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A study of modernization/integration of the manufacturing operation in a small, food company /

Faith Dauberman Clark
Lehigh University

A Study of Modernization/Integration of the Manufacturing Operation in a Small, Food Company

by

Faith Dauberman Clark

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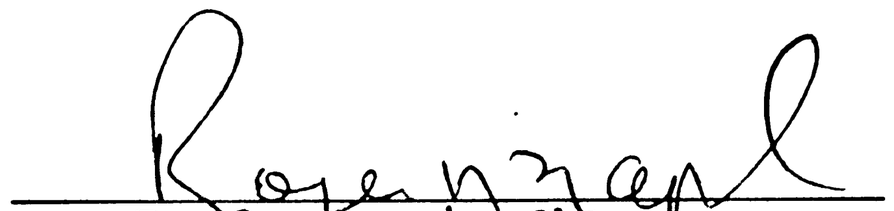
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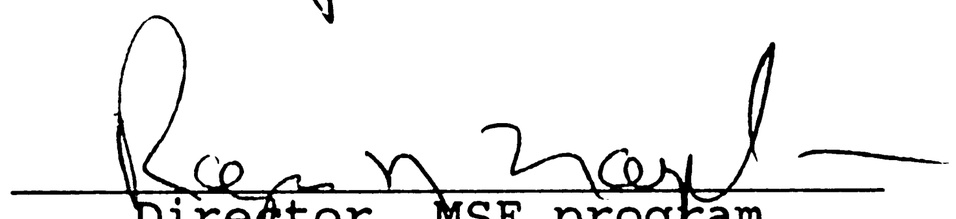
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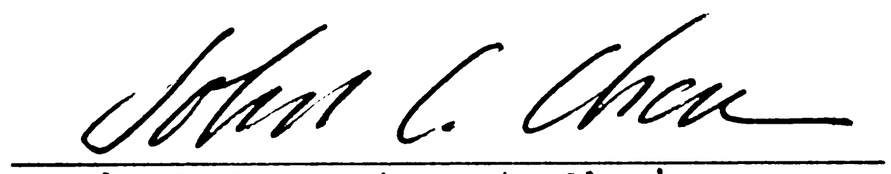
CheE Department Chairman

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I would like to dedicate this work to the MSE golf team, Messrs. Connolly and Habakus, and the remainder of our class for the good times and the hard times, "Are we having fun yet?"

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Abstract

The development of a strategy for modernization using appropriate advanced technology is key to gaining the competitive edge needed for survival in the industrial world today. Industry must know itself and its competitors to properly align the strategy for future growth. The purpose of this thesis is to study the manufacturing operation environment in a small, food manufacturer in preparation for the development of a manufacturing modernization strategy.

Implementation of the strategy will require a stepwise plan to include new technology, change management, financial planning and human resource planning. Barriers towards the use of new technologies in manufacturing exist like inexperience, personnel perceptions, internal resistance, risk aversion, and a lack of a manufacturing strategies. Computer integrated manufacturing provides the data handling capabilities to link the functional areas of the company together, therefore, a better understanding of the overall business is attained. Other benefits prevalent in the food industry include better quality, reduced labor and waste, better

process control thus better weight control, and improved product traceability.

The company studied like many small companies is striving to remain in the market. Projections indicate sales volume may double in the near future. The thesis determines key aspects of the business and more specifically the manufacturing operation that must evolve to support the expected growth of the company. In doing so, the company can better plan their modernization program. The recommendation is made to address the following issues:

* a need for strategies in all functional areas of the company

* a need for well defined and documented manufacturing systems

* a need to develop skills in change management

* and a need for ongoing analysis of the functional business areas

Strategic planning couples the use of analytical skills with intuitive skills. A production scheduling system and simulation are recommended for future use to enhance the planning process.

Introduction

The decline of the U.S. industry is a well publicized fact. The competition has changed due to the entrance of new manufacturing capabilities of foreign countries. New technologies have changed product design and processes. Traditional hierarchical, adversary management practices, organizational structures and decision-making criteria are not supportive of the technology changes and must evolve into a new management style.

Neither technology change or organizational change alone will effect the way the U.S. competes. Each compliments the other. The new technologies will provide many more options to the manager. This makes it critical to have strategies or goals set to help direct the manager in selecting the appropriate options. Decision criteria will be based on the strategy of the corporation and the interrelationships of all functional areas. Every member of the organization becomes a resource.

A key functional area which is often overlooked in corporations is manufacturing. The use of new technology in manufacturing can change the way a company competes. Allowing manufacturing to break away from the "increase productivity through operational change" mentality to

strategic thinking, will open new horizons. The development of a manufacturing strategy will provide the tool needed to look at long term advantages in manufacturing rather than short term operational improvements in productivity.

All this causes a dilemma for the manufacturer. Many understand the need to adapt, but do not know how to bring about the required changes successfully. Small manufacturers lack the monetary and human resources needed to bring about the change. Industries differ. The discrete part or manufacturing industry benefits from different technologies than a processing industry like the food industry. Marketing strategies i.e. price leadership versus product differentiation lead to different selections of appropriate technology. The key is to know the business strengths and weaknesses internally and externally, and then develop the strategy for the future to beat the competition.

The purpose of this thesis is to study the manufacturing /scheduling operation environment in a small, food manufacturer in preparation for the development of a modernization/integration strategy. The company studied like many small companies is striving to remain in the market. Projections by its marketing group indicate strength: Conceivably the business will double

in sales volume in the next couple of years. The intent of this thesis is to determine the key aspects of the business and more specifically the manufacturing/ scheduling operations that must evolve to support the expected growth of the company.

Organization of the Thesis

The thesis begins with a discussion of strategic planning. It is a vital part of the business world today because of the existing complexities and uncertainties. Strategic planning at all levels of the organization gives direction such that appropriate business decisions can be made.

Manufacturing plays a key role in a company and can provide a competitive edge. It should be treated as a strategic part of the company. Many new technologies exist today that can increase productivity and provide sustained advantages. Barriers that inhibit the use of the technology include: inexperience by both the company and vendors, personnel and labor perceptions about new technology, internal resistance and risk aversion in manufacturing, and a lack of a manufacturing strategy. These barriers begin to breakdown when appropriate change management is applied and the interrelationships of decision areas are understood.

Chapter 2 deals with the key aspects of computer integrated manufacturing (CIM) and the benefits achieved with CIM. It provides a more rapid response to external changes in the environment, more flexibility and adaptability, and a lower cost higher quality product. These result from the ability to know more about the business at any instance in time. CIM links all the functional areas of the business.

In chapter 3, a comparison is made between the manufacturing industry (discrete part), processing industries and more specifically the food industry. Some particular details are given concerning marketing, product concerns, and government regulations in the food industry. This is followed by a discussion about small and large corporation differences. Finally the small food manufacturer that was studied is detailed.

Chapters 4-7 deal directly with the study. Chapter 4 describes the methodologies used in the study. A description of the production scheduling process is given in chapter 5. Chapter 6 includes an evaluation of the information attained during the study with respect to communication in the process, order control, scheduling, and shipping areas. Recommendations first with respect to the company in general and then with respect to production

scheduling are given in chapter 7. A concern about product tracking and the potential dangers is also included in this chapter.

Chapter 8 deals with the future. It discusses the use of both analytical skills and intuitive skills to develop the modernization plan. Production scheduling approximation and simulation are two analytical tools which can be used to generate various scenarios of the future. The result is a set of alternatives that can be evaluated and combined with innovation, management proactivity, and risk taking to develop an appropriate strategy for the future.

Chapter 1 A Strategic Plan

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to," said the Cat.
"I don't care much where..." said Alice.
"Then it doesn't matter which way you go,"said the Cat.
"..so long as I get somewhere," Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, "if only you walk long enough." !!!!!

"To paraphrase the Cat, 'If you don't know where you are going, any strategy will take you there.'" (From Alice in Wonderland) (12)

A strategy is a "plan, method or series of maneuvers or stratagems for obtaining a specific goal or result." In the industrial world today, the goal or result is to beat the competition. American industry has seen a strong decline in its ability to compete over the past decade. To regain the edge, some basic philosphies and instruments of management must evolve.

Strategic planning has become a vitally important element of the business world today because of increased complexities and uncertainties. It is not done once and for all, but requires constant monitoring of the business functions, competitors, current goals, and strategic control/implementation. An industry must know itself,

both strengths and weaknesses, and it must know its competition. It can then evaluate if replacement of its current strategy is necessary to meet "changing circumstances of new technology, new competitors, new economic environment, or a new social,financial or political environment." (10)

Evaluation methods used to determine strengths and weaknesses of a corporation or its competitors vary in detail and depth. Typical techniques are self analysis by building different scenarios of potential futures, portfolio analysis, growth share matrices, assessment of the industries structure and its strategy constraints. Each evaluation builds on the current environment or the "As Is" and helps to determine the future environment or the "To Be". The analysis in conjunction with business intuition directs the strategic planning process.

Once the assessment is completed, a strategy is developed, implemented and controlled. The elements of a strategy are characterized by the following: (9)

> Time horizon-It encompasses an extended period of time to both carry out the activities and to observe the impact.

> Impact- This occurs over a relatively long period of time. The benefits are not short term in nature. The source of the benefits is strategic and somewhat abstract such as customer loyalty and better customer service.

Concentration of effort- An effective strategy forces concentration on a few key issues and goals. Because of this attention, concentration is implicitly reduced in other areas.

Pattern of decisions-A strategy requires commitment and consistency in decision making. Many decisions will be made that effect the implementation and finished end product of a given plan. It is critical that management commitment to the strategy exist such that each decision is supportive of the other.

Pervasiveness- A strategy permeates every aspect of the business and therefore each level of the organization must act in ways that reinforce the strategy. Again commitment to and understanding of the strategy is important.

Implementation of a strategy requires a stepwise plan to include new technology and change management, financial planning and human resource planning. If the change is great, by introducing it in a step fashion, the business will not go into shock. Efforts up front to develop an implementation schedule will save time in the end and prevent costly mistakes from occurring. Project management techniques are useful during the implementation phase.

Implementation also requires a method of "strategic funding programming in order to finance each stage of the corporation's strategic change and also to provide

strategic focus for materials, resources, production, distribution, marketing and control." Because the impact of the strategic plan may not be realized for several years, necessitates the use of different accounting methods. These should be planned for up front.

The staffing or human resources strategy must be organized to ensure that the right executives, staff and type of labor force are hired for, or focused on, carrying out each chosen strategy and specifically directed toward each of the parts of that strategy in sequence." Human resource management is crucial to strategic success. The wrong people in charge, the lack of commitment by top management, confused goals or direction, a lack of total commitment by all management, cause failure. It results in chaos, confusion, resentment, and basically a waste of everyone's time. "The strategy must make sense to all of those carrying it out." (10)

Finally strategic control must be in place. This is the opportunity to determine if the strategy is on track: if immediate reevalution is necessary: or what the evolving strategy should be for the future. The industrial environment continuously changes, therefore, it is important to monitor the existing strategic path and make sure it is taking you where you want to go.

Manufacturing Strategy

At this point, we turn to manufacturing strategy and some of the problems faced when trying to implement that strategy. The fact that manufacturing can provide a real competitive edge is finally being realized by American industry. However how to take advantage of this fact is not obvious. Typically firms concentrate on productivity gains through cost cutting, new product introduction, or fluctuations in volume. These gains are operationally oriented and only provide short term gains not a sustained competitive edge.

Ten to fifteen percent increases in productivity are needed by most American companies in order to stay competitive or gain the competitive edge in their respective industries. Increases in operational productivity alone is not the answer. Skinner applies a 20-40-40 rule for competitiveness through manufacturing: 20% gain through productivity, 40% gain through new technology, and 40% gain through manufacturing strategy implementation.

New Technology

New technology is scary to businesses: Are we the innovator or do we sit back and wait for another company to develop the technology? Is it the right technology for

us? What is the life cycle of the new technology? What is the likelihood of failure? What about the learning curve? How costly?

The key issue to implementing new technologies is its integration into the overall business structure. Technology represents significant capital investments and corporations want to make the right choices for them. Wickham points out that the new technologies must be in the plan from the beginning not as an after thought. They must be planned for in terms of change management, human resources, financial resources and in terms of future technologies. Planning helps alleviate some of the barriers that face businesses as they try to implement a new technology in the company. (10)

Barriers to New Technology Enhancements

What are some of the barriers to utilizing new technologies that exist today? One involves the new technologies themselves. Because they are new, there are many unknowns about them: learning curves, reliability, rapid changes, payoffs that are not traditional. Companies typically use a one to three year payoff period. Advantages in new technologies may have a much longer payoff period and may not be in terms of cash. The benefits will be in the areas of flexibility, speed of

customer changes, benefits that are more strategic in nature.

Another barrier is an inappropriate/inadequate system for capital allocations. As mentioned above hurdle rates and return on investments typically used for handling new products or larger capacities are inappropriate for new technology that may not have obvious paybacks for 6-7 years. New measuring systems are needed to help companies evaluate a strategic investment. Justification and amortization of technology purchases will be based on total system performance.

Limitations of vendors on the new technology poses a problem. There are no complete, turnkey systems on the market. The company is basically on their own in putting together the pieces that complete a system. When you are on the frontier of technology, risks of system obsolescence is high.

The fourth deals with personnel and labor problems in the perception of new technology. Workers see new technology bringing on change. They fear the loss of their job and the changing environment. New management techniques, new, more technical jobs, new responsibilities all impact the productivity of the worker. If managed improperly, the human resource problem can be devastating.

The fifth barrier deals with internal resistance and

risk aversion by manufacturing management. Historically manufacturing managers dealt with operational issues in the plant and did not play a strategic role in business. Hayes and Wheelwright (8) discuss the different stages of manufacturing strategic roles in the corporation as:

> (1) minimize manufacturing's negative potential:"internally neutral"-Outside corporate decisions are made about strategies. The facility is kept flexible and reactive.
>
> (2) achieve parity with competitors: "externally neutral"- planning horizons include a single business cycle. Capital investment is the means to catching up to the competition.
>
> (3) provide credible support to the business strategy:"internally supportive" - A manufacturing strategy is formulated and approved. Longer term issues are address systemically.
>
> (4) pursue a manufacturing-base competitive advantage: "externally supportive"- There is a team of engineers, marketing types and manufacturing involved in decisions. Anticipation of upcoming technologies and new practices characterize this stage.

Most manufacturing operations in industry today are in the first two stages-"Make the product without any surprises". Manufacturing is not part of the team for planning the future. Their vision is short term. This results in managers that are stifled by the financial "guru's" of the company when requesting funding for new technology. Justification is in terms of productivity competitiveness

in the future. Because they are not part of the corporate team, they lack the basic understanding of the corporate mission. "Manufacturing managers are good soldiers. They have the infantry mentality" and that is how they get treated.

Strategy

Skinner contends the five barriers mentioned above exist because there is no manufacturing strategy. "Without a long term manufacturing strategy, it is impossible to make plans for a new, expensive, yet risky EPT (equipment and process technology) that will not pay off financially for years and offers only a strategic long term advantage." (10) A plan assures the manufacturing managers that their investment recommendation are on track and it forces executives to look into the future making sure investments build on competitive strategies. It is derived from the corporate strategy and tells manufacturing exactly what must be done to maintain a proactive role in the corporation.

As manufacturing becomes more proactive and respected, the company will begin to move into the third role described by Hayes and Wheelwright: Provide credible support to the business strategy. Manufacturing in the third role is characterized by viewing changes in technology as a natural response to a competitive

position, screening decisions to be sure they are consistant with the corporate strategy, translating the strategy into meaningful terms for manufacturing personnel, looking for ways to improve themselves while enhancing other business units ability to compete, and taking initiative to guide their activities for extended periods of time. (8) "This shift does not happen overnight, and it is far to easy to backslide once a plateau is reached. The shift requires changes in organizational structure and decision-making processes, and it demands new skills: Managers must learn to manage change." (6,10,16)

To understand the changes that occur as new technology and systems develop and manufacturing takes on a strategic role, it is necessary that management know the interrelationships between manufacturing decision areas. These areas include product design, process design, facilities and plant configurations, information and control systems, human resources, R&D, supplier's roles and relationships, and the organization. These functions require close cooperation and tight coordination. A system of effort must develop.

