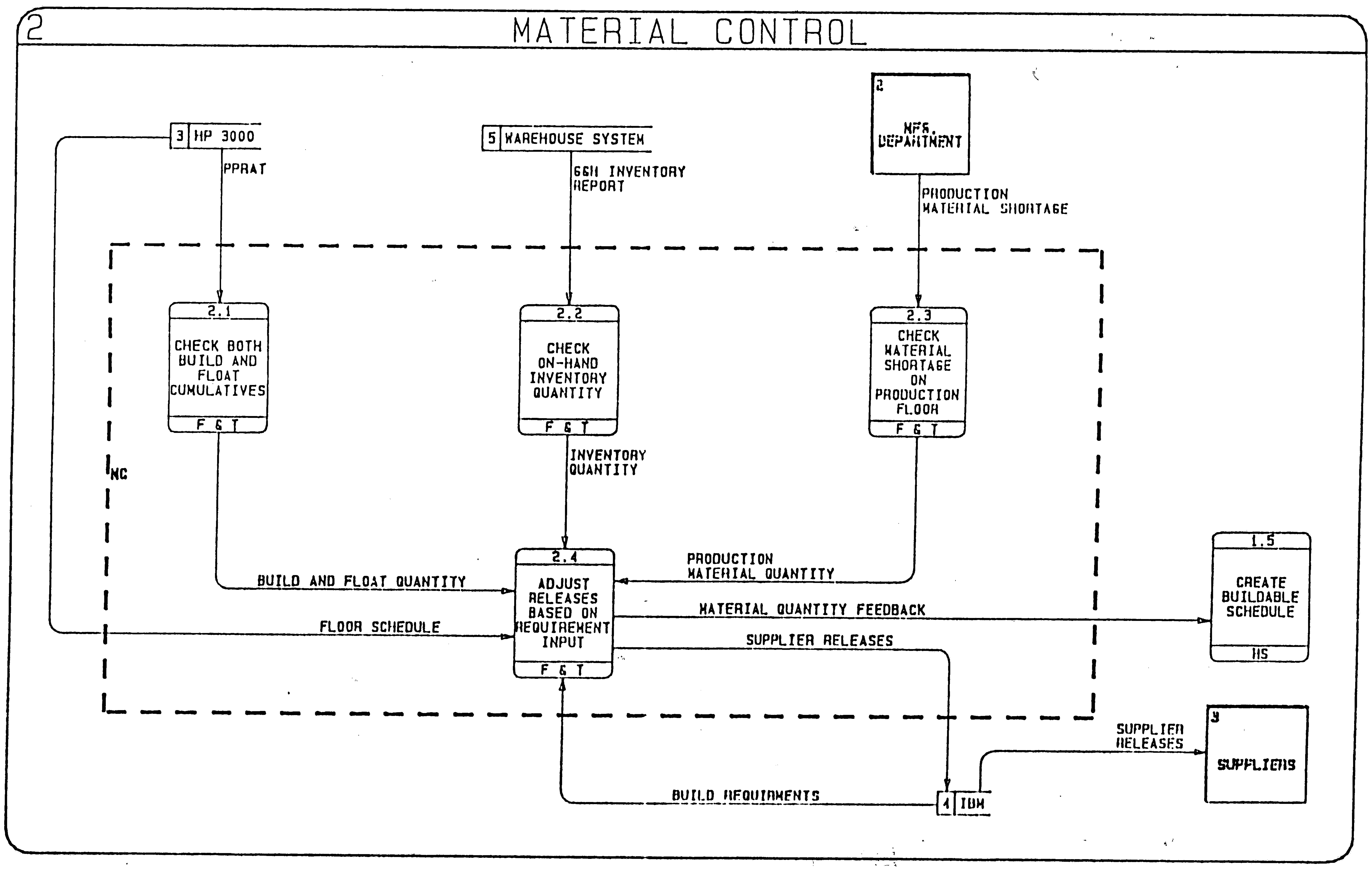

2 MATERIAL CONTROL
3 HP 3000
PPRAT
5 WAREHOUSE SYSTEM
66H INVENTORY REPORT
2 MFG. DEPARTMENT
PRODUCTION MATERIAL SHORTAGE
2.1 CHECK BOTH BUILD AND FLOAT CUMULATIVES F & T
2.2 CHECK ON-HAND INVENTORY QUANTITY F & T
2.3 CHECK MATERIAL SHORTAGE ON PRODUCTION FLOOR F & T
INVENTORY QUANTITY
MC
BUILD AND FLOAT QUANTITY
FLOOR SCHEDULE
PRODUCTION MATERIAL QUANTITY
2.4 ADJUST RELEASES BASED ON REQUIREMENT INPUT F & T
MATERIAL QUANTITY FEEDBACK
SUPPLIER RELEASES
1.5 CREATE BUILDABLE SCHEDULE HS
SUPPLIER RELEASES
3 SUPPLIERS
BUILD REQUIRMENTS
4 IDM

Figure 16

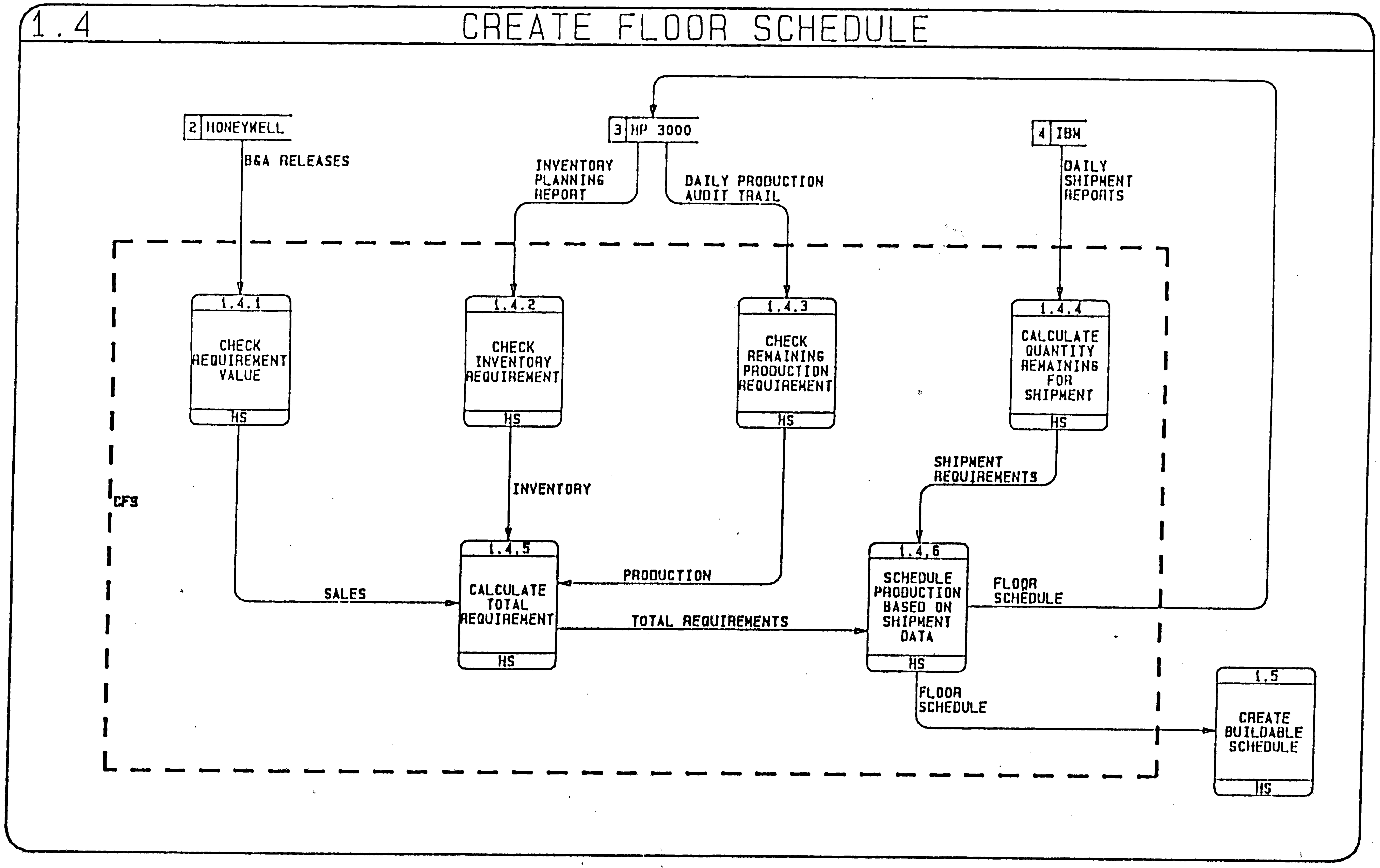
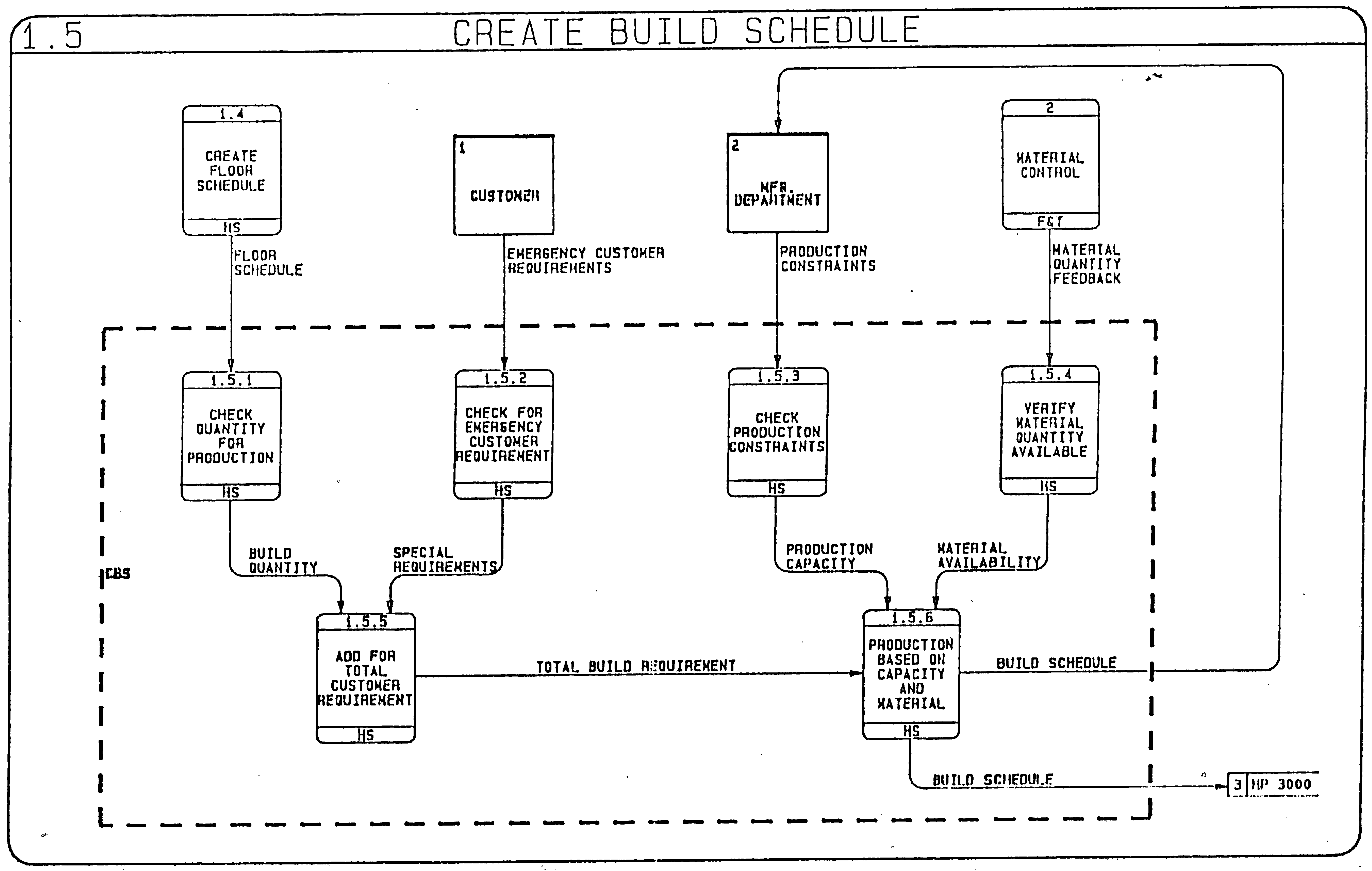

1.4
CREATE FLOOR SCHEDULE
2 HONEYWELL
B&A RELEASES
3 HP 3000
INVENTORY PLANNING REPORT
DAILY PRODUCTION AUDIT TRAIL
4 IBM
DAILY SHIPMENT REPORTS
1.4.1
CHECK REQUIREMENT VALUE
HS
1.4.2
CHECK INVENTORY REQUIREMENT
HS
1.4.3
CHECK REMAINING PRODUCTION REQUIREMENT
HS
1.4.4
CALCULATE QUANTITY REMAINING FOR SHIPMENT
HS
INVENTORY
SHIPMENT REQUIREMENTS
CFS
1.4.5
CALCULATE TOTAL REQUIREMENT
HS
PRODUCTION
SALES
TOTAL REQUIREMENTS
1.4.6
SCHEDULE PRODUCTION BASED ON SHIPMENT DATA
HS
FLOOR SCHEDULE
FLOOR SCHEDULE
1.5
CREATE BUILDABLE SCHEDULE
HS

Figure 17



1.5
CREATE BUILD SCHEDULE
1.4
CREATE FLOOR SCHEDULE
HS
1
CUSTOMER
2
MFG. DEPARTMENT
2
MATERIAL CONTROL
F&T
FLOOR SCHEDULE
EMERGENCY CUSTOMER REQUIREMENTS
PRODUCTION CONSTRAINTS
MATERIAL QUANTITY FEEDBACK
1.5.1
CHECK QUANTITY FOR PRODUCTION
HS
1.5.2
CHECK FOR EMERGENCY CUSTOMER REQUIREMENT
HS
1.5.3
CHECK PRODUCTION CONSTRAINTS
HS
1.5.4
VERIFY MATERIAL QUANTITY AVAILABLE
HS
CBS
BUILD QUANTITY
SPECIAL REQUIREMENTS
PRODUCTION CAPACITY
MATERIAL AVAILABILITY
1.5.5
ADD FOR TOTAL CUSTOMER REQUIREMENT
HS
TOTAL BUILD REQUIREMENT
1.5.6
PRODUCTION BASED ON CAPACITY AND MATERIAL
HS
BUILD SCHEDULE
BUILD SCHEDULE
3
HP 3000

Figure 18

The level two diagrams, found in the Appendix, serve to further detail the scheduling function.

Modeling Problems Encountered:

The ability to create a model that is unruly, incomplete, or contradictory must exist. Most of the tools available at present require completeness and will flag contradictions for correction. While these features are helpful in reducing unintentional modeling errors, an over-ride must exist to permit "errors". Many systems are modeled because they are KNOWN to have problems and the identification of these areas are the goal and must be representable. Figure 16 represents the ideal of a process which in real-life does not work. There was no method available to model the failure.

The filtering function described in Case 3 would also have been useful in this case. Figures 17 and 18 describe functions which are dependent upon several factors. During analysis, the separation of the functions would have saved considerable analysis time.

CHAPTER 4

FUNCTIONAL REQUIREMENTS DEVELOPMENT

The problems described with the modeling of the manufacturing systems presented in Chapter 3 serve as the basis for several functional requirements for a new analysis technique. Those problems primarily address model structure and element functionality issues and they will be restated in this chapter as requirements. In addition to these issues, specifications related to implementation support, and ease-of-use and maintenance control topics are covered.

Model Structure and Element Functionality

* Analysis

First and foremost, the analysis tool must be capable of creating a true <u>model</u>. The techniques and tools available today merely store facts about the system in an organized fashion and produce a simple, standardized representation. The burden of conceptualizing and analyzing the system rests with the user. The new tool(s) must provide verifiable, working models capable of undergoing analysis.

* Flexibility

Current modeling techniques do not allow for the deliberate creation of incomplete or incorrect systems. But it is precisely these systems which have the greatest need to be modeled and analyzed for improvement. Therefore, it is critical that any new tools not only permit this functionality, but allow concentration to be focused upon model "wrongness", in order to support correction analysis.

Although it is useful to supply guidelines for model creation, the imposition of artificial structure (such as the seven entity per page rule) defeats one of the purposes of modeling. The analyst must be free to model the system as it exists.

The ability to assign user-defined keys to any or all of the data structures and then filter the model would greatly enhance the analysis capability of the modeling tool. This would provide a "facet" quality to the model, thereby permitting different views of reality to be examined.

* Data Structures

The existing set of data structures is too limited. Future tools should allow for more complex and user-defined structures in order to more accurately describe system components such as humans.

Closer and more obvious connectivity must be supported for structures between model levels of abstraction. At present, too much of the burden rests with the designer of the data dictionary.

* Logic Operators

It is frequently insufficient to show only information flow on the graphical system model. The addition of logic operators to indicate flow and process options, such as exception and emergency alternatives or ownership versus control status, would significantly improve the clarity of the graphic model representation.

* Interfaces to Other Analysis Tools

No one analysis tool can be expected to handle all of the aspects of systems analysis that now exist and will be created as our systems become more and more complex. Rather, these tools should have the ability to link with one another, reducing the need for redundant modeling and analysis efforts. The systems analyst should have access to structured techniques, decision trees and state tables, mathematical computation packages, spreadsheets, simulators, and/or whatever additional tools the system requires.

Implementation Support

* Graphics

Since the diagrams are an essential component of the analysis technique, graphic support is critical. The tool or tools must provide mechanisms which allow for easy creation and manipulation of graphic elements. Particularly in the case of the data flow element, there should be both a default generation mode and a user-controlled option. This would permit the analyst to change the path, bend-points, or style of the element only when the default setting is unacceptable. The graphics generation facility should naturally provide color and high-resolution attributes.

* Device And Platform Support

In today's multi-vendor marketplace, any structured analysis implementations should be highly portable, providing mobility across several hardware and software platforms. Particular attention to support of several input and output devices is desirable. Aside from keyboard entry of information, other input mechanisms such as barcodes or direct data transfer should be offered. A wide variety of printers and plotters should be supportable, as well as electronic file transfer.

Ease of Use and Maintenance Control

* Conventions for user-defined elements

Although freedom from methodological constraints is desirable, the methodology should provide significant assistance to the analyst in terms of guidelines and conventions for user-defined elements. Examples include new data structure uses, naming standards, and help in establishing indexing mechanisms for the diagrams and structures.

* Rough-cut and Development Support

None of the current structured analysis packages provide a useful means of supporting developing diagrams. A rough-sketch mechanism which bypasses all of the consistency model integrity checks should exist. During the data collection and early investigation stages of modeling, a diagram or set of diagrams may be revised dozens of times and completely re-drawn several times. Because rough-sketching is not supported, this is usually handled manually, requiring a great deal of time and effort. Neatly drawn diagrams, even during development are important since the graphic model representation is often used as the guideline for detailed data collection and model verification with the system experts. Once the diagram has been roughed-out, a transformation facility should exist to transport the diagram from development into the model. During the transfer, the integrity and model consistency checks could be applied.

* Change Control

Particularly on systems projects involving multiple analysts, change control is a critical function. The last five years have produced improvements to the structured analysis packages available, but more work must be done. System directed checks for both graphical and dictionary integrity and consistency should exist. In addition, users should be able to direct consistency checks of the model, searching for specific problems.

Security and revision control should offer several levels of standard protection covering the elements of the model, the activities and procedures applicable to the model, as well as the model itself. In addition, an option for system-manager designed safeguards should be offered.

CHAPTER 5

CONCLUSIONS AND AREAS FOR FUTURE WORK

At the present time, a widely applicable but robust tool for the documentation and analysis of manufacturing systems does not exist. The need for such a tool will only increase with time and our desire to create newer, more complex and highly integrated systems. Very little work has been done in this area and the field is open wide for future research and development.

Our current capability to model manufacturing systems is much like that of the geometric modeler twenty years ago. At that time, geometries were described in terms of points, lines, and curves from each of three views, usually Top, Side, and Front. But no model of the part existed. Instead, the individual geometric views were recorded and these isolated entities were reproduced in a standard fashion, leaving the conceptualization and analysis of the model to the user. Similarly, systems analysts today merely collect and deposit facts about a system without ever creating a real model. They are unable to directly work with and examine a system model and are forced to rely upon their individual capacity for conceptualization and imagination.

With the advent of CAD technology, users moved to 3-D and solids modeling, and were thus provided with analysis techniques and tools. Although the manufacturing systems problem is much wider in scope, the task is the same: find a methodology and a technologically-supportable mechanism.

A promising candidate methodology to fill this void can be found in the development of a technique and tool based upon structured analysis. The basic premise does not restrict the set of systems to which the technique may be applied while still providing a sound foundation for a powerful set of modeling tools. The enhancement of this underlying methodology through the meeting of the requirements outlined in this thesis would provide the capability for significant advances in manufacturing systems analysis.