Once the decision area interrelationships are known, then, the true impact of introducing new technology is

predictable. Many "uncertainties" or variables become "knowns". The implementation planner can deal with the "knowns" up front rather than being surprised by them later. Barriers begin to be removed.

Decision Areas: Interrelationships to the Company

The following section describes general aspects of each decision area. Industries of course differ in the relationships between groups. By studying information flow and evaluating the business, one can identify the specific relationships for a particular industry.

Design aspects can effect the workforce tasks, pose special quality or scheduling problems, or affect raw material requirements. Innovative changes are beneficial however "if the organizational groundwork isn't properly laid, for example, process-design changes may have little lasting effect." Old ways of dealing with problems are maintained. Quality standards do not change. Changes of this nature are implementable and successful if the management and the workers are involved with the development- human resource management.

Facility and plant configuration must occur at the initial stages of the manufacturing strategy. It provides a "catalyst for change" and is a stepping stone for change to occur in other areas. Employees see this as

investment their future and stability of the business.

Information and control systems are intricately tied to all aspects of the corporation and it is therefore critical that they meet the strategic objectives of the corporation. On going evaluations of the business, all decision areas, are easily accomplished with appropriate database structures and data processing capabilities. System development may be necessary before other aspects of the plan can be implemented.

Human resource management can make or break a strategy. Direct labor cost currently account for only about 15% of the manufacturing costs and yet it is one of the first areas attacked for cost reduction. It is only a temporary fix for some underlying problems. More positive effects can be achieved through training and open door policies, treating the employee's as thinking adults. Implementation of a plan in which all employees truly commit to the goals and have had some input into its development, is apt to be more successful.

"R&D is the key to developing proprietary processes and product expertise. It influences almost all other manufacturing decisions, even those involving role and relationships with suppliers, facility location and development of special organizational capabilities." By staying abreast of current and developing technologies, a

corporation may take a whole different view of the long term future. For instance, an aircraft engine company hesitated taking advantage of cheaper Far East produced turbine blades for fear the foreign company might try to enter their market. After R&D provided convincing evidence that the blades of the future would be made of ceramic, the company bought the blades from the Far East and developed new processes to deal with the ceramic materials.

Supplier relationships are evolving into long term relationships via subcontracting, joint research efforts, or other joint efforts. The suppliers are becoming tightly linked to process/product design and even system decisions. Some companies are tying scheduling systems into supplier systems for on the spot inventory and supply checks. A mutual trust develops between suppliers and the companies. Contracts become longer and supplier reliability and quality excels.

Organizational change alone rarely achieves the competitive goal, however, it can enhance its efforts to reaching the goal. By customizing procedures, policies, structures and so on, the organization can better handle the changes in the functional areas that will occur. Change is not the goal but is the means used to attain the

goal. If mismanaged, no amount of capital investments in new technologies or systems will matter. (5,6,10,16)

Interactions of the eight decision areas above in conjunction with constantly reevaluating manufacturing decisions to assure alignment with strategic goals, proper implementation planning/control and utilization of appropriate advanced technology provide elements of success. If interdependencies are ignored or overlooked barriers appear. A strategy is pervasive and contains a pattern of decision all supporting the corporate goal. By integrating manufacturing areas and business areas, looking at the whole rather than isolated functions, the competitive edge is within reach. Chapter 2 deals with key aspects of computer integrated manufacturing and the benefits it provides for any business.

Chapter 2 Computer Integrated Manufacturing

In the previous chapter, we discussed the need for productivity, new technology and manufacturing strategy implementation as key components for a competitive edge. The strategy is the scheme that takes a company from a factory today to a factory of the future. It aligns manufacturing with the corporate goals and provides the actual series of acts that are used to support the business in competition. Technology links the decision areas identified earlier providing a means for each to interact effectively, with sufficient data and in a timely manner. Effectively does not necessarily mean with the most advanced equipment. A system that opens communications can be augmented by technology but it must exist first. Sufficient data is a key word. "The integration of data will be the glue that holds the factory of the future together. In the past, we focused on the physical processes- in the future, we'll focus on data." (21) Companies, both large and small, processing or discrete part, must plan for the future.

New technologies will be applied to various functions of the manufacturing company. Robots have been the center of attention in automation. Other key technologies include

group technology, material requirements planning, flexible manufacturing systems, computer aided inspection, and automated test equipment. The individual technologies each effect a portion of the manufacturing process. When they are integrated via computer hardware and software links to allow information and product flow across technologies, the system is termed computer integrated manufacturing, or CIM. This chapter discusses CIM with respect to two types of industries, processing and manufacturing, strategy differences, organizational change, and benefits it provides.

"CIM refers basically to the data handling capabilities of the manufacturer. It is a sophisticated system for gathering, tracking, processing, and routing information that links purchasing, distribution, marketing, and financial data with design, engineering, and manufacturing data to expand and speed the knowledge available to employees and managers." (16) For the manufacturing industry (discrete part), CIM links CAD/CAM systems, automated inspection systems, modeling and simulation systems, flexible manufacturing systems, materials handling, process planning, etc. In a processing industry like the food industry, its application is in areas of automatic finished goods

handling, raw material handling, feedback control and process control systems, computerized data collection from the plant floor, planning and decision support systems, material tracking systems from supplier through the process to the store front and customer, modelling and simulation systems. Food processors are becoming increasingly interested in data collection pertaining to how personnel, processing equipment, raw materials and energy resources are being used in their facility. This information provides the managers with more options for problem solutions. It creates a whole picture of the business at any instant in time. Having a total picture, allows more efficient use of all company resources.

The concentration of effort of the CIM system will depend on the degree the business strategy is oriented to price leadership or product differentiation. The latter offers a range of prices and performance options and probably would benefit more from the CAD systems and FMS. The low price strategy gives a combination of performance and quality at the lowest possible price but still meeting the needs of the customer. Production, material handling and inspection technologies are of more use with this strategy.

Regardless of which strategy is pursued, three key objectives are apparent:

> "(1) more rapid response both to market changes and to changing consumer demands in terms of product features, availability, quality, and price;
>
> (2) improved flexibility and adaptability; and
>
> (3) low cost and high quality in design and production."

As mentioned early, entwined throughout any strategy objectives is the crucial need for new management approaches, more flexible work rules and organizational changes. These changes are necessary for competitiveness- "new technologies can increase those benefits exponentially." (15)

Expect change

The implementation of the CIM plan requires planning really in two areas: the technical and the organizational. The technical must be in line with the strategy: it is quantifiable and most aspects are known in advance. The opposite is true for the organizational aspects. For some reason, businesses find it easier to ignore these than to plan for them. Developing the factory of the future brings with it change. People resist change because of "threatened self interest, inaccurate perception of the planned change, objective disagreement, and low tolerance for any change." Displacing people with automation may

cause a break in the social bond associated with their work or the power relationship associated with being the senior person of the group. Training of displaced people and remaining people is of prime importance. "Here's the differences between the old and new equipment and here's how it effects your job."

There are changes in managers in the wake also. The new breed will help break some of the barriers to technology mentioned before. Traditionally corporate objectives have been productivity, efficiency and return on investments: technology was power and steam, (mechanical advantages): measures were standards, industrial engineering, controls, efficiency experts. The new breed comes from diverse backgrounds: marketing, finance, systems, human resources. They think of manufacturing in long-term, competitive terms and are willing to take high risks to improve the chances of survival. They are team builders and utilize expertise throughout the company. They excel at team problem solving. A systems approach utilizing the total resources of the company is visible.

Planning for the changes to occur as the strategy is implemented will provide a smooth transition. Part of the effort of the integration team will be devoted to managing the human side of integration of the old to the new. The

success will depend on accurate assessment of the situation (understanding the effect on the workforce), predicting changes in the environment and being prepared for them, and adequate resources to do the job. Resources include planning resources for a smooth transition, an integrator to understand input from the workforce, and adequate personnel to train and educate the workforce, both managers and employees. (10,13,16,21)

Benefits of CIM

Successful implementation of a CIM system provides many benefits to a company. A better understanding of the day to day operations and the identification of potential problems are key benefits to any corporation regardless of the product line. First the corporation becomes proactive rather than reactive. A preventitive maintenance approach can be taken since the future is more predictable. Secondly, from a manufacturing standpoint, the plant is better controlled, resulting in less waste and a better quality product.

A reduction in labor cost is a frequently mentioned benefit of a CIM system however this must be qualified. Typically direct labor decreases with the implementation of automation. This decrease is often offset by increases in indirect labor. A $12 an hour worker or two is

replaced with a $50 an hour technician that maintains the computer systems. Overhead cost increase with CIM systems and must be balanced with the benefits of direct labor reduction.

Miller and Vollman (14) suggest that different types of transactions are the real cost culprit. The transactions "involve changes of materials and/or information necessary to move production along but do not directly result in physical products." Four categories of transactions that deal directly with the customer and getting that product to the customer have been identified. These are

> Logistical transactions which order, execute and confirm the movement of materials from one location to another.
>
> Balancing transactions ensure that the supplies of materials, labor and capacity are equal to demand.
>
> Quality transactions extend beyond quality control, indirect engineering, and procurement to include identification and communication of specifications, certification that other transactions have taken place, and development and recording of relevant information.
>
> Change transactions which update basic manufacturing information systems to accommodate changes in engineering design, schedules, routings, standards and material specifications.

Careful evaluation of the systems used to deal with each transactional area can identify potential improvements for the company. By reducing the amount of paper work involved in each transaction, the indirect labor will be reduced.

Increased efficiency associated with CIM results in reduced inventories-raw material, work in process, and finished goods, and lower occupancy costs of facilities. Reorganization of a facility to utilize group technology, material handling systems and automated tracking systems enhances the throughput of manufacturing. More efficient use of machinery results from the flexibility and adaptability associated with CIM systems.

Another benefit is reduced manufacturing leadtimes. Transactional processes described above impact the leadtime. Changes to orders negatively effect leadtimes. Reorganizing the factory floor cuts out significant traveling time as the part is moved from one operation to another resulting in more efficient use of space and equipment, and thus shorter leadtimes. Installation of computer design and manufacturing significantly reduces leadtimes in the discrete part industry. Scheduling programs can optimize the best plan for the manufacturing of all orders, thus the product is shipped in an optimal amount of time.

Because of the shelf life and other regulatory constraints in the food industry leadtime is not as critical. Typically products are ordered and shipped within a week to two weeks time. The planning systems use forecasting methods to establish the requirements pattern thus enabling the manufacturing function to produce extended economical production runs. Production scheduling has significant impact on the efficiency of the plant. Products must be scheduled to minimize downtime due to variety changeovers. If short runs are scheduled, product quality will be sacrificed.

Quality is the number one benefit of CIM for the food industry. Integration of processes and information provides a consistent product through control and better understanding of the processes. Installation of CRT displays on the factory floor provide faster response to potential problems. A process running poorly at thousands of pounds an hour can be extremely costly. Direct input via on line terminals or bar coding provide trend information, immediate report generation of process statistics, government required production/sanitation data and other pertinent facts about the business operation. Alarm systems relieve the operator of constantly monitoring the process. The operator is more flexible.

More time can be spent on preventitive actions rather than reactions.

A side benefit of having the data available immediately versus the day or week time lag found in manual systems is more efficiency in the upper management ranks. Information transferred across levels is streamlined to meet the readers needs with little extraneous data ever reaching them. This makes the manager better informed to choose the appropriate options or solutions to problems.

Improved weight control is a significant benefit of CIM in the food industry. Product giveaway due to weight fluctuations either at the beginning of the process or in packaging is costly. By better understanding the process and having more process controls installed, the operator can fine tune the machine adjustments which control weight and pinpoint problem areas. Utilization of the state of the art packaging machines at the other end will help achieve the savings.

Product lot tracking capabilities provides a means for total recall in the event that a contamination problem reaches the consumer. Recall refers to retrieving all questionable product from the market place. The use of bar coding and a database system permits the manufacturer to not only track the product through the distribution

centers and store fronts but also allows the raw materials and packaging materials to be associated with each batch of product in the production operation. A second benefit is the ability to track suppliers to identify those sending off quality products. If the raw materials are not top quality then the finished product cannot be top quality.

Computer integrated manufacturing provides the data handling capabilities for the company. Changes occurring as a result of integration must be planned for and will appear in technical, managerial, and organizational areas. CIM clearly enhances the competitiveness of a business.

The benefits, better quality, less waste, reduced labor costs, increased efficiency, reduced leadtimes, better process control, and a better understanding of key elements of the business, increase the competitive nature by providing long term savings. The company can be more responsive to the consumer, more flexible and adaptible, and provide products at lower costs and higher quality then ever before.

Chapter 3 Characteristics of a Small, Food Manufacturer

Previously we discussed gaining a competitive edge through productivity gains, new technology gains and implementation of a manufacturing strategy. A part of this strategy is to link all processes of the organization together to provide a database for access by every functional group in the company or basically to develop a computer integrated manufacturing system. Many benefits such as better quality, less waste, better control of the business and its processes, reduction in labor cost and leadtimes were mentioned. CIM provides flexibility, adaptability, responsiveness and lower cost products with higher quality for the company. It can be applied to any type of industry and any size of industry, although CIM has been more highly publicized in the manufacturing industry. This chapter looks at the differences in the manufacturing industry and the processing industry, specifically the food industry. It then focuses on some key areas of the food industry studied, marketing, product concerns, and government regulations which present some different challenges when implementing CIM. The next section characterizes some specific business differences between a large corporation and small corporation. The

remainder of the chapter describes the basic processes of the industry studied for this thesis and gives some characteristics of the business.

Manufacturing versus The Process Industry

Basically industry can be divided into two types, a manufacturing industry and a process industry. Manufacturing industries are characterized by discrete-item production while the processing industries are continuous or semi-continuous, for instance, food, chemical, plastics, or petroleum. Both industries utilize similar operational groups and basically have the same manufacturing procedures. The discrete part industry uses processing, assembly, inspection, parts transport and storage. In the food processing industry, the product is mixed and extruded, cooked, inspected, packaged and transported to storage. In both industries inspection of parts occurs throughout the manufacturing process with a full inspection upon completion.

Table 1 list some key characteristics of the processing industry, and specifically the food industry, and contrast it with the manufacturing industry. The food industry and other processing industries have well defined capacities with little flexibility to change output or product lines. Lines are typically dedicated to a few

Characteristics	Food	Process	Manufacture
Product/Marketing Characteristics			
Number of customers	more	less	more
Number of products	more	less	more
Product Differentiation	more	more	more
Marketing characteristics	standard avail/ price	standard avail/ price	customized product features
Equipment/Production			
Capital vs labor/material intensive	both	capital	lab/matl
Level of automation	middle	higher	lower
Production layout	flow	flow	job shop/flow
Flexibility of output	less	less	more
Capacity	well defined	well defined	vague
Leadtimes for expansion	higher	higher	lower
Reliability of equipment	higher needs	higher needs	lower needs
Nature of maintenance	shutdown	shutdown	component basis
Number of raw materials	higher	lower	higher
Variability of raw materials	higher	higher	lower
Energy usage	higher	higher	higher
Other Manufacturing Characteristics			
Families of items	primary concern	primary concern	less concern
Aggregation of data	easier	easier	more difficult
WIP inventory	lower	lower	higher
Yield variability	higher	higher	lower
By -Products	more	more	less
Need for traceability	higher	higher	lower

Table 1 Characteristics of Various Type Industries (20)

products. The continuous nature of the processes minimizes WIP. It is best to run the plants at full capacity for maximum efficiencies. Because of the flow-type layout highly reliable equipment is necessary and preventitive maintenance programs are crucial. Maintenance problems cause the lines to shutdown. Energy usage is intensive in some processing industries and accounts for a major portion of operating cost in the food industry. Variability in raw materials and yields is prevalent in the processing industries.

The food industry tends to fall between the other processing industries and manufacturing industries in levels of automation and capital versus labor/material intensiveness. It probably has more consumer exposure, quicker feedback and more product types than either of the other industries. This makes the "need for traceability much higher.

The Food Industry

The food industry does have some particular details about its operation which are not obvious. The following areas will be discussed: marketing specifically promotions, product concerns, and government regulations, specifically underweights and product safety.

Marketing: Promotions

The food industry is conservative. It is characterized by small profit margins, which are caused by competitive retail pricing and the small amount of value added to raw materials by processing. The companies are consumer driven. Feedback about the product is immediate and in terms of continued purchases.

Typically the products are introduced at promotional cost to get the consumer to try the product. Once the promotion ends, it is the product quality that maintains the business. A good example of competitiveness in the market place for the food industry is the "cookie war" that started a couple of years ago. Procter & Gamble introduced a soft chewy cookie to the market. Within six months Frito-Lay, Inc., introduced their version of a similar product. Keebler, Nabisco and Sunshine all jumped on the bandwagon. The purchases of the different brand names were driven totally by the promotional status. It was not until the companies stopped promotions that the true consumer preferences were realized. Needless to say some of the competitors dropped out of the "war".

Product concerns

The number of products, shelf life and quality testing deserve some special attention in comparing

industries. Product differentiation is prevalent in the food company studied in that it produces some 250 different products just at one plant. Fortunately this is a result of packaging four product types with maybe 10 variations on each type into many different labels, both the company brands and private label brands. Private label refers to other stores using the company's product in their own store logo. Forty percent of the business is represented by private label brands. The 250 products really represent then different combinations of brands, sizes, case displays and products.

Unlike the manufacturing industry where products collect dust or risk obsolescence when sitting on the shelf, in the food industry the product ages and quality changes. Shelf life or the amount of time a product is considered fresh varies with the type of product and the manufacturer. Typically shelf life on the products mentioned above range from 35-90 days. The shelf life constraint effects the amount of in-plant and distribution inventories the manufacturer can maintain. In some cases the product must leave the plant with in 1-5 days in order to get to the store front and still have a durable shelf life.

Quality testing with food products is subjective.

One compares the newly produced product with a product standard through taste tests. Gas chromatographs can be used but the human sensory system still remains the method of choice. Product research, home performance testing, test marketing are all performance test used to rate the product by the consumer. If product consistancy doesn't prevail in manufacturing, the money expended on these test procedures is wasted.

Testing procedures like moisture analysis, percent salt, percent oil, and other quantitative test are performed during production, however they take significant amounts of time. While the product is quality tested, the lines continue to run. If the results indicate off quality product, hours of production can be wasted. There is a real need to develop on line testing techniques in the food industry.

Government Regulation

There are many government regulations in industry. Consumer protection in the areas of underweights and product safety are high on their list for the food industry. Selling product whose actual weight is under label weight is illegal and results in a fine and bad publicity.

The other issue, product safety, is a concern dealt

with in varying degrees by companies. The bare minimum is plant inspections by FDA or PDA. Some companies pay the American Institute of Baking (AIB) to come in and fully inspect their facilities to assure a food grade status is maintained. Others use the AIB to inspect their suppliers.

The tragedy occurs when a contamination problem exist and the product has reached the consumer. It is the responsibility of the manufacturer to be able to account for all contaminated product. In a factory where controls are not in place, the manufacturer could loose weeks or months of production. This is one way to eliminate the competition. In this day and age of significant tampering incidents it will be devastating to the company who gets caught unprepared.

Small vs Large Corporations

The perspective of a small company is different than a large corporation. The key issue facing a small competitor is how to gain market share in order to enjoy the economy of scale, experience and market power that the large competitor has. In contrast, the market leader is challenged with trying to hold the market share against smaller rivals trying to take a portion of it away.

There are many other characteristics that distinguish a small business from a large business. Emphasis is not

just one of scale with respect to employees, sales, assets but the "paucity of resources available to achieve objectives." Limited resources leaves the business susceptible to even minor changes in the efficiency of its operations or to changes in the external environment. For example, a competitor that cuts prices as a last resort for survival, has much more impact on the small business than on the market leader. By the same token a newcomer in the market may employ the same tactic with similar results.

Human resource availability frequently plagues a small business. They cannot always afford to have key expertise in house for accounting, personnel or legal functions. Executive time is short and usually dictates what is accomplished and what is not. In large corporations the executives are supervisors of other people's efforts and they must modify their objectives accordingly. The CEO of a small business can deal with the business however he/she deems fit. The personality of the CEO is usually evident in the manner in which a small business is operated.

Small firms are usually forced to compete on a technology driven basis rather than a capital-driven basis. Large expenditures are not put into R&D, however the smaller business seem to be more innovative and take

higher risks . There is not as much "red tape" in a small firm and therefore the employees are freer to try new ideas. The environment fosters innovation and entrepeneurship. (2)

Because of the limited resources, a small business must be selective in how they expend those resources. This is where strategic planning helps. The business must know itself and its competitors and build on its strengths and the competitors weaknesses. By developing a good strategy at each level of the business, they can safeguard against costly, devastating errors.

The Small Food Manufacturer

Table 2 gives some details about the manufacturer studied. At the time of the study, there were four plants. All warehousing of product inventories and raw ingredients is at the plant sites. Plant R is the mixing plant for all products and for the purchased products (or products made by other companies and distributed by this company.) Product is shipped in their own fleet of trucks, for the most part, directly to customers, to company franchised distribution centers and to a privately owned distribution center. They have exposure as far west as Ohio and from Maine to Florida.

Characteristic	Description
Ownership	private
CEO	owner
Sales Volume	$70 million
Number of employees	~500
Integration strategy	developing
Management commitment to integration	CEO yes, upper management to a degree
Attitude towards manufacturing (8)	flexible, reactive, minimize negative potential
Team effort	moderate
MRP usage	moderate
JIT	moderate
FMS	minimum

Table 2 Characteristics of the Company Studied

The processes used in the food industry are very basic and old: mixing, cooking and preserving. There are basically four processes used in the plants: mixing, extrusion, cooking and packaging. They are described in some detail below.

Processing

The company studied for this thesis has a semi-continuous process. It begins in a batch mode for mixing

continuous process. It begins in a batch mode for mixing 3 or 4 or as many as 40 ingredients together. Obviously there are staple ingredients that are in large quantities but the remainder are minor, just ounces maybe added to 1000 pound batch. The minor ingredients are purchased in small quantities to assure they are used with in their shelf life. This results in added cost by the suppliers because of the inefficiency in producing small quantities. The mixing operation is manual. There is some use of automatic weighing and feed on the major ingredients.

The next step is the extrusion process or the process in which the final form of the product is made. Once the extrusion or forming process is started, production becomes continuous through the packaging operation. There are no buffers or queing associated with the lines. Each operation that the product passes through is closely coupled to the next. If an operation is shut down, the entire line shuts down. Changeover time from one product to another or setup time is about 15-45 minutes (product dependent).

Process control at this point is important because of the continuous nature. Weight of the finished product is determined by the raw piece weight generated in the extrusion process. A process out of control results in off quality product and poor package weight either as over

or under label weight. Overweight packages of course are a better deal for the consumer, more for their money. Under weight packages can result in a fine from the government.

Quality standards are determined by product in a specific weight range. Some off quality product is ground and used in the initial mix at low percentages. Large quantities of waste are sold as animal feed for a few cents per pound.

Cooking is the next step. This involves many different media depending on the product. It is an energy intensive process since most products require high temperature. Again, product quality is extremely sensitive to changes in any of the cooking operations. Usually there is a specified residence time in the operation for cooking and cooling the product.

Packaging is the remaining process. This operation is usually labor intensive especially if the product is fragile. Packaging materials require long leadtimes. Ordering these supplies must be tightly coupled with forecasting future needs.

Weight control of the package is the responsibility of the packaging department. Special packaging equipment with statistical weight control built in is available now. Savings in this area can be substantial. In the cookie

industry, reducing the weight of a cookie by one half gram or 5 grams per package resulted in a half a million dollars in savings when the lines were running at full capacity.

The product then moves into the finished goods inventory and is shipped either to a store or distribution center. Air bags or pallet stretch wrap is used to protect the product during shipment. Product is usually shipped quickly because of shelf life limitations.

The Business

This industry is composed of competitors ranging from international to moderately sized regional operations. Under previous ownership the manufacturing was neglected. The company was near failure when purchased by the current owner. Operating practices were implemented that turned the business around. Now they are faced with closing the technology gap with respect to its competition. This gap applies not only to manufacturing but in all aspects of the business.

The company is ready to embark on a modernization effort. This effort is necessary to close the technology gap and to be able to accommodate significant growth in the next couple of years. Funds are available for a substantial investment in their future to assure a

competitive advantage. The remainder of this thesis is dedicated to studying the production scheduling process in this small food manufacturer to determine key aspects of the process that must evolve to support the expected growth.

Chapter 4 Methodologies

Survival provides the impetus to plan for the future and work to provide long term strategic savings rather than short term operational savings. Capital investments have to be made in resources to carry out the plan. Hayes and Clark (6) suggest that

> "Simply investing money in new technology or systems guarantees nothing. What matters is how their introduction is managed, as well as the extent to which they support and reinforce continual improvement throughout a factory. Managed right, new investment supports cumulative, long-term productivity improvement and process understanding--what we refer to as 'learning'. ... investment unfreezes old assumptions, generates more efficient concepts and designs for a production system, and expands a factory's skills and capabilities."

First, analyzing the current system, results in improvements which are inexpensive and easily implemented. Many deal with the transactional operations described earlier. A reduction in the confusion level, having the right information available when needed, provides a means for smooth operation of a facility. Once the systems are streamlined and understood, then the future systems can be addressed.

The company studied is willing to make a $5 million investment over the next five years to modernize and integrate their manufacturing facilities. As part of this

investment, a determination of the current status of the production scheduling area and the effects of other functional areas on it was performed. With this analysis then, recommendations were made to pinpoint opportunities that will help sustain future growth. This chapter of the thesis will provide the methodologies of the study and give the results and discussion.

Determination of the "As Is"

System analysis is the process of gathering and interpreting facts, diagnosing problems, and using the facts to improve the system. It results in an evaluation of how the current methods are working and whether adjustments are necessary or possible. The typical application of systems analysis is in the development of a new computer system for a company. The development life cycle looks something like this:

1. Preliminary investigation-project proposals generated and evaluated to determine feasibility, approval or denial for further attention.

2. Determination of requirements-acquiring a detailed understanding of all important facets of the business area under investigation.

3. Design of system- develop the logical design of the new system, prototyping can be used here.

4. Development of software- Physical design of the system

5. Systems testing

6. Implementation (19)

This life cycle parallels the development of a CIM strategy. A global perspective of the entire business is required rather than a specific area of study. This perspective is gained through the understanding of how each area effects the other and the corporation as a whole. To develop the understanding one must determine how information flows between groups or really answer four basic questions in each area: "What is the basic business process? What data is used or produced during that process? What are the limits imposed by time and the volume of work? and What performance controls are used?" Answering these questions should provide the information necessary to build an "As Is" model of the current automated and manual systems.

Evaluation of the "As Is" system model then provides insight into what is done well, what is not done at all, and what is not being done well. From this evaluation then, the good things are preserved or enhanced, others are added or improved on. A "To Be" model grows out of the evaluation. Simulation techniques are used to test the validity of the models and to evaluate various versions of the "To Be" model. (15)

The "As Is" model development represents the determination of requirements phase of the life cycle described above while the "To Be" model represents the systems design phase. In the implementation plan, bear in mind, it is critical that the "To Be" model focus on technically feasible solutions and be aligned with the goals and objectives of the business. Plan for the future. The life cycle may not be completed for a couple years. Awareness of modularity and interface design will ease the use of new technologies of the future.

Analytical tools

Structured analysis or data flow analysis techniques were used to describe the current system. Data drives the business activities. By following data flow through the organization, a great deal is learned on how the organization meets its objectives. The purpose of data flow analysis is just that, to follow data flow through the business processes. Structured analysis studies the use of data as it is input, processed, stored, retrieved, used, changed, and output. It is a data modelling tool used to create a logical model of a system. It provides a systemic approach for analysis, aids in defining the problem/situation, is task/process driven, and is not based on preconceived notions but on facts.

Structured analysis is an interactive process which involves starting conceptually at the top of a system and decomposing downward in all directions until the system can no longer be subdivided. At this lowest level of decomposition, complete definition of the system occurs. The process requires that a clear scope of the area under study is defined. The problem must be bounded. Then a team knowledgeable in structured analysis and in the areas being examined is put together and fact finding interviews are performed. The first generation of the system definition is completed, reviewed and revised. This is an iterative process until the system is completely defined.

Data flow diagrams graphically represent the flows complemented by a data dictionary which formally describes the system data and where it is used. These tools then allow the analysts to evaluate the system to determine where opportunities for improvement lie. The "picture" of the current operations is evaluated to gain a clear understanding of what the current system does well, does poorly, or does not do at all. The data dictionary is key in the "To Be" model development since it is descriptive of each data element. This study uses only the data flow diagrams since a "To Be" model is not being developed.

Yourdon methodology is employed for this thesis. It generates only one logical model rather than the three

models characteristic of IDEF. The components of the model are as follows:

-Process: A specific function or task.

-Data Flow: A piece of information that flows from point to point within the model

-Data Store: A repository for data.

-External Entity: A specific function, task, organization, etc. not under investigation. Therefore, its functions are not to be decomposed. (This has been modified to include processes which exist external to the layer being defined.)

-Data Diagram: A graphic depiction of the relationships between processes, data flows, data stores, and external entities.

-Data Dictionary: A mechanisms which articulates the decomposition of each process, data flow, data store, and external entity. It is developed from the lowest decomposition level.

A graphics package called DFDdraw was used to create the flow diagrams. It uses the same component definition described above. The data dictionary is not part of the package. (3)

In addition to the use of structured analysis, some statistical work was performed utilizing existing report data and a Lotus spreadsheet. Because the direct download capability was not possible, manual data entry into the spreadsheet occurred.

Interviews

Several interview techniques are available for fact finding: one-on-one interview, questionaire, record inspection, and observation. Some form of each one of these was used to gather data for this thesis. Selected people in each department were interviewed one-on-one including vice presidents to clerks who handled data entry. Each interview was structured to answer a particular set of questions with focus on production scheduling. Once the initial interviews were completed, more in depth interviews were performed usually in the lower management ranks and employee level. More specific details were obtained about the data flow at this level.

Questionaires were used at the plant to determine the volume and timing associated with data entry for production and shipping reports. A shipping questionaire pertaining to duties, truck scheduling, exceptions was given to the shipping manager. A questionaire was used because one-on-one interviewing time could not be scheduled.

Observation in addition to interviews was used with the production schedular. By spending time with her, hands on experience provided insight into how her job was managed. Methods of communication and content of communications became apparent. Scheduling rules were

noted. The level of activity and types of interactions could be observed. Of special importance was the advantage of finding out what information is used, if procedures are followed as described by others, what bottlenecks exist and what troublesome areas are for the schedular.

Record review was used to better understand the business and to compare what was said about the business and what was actually happening in the business. Typically written policy manuals, regulations and standard operating procedures provide this type of information. These are not available at the company studied. The records reviewed were data provided through reports generated by a department or production/shipping information received from data processing. In most cases the data was summarized manually in a Lotus spreadsheet where analysis could be performed. (19)

Each technique used above cannot stand on its on. It is the particular advantages of one over the other that allows the analyst to gather details and compile an accurate description of the system. Throughout the data collection process cross checking of facts occurs. Data flow analysis or structured analysis was used to assist in organizing the details collected, while at the same time

pinpointing areas where more information was needed to gain a clear understanding of the system.