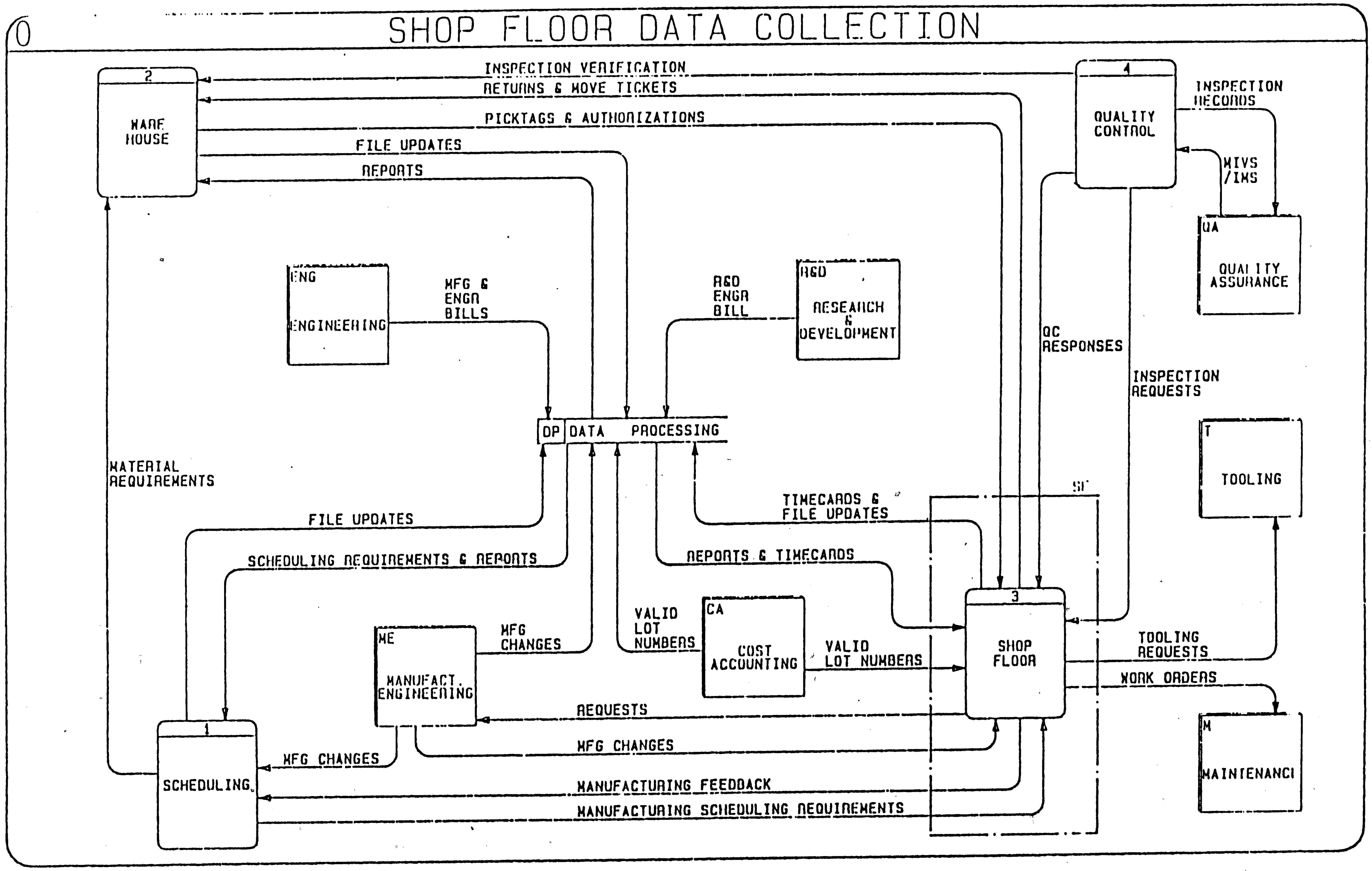
The methodology must be capable of providing a real model able to withstanding analysis. Additionally, it should offer modeling consistency and completeness, while not eliminating the user's freedom and ability to represent inexact systems. The modeling approach should allow for modular implementation of the techniques. It must be robust and powerful, yet it's concepts must be easy to understand and follow throughout implementation. In order to be useful, it must of course also be physically implementable.

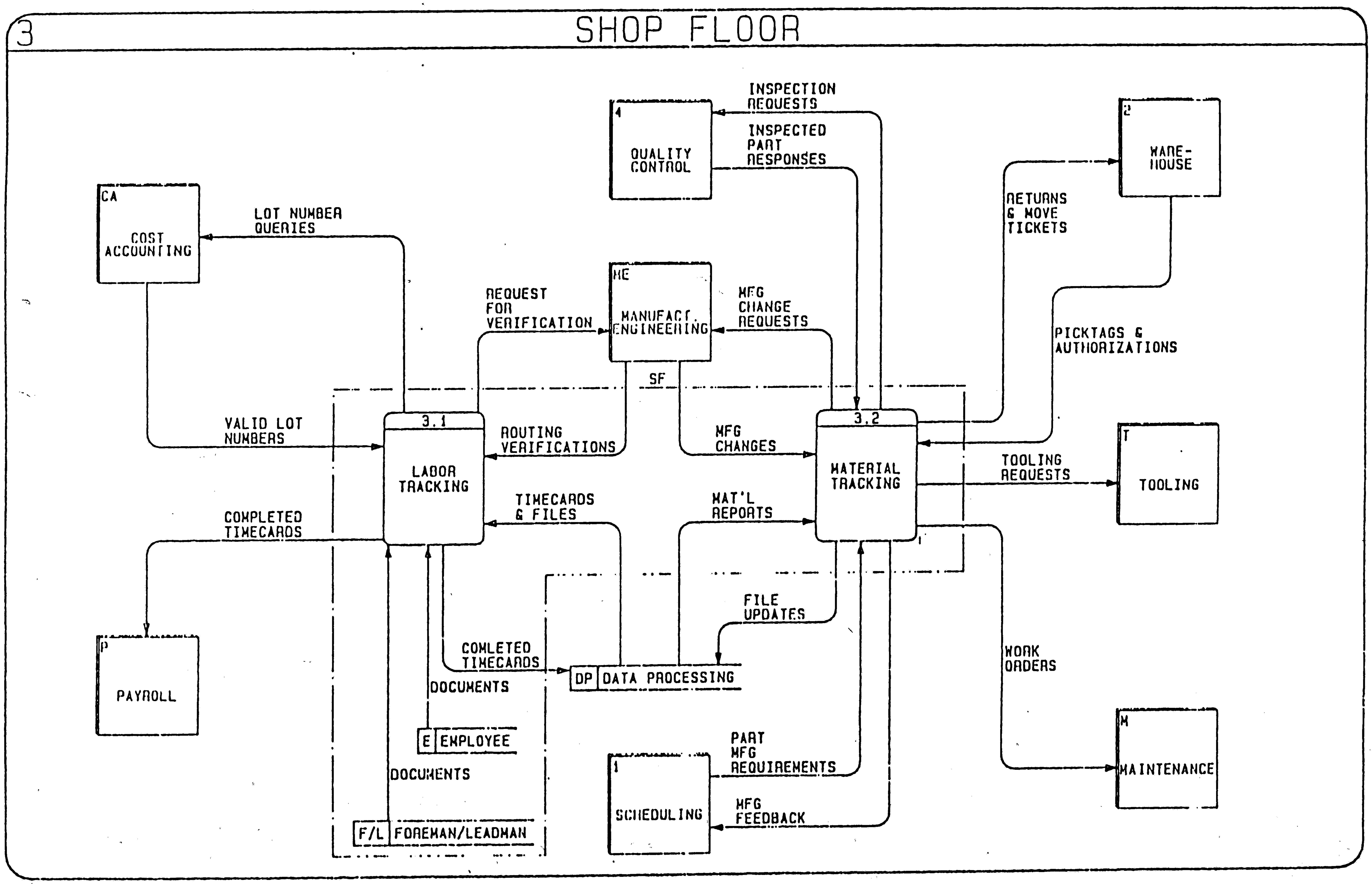
The implementation of the technique should support all of the attributes and requirements of the method as well as providing for user needs such as fast response and turn-around time, user friendliness, and high quality software and hardware support and portability.

This thesis has presented a requirements definition for a general-purpose manufacturing systems analysis tool. It is hoped by this author that the modest work begun here will spark an interest in providing a product for a market in great need, namely manufacturing professionals. Particularly in the U.S., where we have lost and continue to lose hold of our competitive edge, any contribution toward improving our ability to manage the manufacturing function should be encouraged. It is additionally hoped by the writer that the requirements set forth here will provide direction for future research into meeting the specifications and building such a tool.

APPENDIX

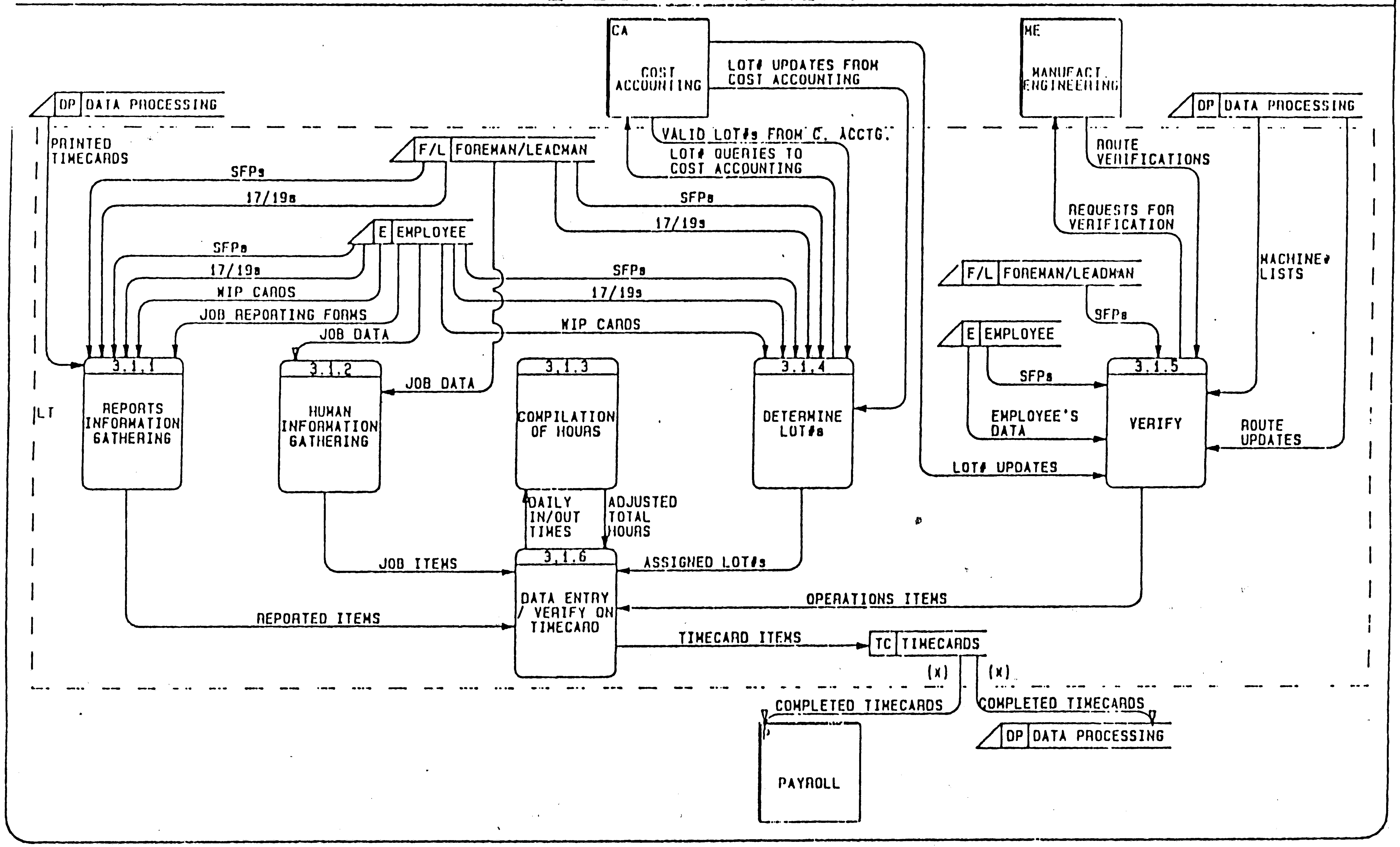
CASE 1


0
SHOP FLOOR DATA COLLECTION
2
WARE HOUSE
INSPECTION VERIFICATION
RETURNS & MOVE TICKETS
PICKTAGS & AUTHORIZATIONS
FILE UPDATES
REPORTS
4
QUALITY CONTROL
INSPECTION RECORDS
MIVS /IMS
QA
QUALITY ASSURANCE
ENG
ENGINEERING
MFG & ENGR BILLS
R&D ENGR BILL
R&D
RESEARCH & DEVELOPMENT
QC RESPONSES
INSPECTION REQUESTS
DP
DATA PROCESSING
T
TOOLING
MATERIAL REQUIREMENTS
TIMECARDS & FILE UPDATES
SF
FILE UPDATES
SCHEDULING REQUIREMENTS & REPORTS
REPORTS & TIMECARDS
VALID LOT NUMBERS
CA
COST ACCOUNTING
VALID LOT NUMBERS
3
SHOP FLOOR
TOOLING REQUESTS
WORK ORDERS
ME
MANUFACT. ENGINEERING
MFG CHANGES
REQUESTS
MFG CHANGES
M
MAINTENANCE
1
SCHEDULING
MFG CHANGES
MANUFACTURING FEEDBACK
MANUFACTURING SCHEDULING REQUIREMENTS

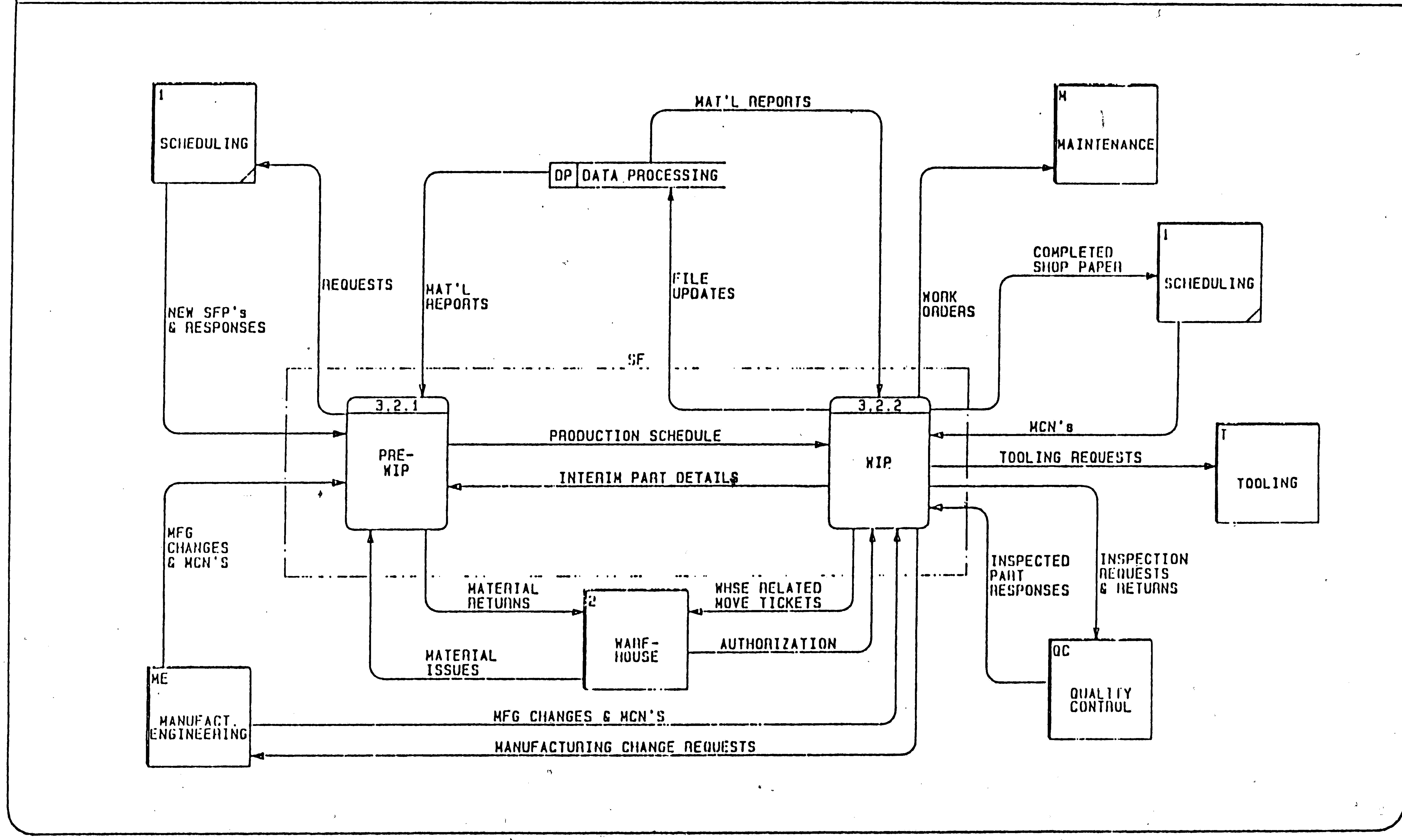


3
SHOP FLOOR
4
QUALITY CONTROL
INSPECTION REQUESTS
INSPECTED PART RESPONSES
2
WARE-HOUSE
CA
COST ACCOUNTING
LOT NUMBER QUERIES
RETURNS & MOVE TICKETS
ME
MANUFACT. ENGINEERING
REQUEST FOR VERIFICATION
MFG CHANGE REQUESTS
PICKTAGS & AUTHORIZATIONS
SF
VALID LOT NUMBERS
3.1
LABOR TRACKING
ROUTING VERIFICATIONS
MFG CHANGES
3.2
MATERIAL TRACKING
T
TOOLING
TOOLING REQUESTS
COMPLETED TIMECARDS
TIMECARDS & FILES
MAT'L REPORTS
FILE UPDATES
P
PAYROLL
COMLETED TIMECARDS
DP
DATA PROCESSING
WORK ORDERS
DOCUMENTS
E
EMPLOYEE
1
SCHEDULING
PART MFG REQUIREMENTS
M
MAINTENANCE
DOCUMENTS
MFG FEEDBACK
F/L
FOREMAN/LEADMAN

3.1 LABOR ..CKING



3.2 MATERIAL TRACKING



MINI SPEC ENTRY

PROCESS NAME: DATA ENTRY/VERIFY ON TIMECARD   PROCESS ID #: 3.1.6.

<DESCRIPTION:>

THE PROCEDURE WHEREBY THE FOLLOWING ARE WRITTEN ON THE TIMECARD: REPORTED ITEMS + JOB ITEMS + ADJUSTED TOTAL HOURS + ASSIGNED LOT#S + OPERATIONS ITEMS.

IN BOUND DATA FLOWS:	FREQUENCY PER (H,D,W,M)	USAGE PERCENT
1) REPORTED ITEMS	5000/D	99
2) JOB ITEMS	6750/D	99
3) ADJUSTED TOTAL HOURS	1775/D	99
4) ASSIGNED LOT#S	2750/D	99
5) OPERATIONS ITEMS	2350/D	99
6)	0/	0
7)	0/	0

OUT BOUND DATA FLOWS	
1) DAILY IN/OUT TIMES	1775/D
2) TIMECARD ITEMS	9999/D
3)	0/
4)	0/
5)	0/
6)	0/
7)	0/

<SPECIAL NOTES:>

FREQUENCY FOR THE OUT BOUND DATA FLOW TIMECARD ITEMS DENOTED ABOVE AS 9999/D ACTUALLY 18,625/D.

ACCURACY LEVEL: 99%
TIME IN PROCESS: 2 MINUTES
INITIALS: DER
LAST MODIFICATION DATE: 07/17/85
REVISION LEVEL: 2

<<LOGIC SUMMARY>>

WRITE ON TIMECARD: REPORTED ITEMS + JOB ITEMS + ADJUSTED TOTAL HOURS + ASSIGNED LOT#s + OPERATIONS ITEMS

DATA FLOW ENTRY

DATA FLOW NAME: WEEKLY PRINTED TIMECARDS

<DESCRIPTION:>

BADGE + DATE + SHIFT + NAME + DEPARTMENT + FOREMAN + TIME [illegible]

ORIGINATES FROM:

TYPE (DS,PR,EE)	NAME	AVERAGE (TRANSITION) TIME	NEED (BY) TIME
1) DS	DATA PROCESSING	1D	
2)			
3)			
4)			
5)			

ENTERS TO:

TYPE (DS,PR,EE)	NAME
1) DS	TIMEKEEPING OFFICE
2)	
3)	
4)	
5)	

* INDICATES DATA FLOW MOVEMENT FROM ONE MAJOR WORK CENTER TO ANOTHER MAJOR WORK CENTER

<SPECIAL NOTES:>

A BATCH OF A WEEK'S WORTH OF TIMECARDS IS TAKEN TO THE TIMEKEEPING OFFICE TOWARD THE END OF EACH WEEK FOR USE THE FOLLOWING WEEK.

ACCURACY LEVEL: 99%

MEDIUM USED: PAPER

DATA FLOW SIZE IN K-BYTES: 1

LAST MODIFICATION DATE: 07/16/85

REVISION LEVEL: 1

INITIALS: DER

DATA STORE ENTRY

DATA STORE NAME: EMPLOYEE (1 OF 2) PROCESS ID #: 5

<DESCRIPTION:>

INCLUDES ALL INDIVIDUALS WORKING ON THE SHOP FLOOR WHO REPORT THEIR HOURS FOR TIMECARD ENTRY

IN BOUND DATA FLOWS:	FREQUENCY PER(H,D,W,M)	USAGE PERCENT
1)	0/	0
2)	0/	0
3)	0/	0
4)	0/	0
5)	0/	0
6)	0/	0
7)	0/	0

OUT BOUND DATA FLOWS	
1) JOB REPORTING FORMS	100/D
2) JOB DETAILS	1200/D
3) SFPS	2100/D
4) CLOCK-IN TIMES	1600/D
5) CLOCK-OUT TIMES	1760/D
6) WIP CARDS	[illegible]
7) 17/195	250/D

LOCATIONS OF STORE	# OF USERS	LOCATIONS OF STORE	# OF USERS
…P FLOOR	11	2)	0
	0	4)	0
	0	6)	0
	0	8)	0
9)	0	10)	0
11)	0	12)	0
13)	0	14)	0
15)	0	16)	0
17)	0	18)	0
19)	0	20)	0

ORGANIZATION: HUMAN

UPDATE PROCESS:

VERBAL, PAPER

FREQUENCY OF UPDATE: 999/D

<SPECIAL NOTES>

FREQUENCY OF UPDATE DENOTED ABOVE AS 999/D ACTUALLY RANGES BETWEEN 1/DAY AND 20/DAY DUE TO THE NATURE OF THE DIFFERING WORKING ENVIRONMENTS.