Boundaries of the Study

The production system has three key areas within it: The machine technology base, the organization of the production system and the techniques used by management to control the operation of the system. Each area was frozen in time for the study. The evaluation represents the summer of 1986. It concentrates on the organization of the production system, specifically production scheduling.

The study encompasses all corporate departments interacting with production scheduling process. Only one out of four manufacturing facilities was included and only three out of four major product lines were involved. (This is a result of the selection of the manufacturing facility.) No hourly employees at the plant were interviewed. Clerks involved with data entry, supervisors, department managers, and vice presidents of various departments participated in the study.

Chapter 5 Production Scheduling Process: Data Flow Diagrams

A description of the production scheduling process was generated using the structured analysis techniques described in the previous chapter. Interactions between departments and basic policies will be discussed in this chapter. Departments include order entry, order control, production planning, production scheduling, traffic and shipping. The data flow diagrams are included in appendix. Evaluation and conclusions are then presented in the following chapter with respect to these areas: communication, order control, production scheduling, traffic, and shipping. Chapter 7 presents recommendations with key issues addressed for the modernization/ integration and growth anticipated at the company.

Overview of the Process:

Production Scheduling Process

There are five key processes in which interactions occur with the production schedular:

> Order entry/Order control managed by a supervisor with several clerks reporting to her. Data is collected on paper and then entered into the computer.
>
> Production planning is computer modules providing key requirements reports to the schedular. The modules receive input from the

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plant, shipping, and order control. Updates to the modules are made per the director of manufacturing and the manager of data processing.

Production is managed by a plant manager and several supervisors at the plant. The supervisors provide daily production reports to the plant clerks for entry into planning modules and the shift report. The plant manager reports to the vice president of manufacturing. All systems are manual until data entry.

Shipping is managed by a supervisor reporting to the plant manager. He provides the daily shipped product reports to the plant clerks for input into the planning modules. All systems are manual.

Traffic has a controller/dispatcher who is responsible to schedule the trucks for shipments to the customer. The system is manual. He receives the order schedule from order control on paper and several computer reports generated from the production planning modules.

Other groups interacting in an external entity capacity include: accounting, sales/marketing, purchasing, direct customers, Demoulus customers, and Nabisco. Each interaction will be described in more detail with the process they effect.

Order Entry

Order entry is the clerical group of order control. Their basic functions are to receive orders from the customer and enter them into the compute, communicate

changes to the orders back to the customer, run reports which generate appropriate paperwork for other groups, manage customer awareness of promotions, of credit availability, and of product shortages. They are provided with information concerning customer credit through accounting, the promotion schedule from sales/marketing, and major material shortages through purchasing. Changes to orders which are late in the order cycle are coordinated through order control. Once the orders are entered into the computer and the invoice produced, it is compared to the handwritten order for a validity check.

The order cycle is viewed as a seven day cycle. On the first day of the cycle the order is placed and entered into the computer system. If a change is to occur and the change placed electronically, it must be made within the first four days of the cycle. After that time the change is manually entered into the system by the schedular and is approved through order control. On the fourth day, the loading copy is printed, the order is firmed, and product produced in the plant. The loader copy is a form which specifies a customer's order, how the order is to be loaded in the truck and where and when the order is due. On the fifth day the order is shipped to the customer for arrival on day 6 or day 7. This is the general idea of their order cycle however there are many exceptions which

will be shown later on.

There are four types of customers at this company:

Direct customers - these are individual stores ordering directly from the company.

Indirect customers - these are franchised distribution centers that distribute to the customers and orders placed as needed.

Demoulus accounts- this a chain of 26 stores that is actually dealt with outside of the computer system as far as order entry is concerned. Basically this is a mini company within this company. The orders are placed through order entry but are not based on direct customer contact. The order represents a forecast over 11 days of needs. This forecast is nothing more that a feel for what is happening. Some historical data is consulted for trends. Loader copy is generated when the product is transferred to the distribution center. A separate system is used in accounting and order entry to accommodate the Demoulus account.

Nabisco- orders from Nabisco are placed directly through production scheduling. The orders are forecast and firm for at least a month in advanced. The forecast represents 3-6 months of orders. The product is produced in truckload quantities. After production the appropriate paperwork is generated.

As you can see there are basically three order systems in this company. The first two types of customers are the majority and cause the company to be customer driven. There are no forecasting techniques used. In addition to this, often the company is not made aware of promotions

unexpected surges in the system.

Order Control

Order control functions as the communication link with traffic, production scheduling and the plant. It provides decisions on whether orders can be changed after consultation with the other groups. If the request for change is customer initiated, order control will contact either the schedular or shipping. Production scheduling is asked if the product can be produced in the time frame needed. Shipping is asked if the product is in the warehouse and can it be added to the shipment on a particular truck. The decision is communicated to order entry who inturn notifies the customer of acceptance or denial. When the request is production schedular initiated, order control tells order entry to notify the customer of a change usually due to shortships or no machine time. Seventy-five percent of order control's time is spent dealing with exceptions to the system.

Another function of order control is to prepare load assignments. Order entry gives a listing of daily orders with load dates to order control. With this information order control proceeds to contact the customer to arrange for delivery times. The orders are then tied together to make truckload shipments based on trailer sizes needed.

The load dates, delivery times, and load assignments are then transferred to traffic for trailer assignments.

Other duties include managing product complaints and making appropriate referrals when they come in, act as sales people when they think a customer is unaware of a promotional item, and help distributors to get rid of left over product before shelf life expires.

Production Scheduling

The task of production scheduling is assigned to one person. Basically it is a manual task supported by a summary of planned requirements report output from the production planning module. The report presents a six day horizon of orders, beginning and ending inventories, production, and shipping numbers. These are then tallied into a requirement for that day of scheduling. Information is gathered pertaining to any problems associated with this production whether it is from manufacturing, purchasing, traffic or order control. Recall that days 4,5,6 on the report can change through the computer system. Changes in day 1,2, or 3 occur manually and by the schedular. In addition to the schedule preparations the schedular does a validity check on actual inventory and the calculated inventory via the planned summary report. Discrepancies of greater than +/- 25

cases are reconciled with the plant. Adjustments are made to the report as needed.

The schedular begins the day at the plant to receive the shortship report and any information on production that is needed for that day's planning. Upon arrival at headquarters the short ships are discussed with order control. Some information transfers between groups that effect that scheduling day. Prior to the receipt fo the planned summary report, considerations are given to the tentative schedules for the next day. There are actually three types of schedules produced in a weeks time. A weekly tentative schedule is prepared on Friday's to alert the plant of what processes will most likely be running. This schedule is really only accurate for the first 2 days. Each day a tentative schedule is prepared for the following three shifts. The firm schedule represents the 2nd and 3rd shifts of the scheduling day and the 1st shift of the next day. The planned summary report arrives at the schedular's desk between 10:30 and 11:30 AM. The schedules should be at the plant at 12:00 noon. Typically it is communicated over the phone with followup copies delivered at the plant by mail or the schedular.

Data collection for scheduling purposes involves both verbal and written communications. In addition to the

planned summary report and the short ship report mentioned above, the followi information is available: firmed orders from Nabisco, warehouse finished goods inventory(once/week), promotion schedules, and process data contained in a book for reference on rates, wrappers, etc. Maintenance data is communicated over the phone, as well as information concerning substitution for short ship product. Problems with raw material and packaging material are verbally communicated. Sometimes this information is solicited by the schedular. Accumulation of the verbal data is somewhat haphazard but mostly concentrated in the morning.

After production has entered their shift data and billing, the planned summary report is generated and the scheduling process begins. In addition to verbal input mentioned above, the schedular considers the following rules:

1. Priority of products- for example noncoated products are produced before ones that are coated. Specially processed products are made on certain days.

2. Load dates- products that must be made first to meet shipping arrangements.

3. Short ship backorders- This is not represented in the planned summary report but is communicated by order control or based on the history of a particular customer.

4. Quantity ordered- Is 25 cases worth producing or should they be accumulated for a future order?

5. Upcoming promotions- If possible she builds inventory to cover promotional items.

6. Efficiency factors-- currently using about 80%.

7. Order trends- By following trends in decreasing or increasing quantities on particular items, those items are used to fill time or make more time.

8. Packing machine constraints- The last wrappers in the series do not run as efficiently as the others since they are starved of product.

9. Special account orders- the Demoulus orders or Nabisco orders are received directly by the schedular.

Taking all of this into consideration plus orders for the week, day and shift, the decision is made as to what products will be made on what processes and packaging machine and in what precedence.

Prior to discussing the firmed schedule with the plants, contact is made a last time with the various groups to be assured the status of verbal communications has not changed. The schedules are then communicated and confirmed.

Production Planning

The following input is received for the computer modules: order entry enters orders and adjustments to orders, production enters validated cases produced and

shipped, and the schedular enters validated inventory where necessary. The reports are actuated through the schedular after data entry is completed. It shows the status of the plant at the end of the plan day and the requirements needed for a six day horizon. This report does not reflect shortship product which is backordered, Nabisco product to be produced, accurate Demoulus orders and any order change request after the report is run.

Production

The main goal of production of course is to get the product to the warehouse for shipment. This is dependent on the schedular. Product mixes effect the crewing. Typically the daily tentative schedule is used to estimate crewing. When the firm schedule arrives necessary lay offs or call ins are made. The schedule is communicated then to packaging and processing to allow them to set up for their shift and the next shift when possible.

Shift data is collected concerning downtime and efficiencies of the lines and packaging area. The cases of product are manually tracked and sent to the shipping department. All shift data is submitted to the office by 7:00-7:30 AM for entry into the planned summary module. It takes three and half hours to enter both production data and shipping data and to perform a validity check on

the information.

Shipping

The shipping department is responsible to load trailers with the finished product, to receive product from outside suppliers which are distributed through the plant, and to receive raw materials for production. Shipping is also involved with handling the returned goods and damaged product, and accounting for inventory. This plant acts as the mixing distribution center for other plant's product and outside products (not made by this company but distributed through them).

Instructions are received from traffic as to what products are loaded (per the loader copy) on a given trailer and in what order. These arrive 5:00 PM the day prior to loading. The shipping manager schedules the crew. Variation in loads per day range from 6 to 30.

Weekly inventories are taken and reconciled with computer inventories. Also old code or old product inventories are maintained to assure first in , first out policies are followed reasonably well.

Files are maintained on shipping diaries, finished goods inventory reports, old code reports, and shipping data status. These reports are kept approximately six months. All shipping transactions are on paper. Billing

and cases shipped information are transferred into the computer between 7:00 and 11:00 AM.

Traffic Release for Shipment

Traffic's responsibility is to have trailers available for loading and customer delivery. Traffic receives load dates, delivery dates, and load assignments from order control. These are then matched with available trailers and a load schedule is generated for shipping. In the event that the loads cannot be delivered as assigned by order control then a new delivery date is arranged.

In addition to scheduling shipments to customers, the company performs backhauls. Backhauls save money. Trucks which have made deliveries pick up product from other companies and deliver it in there home areas.

A drivers board (5'x10' wall board) is used to track trailers on the road and in the yard. All operations in traffic are performed manually.

This concludes the description of the systems involved in production scheduling. The minor groups listed as external entities play an important role in providing information to each of the processes. This information is in the form of paper, verbal messages, and some electronic information depending on the group. The

next chapter will discuss the results of the evaluation of the data flow diagrams and other data collected from the reports generated at the company. Special attention is given to areas of communication and three of the basic processes in the diagram, production scheduling, order control, and shipping.

Chapter 6 Evaluation of the Production Scheduling Process

After the data flow diagrams were compiled, the diagrams and other pertinent data were evaluated. Information from the planned summary report like inventories and daily orders were summarized utilizing a Lotus spreadsheet. Shortship reports, shipping diaries, and the manual change log were also used to further evaluate order control and shipping concerns.

Communication

Five types of communication were chosen to characterize the information flows in the scheduling system: Phone,verbal,mental, electronic and paper. Figure 1 shows that the majority of the communications occur through the use of paper. This is in the form of reports generated at the plants, from the planning module and summaries used in traffic. The 18% electronic is mostly from order control and data entry at the plants. About 33 % of the data flows through undocumented methods either verbal or by phone.

The company has a communications problem in the production scheduling area. The informal and not well documented communication causes interruptions in the operation and undo stress. There are instances where the key people have been bypassed on order changes: shipments

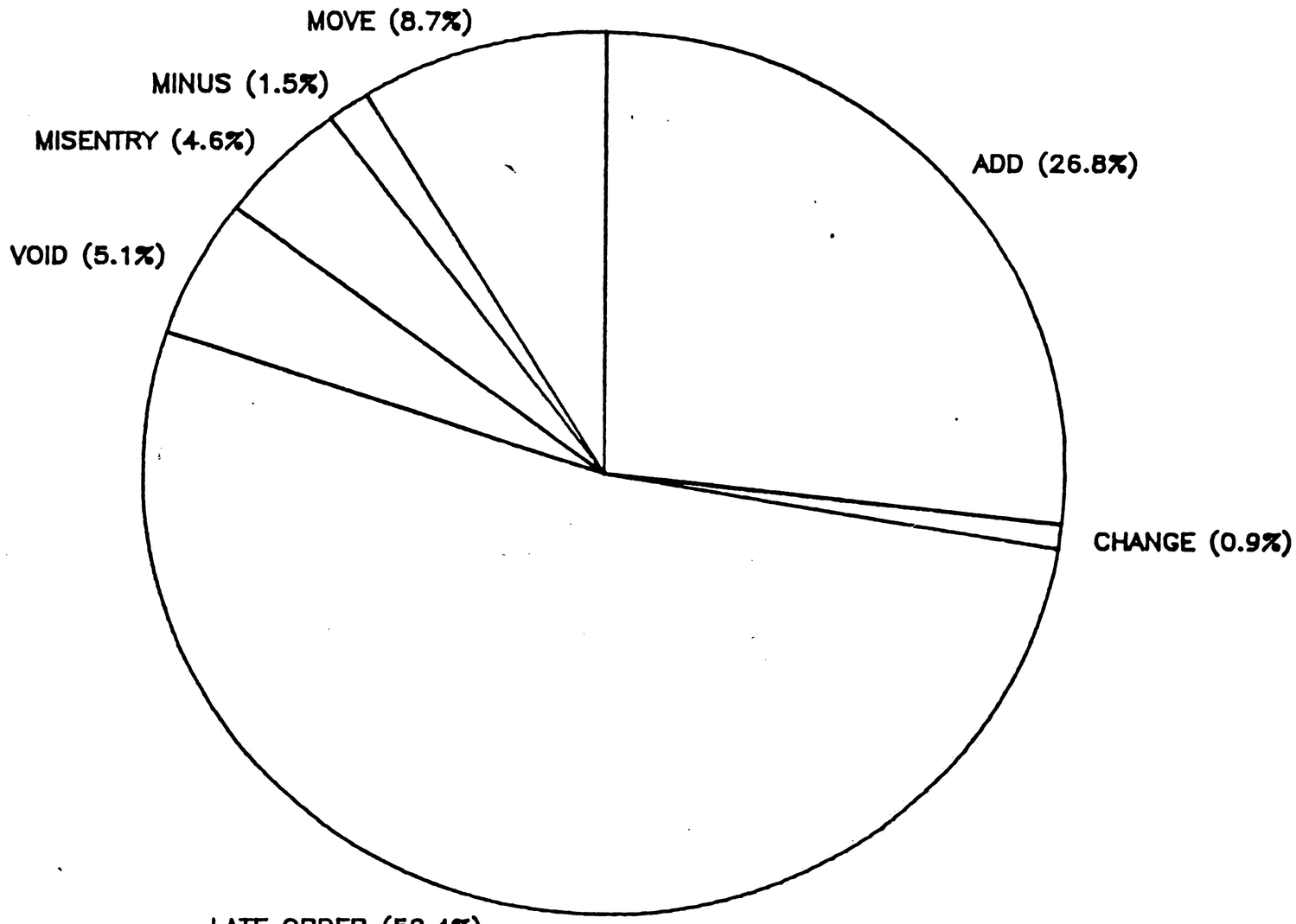

Figure 1 Methods of Information Flow

were to be made on first shift when the product was not scheduled until the second or third shift of the day: raw material inventory was depleted on an item and the schedular was not aware of it. The use of an electronic mail system and weekly meetings with people who effect the schedule are appropriate.

Each area or process mentioned in the previous chapter has a key individual managing the department. Of critical concern is the reliance on a single production schedular to schedule their major plant. Although the plant manager can schedule the products to some extent, should they loose their schedular, many undocumented rules would be lost and havoc would prevail. The schedular uses her knowledge of the production facility coupled with intuition to schedule. There are no written manufacturing standards or rules in this area.

Timely communications are critical to maintain a smooth operation. Table 3 describes the sequence of events that must occur prior to the schedular beginning to put together the schedule for the next shift and subsequent days. A preliminary weekly schedule is sent to the plant based on the six day horizon in the planned summary report however, until the actual day of production and in some instances until the actual hour the schedule

may change. A schedule predicting the daily needs is sent to the plant one day in advance and finally the firmed schedule is sent to cover shift 2,3 and 1 of the next day. Table 3 shows that the need time for the production schedule is less than the completion time by one hour and

Event by Precedence	Time to Complete	Start Time	Finished Time
Billing/Shift Data Entry	2.5-3.5 hrs	7:30 AM	10-11:30
Report Generation	.25	10-11:30	10:15-11:45
Scheduling Plant R	2.75	10:15-11:45	1:00-2:30

Table 3 Events for Scheduling: Time Requirements

thirty minutes. The scheduling could be expedited by eliminating the manual changes which are occurring, and by use of automatic data entry in the production and shipping departments. In any event each department must stay on top of problems such that smooth operation of the closely coupled system occurs.

As the company continues to grow, the key issues in the area of communications which must be addressed are:

The lack of key communication between groups

The reliance on key individuals to perform critical jobs

The informal and not well documented information flow

Timely information transfer between groups and

The tightly coupled communications.

Order Control

Three areas need to be addressed with regard to order control: changes to orders both computer and manual, and the six day horizon. The data that follows was collected from a computer print out of all changes that occurred within the first three days of the order cycle since February of 1986. It represented approximately 6 months of data. The manual change data comes from a log book which records the change, the store, the brand, and the reason for the change. This data also covers a 6 month time span. Information concerning the horizon was obtained from the planned summary report representing the time frame from July 1 to August 7,1986. Table 4 summarizes the results.

The two key conclusions deal with the fact that the customer is controlling the order cycle rather than the company and that the six day horizon really is only three days in length. First let's look at the manual changes to orders.

Computer Changes	122/week	Company wide
Manual Changes	43/week	Plant R
	32/week	Plant P
Total Cases Involved in Changes	10293 cases	Plant R
	4956	Plant P
Average Cases Involved in Changes/week	430	Plant R
	200	Plant P
Cases Changed on Production Day	70	Plant R
	1	Plant P
Notification Before Production Day	3 days	Plant R
	3.6 days	Plant P

Changes in Planned Summary Report:
Percent Change in Requirements by Day

	Requirement Day					
	1	2	3	4	5	6
Percent Change	1.76	3.63	4.27	68.09	22.26	

Table 4 Characteristics of Changes Made to Orders

Manual changes

Effectively scheduling production runs is difficult because of the order pattern that the company has established with its customers. Changes that were made within the first three days of the seven day cycle, thus entered directly into the computer prior to loader copy printing, occurred at a rate of 122/week (company wide).

The plant under study, plant R, incurred 43 manual changes per week while another facility, plant P, had 32/week. The average notification time was 3 days for plant R and 3.6 days for plant P (range from 0 to 7 days).

Figure 2 shows the reasons for changes. The majority of the manual changes resulted from late orders. The company accepts the change, therefore, the customer realizes a couple of more days before a decision must be made on the final order quantity. In addition to late orders, 26.8% resulted from additions to existing orders: again, customer control. The plant becomes extremely flexible in its operation but not necessarily cost effective and efficient.

Horizon

To determine the actual horizon represented in the production planning module, orders from July 1 to August 7, 1986 were tabulated into a spreadsheet. To arrive at the number of changes occurring in the cycle, the difference was determined between each day. Day 0, the day of production, minus day 1 represents the changes which occurred during that 24 hour period, etc. The data shows that the three days prior to production are relatively stable with only 2-4 % changes occurring in the total cases required: however, the orders are unstable

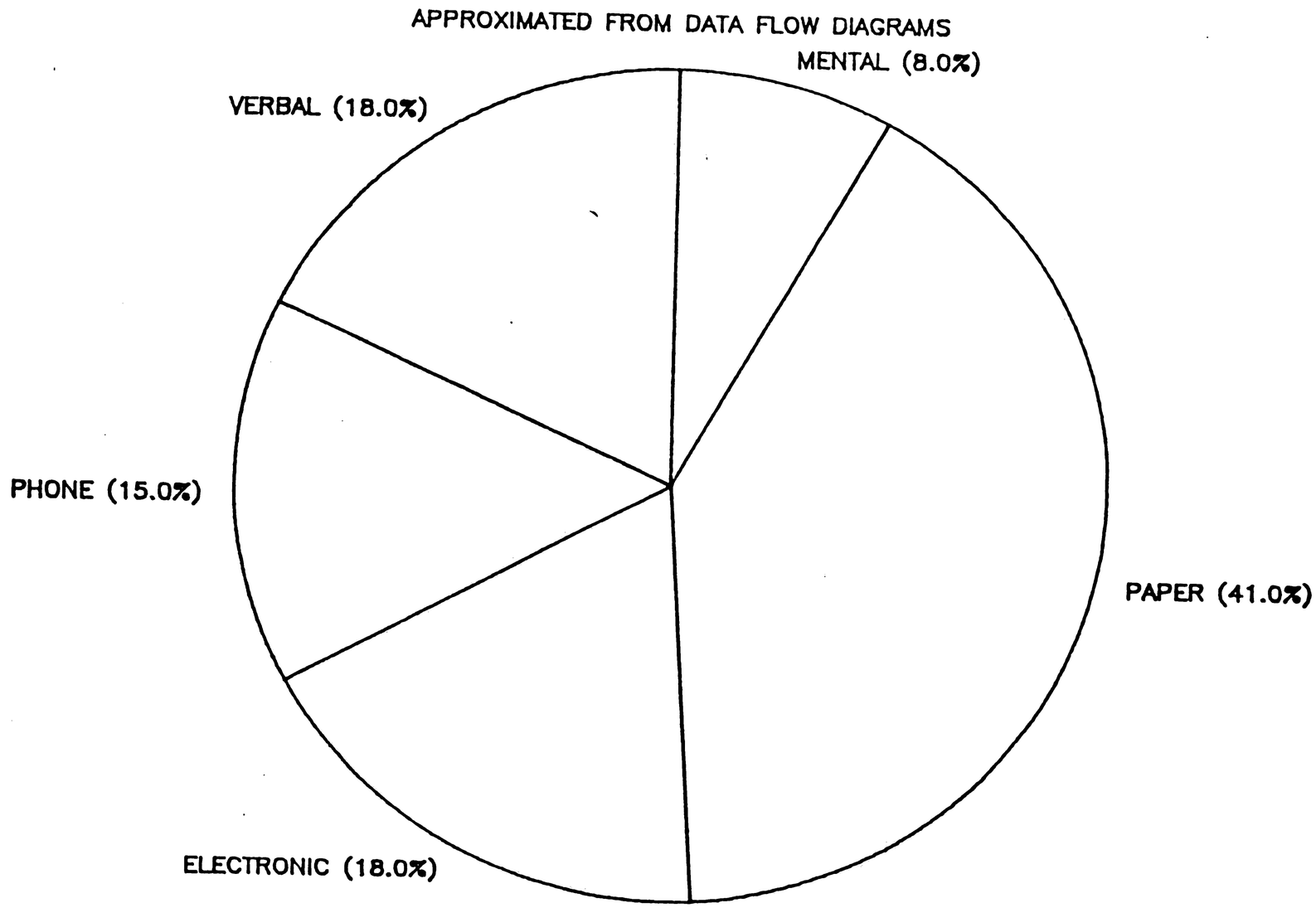

Figure 2 Customer Control: Manual Changes to Orders

for the fourth day and outward. This makes the weekly production schedule a tentative schedule at best. Production really cannot be scheduled accurately until the final hours before it is to occur.

The major effect of the order changes is inefficiency. Because of the manual changes additional paperwork is generated and computer changes must be made prior to the report generation. Product is not always available for shipment when needed. Time delays occur in the closely coupled production scheduling system. The reports are delayed because of additional data entry and thus the production schedule gets delayed

Conclusions concerning the order control area are as follows:

Customers control the order cycle rather than the company controlling the cycle

A weekly schedule appears to be of little use in light of the ordering structure

A three day horizon is shown on the planned summary report rather than the intended six day horizon

The company is flexible in accommodating customers however there is no measure of customer service with respect to changes within the 7 day cycle.

There are side effects to the changes. The plants really do not have accurate schedules to plan crews and setup

times until the final hours of production. The inaccurate paperwork that arrives at the shipping department must be updated to reflect the changes assuring the appropriate product reaches the customer. Then the invoices or billings must be changed to reflect the quantity shipped. The changes to orders effect all four of the transactional areas discussed earlier: logistics, balancing, quality and change.

Scheduling

The key aspects concerning scheduling deal with maintaining a well organized person in the position of schedular. The current planned summary report and raw material inventory modules are useful however improvements could be made. The planned summary report is approximately 15 to 20 pages long. Every product ordered appears on the report. These are not necessarily products which must be produced on a given day. In some instances there are zero requirements and positive inventories. It clutters the job of determining the requirements for scheduling purposes. Some sort of routine which selects only the records that need scheduling would be useful.

The raw material inventory module is used primarily by the purchasing group. Accuracy could be increased with the utilization of forecasting techniques which are

applicable to the type of business of this company. Perhaps Winter's method or a Fourier series would be appropriate. It is a seasonal business. The current method of forecasting for this report is a moving 13 week average.

The schedular relies on past history and intuition to do the schedule. Supplemental tools are lacking as well as documentation concerning the rules used in scheduling. Because of the lack of documentation (message type) it is important that the lines of communication remain open between various groups effecting and effected by the schedular.

Changes to orders and small run sizes cause inefficiency in scheduling and in production. The changes to orders were discussed previously. They effect the timing of scheduling, the efficiency of the plant, and excess paper work. The small run sizes cause frequent changeovers at the plant both in processing and in packaging. A changeover from one product to another can take up to 15-45 minutes. In packaging it ranges from 7-15 minutes for wrapper change or a size changeover.

Figure 3 indicates that 28 % of the orders are for 100 cases or less and that the distribution is skewed to the left of the graph. Approximately only 6 % of the orders are greater than 4000 cases with .65 % at the