REVISION LEVEL: 3 LAST DATE OF MODIFICATION: 07/27/85

ACCURACY LEVEL: 75% SIZE OF STORE IN K-BYTES: 1KB

INITIALS: DER

DATA STORE ENTRY

DATA STORE NAME: EMPLOYEE (2 OF 2) PROCESS ID #: E

<DESCRIPTION:>

SEE PAGE 1

IN BOUND DATA FLOWS:	FREQUENCY PER(H,D,W,M)	USAGE PERCENT
1)	0/	0
2)	0/	0
3)	0/	0
4)	0/	0
5)	0/	0
6)	0/	0
7)	0/	0

OUT BOUND DATA FLOWS	
1) EMPLOYEE'S LOT#S	100/D
2) EMPLOYEE'S MACHINE#S	50/D
3) EMPLOYEE'S ROUTINGS	5/D
4)	0/
5)	0/
6)	0/
7)	0/

-IONS OF STORE	# OF USERS	LOCATIONS OF STORE	# OF USERS
FLOOR	11	2)	0
	0	4)	0
	0	6)	0
	0	8)	0
7)	0	10)	0
9)	0	12)	0
11)	0	14)	0
13)	0	16)	0
15)	0	18)	0
17)	0	20)	0
19)	0		

ORGANIZATION: HUMAN
UPDATE PROCESS:
VERBAL, PAPER
FREQUENCY OF UPDATE: 999/D

<SPECIAL NOTES>

SEE PAGE 1

REVISION LEVEL: 1 LAST DATE OF MODIFICATION: 07/27/85

ACCURACY LEVEL: 75% SIZE OF STORE IN K-BYTES: 1KB

INITIALS: DER

EXTERNAL ENTITY ENTRY

DATA STORE NAME: MANUFACT. ENGINEERING PROCESS ID #: ME

<DESCRIPTION:>

RESPONSIBLE FOR METHODS, ROUTINGS, MCN's, AND GENERAL MANUFACTURING CHANGES.

IN BOUND DATA FLOWS:	FREQUENCY PER(H,D,W,M)
1) REQUESTS FOR ROUTE VERIFICATIONS	2/D
2) APPROVED-1 MCN COPY	10/D
3) M+D FORM COPY	20/W
4) MANUFACTURING CHANGE REQUESTS	50/W
5)	0/

OUT BOUND DATA FLOWS	
1) ROUTE VERIFICATIONS	2/D
2) MFG CHANGES	200/W
3)	0/
4)	0/
5)	0/

<SPECIAL NOTES>

THERE IS NEXT TO NO COORDINATION OF MANUFACTURING CHANGES & MCN'S OUT ON THE SHOP FLOOR. THIS RESULTS IN A LARGE NUMBER OF RECALLED VEHICLES. THIS MUST BE ADDRESSED.