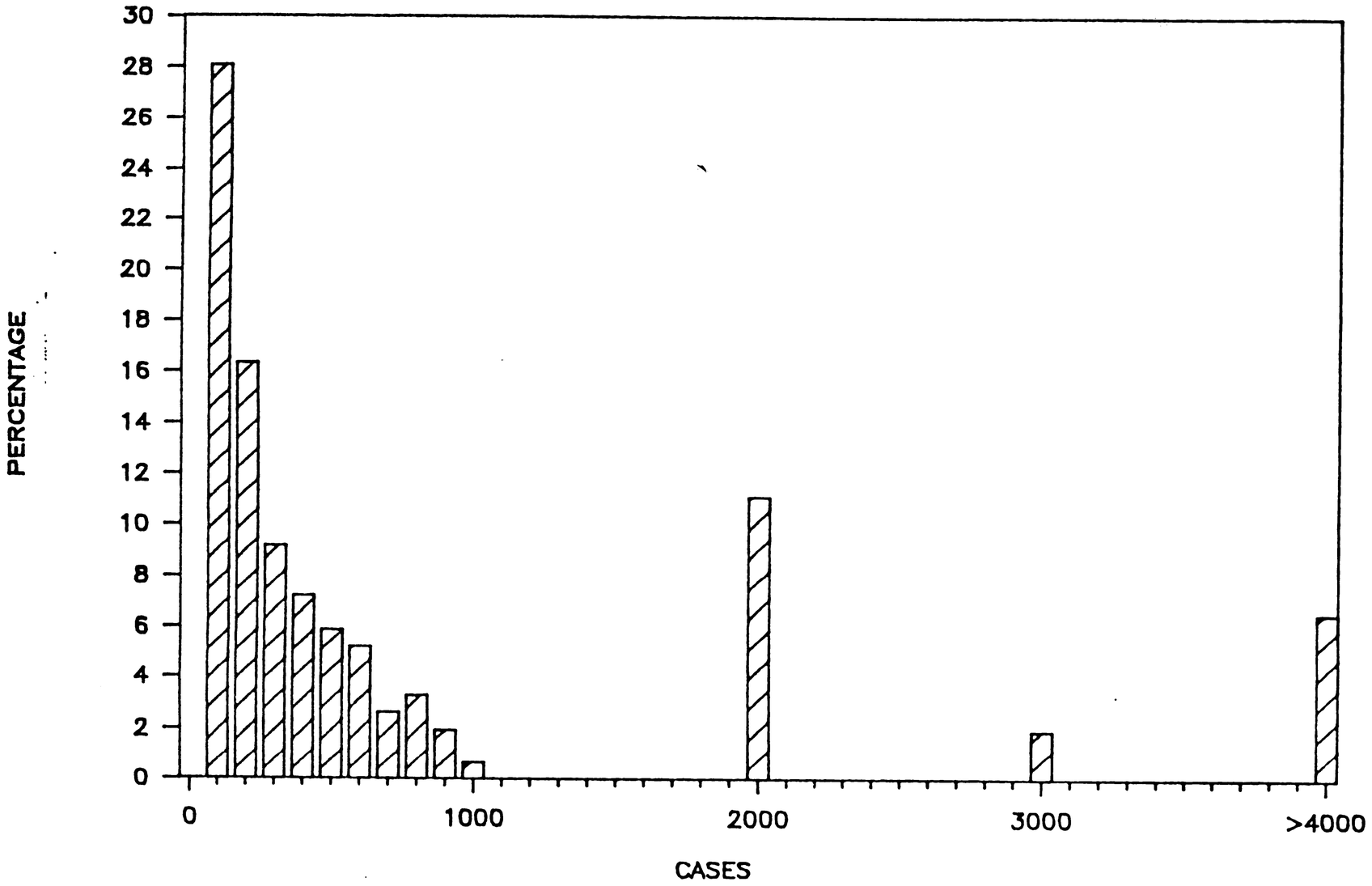

Figure 3 Distribution of All Orders to Be Produced at Plant R

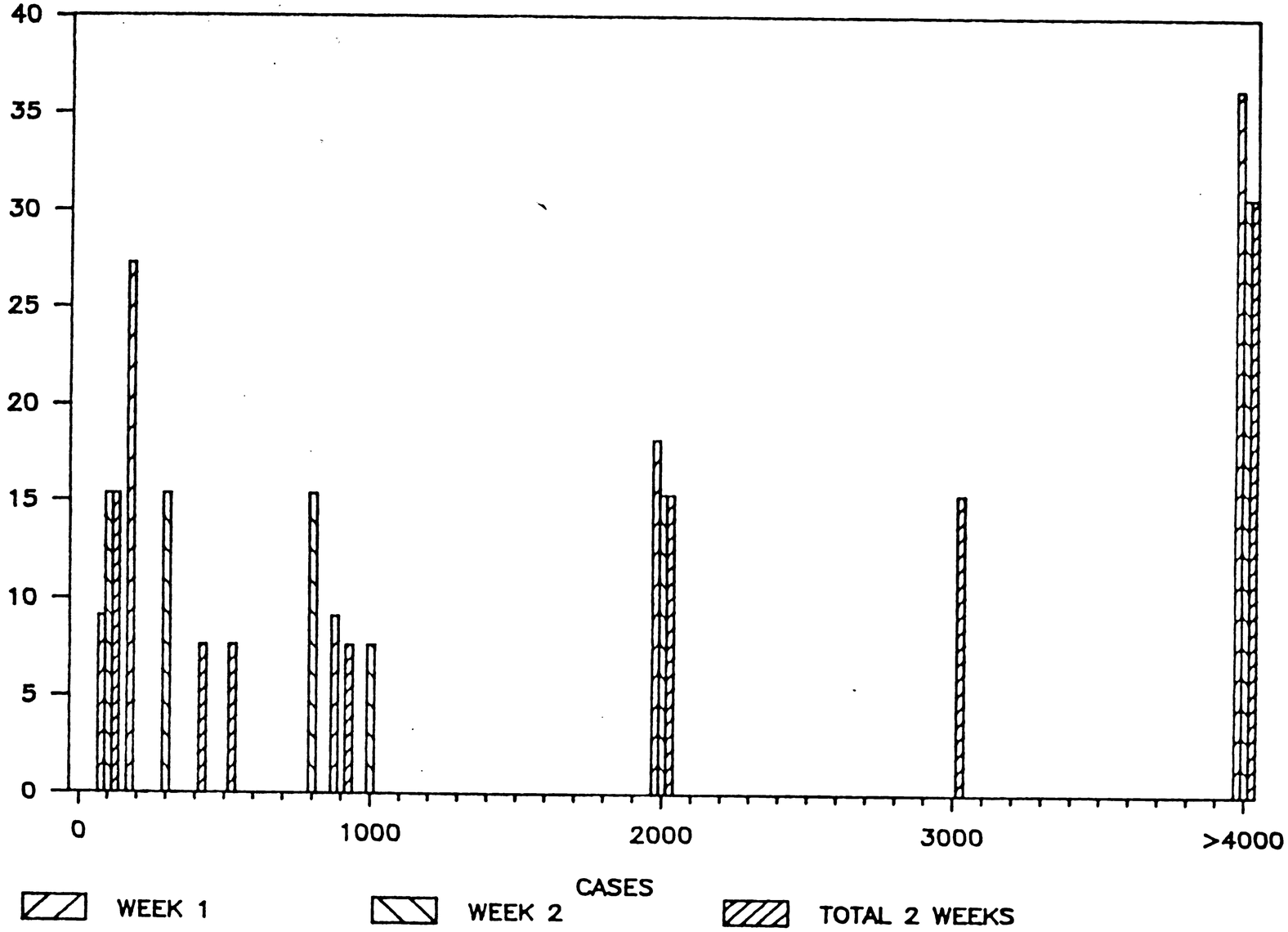

Figure 4 Accumulation of Orders for One and Two Weeks

10,000 case range. If we accumulate product for one week to two weeks and then produce it, Figure 4,the small orders drop to 9-15 %. The distribution begins to accumulate past the 900 to 10,000 case quantity runs. Now 32 to 36 % are greater than 4000 cases. This would represent an 8 hour shift or more of production on a single product and less packaging changeovers.

To begin to move towards longer runs will require planning and strategies so that customers are not lost. Inventory rules will have to be established in addition to order control policies concerning small orders. Once the decision is made to establish a minimum order, cooperation is needed from sales and marketing to prepare the customer for a shift in the way they do business. The customer and the company will incur more inventory cost. A determination should be made to find the breakeven point. Again planning for the change is crucial.

To maintain the scheduling for future growth the following items will be necessary:

The company continues to need a well organized person in the position of scheduling to be able to mentally assimulate all the bits of information that filter into the area

Supplemental tools are needed for the schedular to be more efficient

Documentation of scheduling rules and historical patterns in orders is required

More effective information transfer between traffic, shipping, production, order control, quality assurance, sales and cost is a must

Changes to the order distribution/cycle to provide more efficient scheduling

Improvements are needed in the planned summary report and the raw material inventory module.

Incorporating any of these changes will require planning and change management. The same basic system will exist but it will be more formal. A better understanding of the business by those involved in the scheduling process will help them to do a better job and to become more efficient.

Shipping

Shipping is the funnel from production to the customer. It is their responsibility to assure that the correct product is loaded onto the truck and in a timely manner such that the product arrives when scheduled at the customer's door. Three issues concern shipping: uneven loading, warehouse space and inefficiencies due to trailer problems, order changes and scheduling.

Monday and Friday are the heaviest days for loading trailers as a result of the actual order cycle not the seven day intended cycle. It is effected by the nature of the business. Store shelf stocking occurs in the

beginning of the week for the heavier shopping days incurred at the end of the week. The loading could be evened out more by adhering to the seven day cycle.

Warehouse space is limited at this company. Random stacking policies cause delays in retrieving product for shipment. Sometimes product is buried and the first in, first out policy is violated. Simulation studies will provide insight into better policies and perhaps into space allocation concerns.

Data taken from the shipping diaries points to trailers (44%), product availability (26 %), and common carriers and ASAP loads from other plants (11 and 12 % respectively) as contributing most to the problems in shipping department. Scheduling of loads comes from traffic. Better communications between the two groups is needed for a coordinated effort. Trailers are tracked via the driver's board. They may not arrive at the plant at the specified time hence loading cannot occur. Sometimes the trailer is in the yard but the tractor is not. When this happens, traffic resorts to the use of common carriers.

Common carriers provide an economical means of transportation but they do not adhere to strict schedules like the companies private drivers. The common carrier typically has an 8 hour window in which he can be loaded.

If shipping doesn't know when the truck is going to be there, they cannot effectively schedule their crew. Trade offs from both traffic and shipping will be necessary to facilitate these problems.

Another issue is the product availablity. Sometimes product is needed which has not been produced yet. The trailer is pulled away from the dock (half hour in time) and it waits for the product. Now it is pulled back to the dock and loaded. All of these issues can lead to short shipments. This is when a customer has ordered a particular quantity of product and only a partial shipment is made or none at all. Shipping is held accountable for short shipments.

In evaluating the causes of short ships, two different time periods were used: 1/86-7/86 and the same dates excluding weeks 6/25 through 7/16. The reason for the two time periods is because 6/25-7/16 represented a heavy promotional period for a particular product and processing problems caused abnormally high shortships during this time. One problem facing the analyst when dealing with promotional products is finding an appropriate base line. This study has lump all product sales/orders into the same category. In the future it would be interesting to determine the baseline and the

effects the promotions have on the business.

Figure 5 shows that no machine time, cubing and shortship product from outside suppliers causes the majority of shortships. This graph includes the promotional period. When this is eliminated, "no machine time" is ranked third or fourth. The machine time may be hinting at another problem: capacity and/or preventitive maintainance. If equipment problems appear during heavy production time product must be short shipped. If the problem is purely a scheduling problem, then capacity may be the issue. Tracking downtime would be beneficial in determining the true cause.

Cubing or how the product is arranged on the truck is an issue because of the many case sizes sold and the varying sizes of the truck beds. The company is embarking on standardizing both the case size and the truck bed. Perhaps once standardized a stacking simulation would be useful in determining the optimum loading pattern.

Efforts in shipping are required in the following areas:

Smooth out the loading cycle

Study the warehouse space and warehousing policies for ease of inventory storage and retrieval.

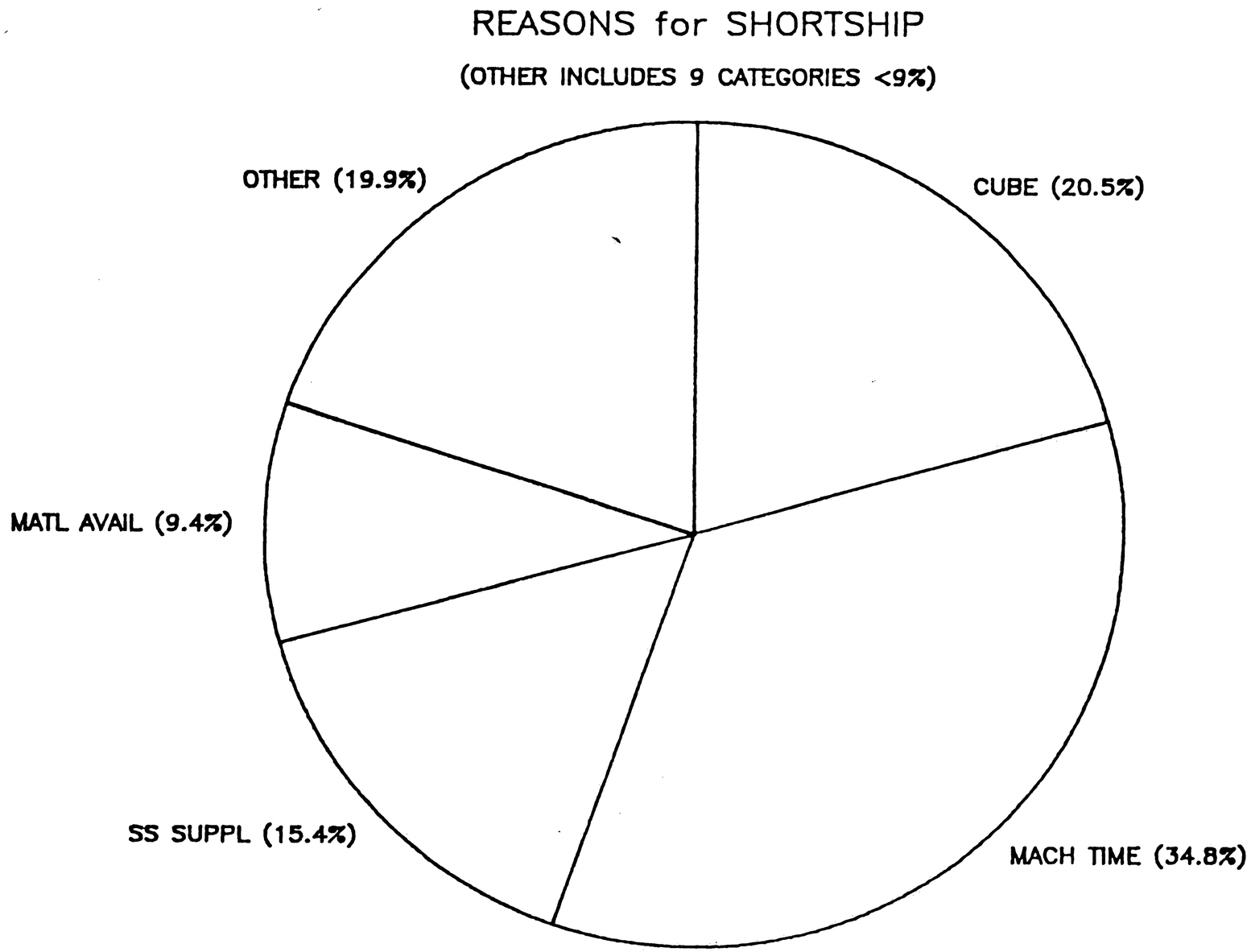

Figure 5 Shipping: Shortships

Address the causes of inefficiencies due to trailer delays, production scheduling, changes to orders and cubing problems with the trailers

Communicate!

It is evident that communication and interaction between the processes in production scheduling is important. As the company experiences increases in growth or even promotional activity, the systems as they are now begin to break down. Comments have been made that 10-20 % increases in production cause the system to fail. What will happen when production doubles or triples?

Just to exemplify some problems resulting from increases in production, let's consider the period between 6/25-7/16, a heavy promotion period on a single product type.

Manufacturing- The majority of the problem was machine time. As mentioned before, it resulted from an extrusion problem in the process. The result, short shipments, because product was not in inventory. What caused the problem? Is it capacity related? Is it preventitive maintenance related?

Shipping- During this time the majority of the problems in shipping were waiting on trailers to return from shipments and waiting on production for product.

Production was in a situation where there was no inventory of critical products. Shipments were occurring right off the line.

When production was running well and filling up the warehouse, a problem existed with trailer availability. Trailers were not returning from outgoing shipments in time to meet the next shipping time. Traffic resorted to some common carrier usage. The common carriers do not arrive at a specific time therefore the shipping department could not load the trucks. The warehouse space is depleted.

Short ships increased during this time period. For June they were at 1.326% and for the time understudy, 2.845 %, an increase of 1.519 %. The main causes were no machine time, cubing, short ships from outside suppliers and material availability.

Scheduling-The schedular tried to inventory product in anticipation of the promotion, however with the extruder problem, the inventories were quickly depleted and orders were delayed. Order control was involved in calling the customers to reschedule. The production planning report was not available until 11:30 or later and the schedules were forced to be late. This of course effected productions ability to schedule crewing and setups.

Quality- Increased production means increased risk for quality problems. The potential for a major contamination problem is high. Currently this company has no tracking system on raw materials or finished product. How will they recover from a contamination problem? There is no proof or history on the suppliers to indicate if they were the cause and to help recoup the losses if it is a supply problem. During times of increased production too often quality takes a second place. At a time of increased exposure, can you afford a quality issue?

The description is characterized by a snowball effect. A problem in one group causes problems in other groups. The system is tightly coupled with interrelationships across the functional areas of the company. This scenario only represents problems that occurred or could have occurred when production rose only slightly. The company is anticipating doubling production over the next couple of years. How is disaster prevented?

Chapter 7 Recommendations

"If you don't know where you are going, any strategy will take you there." (12)

The first set of recommendations is directed to the company as a whole. They are as follows:

1. Develop the corporate strategy identifying the mission for each area: Manufacturing, shipping, order control, traffic and production scheduling

2. Develop area strategies which are consistent with the overall strategy as well as with other functional areas

3. Develop integrated policies, standards, and procedures in each area and adhere to them

Although only a part of the company was studied, it is evident that direction is needed. Production scheduling is interrelated to traffic, order control, manufacturing, the whole company. Anyone of the groups can make or break the organization without a clear understanding of "where they are going."

A key task for executives in manufacturing firms is to select a mission for the business in order to determine how the firm will compete in the long run. Once a mission has been identified, goals and objectives can be

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A key task for executives in manufacturing firms is to select a mission for the business in order to determine how the firm will compete in the long run. Once a mission has been identified, goals and objectives can be

established, priorities set and strategies formulated for other areas of the firm. Systems can then be developed which help attain the company goals. Change will occur as the company strives to meet the corporate strategy. Organizational structure, the means of communicating, the instruments used to do business will look different.

The strategy will force each area to concentrate their efforts in the same direction. If customer service is the priority, then each group must have guidelines that are consistent to catering to the customer. If it is quality, then maybe the order cycle is extended such that more consistent runs are produced. If it is a combination of customer service, quality and efficiencies then maybe longer runs, better communications, helpful management tools, a pervasive strategy is the key. Regardless of the strategy each group must understand it and work towards the strategy as a team. No one group can achieve it without the other.

New technology and systems will support the strategy. Computer integrated manufacturing will provide the means to link decision areas for each to interact effectively, with sufficient data and in a timely manner. The company must overcome the barriers that exist to new technology development: (10)

1. technology unknowns

2. outdated systems for capital allocation

3. vendor limitations

4. personnel and labor attitudes towards new technology

5. internal resistance and risk aversion in manufacturing

6. and a lack of a manufacturing strategy.

The first three are a concern in any company. Special attention is needed, in particular to the last three, for this company.

Manufacturing is a key part of the business. Just as marketeers plan marketing strategies to more effectively entice the consumer to buy their product, manufacturing must plan its business to be able to support the other functions of the company. Using new technologies in the quality assurance department can speed up quality testing thus reducing scrap and better meeting the high quality demanded by the consumer. By knowing what product lines are in the future more flexible process lines can be designed. The manufacturing people know the processes. Particularly in this organization, the manufacturing group desires to know more about the business. Build teams from corporate and manufacturing to solve problems. In doing this, manufacturing will be able to see the complete

picture and begin to think strategically rather than operationally.

Special attention must be given to change management as direction changes. Each department is intrically dependent on the other for information, cooperation, and coordination. Limited resources make the business susceptible to even minor changes. This is evident in the tightly coupled communications that occur to produce a schedule. A delay or change in any group effects that schedule. As new systems are developed or old ones altered, change will occur. The impact of the change must be addressed. Employees must be educated as to what the change is, why it is being implemented, the benefits it achieves, the timing, and how the effect will be measured.

Unawareness jeopardizes the success of the change. Employees will circumvent and even deliberately cause its failure unless they understand and buy into the change. One sign that this is occurring is the generation of a list of exceptions to the change. "We can't handle it this way because ..."

By measuring the effect of the change you can determine the need for review by personnel or for revision. Think the change through and its impact on the business and the employees. Be prepared for the "surprises" rather than be surprised with the problems

that may be incurred as a result of the change. Planning ahead provides a smooth transition when implementing changes.

The strategy once developed must be implemented and controlled. The implementation must include plans for new technologies, finances, and human resources. The wrong people in charge and a lack of commitment by any management personnel will cause failure. Chaos, confusion, and resentment will result.

Policies, standards and procedures reduce confusion in an organization and facilitate learning about the business. Learning requires controlled experimentation, good data, and careful analysis. If each department does similar task differently then confusion will result. Confusion makes it hard to pick up on the underlying problem or to figure out the source of a problem.

> "A factory that manages change poorly. that does not have its processes under control, and that is distracted by the noise in its systems learns too slowly, if at all, or learns the wrong things. In such a factory, new equipment will only create more confusion, not more productivity. ...they will simply argue, 'It can't work here. We're different.' Indeed they are- and less productive too." (6)

The current systems must be documented and evaluated to determine their complexity and confusion levels.

Simplification and clarification follows. At this point then new tools, i.e. computer tools like bar coding, MRP, can be introduced to augment the simple, concise system. "Computerizing a poorly organized and error-ridden information system simply creates more problems: garbage in, garbage out." (6)

If we look specifically at scheduling the following issues need addressed:

1. Document a formal system where:

- a defined ordering cycle is adhered to,

- orders are not changed within the cycle time,

- raw material inventories are known,

- promotional information, both the companies and private label, is timely,

- minimum and maximum inventory levels are established,

- loading cycles are evenly distributed over the week,

- forecasting is used to better predict promotion and production schedules.

2. Perform on going analysis of the functional areas and work to improve them

3. Once the systems are in place, use the computer to augment them

This company as it grows is becoming more and more complex as evidenced by contrasting plant R and plant P.

The company's plant P is basically a single product plant. There are many different packages and a few varieties within the product type. The scheduling is accomplished by the plant manager who is well aware of the production problems, of customer orders, shipping situations and the material inventory. In reviewing data from this plant there was only one incident where the order was changed on the same day of production; cubing was the major shortship problem; in general this plant is viewed as running more efficiently. The processes in the plant P are more straight forward. The raw materials consist of two or three that make up the majority. The systems are simpler because of the nature of the products.

Plant R is more complex, with more product types and varieties, more processes and different processes. Hence the systems are more complex. There are over 800 possible wrapper combinations alone in plant R. Documentation of the systems used to operate plant R will make the plant remain consistent as it grows. Deviations from standards then will be evident and corrections can be made. If the system is not known to management then they will not be able to easily see deviations occurring and turmoil will prevail.

Changing the production schedule at the last minute, overriding the production schedule by expediting orders,

changing crew, haphazardly adding new products or playing with the processes cause confusion. They not only effect the production of the products but has side effects in all other departments. The problems will only multiply if rules are not established and adhered to. Recall the snowball effect mentioned earlier.

Introducing too much change at one time without good systems in place to start with could be devastating. This company within the next six months is anticipating rolling out a new warehouse facility which will be significantly different than the current shipping area. They are consolidating two plants and thus introducing a couple of new products to the plant R. In the third quarter a computerized production scheduling system representing the current system is to be initiated. And further a new business adventure in the distribution area begins. That's ambitious for a small company. Critical to the success of the projects will be planning, project management, and management of the changes which must occur. By having well established systems and understanding the interrelationships of the departments effected by these changes, they can insure success and a less stressful situation to the employees.

A last recommendation is in terms of a quality issue:

product contamination. Food companies are subject to government food inspections. These supposively help protect the consumer against product problems. Yet today we constantly hear of situations where food manufacturers have been forced to take product off the market for one reason or another: needles found in finished product, glass in the baby food industry, bacterial contamination, cyanide poison. A food company uses many ingredients in the recipes. Each one adds additional exposure to contamination. In the event that a problem occurs, the company is responsible to locate all product associated with the problem. If proper records are not kept, the manufacturer can loose weeks or months worth of production. Small companies cannot afford this.

To help safeguard against this possibility, it is recommended that a complete recall system be established in this organization. A recall system requires tracking of every lot of raw ingredient that enters the plant. This is from receipt through the batches that it is added to, the finished product, the distribution center it is shipped to and the store front at which it is sold. Not only does this help protect against loosing weeks worth of product because of ill defined usage periods, but a side benefit is that the performance of an ingredient is tracked. If performance is a problem, the supplier is

contacted and corrections can be made. Thus you can improve the overall product quality. Once the system is established, bar coding can be installed to expedite the tracking procedure. Again the system must be in place before computer tracking can be used to augment it!

Chapter 8 The Future

"A major problem in strategic management lies in both analyzing a chaotic environment and developing a level of understanding that utilizes intuitive skills to create strategic opportunities." (12)

In the previous chapters discussions concerned the development of a strategy, using computer integrated manufacturing as a means of linking all business functions of a company together, comparing different types of industries to the food industry, looking at small vs large corporation, and analyzing the production scheduling system in a small food manufacturer. The need to view manufacturing as a competitive weapon and develop strategic thinking in the manufacturing ranks is important. Managing change throughout the integration and modernization process is critical to its success.

The development of the modernization strategy relies on the business knowing the business. This study has looked at one area of the company and found that there is

* a need for strategies in all functional areas of the company,

* a need for well defined and documented manufacturing systems

* a need for change management, and

* a need for ongoing analysis of the functional business areas.

Although other functional areas were not studied in depth, many were dealt with in the study of production scheduling. It is believed that the four "needs" mentioned above apply to the other functional groups as well.

Strategic planning couples the use of analytical skills with intuitive skills. McGinnis (12) refers to six issues that "effect the ability of a firm to understand its environment and thus create strategic opportunities: intelligence, organizational balance, analysis, innovation, proactivity, and risk taking." The first three are primarily analytical skills and provide structure to the ill defined, both in internal and external environments, and identify alternatives to consider. The last three are more intuitive. They allow the company to be creative, to bend, learn new ways of doing things. Each term is defined below.

"Intelligence is the firm's ability to simultaneouly scan and interpret its external environments, monitor itself and communicate effectively with itself.A weak link in any of these three areas undermines the total corporate intelligence system.

Balance is the ability to be centralized and decentralized simultaneously. Direction and policy making should be centralized, while operating authority should be decentralized.

Analysis is the ability to evaluate systemically a problem using both quantitative and qualitative information and to develop an array of possible responses. The role of analysis is the clear delineation of choices, not the determination of strategy."

Innovation refers to the firm's" willingness to learn new ways and willingness to bend.

Proactivity is defined as the firm shaping its environment with new products, technologies and administrative techniques.

Risk taking refers to the ability to take bold and venturesome action in the face of uncertainty." It is a part of business.

The relationship between these skills is an interactive one. Management must continuously analyze the business to get the facts about the environment, use it's intelligence system to assess the strengths and weaknesses, and communicate those findings throughout the company, and use organizational balance to enable each functional areas to focus on its strength and compliment other areas. The intuitive issues allow the firm to exploit their alternatives identified in the analytical process. Without innovation, proactivity and risk taking this cannot be accomplished. Polarization occurs resulting in dominance of either the analytical skills and too much structure or intuitive skills and too much

confusion.

In this study, structured analysis techniques were used to help identify the strengths and weaknesses of the production scheduling area. To quantify the impact of the key issues surrounding production scheduling and growth of the company and to delineate clear solutions, it is recommended that a computer based approximation of the current scheduling process be developed and that the current production and warehousing operations be modelled using simulation. With these approximations then, the following issues can be addressed:

* various order cycle scenarios like a three day firm cycle vs a six day firm cycle.

* the impact of manual order changes, for instance, what would the schedule be without the change and then with the change?

* the impact of doubling, tripling etc., the current production mix on production, shipping, traffic and other areas.

* raw material inventory management, finished goods inventory management

* loading cycles and product distribution management and

* short term scheduling system improvement opportunities.

These approximations not only provide the evaluation of the issues at hand but they also provide the opportunity to begin building future scenarios for optimal

modernization planning, to document and refine the current production scheduling system, and to initiate the development and implementation of the next generation production scheduling system.

Simulation and production system approximation will provide alternatives for the modernization and integration strategy in terms of production issues. This information must then be integrated with the corporation's strategy. Remember a strategy is pervasive. It permeates every aspect of the business.