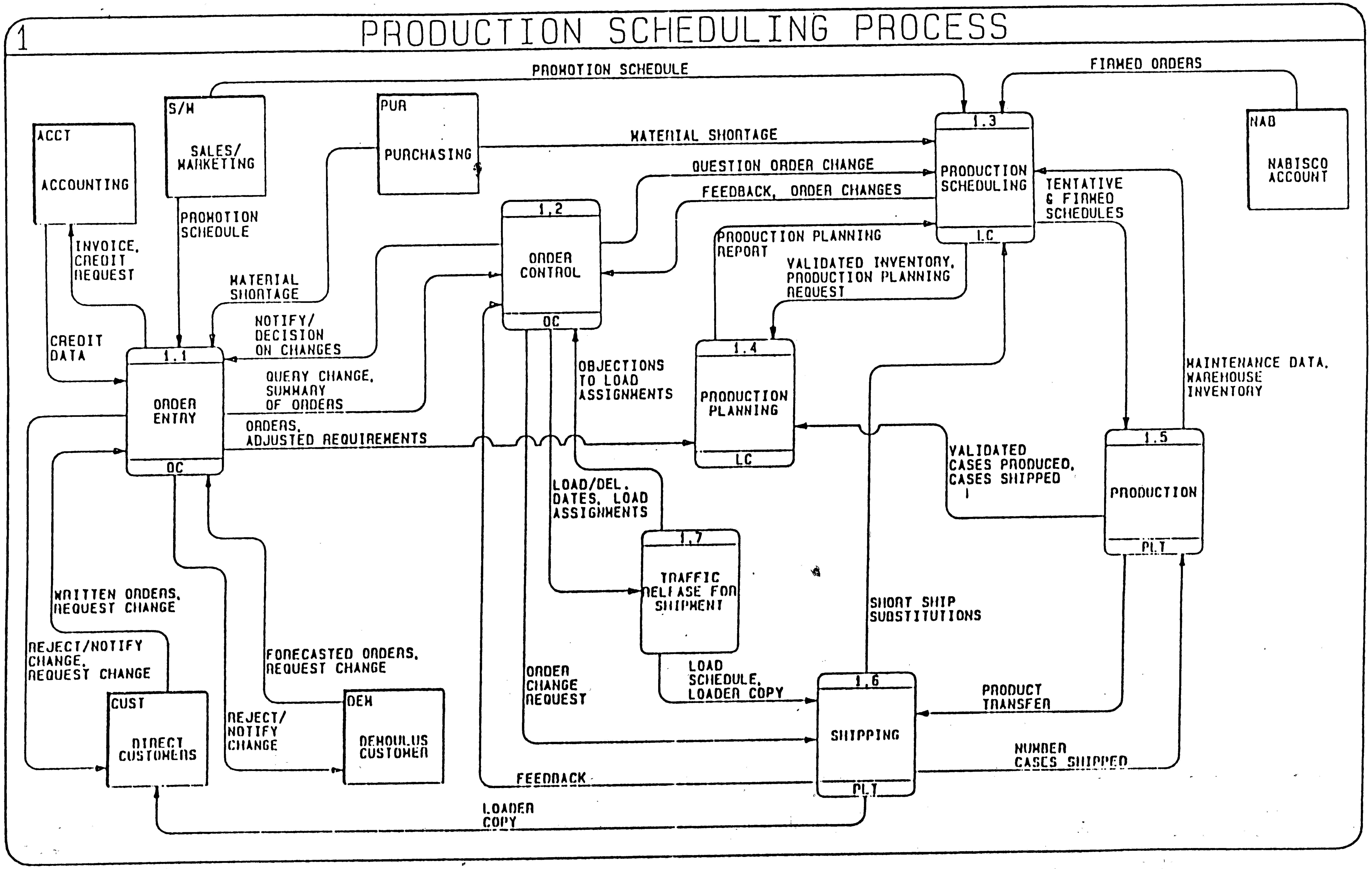
REVISION LEVEL: 2

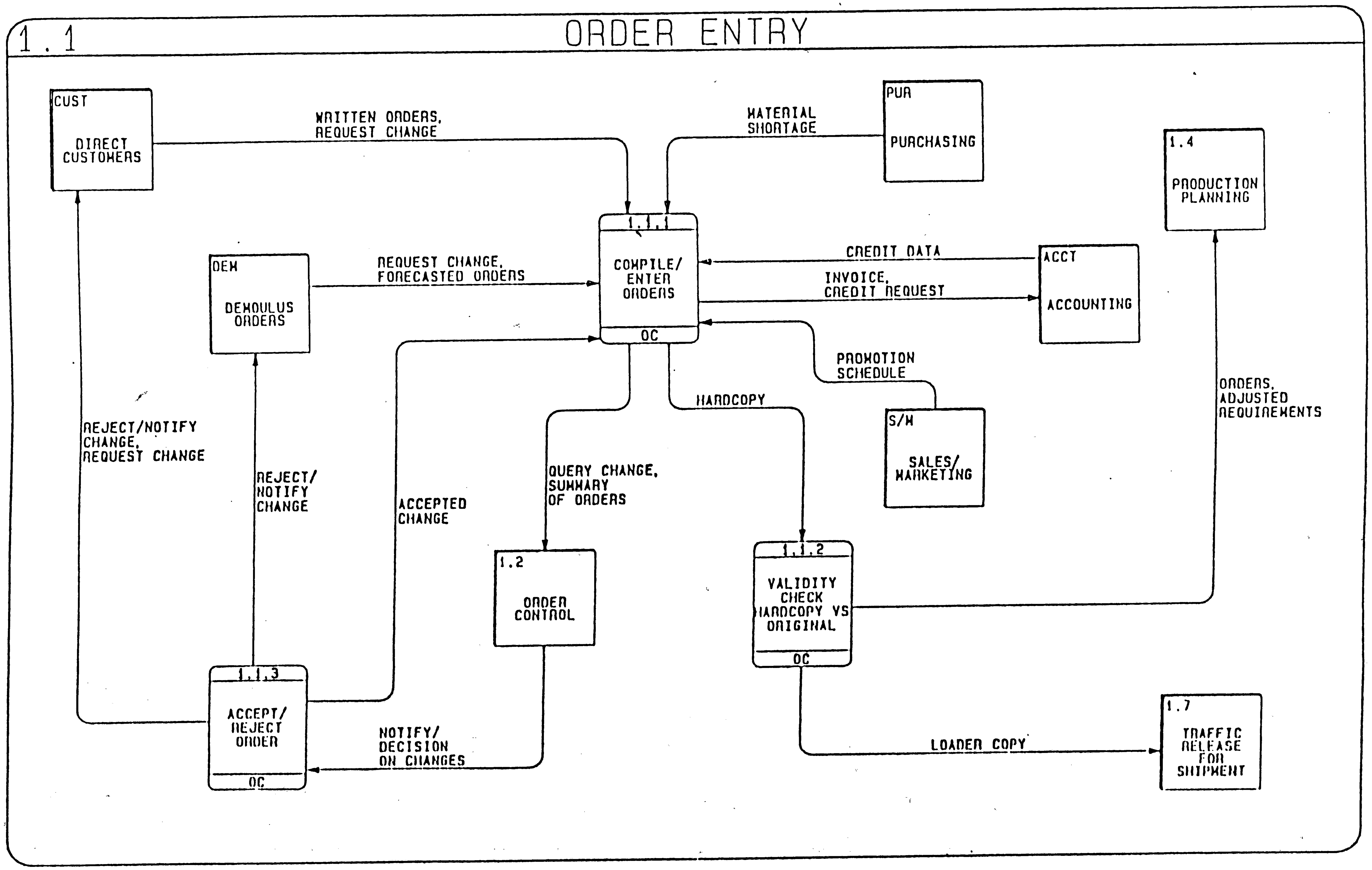
LAST DATE OF MODIFICATION: 07/17/85

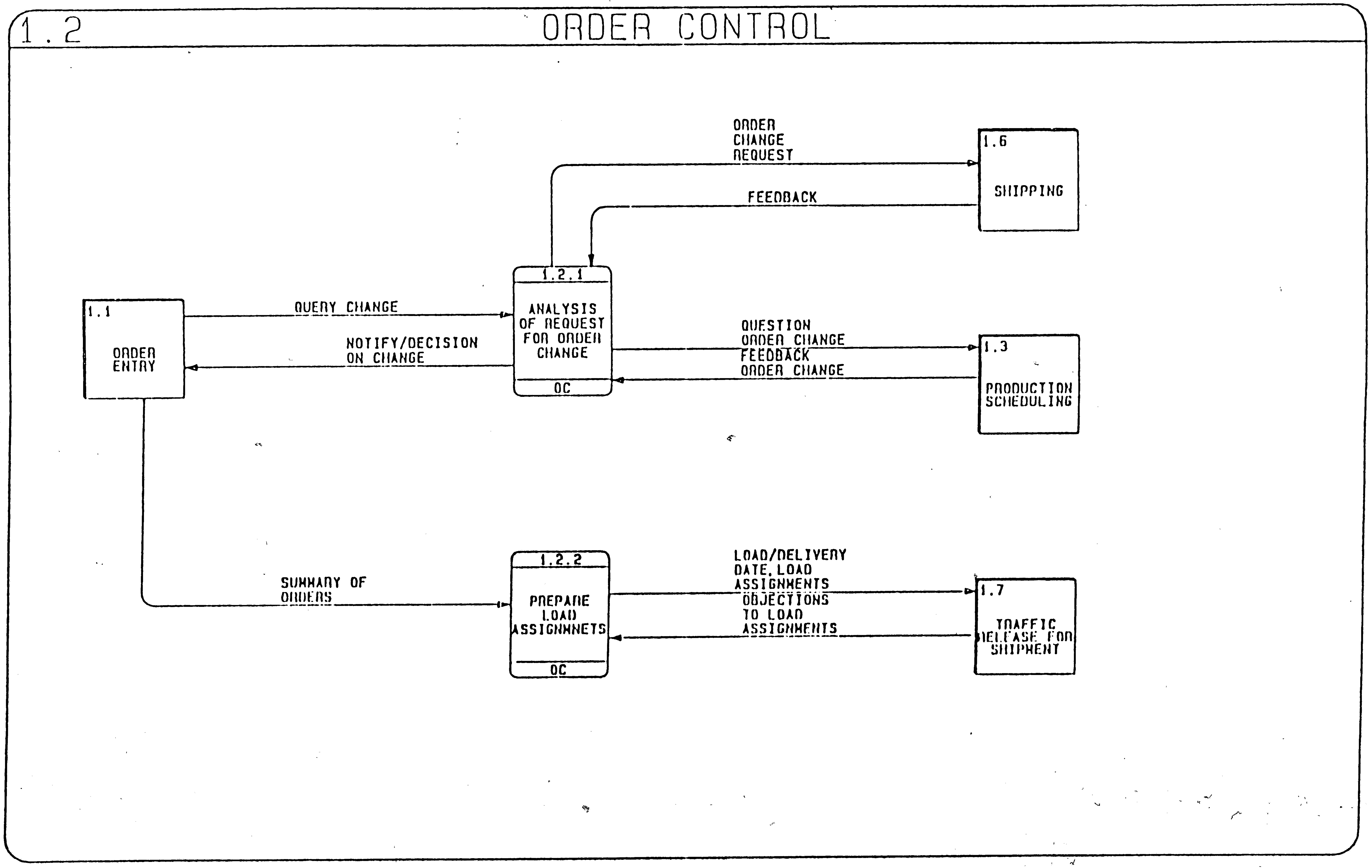
ACCURACY LEVEL: 25%

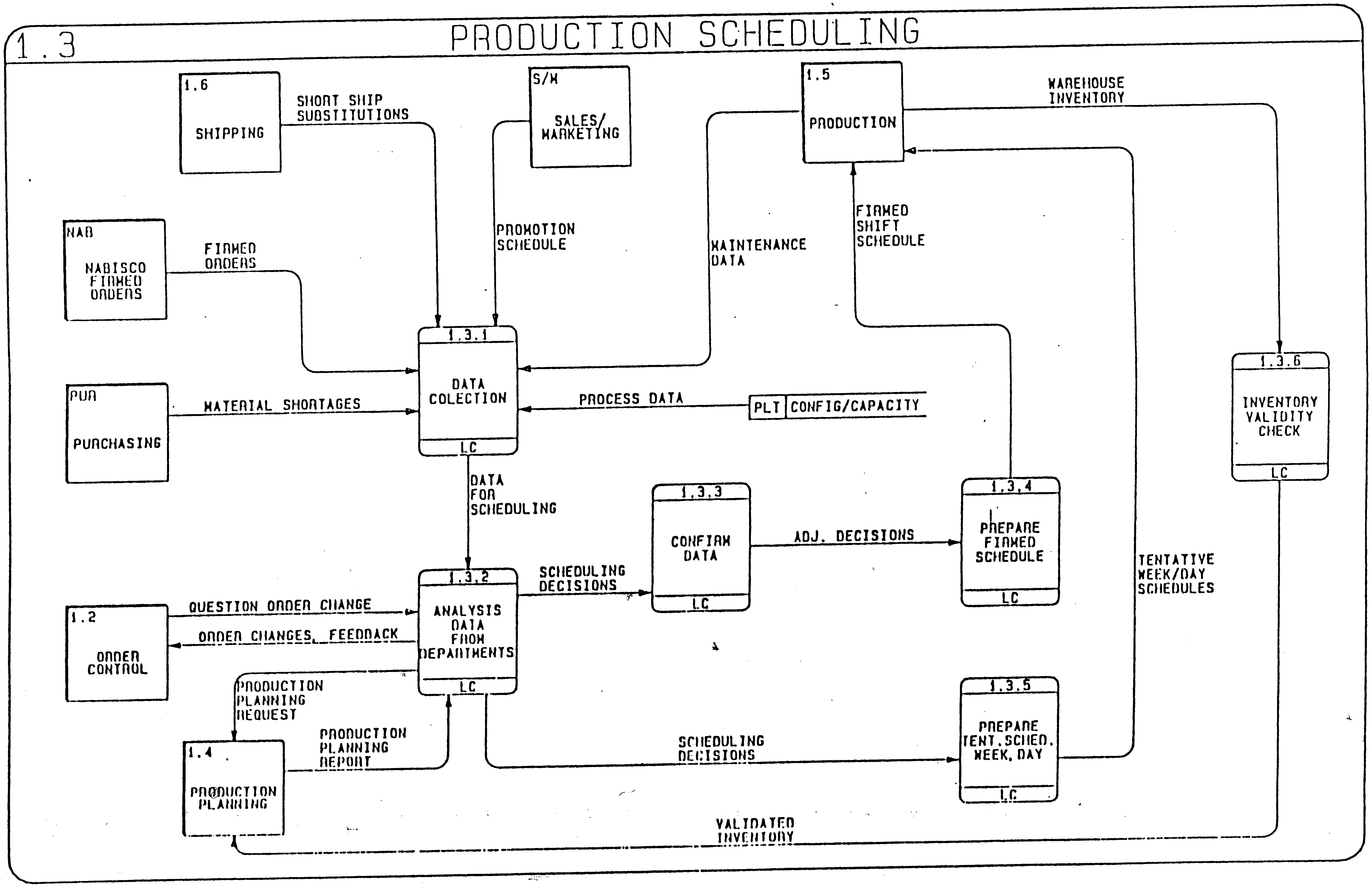
INITIALS: WCW

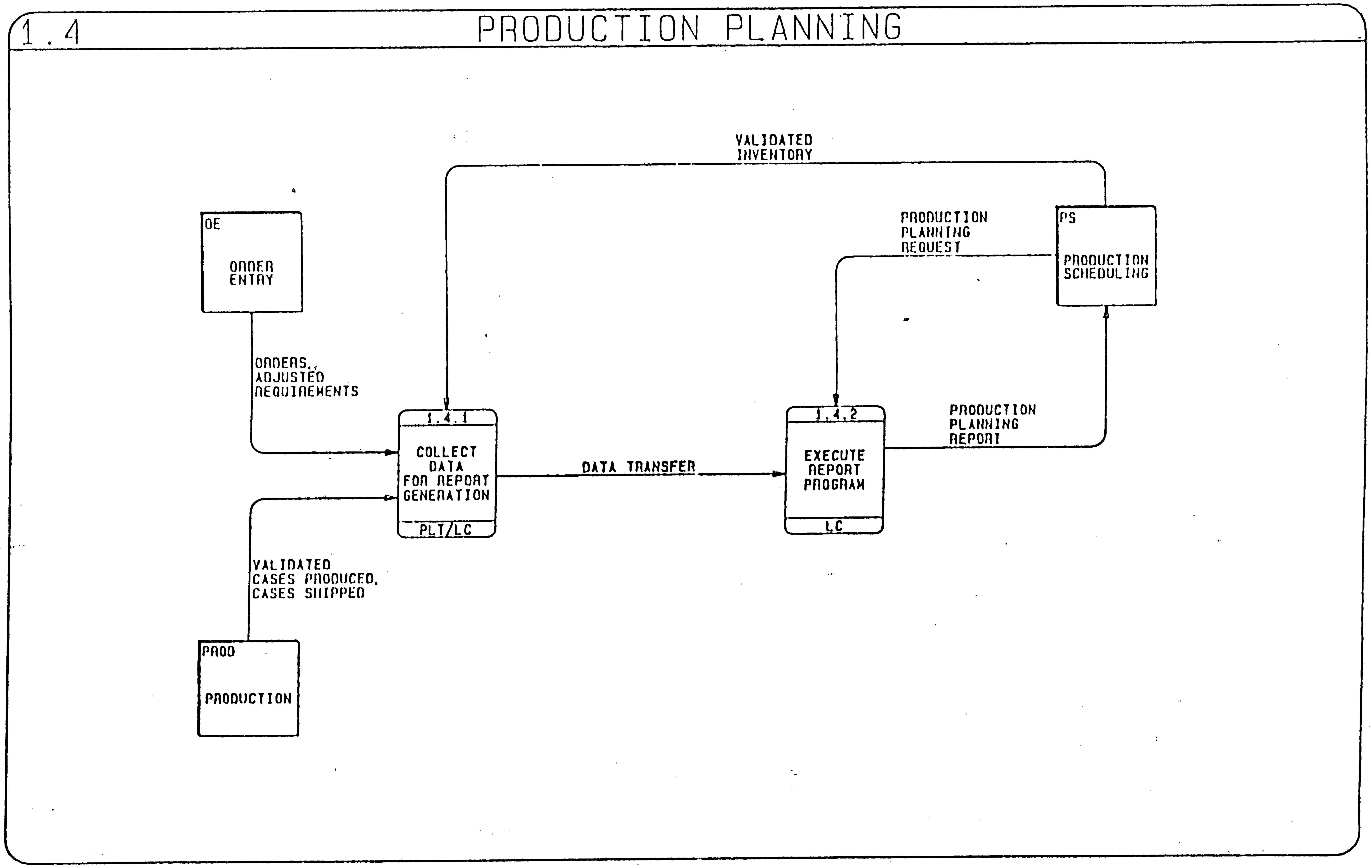
CASE 2

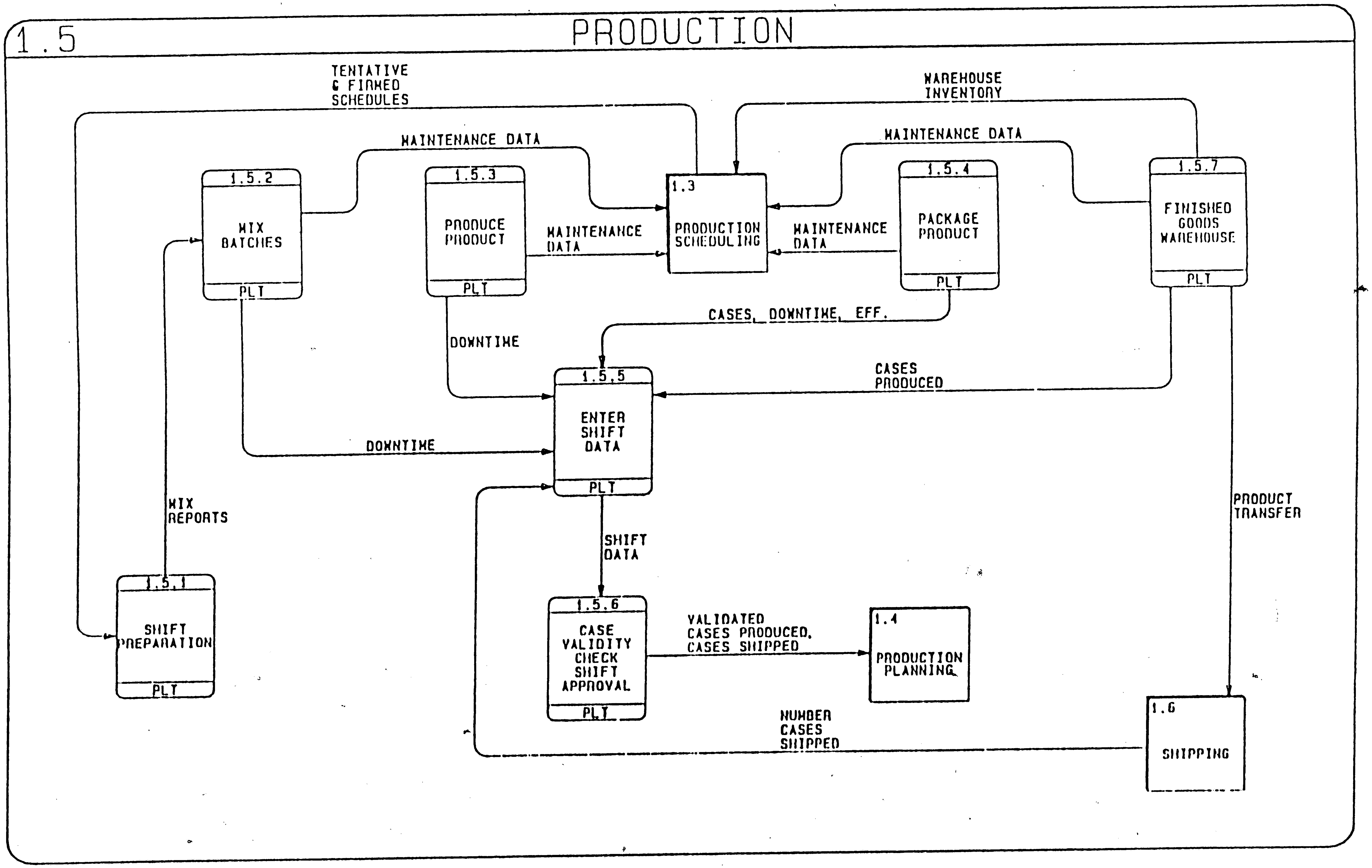

1
PRODUCTION SCHEDULING PROCESS
PROMOTION SCHEDULE
FIRMED ORDERS
ACCT
ACCOUNTING
S/M
SALES/
MARKETING
PUR
PURCHASING
MATERIAL SHORTAGE
QUESTION ORDER CHANGE
FEEDBACK, ORDER CHANGES
1.3
PRODUCTION SCHEDULING
LC
NAB
NABISCO ACCOUNT
TENTATIVE
& FIRMED
SCHEDULES
PROMOTION
SCHEDULE
INVOICE,
CREDIT
REQUEST
1.2
ORDER CONTROL
OC
PRODUCTION PLANNING
REPORT
VALIDATED INVENTORY,
PRODUCTION PLANNING
REQUEST
MATERIAL
SHORTAGE
NOTIFY/
DECISION
ON CHANGES
CREDIT
DATA
1.1
ORDER ENTRY
OC
QUERY CHANGE,
SUMMARY
OF ORDERS
ORDERS,
ADJUSTED REQUIREMENTS
OBJECTIONS
TO LOAD
ASSIGNMENTS
1.4
PRODUCTION PLANNING
LC
MAINTENANCE DATA,
WAREHOUSE
INVENTORY
VALIDATED
CASES PRODUCED,
CASES SHIPPED
1.5
PRODUCTION
PLT
LOAD/DEL.
DATES, LOAD
ASSIGNMENTS
1.7
TRAFFIC
RELEASE FOR
SHIPMENT
WRITTEN ORDERS,
REQUEST CHANGE
SHORT SHIP
SUBSTITUTIONS
REJECT/NOTIFY
CHANGE,
REQUEST CHANGE
FORECASTED ORDERS,
REQUEST CHANGE
ORDER
CHANGE
REQUEST
LOAD
SCHEDULE,
LOADER COPY
1.6
SHIPPING
PLT
PRODUCT
TRANSFER
CUST
DIRECT CUSTOMERS
REJECT/
NOTIFY
CHANGE
OEM
DEMOULUS CUSTOMER
FEEDBACK
NUMBER
CASES SHIPPED
LOADER
COPY

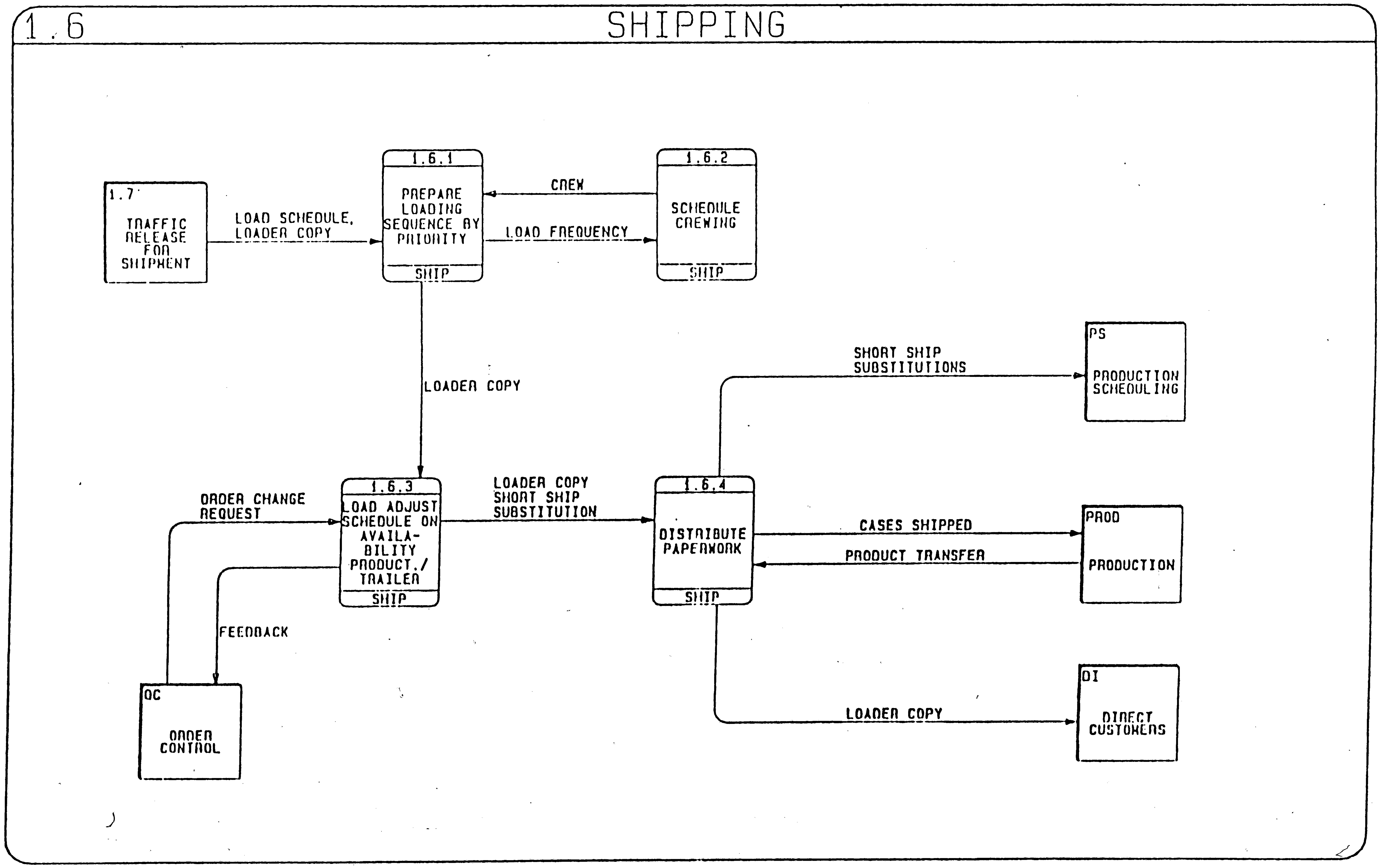

1.1
ORDER ENTRY
CUST
DIRECT CUSTOMERS
WRITTEN ORDERS, REQUEST CHANGE
MATERIAL SHORTAGE
PUR
PURCHASING
1.4
PRODUCTION PLANNING
1.1.1
COMPILE/ ENTER ORDERS
OC
CREDIT DATA
ACCT
ACCOUNTING
INVOICE, CREDIT REQUEST
OEM
DEMOULUS ORDERS
REQUEST CHANGE, FORECASTED ORDERS
PROMOTION SCHEDULE
S/M
SALES/ MARKETING
HARDCOPY
ORDERS, ADJUSTED REQUIREMENTS
REJECT/NOTIFY CHANGE, REQUEST CHANGE
REJECT/ NOTIFY CHANGE
ACCEPTED CHANGE
QUERY CHANGE, SUMMARY OF ORDERS
1.2
ORDER CONTROL
1.1.2
VALIDITY CHECK HARDCOPY VS ORIGINAL
OC
1.1.3
ACCEPT/ REJECT ORDER
OC
NOTIFY/ DECISION ON CHANGES
LOADER COPY
1.7
TRAFFIC RELEASE FOR SHIPMENT

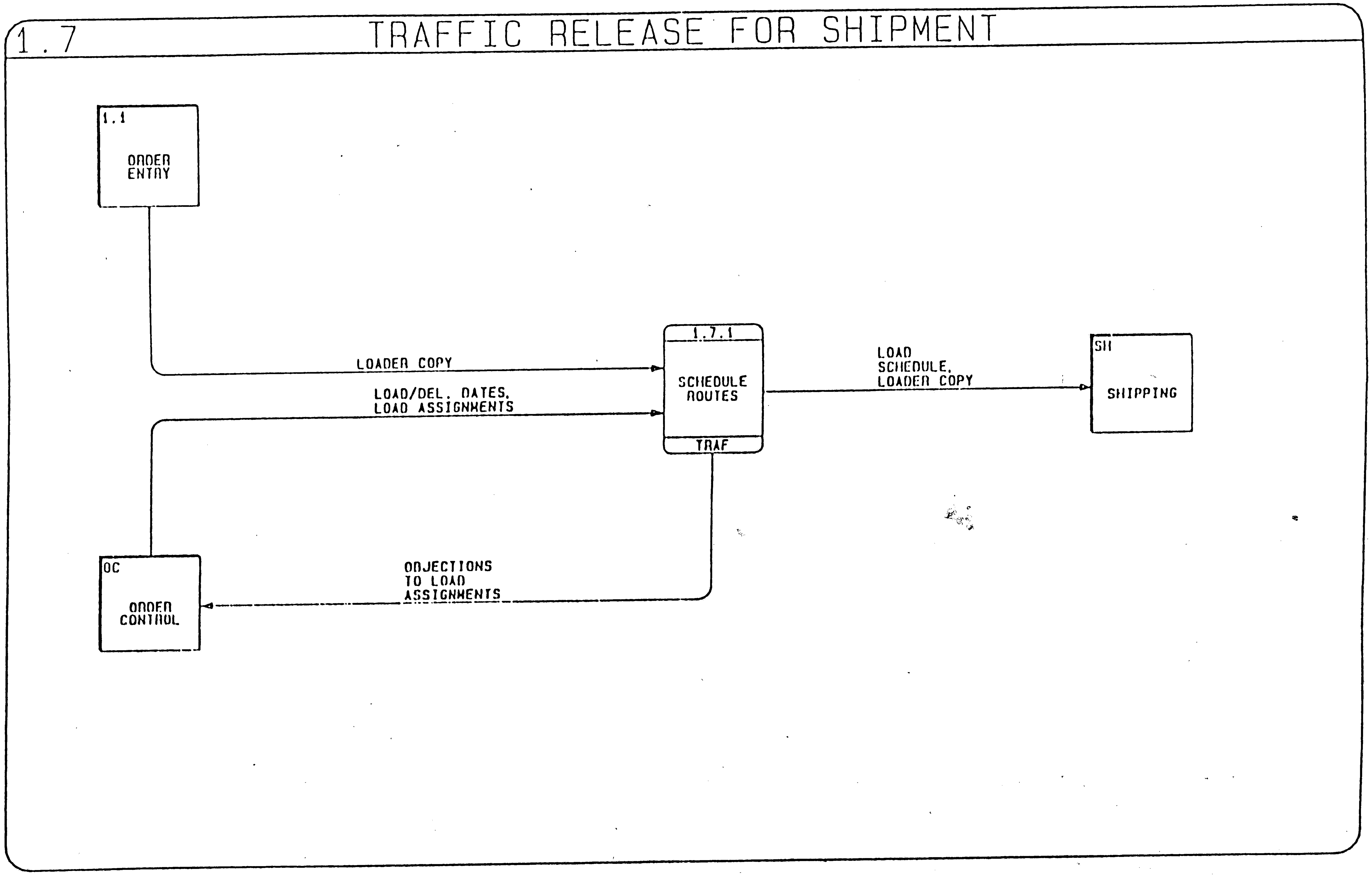

1.2
ORDER CONTROL
1.1
ORDER ENTRY
QUERY CHANGE
NOTIFY/DECISION ON CHANGE
1.2.1
ANALYSIS OF REQUEST FOR ORDER CHANGE
OC
ORDER CHANGE REQUEST
FEEDBACK
1.6
SHIPPING
QUESTION ORDER CHANGE
FEEDBACK ORDER CHANGE
1.3
PRODUCTION SCHEDULING
SUMMARY OF ORDERS
1.2.2
PREPARE LOAD ASSIGNMNETS
OC
LOAD/DELIVERY DATE, LOAD ASSIGNMENTS
OBJECTIONS TO LOAD ASSIGNMENTS
1.7
TRAFFIC RELEASE FOR SHIPMENT


1.3
PRODUCTION SCHEDULING
1.6
SHIPPING
SHORT SHIP SUBSTITUTIONS
S/M
SALES/ MARKETING
PROMOTION SCHEDULE
1.5
PRODUCTION
WAREHOUSE INVENTORY
MAINTENANCE DATA
FIRMED SHIFT SCHEDULE
NAB
NABISCO FIRMED ORDERS
FIRMED ORDERS
PUR
PURCHASING
MATERIAL SHORTAGES
1.3.1
DATA COLECTION
LC
PROCESS DATA
PLT
CONFIG/CAPACITY
1.3.6
INVENTORY VALIDITY CHECK
LC
DATA FOR SCHEDULING
1.3.3
CONFIRM DATA
LC
ADJ. DECISIONS
1.3.4
PREPARE FIRMED SCHEDULE
LC
TENTATIVE WEEK/DAY SCHEDULES
1.2
ORDER CONTROL
QUESTION ORDER CHANGE
ORDER CHANGES, FEEDBACK
1.3.2
ANALYSIS DATA FROM DEPARTMENTS
LC
SCHEDULING DECISIONS
PRODUCTION PLANNING REQUEST
PRODUCTION PLANNING REPORT
1.4
PRODUCTION PLANNING
SCHEDULING DECISIONS
1.3.5
PREPARE TENT. SCHED. WEEK, DAY
LC
VALIDATED INVENTORY

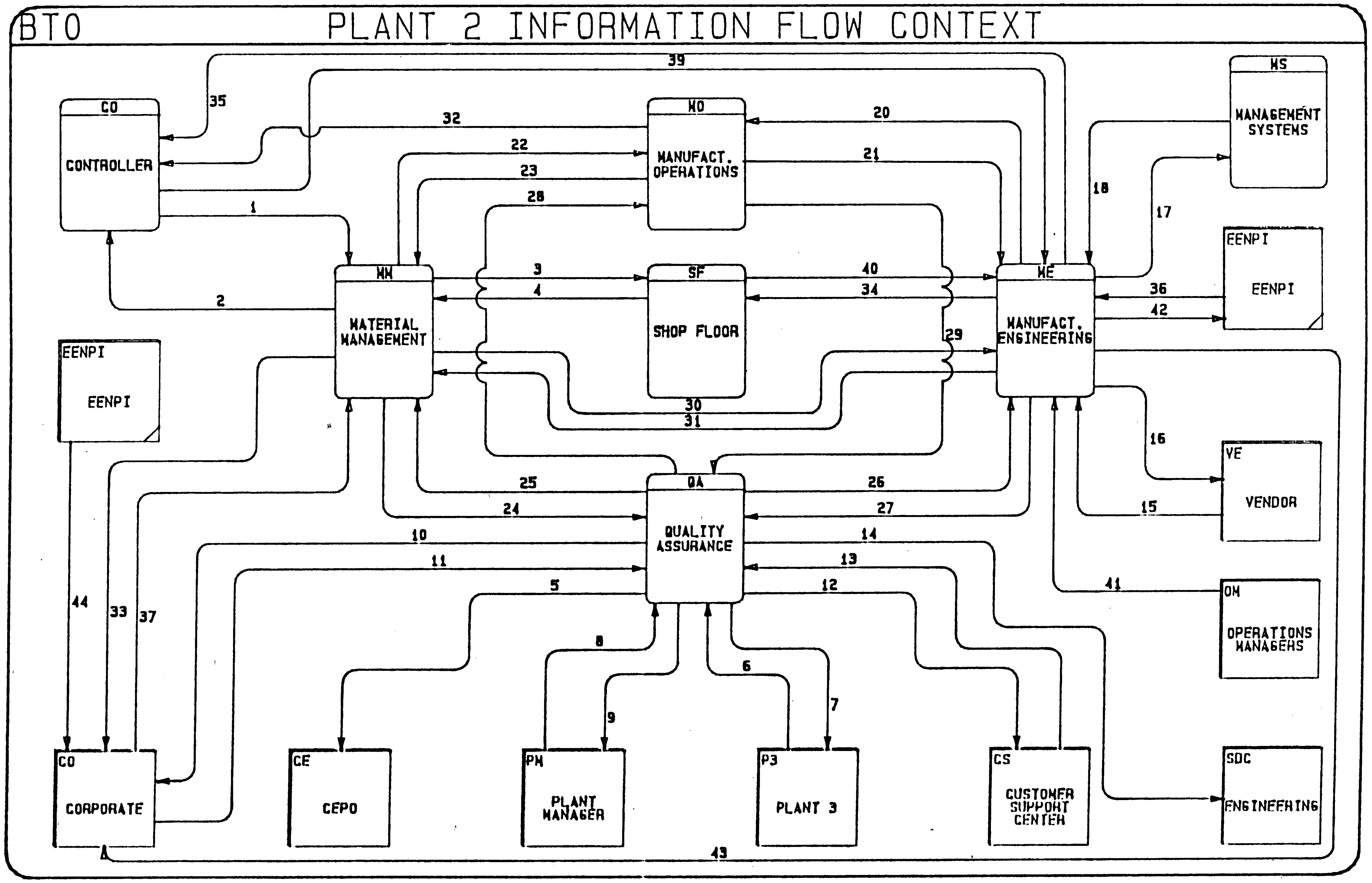

1.4
PRODUCTION PLANNING
VALIDATED INVENTORY
OE
ORDER ENTRY
PS
PRODUCTION SCHEDULING
PRODUCTION PLANNING REQUEST
ORDERS, ADJUSTED REQUIREMENTS
1.4.1
COLLECT DATA FOR REPORT GENERATION
PLT/LC
DATA TRANSFER
1.4.2
EXECUTE REPORT PROGRAM
LC
PRODUCTION PLANNING REPORT
VALIDATED CASES PRODUCED, CASES SHIPPED
PROD
PRODUCTION


1.5
PRODUCTION
TENTATIVE & FIRMED SCHEDULES
WAREHOUSE INVENTORY
MAINTENANCE DATA
MAINTENANCE DATA
1.5.2
MIX BATCHES
PLT
1.5.3
PRODUCE PRODUCT
PLT
MAINTENANCE DATA
1.3
PRODUCTION SCHEDULING
MAINTENANCE DATA
1.5.4
PACKAGE PRODUCT
PLT
1.5.7
FINISHED GOODS WAREHOUSE
PLT
CASES, DOWNTIME, EFF.
DOWNTIME
CASES PRODUCED
1.5.5
ENTER SHIFT DATA
PLT
DOWNTIME
MIX REPORTS
SHIFT DATA
PRODUCT TRANSFER
1.5.1
SHIFT PREPARATION
PLT
1.5.6
CASE VALIDITY CHECK SHIFT APPROVAL
PLT
VALIDATED CASES PRODUCED, CASES SHIPPED
1.4
PRODUCTION PLANNING
NUMBER CASES SHIPPED
1.6
SHIPPING


1.6
SHIPPING
1.7
TRAFFIC RELEASE FOR SHIPMENT
LOAD SCHEDULE, LOADER COPY
1.6.1
PREPARE LOADING SEQUENCE BY PRIORITY
SHIP
CREW
LOAD FREQUENCY
1.6.2
SCHEDULE CREWING
SHIP
LOADER COPY
1.6.3
LOAD ADJUST SCHEDULE ON AVAILA-BILITY PRODUCT./ TRAILER
SHIP
ORDER CHANGE REQUEST
FEEDBACK
OC
ORDER CONTROL
LOADER COPY SHORT SHIP SUBSTITUTION
1.6.4
DISTRIBUTE PAPERWORK
SHIP
SHORT SHIP SUBSTITUTIONS
PS
PRODUCTION SCHEDULING
CASES SHIPPED
PRODUCT TRANSFER
PROD
PRODUCTION
LOADER COPY
DI
DIRECT CUSTOMERS


1.7
TRAFFIC RELEASE FOR SHIPMENT
1.1
ORDER ENTRY
LOADER COPY
LOAD/DEL. DATES, LOAD ASSIGNMENTS
1.7.1
SCHEDULE ROUTES
TRAF
LOAD SCHEDULE, LOADER COPY
SH
SHIPPING
OC
ORDER CONTROL
OBJECTIONS TO LOAD ASSIGNMENTS

CASE 3


BTO
PLANT 2 INFORMATION FLOW CONTEXT
CO
CONTROLLER
MO
MANUFACT. OPERATIONS
MS
MANAGEMENT SYSTEMS
MM
MATERIAL MANAGEMENT
SF
SHOP FLOOR
ME
MANUFACT. ENGINEERING
EENPI
EENPI
EENPI
EENPI
VE
VENDOR
QA
QUALITY ASSURANCE
OM
OPERATIONS MANAGERS
CO
CORPORATE
CE
CEPO
PM
PLANT MANAGER
P3
PLANT 3
CS
CUSTOMER SUPPORT CENTER
SDC
ENGINEERING
1
2
3
4
5
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11
12
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14
15
16
17
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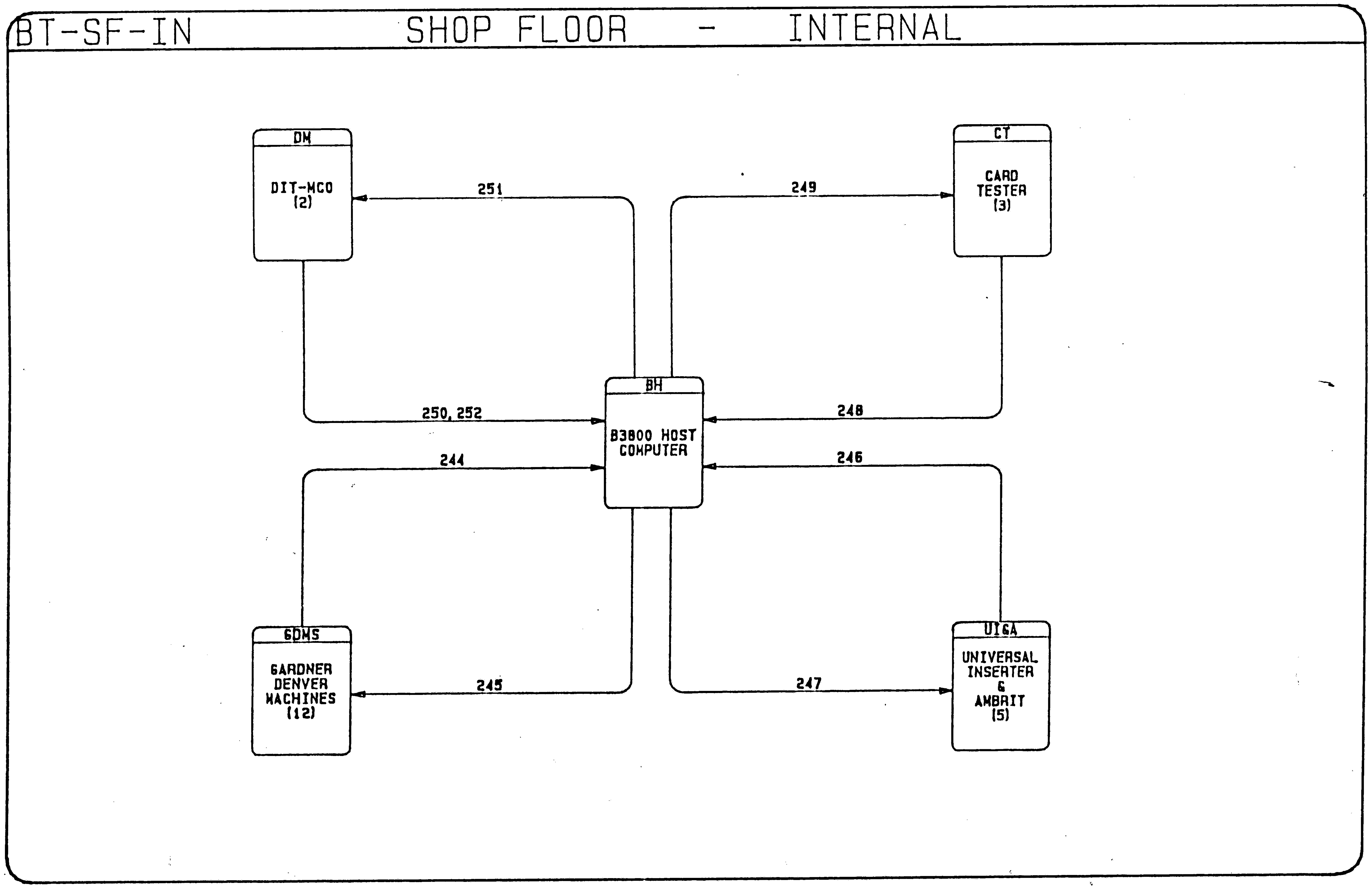
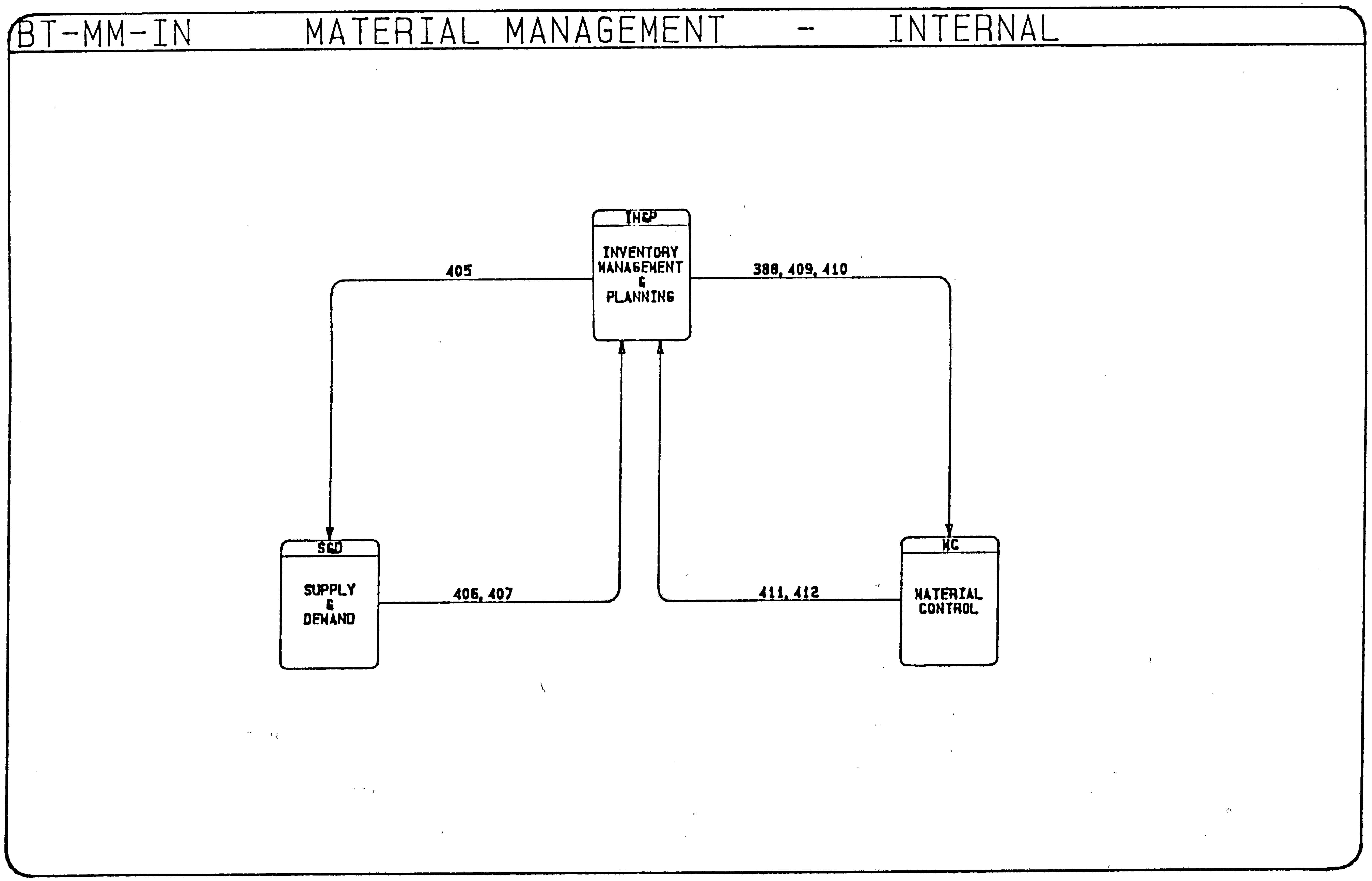
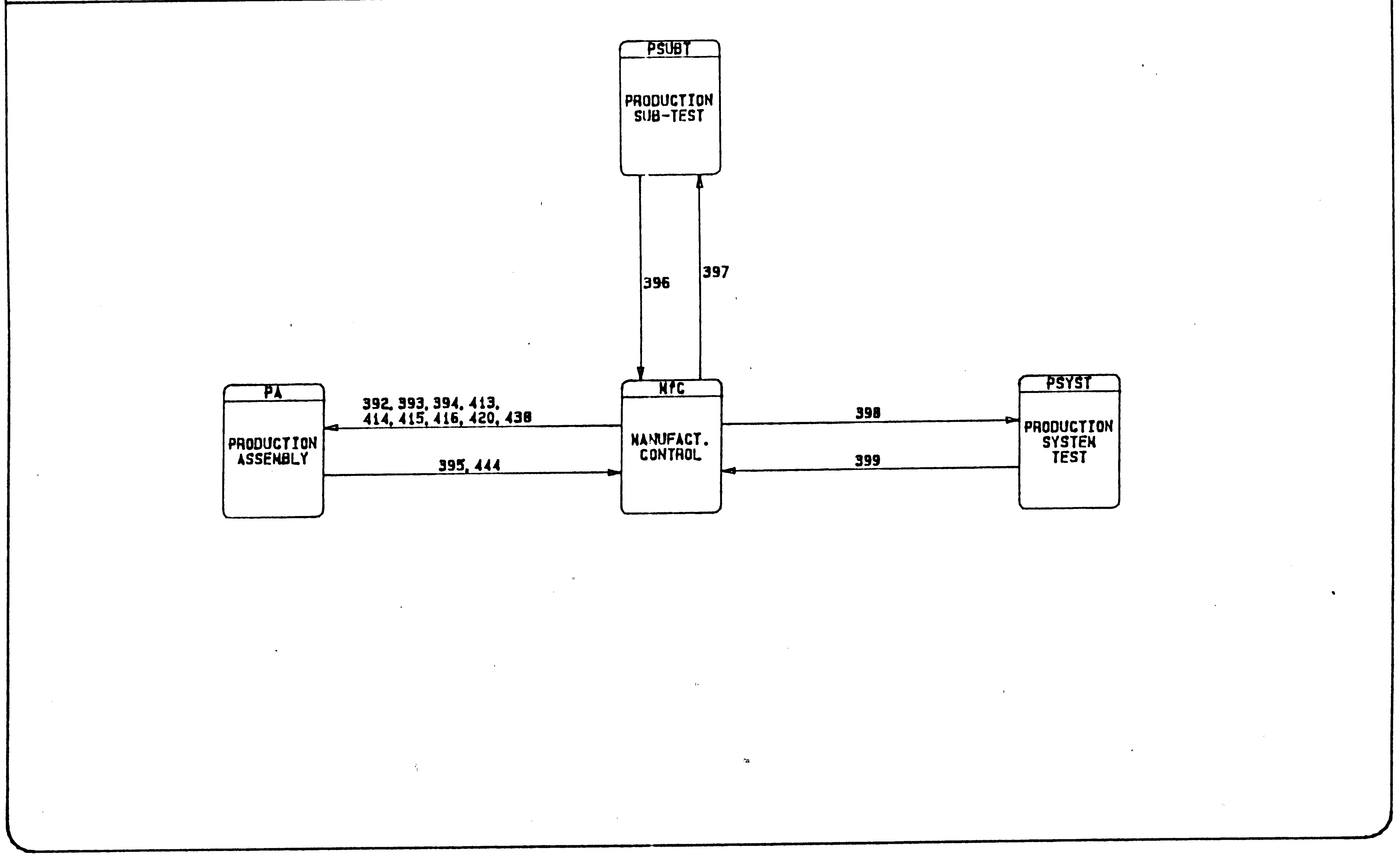
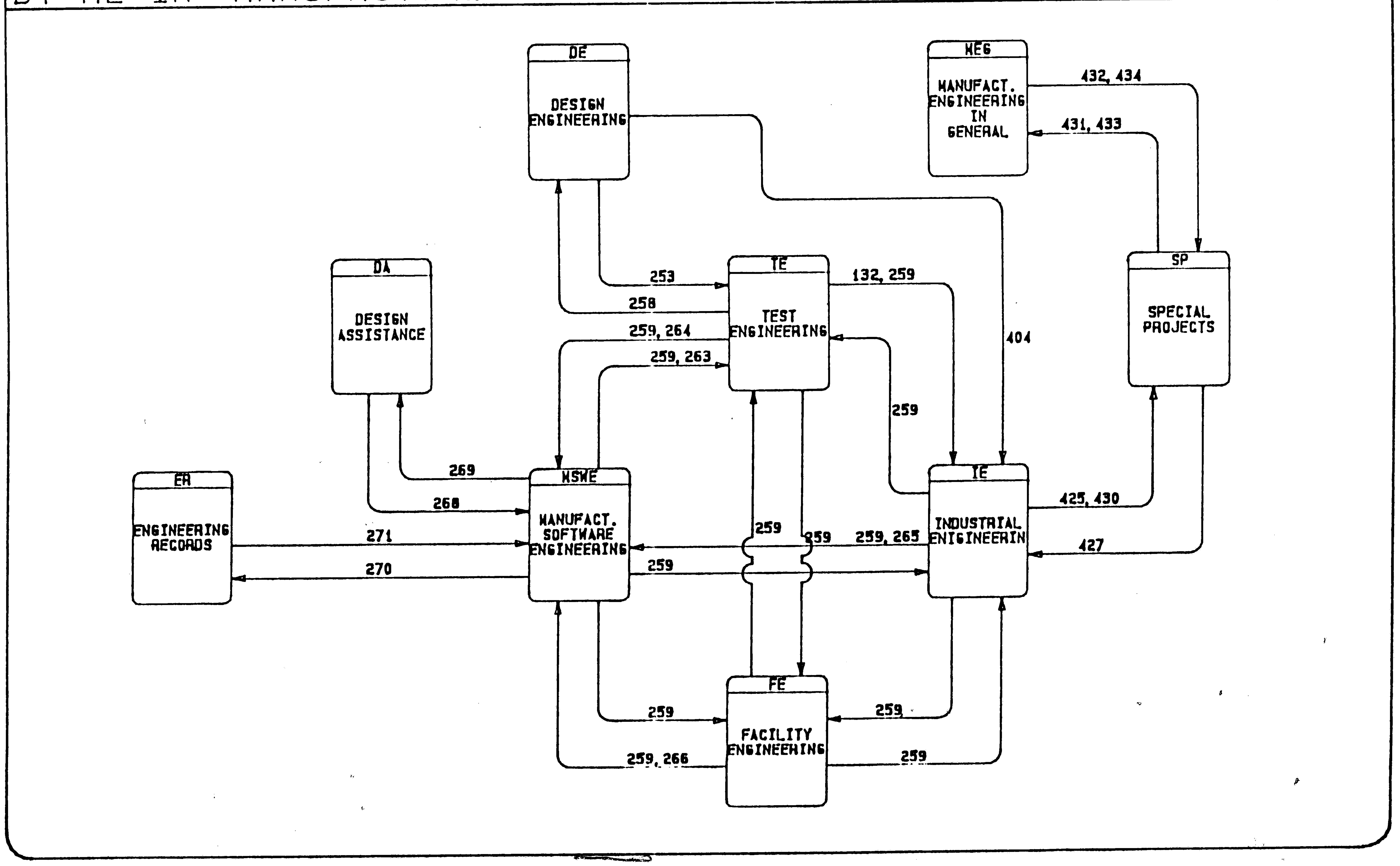

BT-SF-IN
SHOP FLOOR - INTERNAL
DM
DIT-MCO (2)
CT
CARD TESTER (3)
BH
B3800 HOST COMPUTER
GDMS
GARDNER DENVER MACHINES (12)
UIGA
UNIVERSAL INSERTER & AMBRIT (5)
251
249
250, 252
248
244
246
245
247

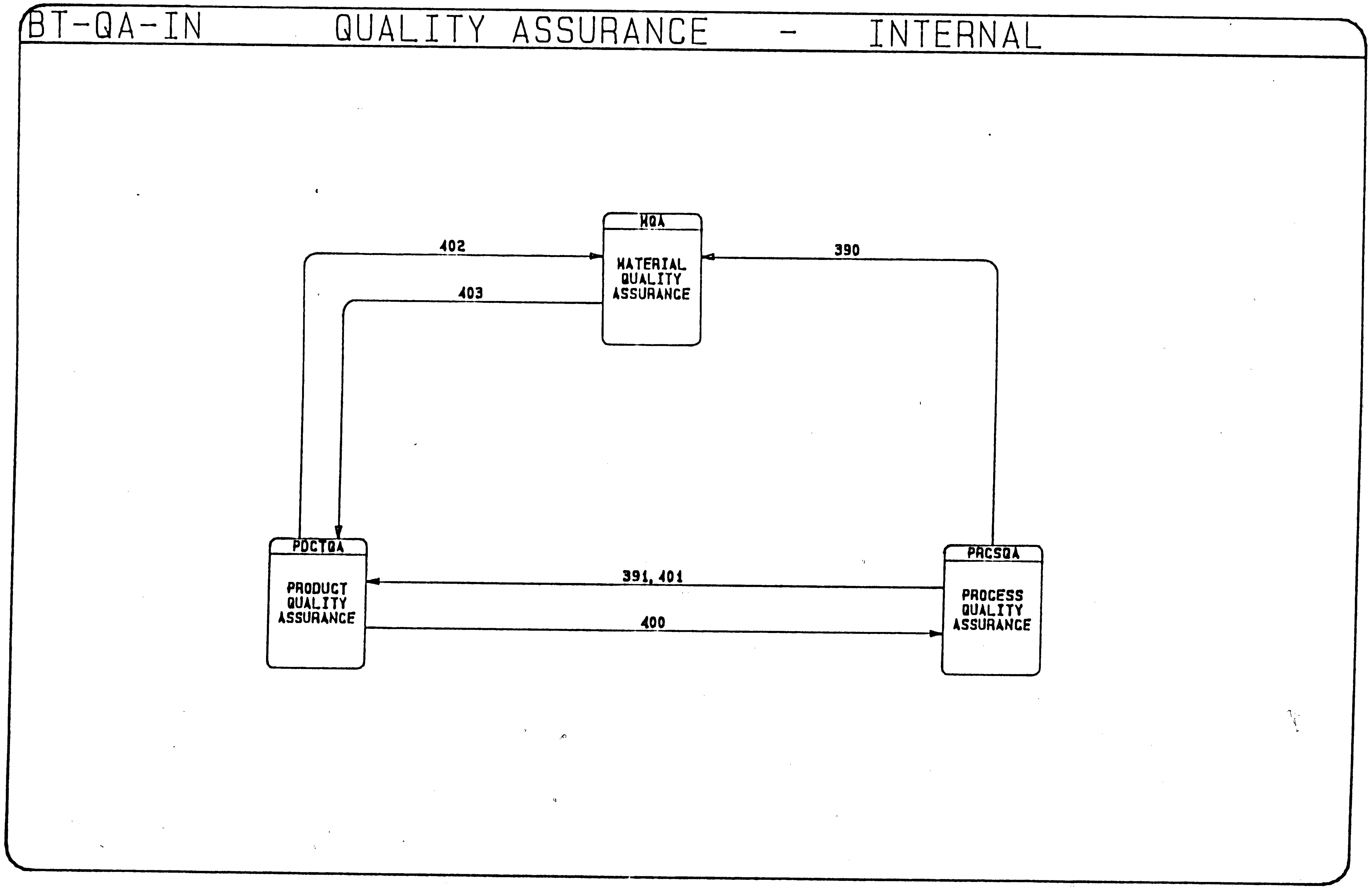

BT-MM-IN MATERIAL MANAGEMENT - INTERNAL
IM&P
INVENTORY MANAGEMENT & PLANNING
405
388, 409, 410
S&D
SUPPLY & DEMAND
406, 407
411, 412
MC
MATERIAL CONTROL

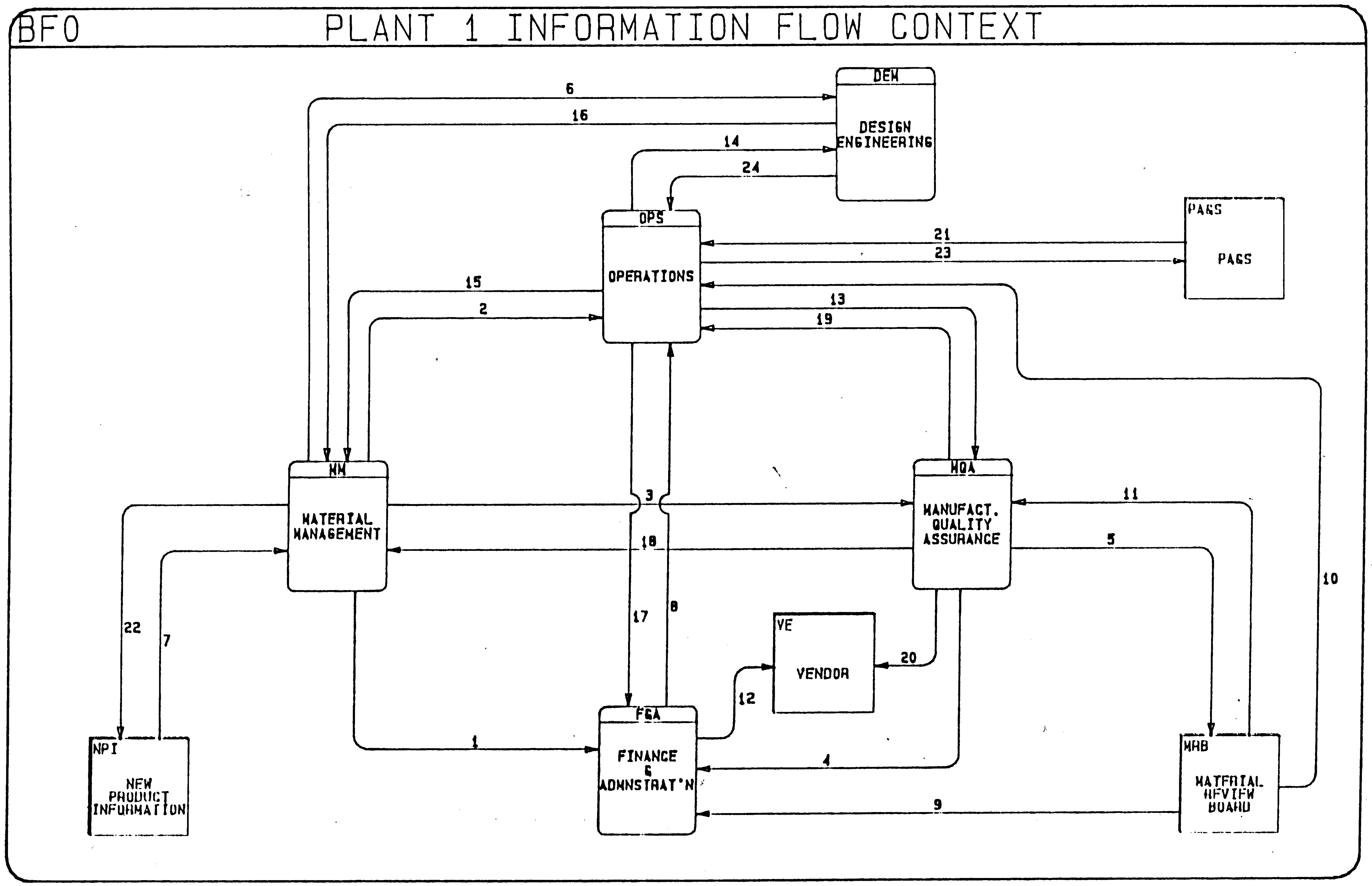
BT-MO-IN MANUFACTURING OPERATIONS - INTERNAL



BT-ME-IN MANUFACTURING ENGINEERING - INTERNAL




BT-QA-IN QUALITY ASSURANCE - INTERNAL
MQA
MATERIAL QUALITY ASSURANCE
402
403
390
PDCTQA
PRODUCT QUALITY ASSURANCE
PRCSQA
PROCESS QUALITY ASSURANCE
391, 401
400


BFO
PLANT 1 INFORMATION FLOW CONTEXT
DEW
DESIGN ENGINEERING
OPS
OPERATIONS
PAGS
PAGS
MM
MATERIAL MANAGEMENT
MQA
MANUFACT. QUALITY ASSURANCE
VE
VENDOR
NPI
NEW PRODUCT INFORMATION
F&A
FINANCE & ADMNSTRAT'N
MRB
MATERIAL REVIEW BOARD
1
2
3
4
5
6
7
8
9
10
11
12
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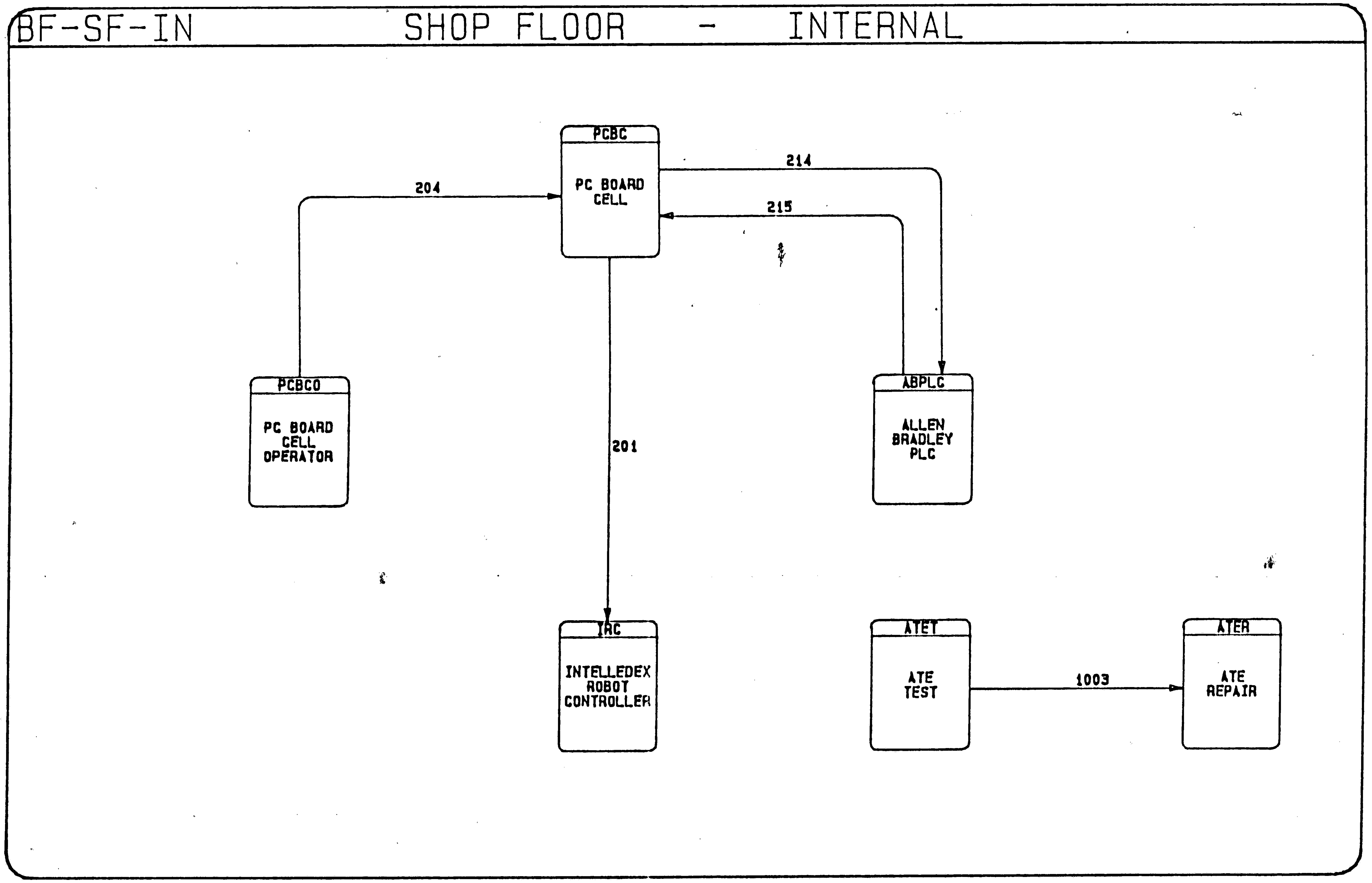
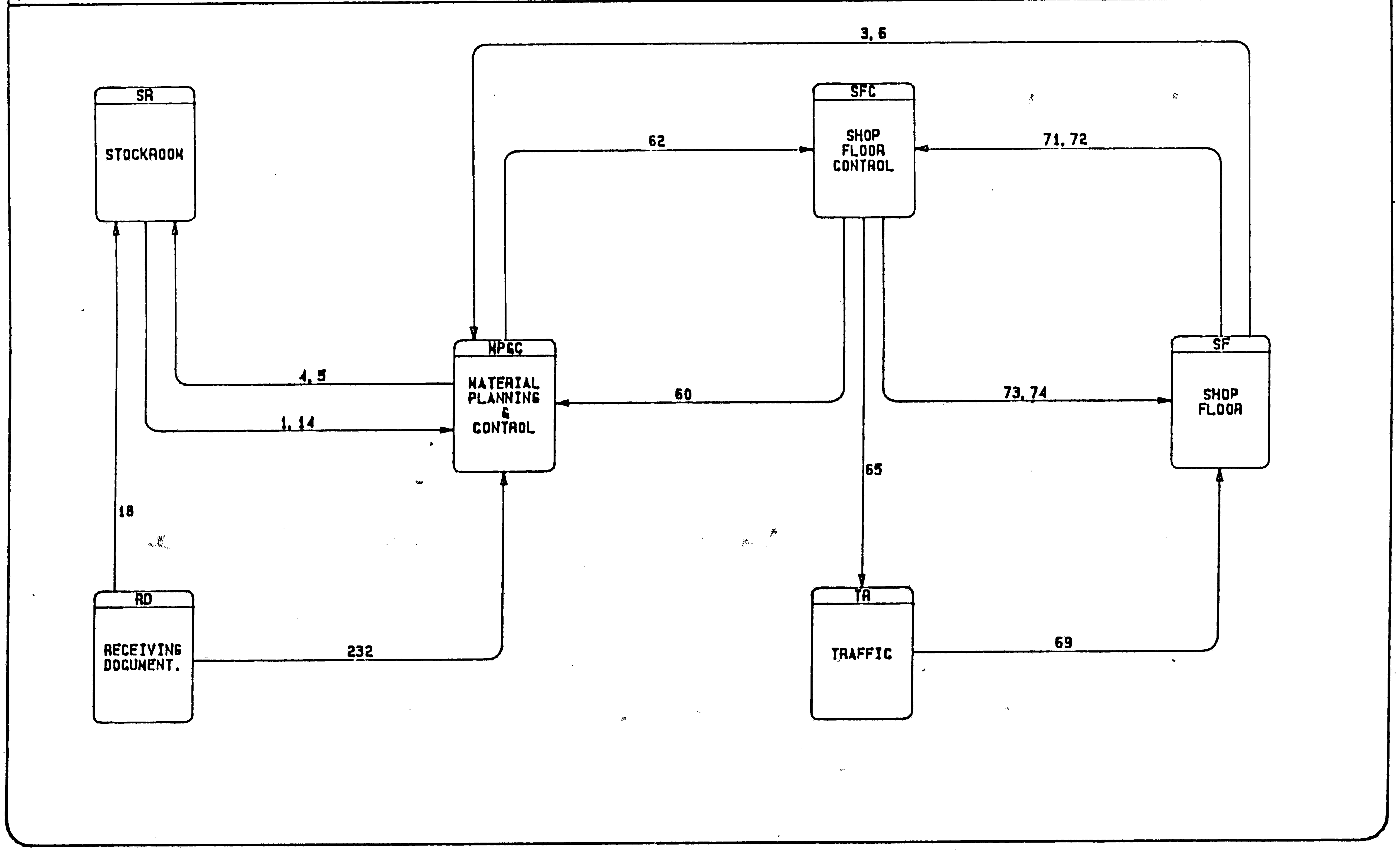
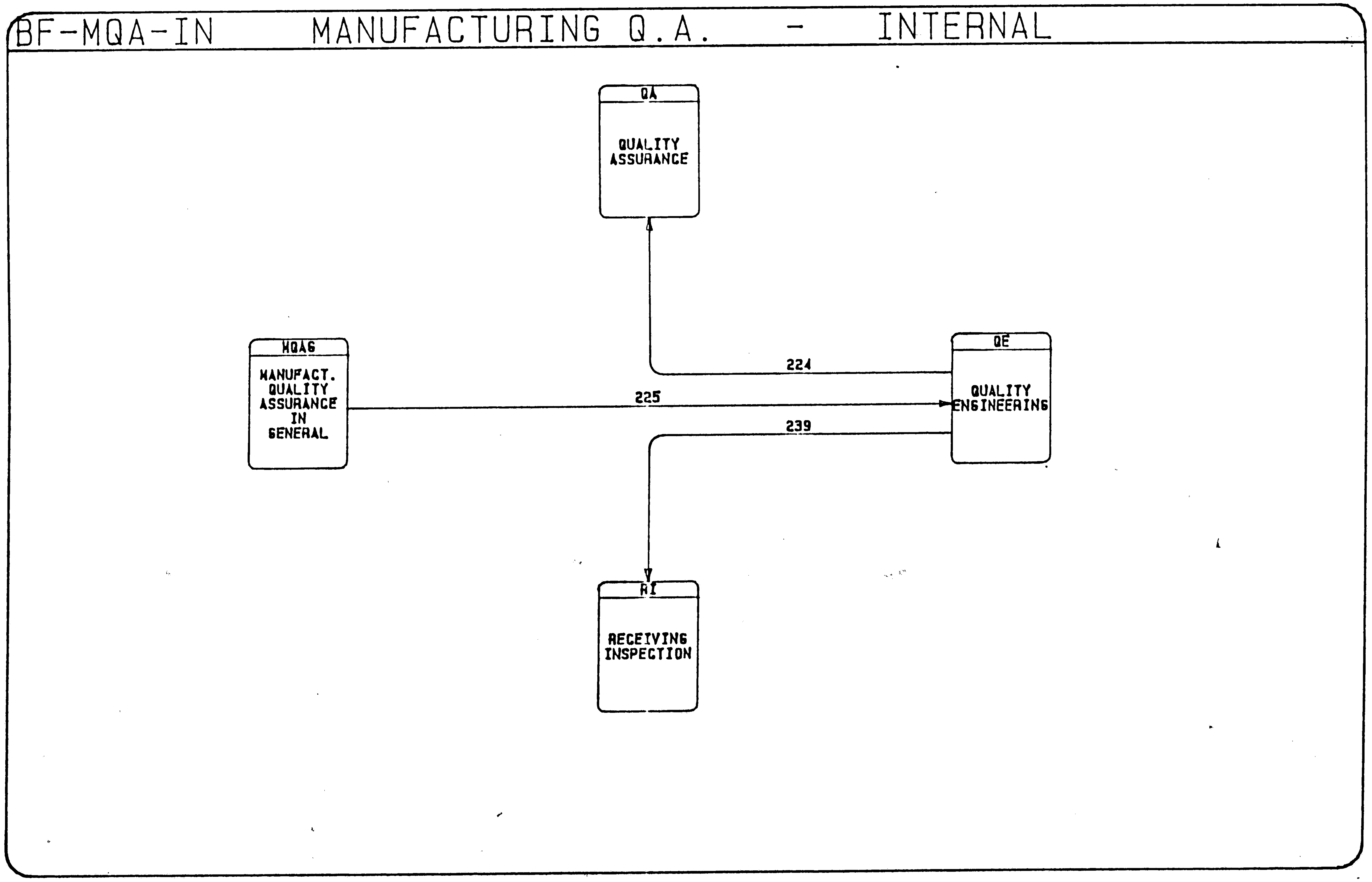
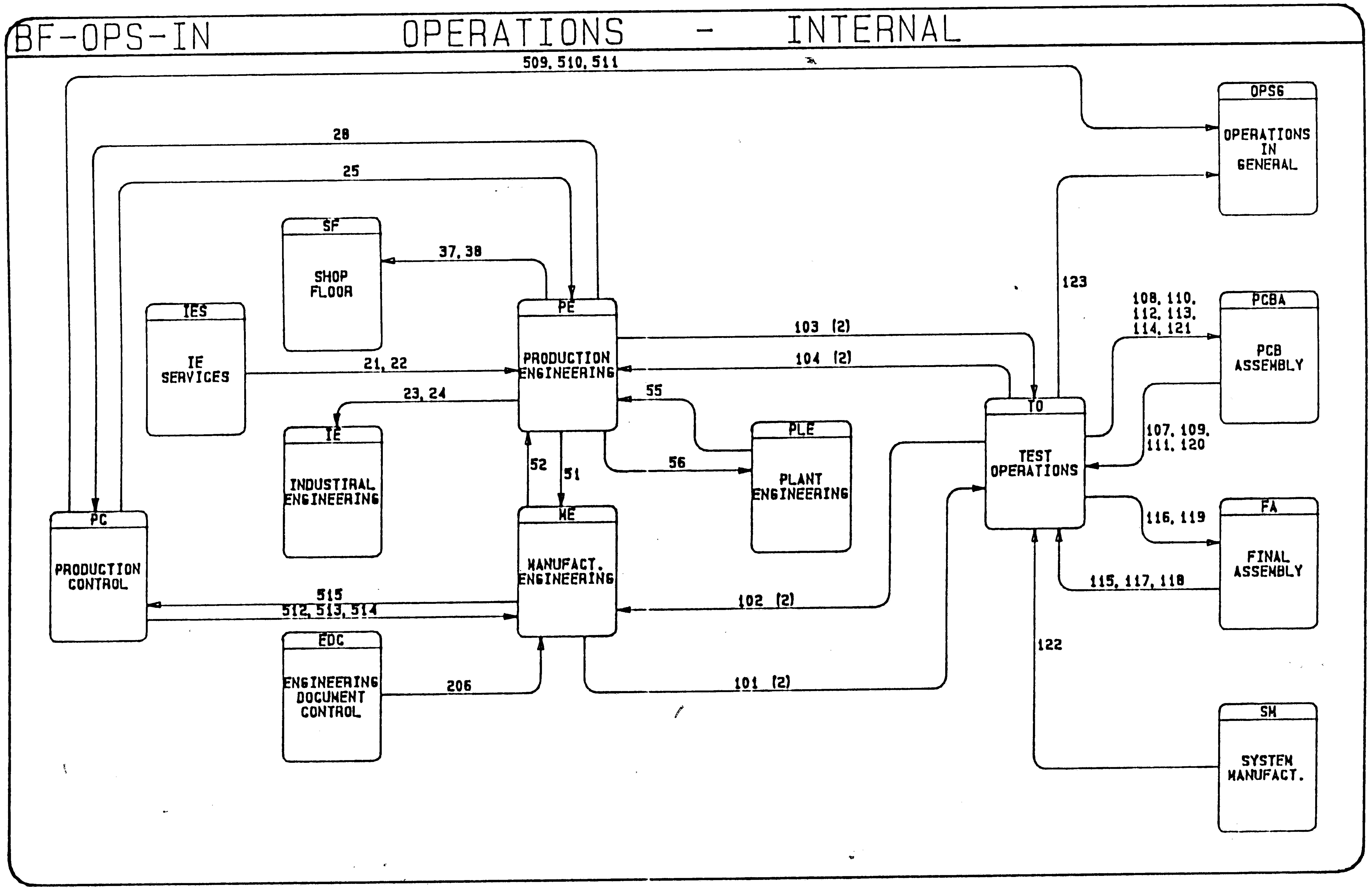
14
15
16
17
18
19
20
21
22
23
24


BF-SF-IN SHOP FLOOR - INTERNAL
PCBC
PC BOARD CELL
204
214
215
201
PCBCO
PC BOARD CELL OPERATOR
ABPLC
ALLEN BRADLEY PLC
IRC
INTELLEDEX ROBOT CONTROLLER
ATET
ATE TEST
1003
ATER
ATE REPAIR

BF-MM-IN MATERIAL MANAGEMENT - INTERNAL




BF-MQA-IN MANUFACTURING Q.A. - INTERNAL
QA
QUALITY ASSURANCE
MQAG
MANUFACT. QUALITY ASSURANCE IN GENERAL
QE
QUALITY ENGINEERING
RI
RECEIVING INSPECTION
224
225
239



BF-OPS-IN OPERATIONS - INTERNAL
509, 510, 511
OPS6
OPERATIONS IN GENERAL
28
25
SF
SHOP FLOOR
37, 38
IES
IE SERVICES
PE
PRODUCTION ENGINEERING
21, 22
23, 24
IE
INDUSTRIAL ENGINEERING
55
56
PLE
PLANT ENGINEERING
52
51
PC
PRODUCTION CONTROL
ME
MANUFACT. ENGINEERING
515
512, 513, 514
EDC
ENGINEERING DOCUMENT CONTROL
206
103 (2)
104 (2)
102 (2)
101 (2)
TO
TEST OPERATIONS
123
108, 110, 112, 113, 114, 121
PCBA
PCB ASSEMBLY
107, 109, 111, 120
116, 119
FA
FINAL ASSEMBLY
115, 117, 118
122
SM
SYSTEM MANUFACT.

DEVICE DATABASE UPDATE

May 30, 1986 11:13:31 am

== 1 ==

Name: UALI UNIVERSAL AXIAL LEAD INSERTER
Plant: F Desc/Use:
Vendor: UI UNIVERSAL Qty: 3 Noise: MEDIUM
Control: DEC MINICOMPUTER Protocol: PAPER TAPE
Communications: Existing: PAPER TAPE Desired: WIRE

Name: UDIP UNIVERSAL DUAL IN-LINE PACKAGE INSERTER
Plant: F Desc/Use: DIP INSERTER
Vendor: UI UNIVERSAL Qty: 5 Noise: MEDIUM
Control: DEC MINICOMPUTER Protocol: PAPER TAPE
Communications: Existing: PAPER TAPE Desired: WIRE

Name: US UNIVERSAL SEQUENCERS
Plant: F Desc/Use:
Vendor: UI UNIVERSAL Qty: 2 Noise: MEDIUM
Control: DEC MINICOMPUTER Protocol: PAPER TAPE
Communications: Existing: PAPER TAPE Desired: WIRE

Name: SRT SEIKO ROBOT T3000
Plant: F Desc/Use: KEYBOARD ASSEMBLY
Vendor: SKO SEIKO Qty: 3 Noise: MEDIUM
Control: SKO MINICOMPUTER Protocol: MAGNETIC TAPE
Communications: Existing: MAGNETIC TAPE Desired: WIRE

Name: TIWC TEXAS INSTRUMENTS PLC
Plant: F Desc/Use: CONTROLS 3 ROBOTS IN KEYBOARD WORKCELL SEIKO ROBOTS
Vendor: TI TEXAS INSTRUMENTS Qty: 1 Noise: MEDIUM
Control: TI LOGIC-CONTROLLE Protocol: MAGNETIC TAPE
Communications: Existing: MAGNETIC TAPE Desired: WIRE

Name: IRC INTELLEDEX ROBOT 405
Plant: F Desc/Use: PC BOARD ASSEMBLY
Vendor: INTLX INTELLEDEX Qty: 3 Noise: MEDIUM
Control: INTL MINICOMPUTER Protocol: DISKETTE
Communications: Existing: DISKETTE Desired: WIRE

Name: ABPC ALLEN BRADLY PLC
Plant: F Desc/Use: CONTROLS MECHANICAL FUNCTIONS PC BOARD CELL
Vendor: AB ALLEN BRADLY Qty: 1 Noise: MEDIUM
Control: AB LOGIC-CONTROLLE Protocol: DISKETTE
Communications: Existing: DISKETTE Desired: WIRE

Name: B25 BURROUGHS B25
Plant: F Desc/Use: CELL CONTROLLER
Vendor: BUR BURROUGHS Qty: 11 Noise: MEDIUM
Control: BUR PERSONAL COMPUT Protocol: DISKETTE
Communications: Existing: DISKETTE Desired: WIRE

DF Name WORK ORDERS					Plant F	Type	BATCH
Desc B						Media	WIRE
Source ACR SFC	SHOP FLOOR CTRL					Baud Rate	9600
Dest ACR SF	SHOP FLOOR					Percent used	
Size		Converts to	2708	B		Criticality	HIGH
Transmission Time	ERROR	Frequency	72	DAY		Serial #	7
						Initials	DER

DF Name REMNANT REPORT					Plant F	Type	REAL-TIME
Desc EXTRA MATERIAL TO RETURN TO STOCK						Media	WIRE
Source ACR SF	SHOP FLOOR					Baud Rate	9600
Dest ACR MPC	MATL PLN & CTRL					Percent used	
Size		Converts to	74	B		Criticality	MEDIUM
Transmission Time	ERROR	Frequency	50	DAY		Serial #	8
						Initials	DER

DF Name WORK ORDER CANCELLATIONS					Plant F	Type	REAL-TIME
Desc USED WHEN WORK MUST BE SUSPENDED						Media	WIRE
Source ACR SF	SHOP FLOOR					Baud Rate	9600
Dest ACR SFC	SHOP FLOOR CTRL					Percent used	
Size		Converts to	30	B		Criticality	MEDIUM
Transmission Time	ERROR	Frequency	48	DAY		Serial #	9
						Initials	DER

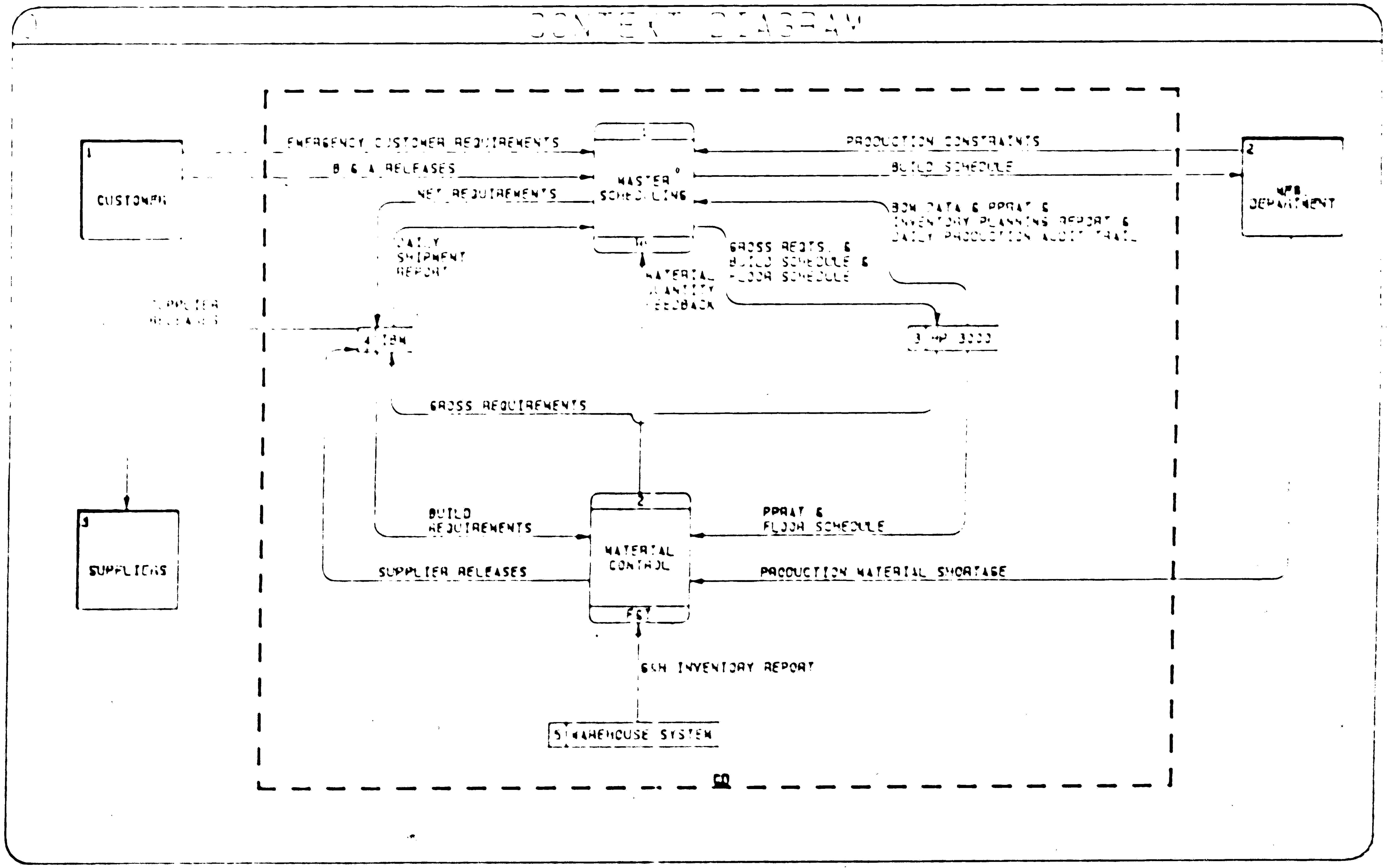
DF Name PARTIAL COMPLEATIONS ON WORK ORDERS					Plant F	Type	REAL-TIME
Desc						Media	WIRE
Source ACR SF	SHOP FLOOR					Baud Rate	9600
Dest ACR MPC	MATL PLN & CTRL					Percent used	
Size		Converts to	72	B		Criticality	MEDIUM
Transmission Time	ERROR	Frequency	606	DAY		Serial #	10
						Initials	DER

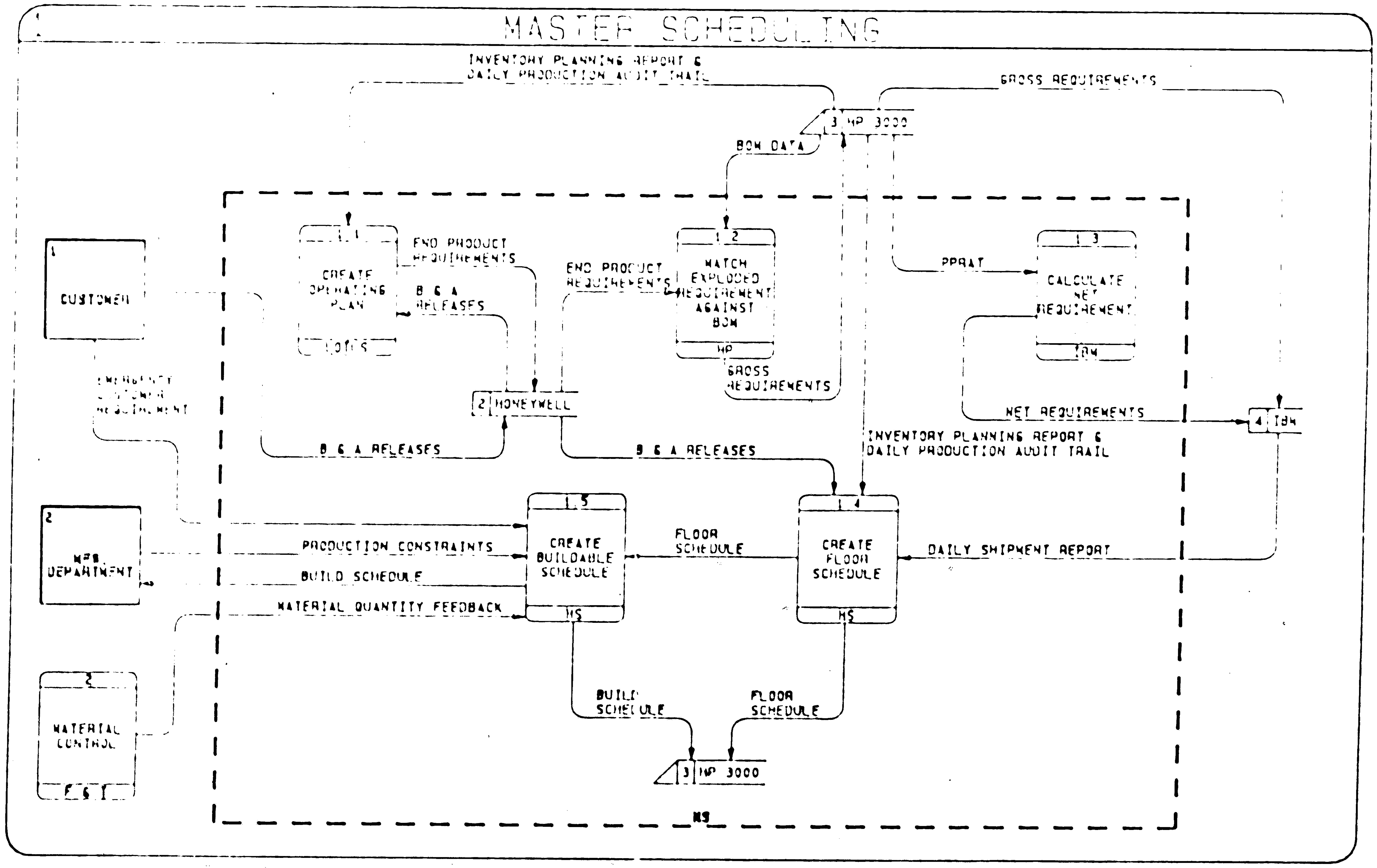
DF Name ASSEMBLY INVENTORY REQUEST					Plant F	Type	REAL-TIME
Desc LOCK / UNLOCK STATUS CHANGE						Media	WIRE
Source ACR RI	RECEIVING INSPECTION					Baud Rate	9600
Dest ACR MPC	MATL PLN & CTRL					Percent used	
Size		Converts to	61	B		Criticality	HIGH
Transmission Time	ERROR	Frequency	47	DAY		Serial #	13
						Initials	DER

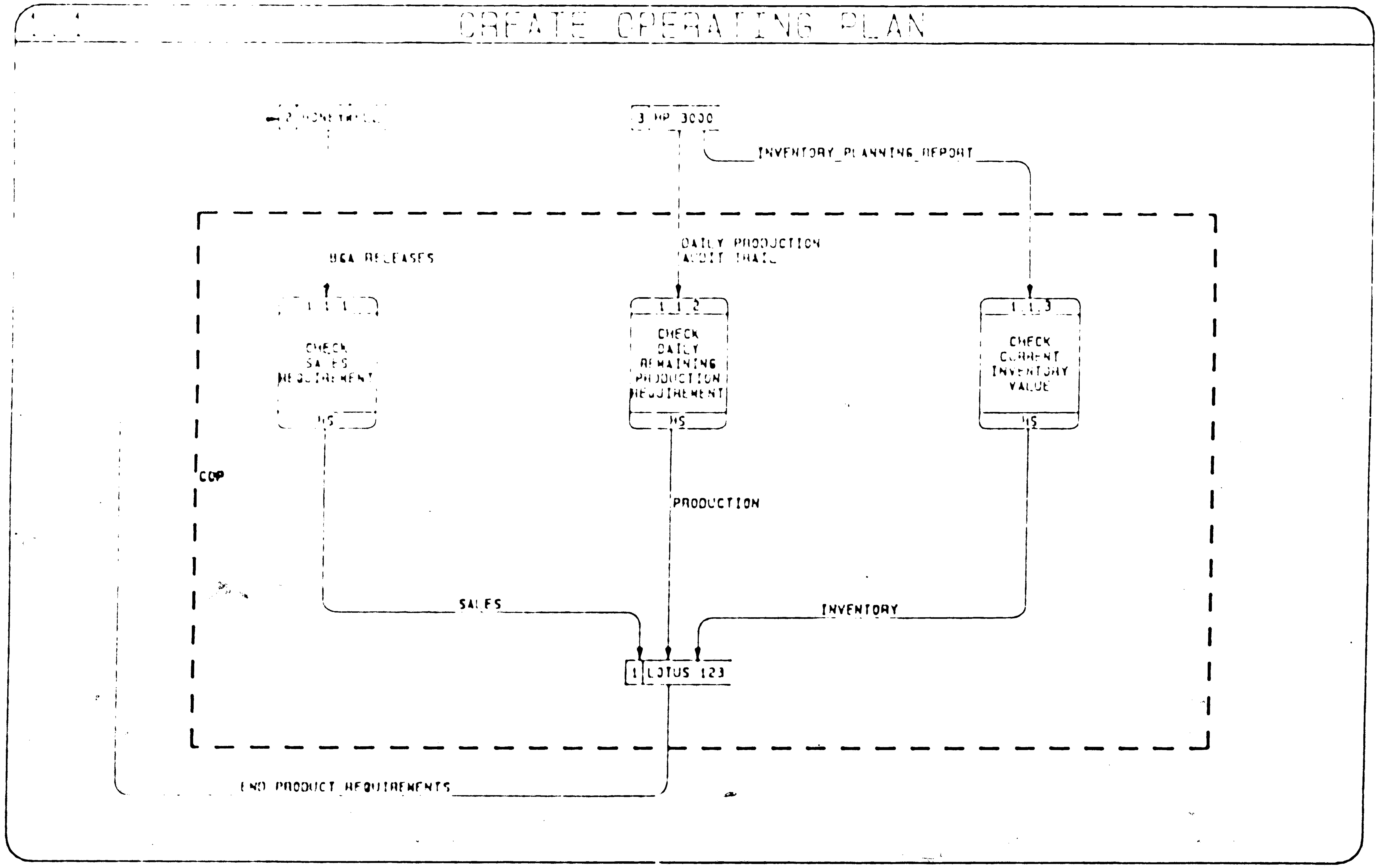
DF Name ASSEMBLY CHANGE IN STOCK LOCATION					Plant F	Type	REAL-TIME
Desc STOCK NOT STORED IN PRIMARY LOCATION						Media	WIRE
Source ACR S	STOCKROOM					Baud Rate	9600
Dest ACR MPC	MATL PLN & CTRL					Percent used	
Size		Converts to	61	B		Criticality	MEDIUM
Transmission Time	ERROR	Frequency	10	DAY		Serial #	14
						Initials	DER

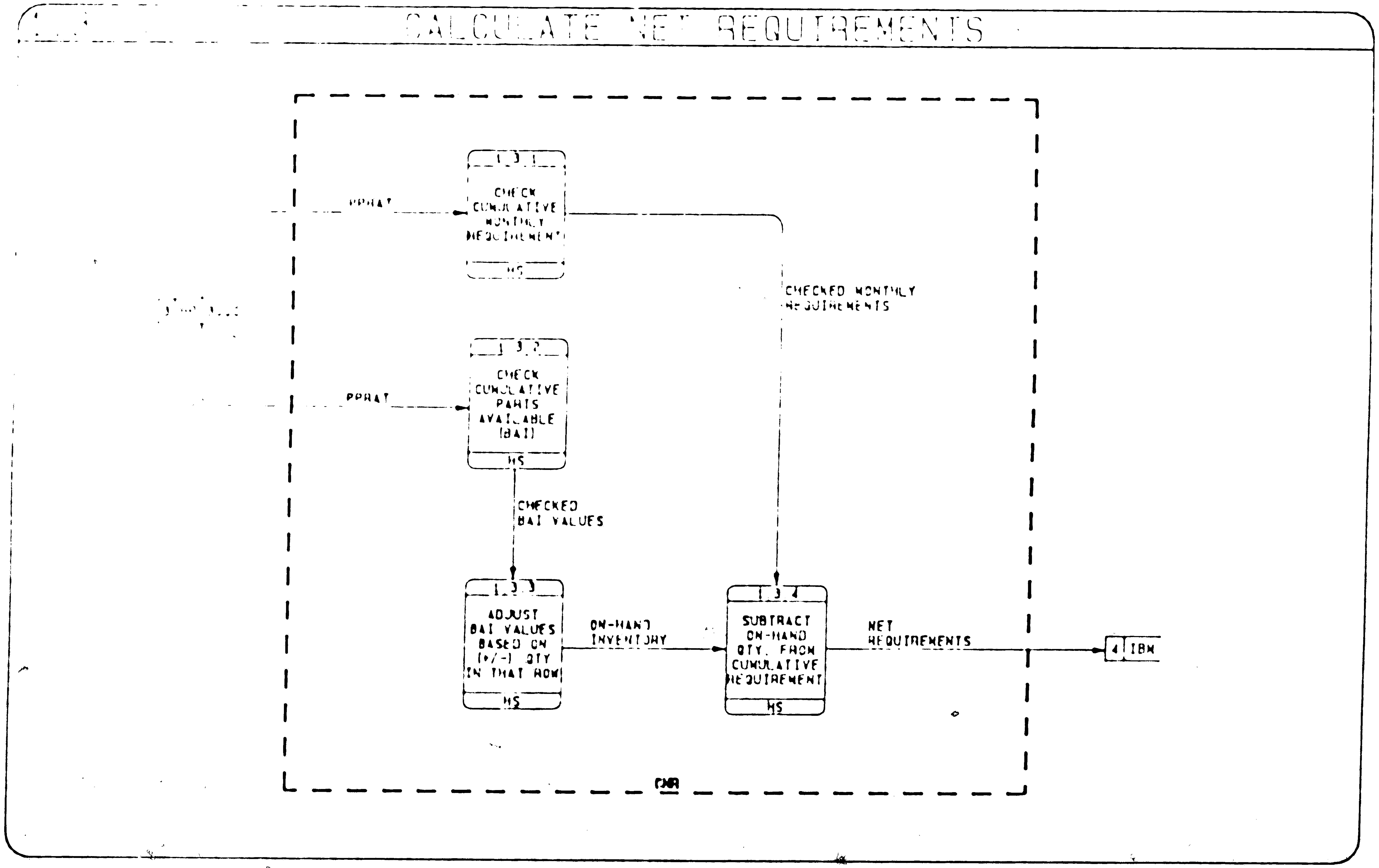
CASE 4

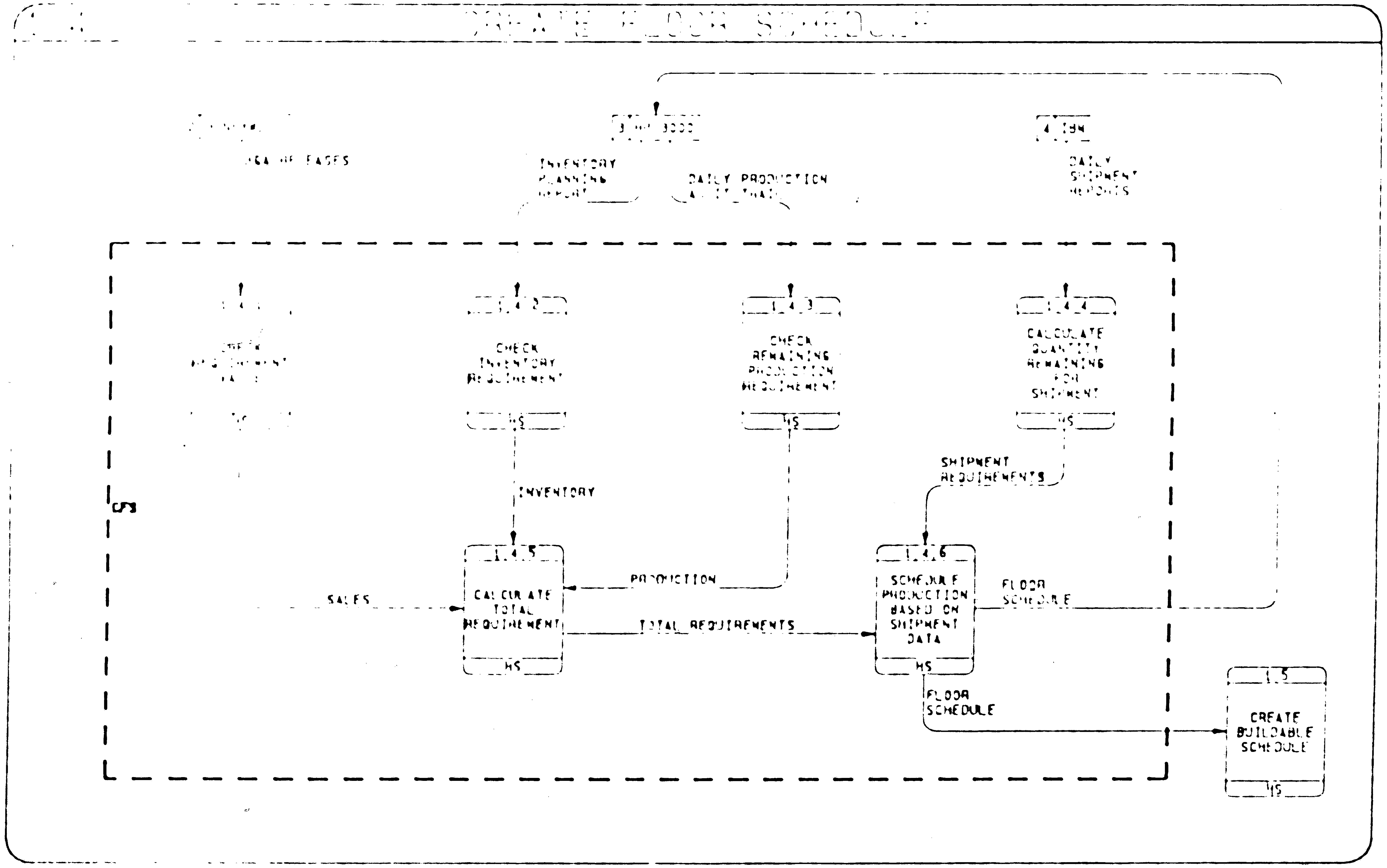
CASE 4


CONTEXT DIAGRAM
1
CUSTOMER
EMERGENCY CUSTOMER REQUIREMENTS
B & A RELEASES
NET REQUIREMENTS
MASTER SCHEDULING
PRODUCTION CONSTRAINTS
BUILD SCHEDULE
2
MFG DEPARTMENT
BOM DATA & PPRAT &
INVENTORY PLANNING REPORT &
DAILY PRODUCTION AUDIT TRAIL
DAILY SHIPMENT REPORT
MATERIAL QUANTITY FEEDBACK
GROSS REQTS. &
BUILD SCHEDULE &
FLOOR SCHEDULE
4 IBM
3 HP 3000
GROSS REQUIREMENTS
3
SUPPLIERS
BUILD REQUIREMENTS
2
MATERIAL CONTROL
PPRAT &
FLOOR SCHEDULE
SUPPLIER RELEASES
PRODUCTION MATERIAL SHORTAGE
FGI
6&H INVENTORY REPORT
5 WAREHOUSE SYSTEM
CD

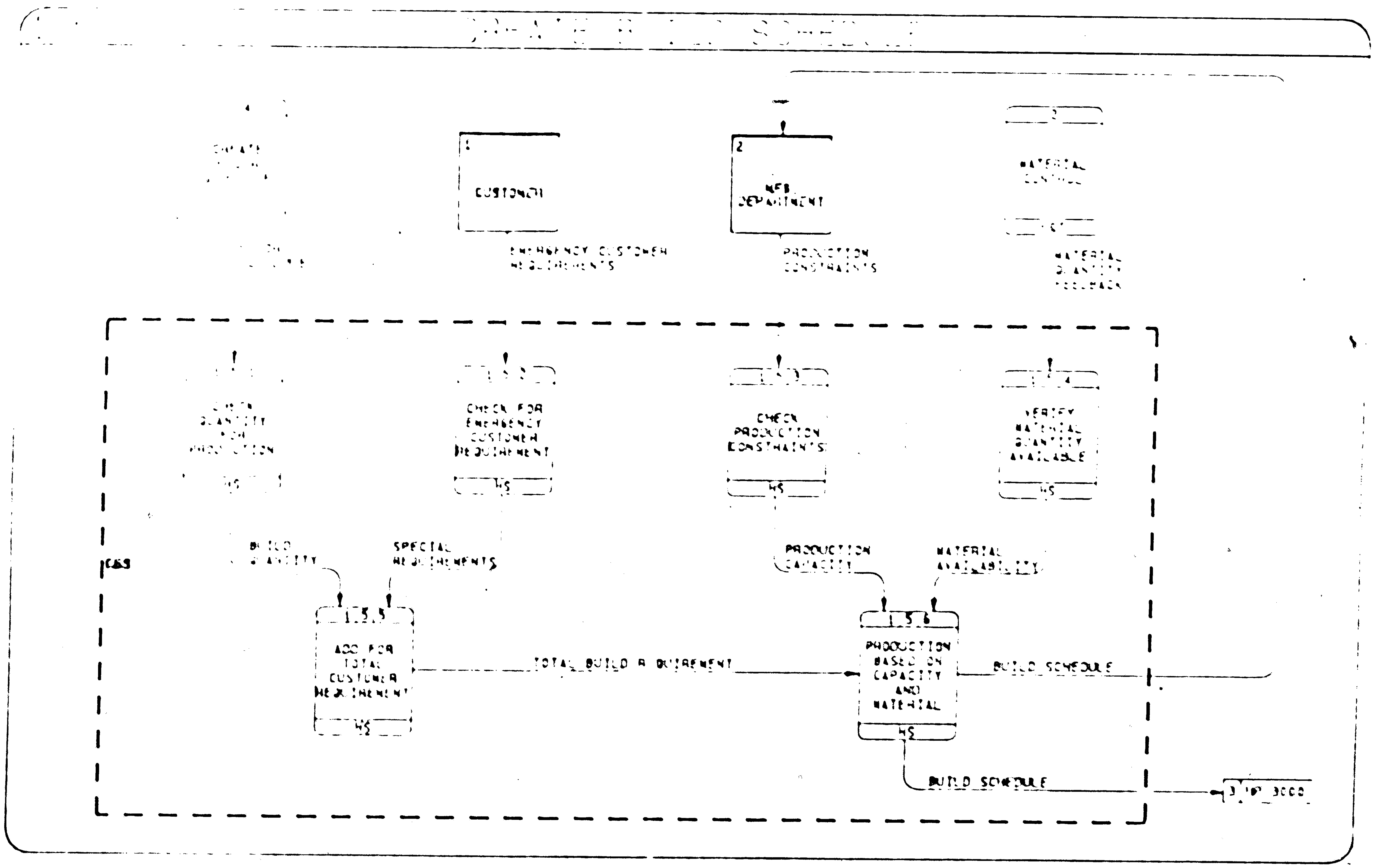

MASTER SCHEDULING
INVENTORY PLANNING REPORT &
DAILY PRODUCTION AUDIT TRAIL
GROSS REQUIREMENTS
3 HP 3000
BOM DATA
CUSTOMER
1.1
END PRODUCT
REQUIREMENTS
CREATE
OPERATING
PLAN
B & A
RELEASES
END PRODUCT
REQUIREMENTS
1.2
MATCH
EXPLODED
REQUIREMENT
AGAINST
BOM
HP
GROSS
REQUIREMENTS
PPRAT
1.3
CALCULATE
NET
REQUIREMENT
IBM
2 HONEYWELL
NET REQUIREMENTS
4 IBM
INVENTORY PLANNING REPORT &
DAILY PRODUCTION AUDIT TRAIL
B & A RELEASES
B & A RELEASES
1.5
1.4
MPS
DEPARTMENT
PRODUCTION CONSTRAINTS
BUILD SCHEDULE
MATERIAL QUANTITY FEEDBACK
CREATE
BUILDABLE
SCHEDULE
FLOOR
SCHEDULE
CREATE
FLOOR
SCHEDULE
DAILY SHIPMENT REPORT
HS
HS
MATERIAL
CONTROL
BUILD
SCHEDULE
FLOOR
SCHEDULE
3 HP 3000
HS

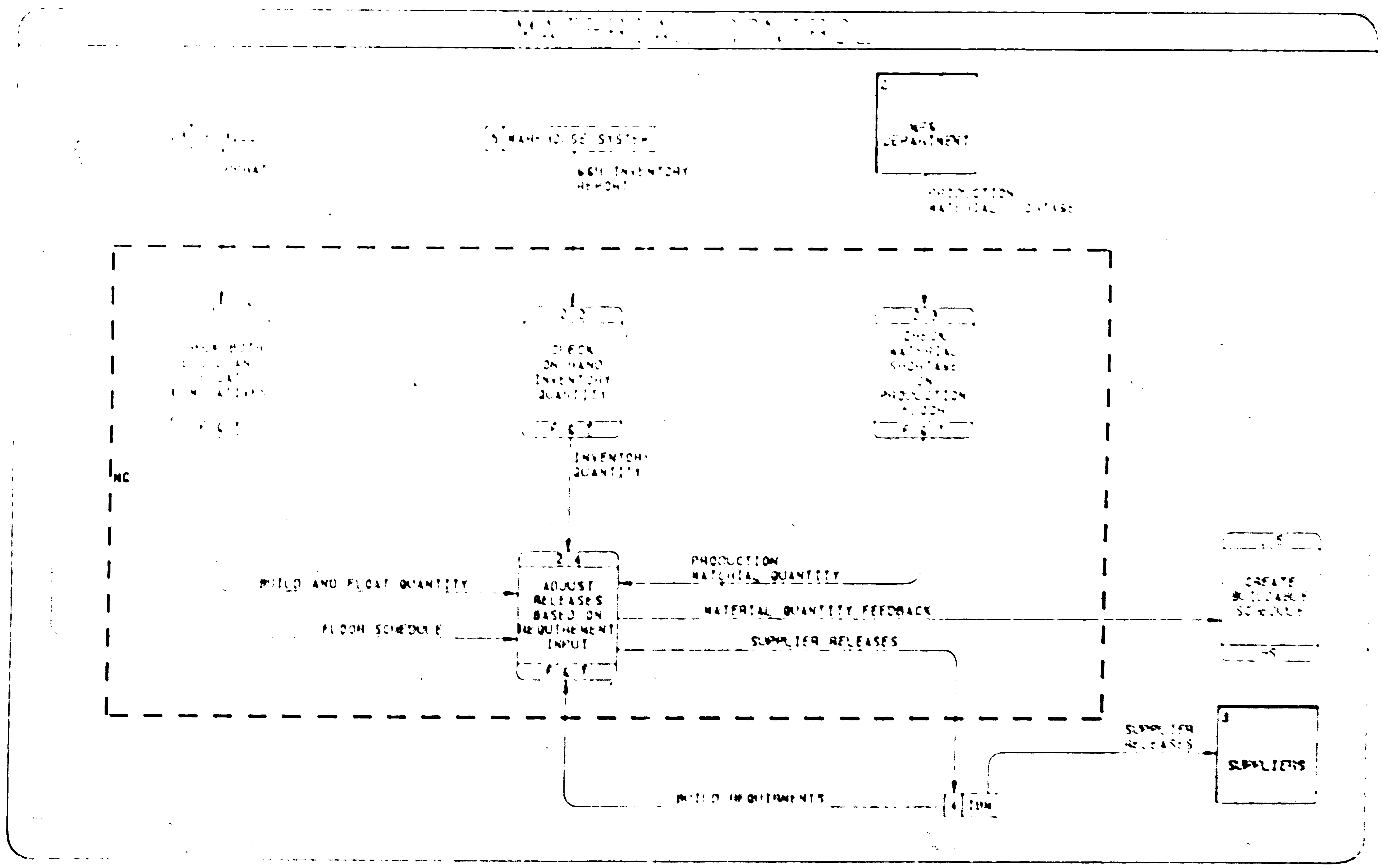

CREATE OPERATING PLAN
3 HP 3000
INVENTORY_PLANNING_REPORT
DAILY PRODUCTION
AUDIT TRAIL
1.1.2
CHECK
DAILY
REMAINING
PRODUCTION
REQUIREMENT
HS
1.1.3
CHECK
CURRENT
INVENTORY
VALUE
HS
CHECK
SALES
REQUIREMENT
HS
COP
PRODUCTION
SALES
INVENTORY
1 LOTUS 123
END PRODUCT REQUIREMENTS


CALCULATE NET REQUIREMENTS
PPRAT
CHECK CUMULATIVE MONTHLY REQUIREMENT
HS
CHECKED MONTHLY REQUIREMENTS
PPRAT
CHECK CUMULATIVE PARTS AVAILABLE (BAI)
HS
CHECKED BAI VALUES
ADJUST BAI VALUES BASED ON (+/-) QTY IN THAT ROW
HS
ON-HAND INVENTORY
SUBTRACT ON-HAND QTY. FROM CUMULATIVE REQUIREMENT
HS
NET REQUIREMENTS
IBM
CNR



4 IBM
INVENTORY
DAILY SHIPMENT REPORTS
1.4.2
CHECK INVENTORY REQUIREMENT
HS
1.4.3
CHECK REMAINING PRODUCTION REQUIREMENT
HS
1.4.4
CALCULATE QUANTITY REMAINING FOR SHIPMENT
HS
SHIPMENT REQUIREMENTS
CFS
1.4.5
CALCULATE TOTAL REQUIREMENT
HS
SALES
PRODUCTION
TOTAL REQUIREMENTS
1.4.6
SCHEDULE PRODUCTION BASED ON SHIPMENT DATA
HS
FLOOR SCHEDULE
FLOOR SCHEDULE
1.5
CREATE BUILDABLE SCHEDULE
HS


CUSTOMER
MFG. DEPARTMENT
EMERGENCY CUSTOMER REQUIREMENTS
PRODUCTION CONSTRAINTS
MATERIAL CONTROL
CHECK FOR EMERGENCY CUSTOMER REQUIREMENT
CHECK PRODUCTION CONSTRAINTS
VERIFY MATERIAL QUANTITY AVAILABLE
SPECIAL REQUIREMENTS
PRODUCTION CAPACITY
MATERIAL AVAILABILITY
1.5.5
ADD FOR TOTAL CUSTOMER REQUIREMENT
TOTAL BUILD REQUIREMENT
1.5.6
PRODUCTION BASED ON CAPACITY AND MATERIAL
BUILD SCHEDULE
BUILD SCHEDULE


MFG. DEPARTMENT
MRP INVENTORY REPORT
INVENTORY QUANTITY
2.4
ADJUST RELEASES BASED ON REQUIREMENT INPUT
BUILD AND FLOAT QUANTITY
FLOOR SCHEDULE
PRODUCTION MATERIAL QUANTITY
MATERIAL QUANTITY FEEDBACK
SUPPLIER RELEASES
SUPPLIERS
NC

MINI SPEC ENTRY

PROCESS NAME : MATCH EXPLODED REQUIREMENTS AGAINST BOM | PROCESS ID #12

< DESCRIPTION >

This process of matching the end products requirements data (stored in the HONEYWELL system) with the Bill of Material data (stored in the HP 3000 system) is automatic. There is no need for manual intervention at any point in time. Thus, there is no further explosion of this process.

	FREQUENCY USAGE PER(H,D,W,M)
IN BOUND DATA FLOWS :	
END PRODUCT REQUIREMENTS	W
BOM DATA	W
OUT BOUND DATA FLOWS :	
GROSS REQUIREMENTS	W

<SPECIAL NOTES>

Gross requirements are output as weekly requirements by part.

DATA FLOW ENTRY

DATA FLOW NAME: BUILD REQUIREMENTS

< DESCRIPTION >

Build requirements are input into the material control process in the form of supplier releases. The material requirements on these releases need to be checked by material control analysts. Build requirements contain total net requirements data stored on the IBM system. Build requirements are a part of total material requirements, along with shop floor and inventory requirements.

ORIGINATES FROM:

TYPE (DS,PR,EE)	NAME	MEDIUM USED
DS 4	IBM SYSTEM	ELECTRONIC, PAPER

ENTERS TO:

TYPE (DS,PR,EE)	NAME
PR 2.4	ADJUST SUPPLIER RELEASES BASED ON REQTS.

< SPECIAL NOTES >

This data flow concentrates on material requirements based on the created operating plan.

DATA STORE ENTRY

DATA STORE NAME : HP 3000 ID #: 3

<DESCRIPTION>

The HP 3000 contains a great deal of information and is used at every level of material control. The following is a brief synopsis of the major data elements stored in the HP 3000. Floor and build schedules inventory status and production material shortage datawhich passes between MP&C and manufacturing. Programs which store production data and create the Purchase parts requirements audit trail (PPRAT). The PPrat is created through the requirements and releasing system and is used to generate the net requirements. Bill of material (BOM) data is stored and is used with the releases to create the gross requirements. Inventory and production requirements are also stored and the data is output through two key reports Inventory planning report and Daily production audit trail. The latter contains the build and float quantities.

IN BOUND DATA FLOWS :

GROSS REQUIREMENTS

FLOOR SCHEDULE

BUILD SCHEDULE

OUT BOUND DATA FLOWS :

PURCHASE PART REQUIREMENTS AUDIT TRAIL(PPRAT)

GROSS REQUIREMENTS

INVENTORY PLANNING REPORT

BILL OF MATERIAL (BOM) DATA

DAILY PRODUCTION AUDIT TRAIL

FLOOR SCHEDULE

<SPECIAL NOTES>

NONE

DATA STORE ENTRY

DATA STORE NAME : HP 3000 ID #: 3

<DESCRIPTION>

The HP 3000 contains a great deal of information and is used at every level of material control. The following is a brief synopsis of the major data elements stored in the HP 3000. Floor and build schedules inventory status and production material shortage datawhich passes between MP&C and manufacturing. Programs which store production data and create the Purchase parts requirements audit trail (PPRAT). The PPrat is created through the requirements and releasing system and is used to generate the net requirements. Bill of material (BOM) data is stored and is used with the releases to create the gross requirements. Inventory and production requirements are also stored and the data is output through two key reports: Inventory planning report and Daily production audit trail. The latter contains the build and float quantities.

IN BOUND DATA FLOWS :

GROSS REQUIREMENTS

FLOOR SCHEDULE
BUILD SCHEDULE

OUT BOUND DATA FLOWS :

PURCHASE PART REQUIREMENTS AUDIT TRAIL(PPRAT)
GROSS REQUIREMENTS
INVENTORY PLANNING REPORT
BILL OF MATERIAL (BOM) DATA
DAILY PRODUCTION AUDIT TRAIL
FLOOR SCHEDULE

<SPECIAL NOTES>

NONE

EXTERNAL ENTITY ENTRY

EXTERNAL ENTITY NAME : MFG. DEPARTMENT ID # : 2

<DESCRIPTION>

The Manufacturing department sends production constraints to be considered during the build schedule creation process and receives all build schedules after the master scheduling process has completed them. The build schedule is sent to Manufacturing on paper and stored on the HP 3000.

	FREQUENCY USAGE
IN BOUND DATA FLOWS :	PER(H,D,W,M)
BUILD SCHEDULE	W
OUT BOUND DATA FLOWS:	
PRODUCTION CONSTRAINTS	W
PRODUCTION MATERIAL SHORTAGE	D

<SPECIAL NOTES>

Production constraints include available manpower, machine downtime etc. Daily schedule adjustments are based on changes to the production capacity constraints value.

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6. Wittry, Eugene J., Managing Information Systems - An Integrated Approach, Society of Manufacturing Engineers Publication Development Department, Marketing Division, Dearborn, Michegan, 1987.

VITA

Elisa Marie Bradshaw, nee Donna Elisa Rebollo, was born in Elizabeth, New Jersey to William and Audrey Rebollo on March 27, 1960. She attended Lehigh University in Bethlehem, Pennsylvania where she received a Bachelor of Science degree in Computer Engineering in 1985. In the same year, she began working for the University as a research engineer in the Manufacturing Systems Engineering group and continued her studies on a part-time basis.

Elisa is a candidate for the degree of Master of Science in Industrial Engineering and is expected to graduate in January 1990. She continues her employment with Lehigh University as a research engineer with the Intelligent System Laboratory.