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Appendix

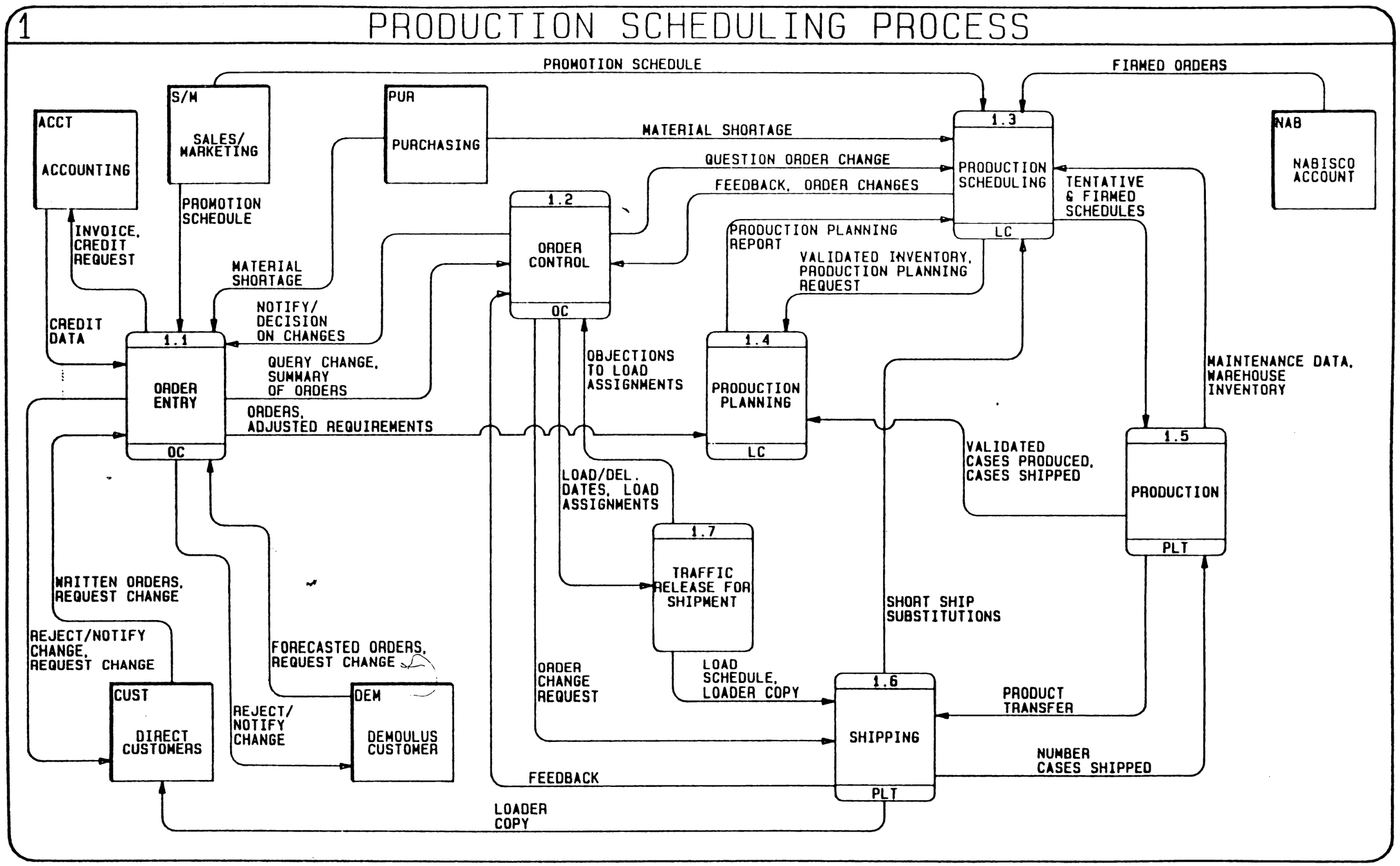

Figure 6 1 Production Scheduling Process

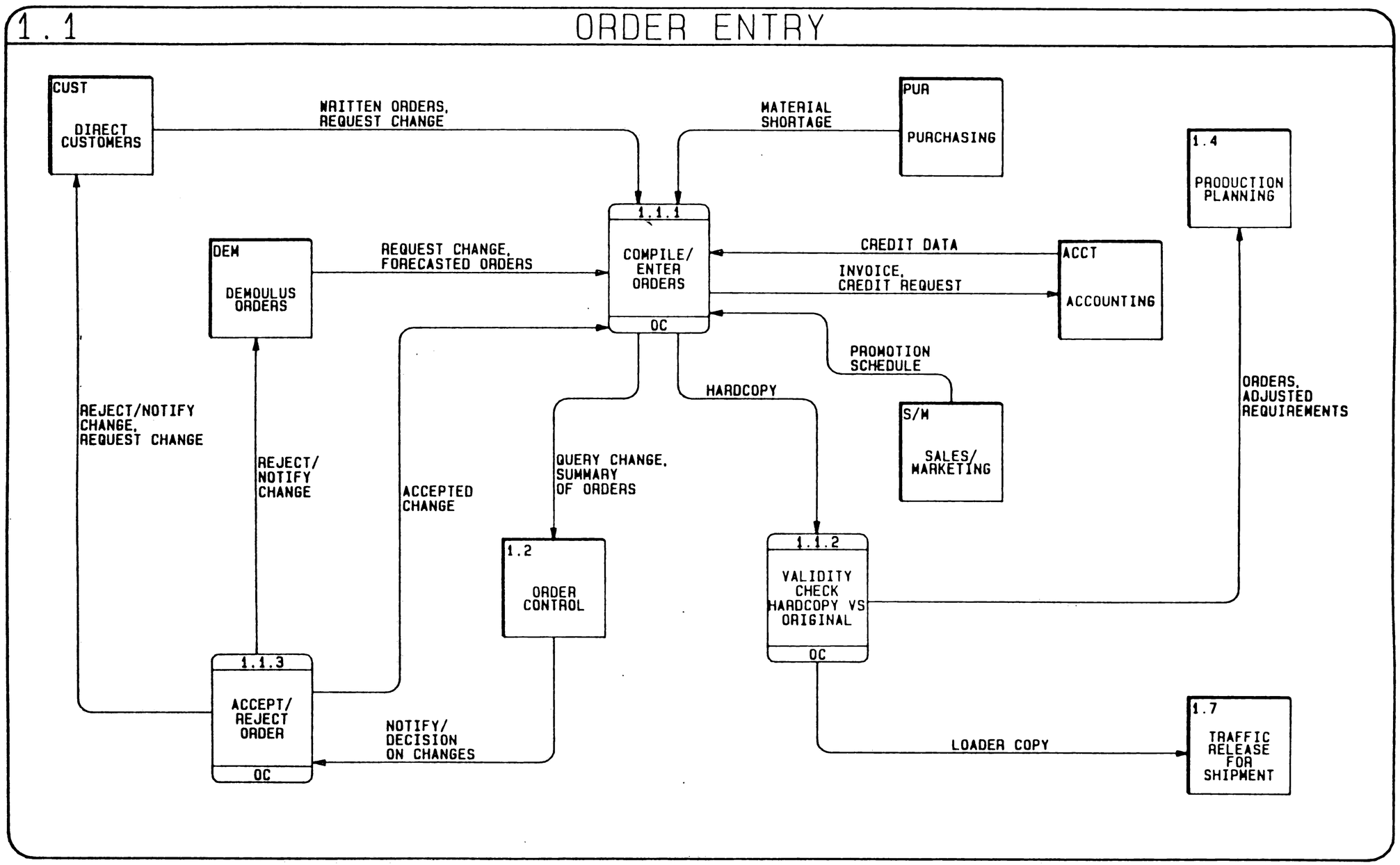

Figure 7 1.1 Order Entry

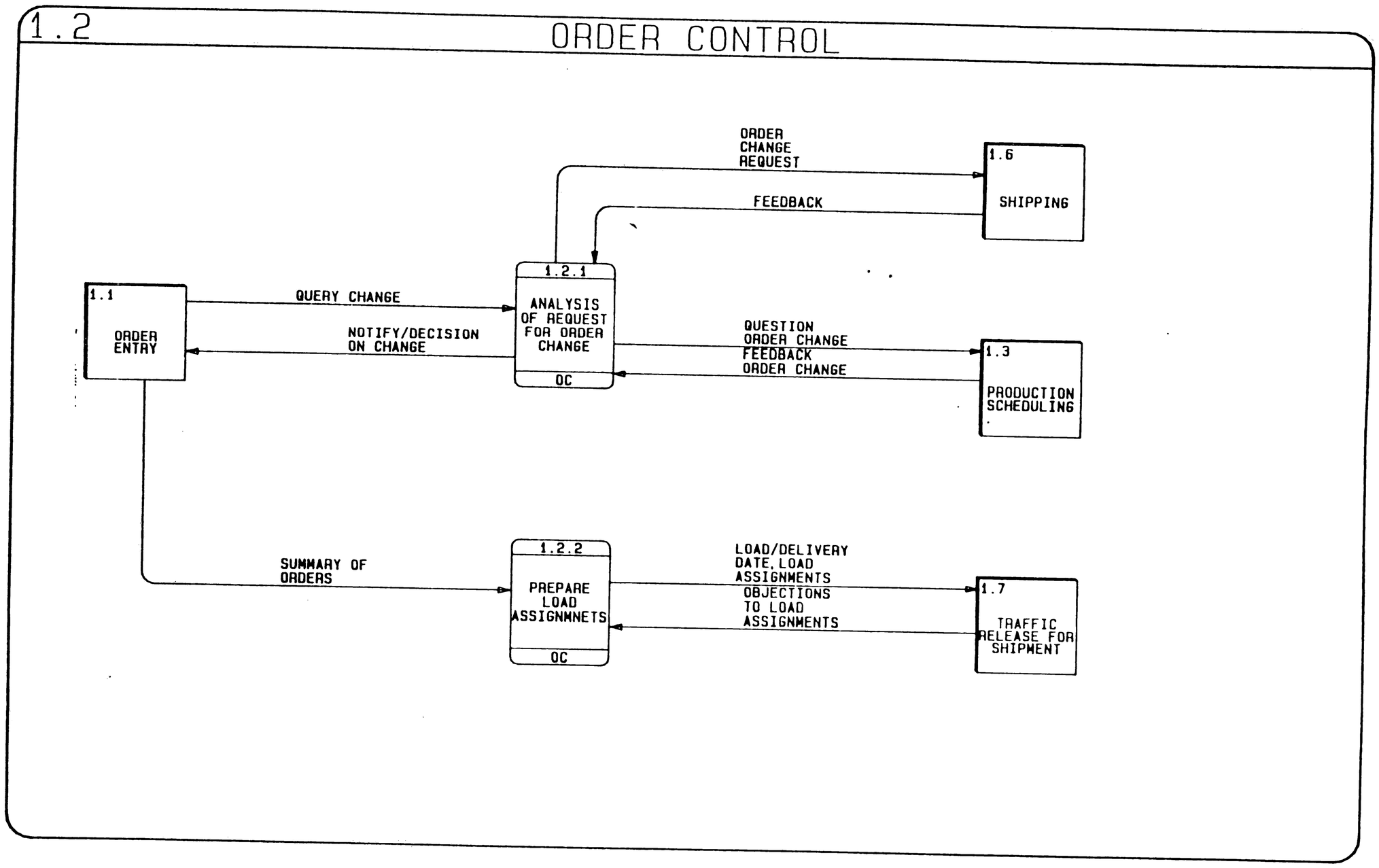

Figure 8 1.2 Order Control

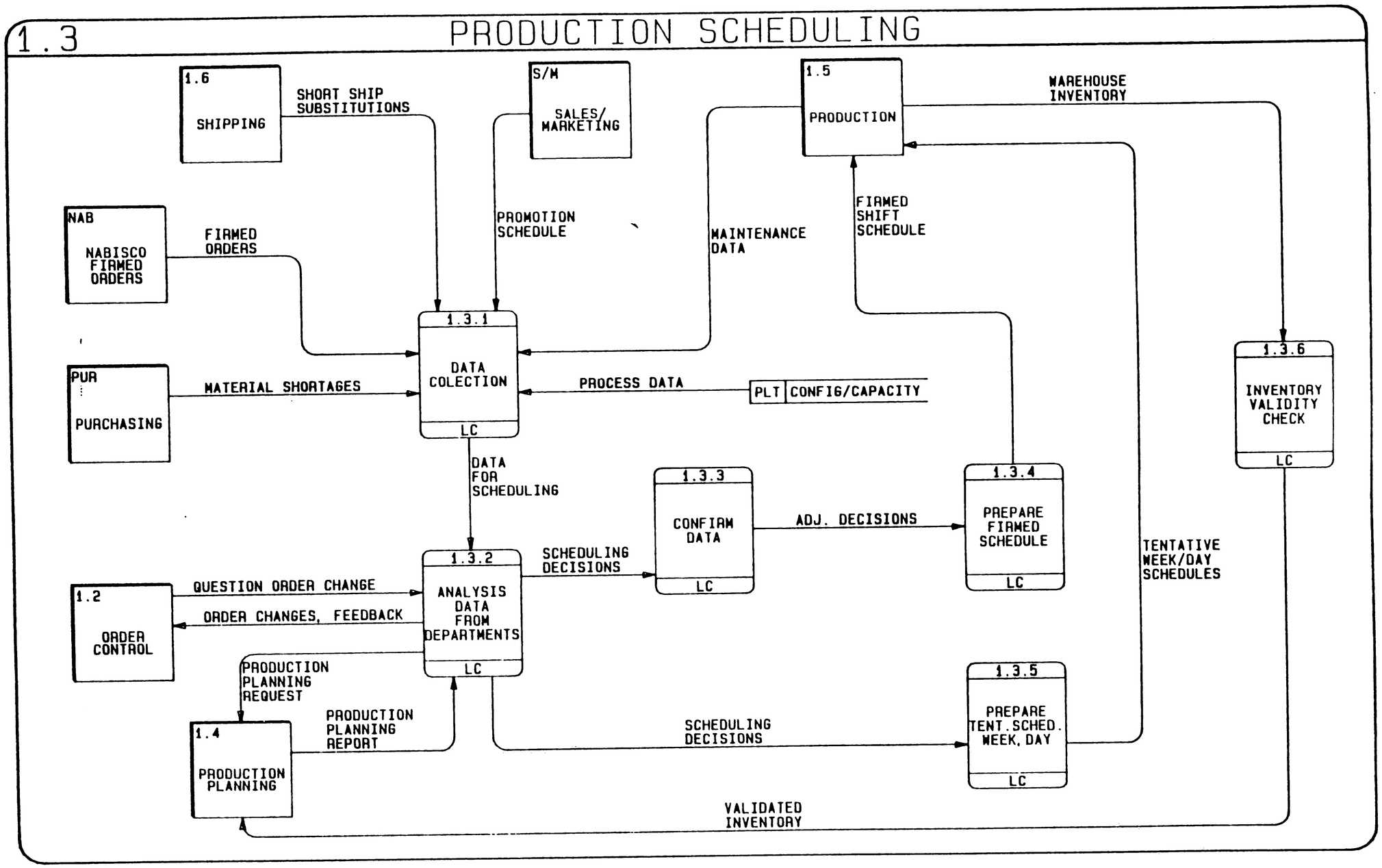

Figure 9 1.3 Production Scheduling

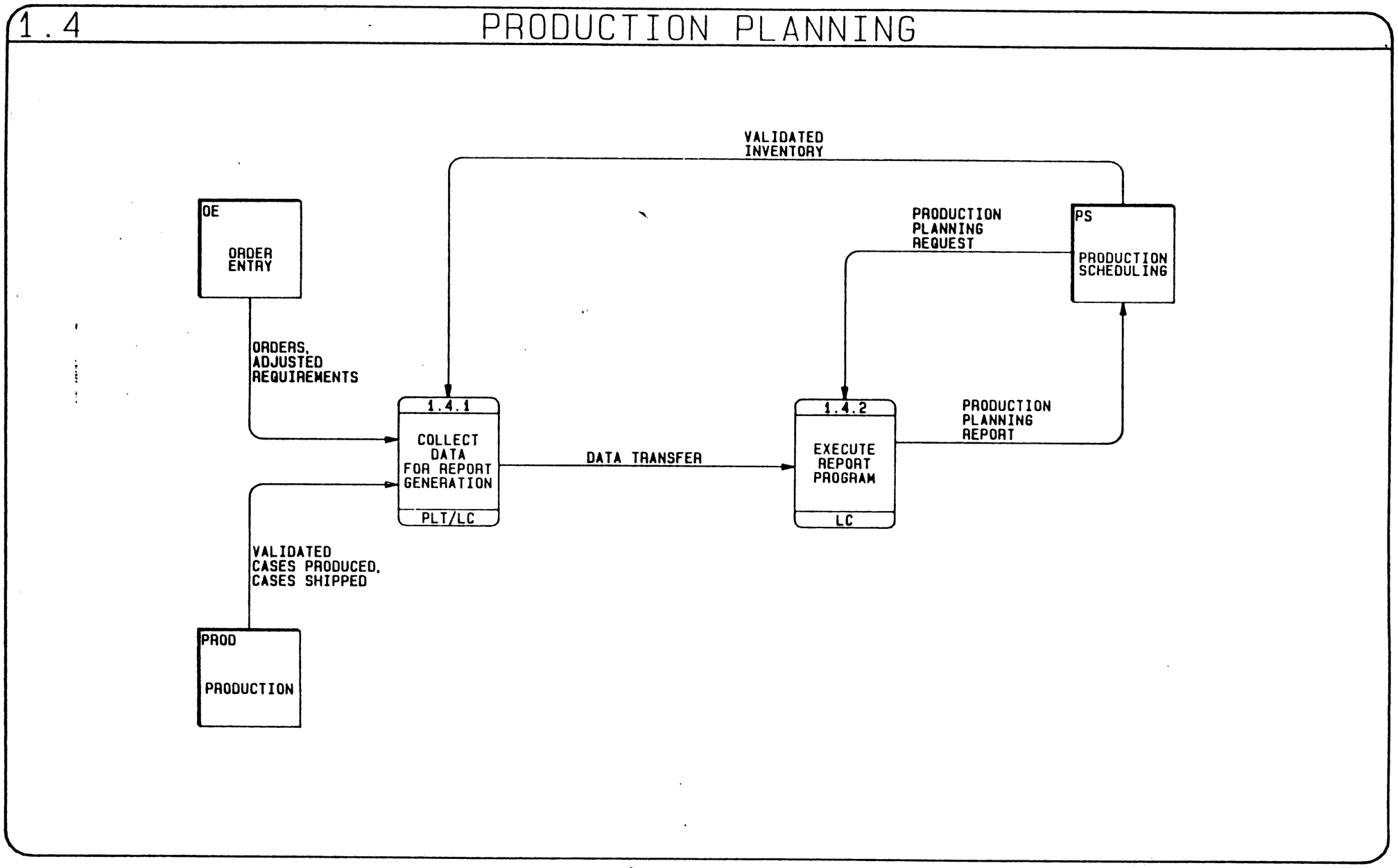

Figure 10 1.4 Production Planning

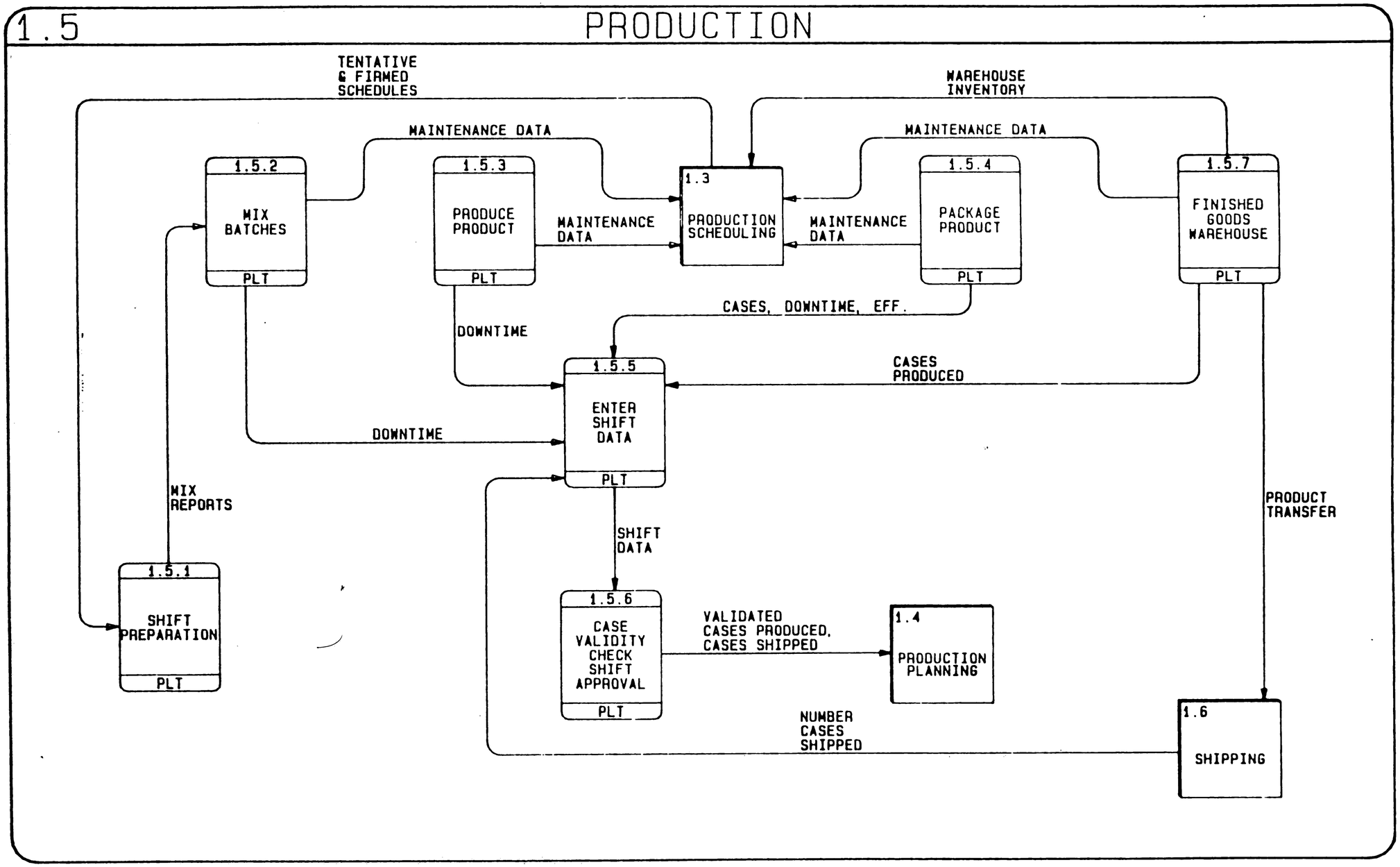

Figure 11 1.5 Production

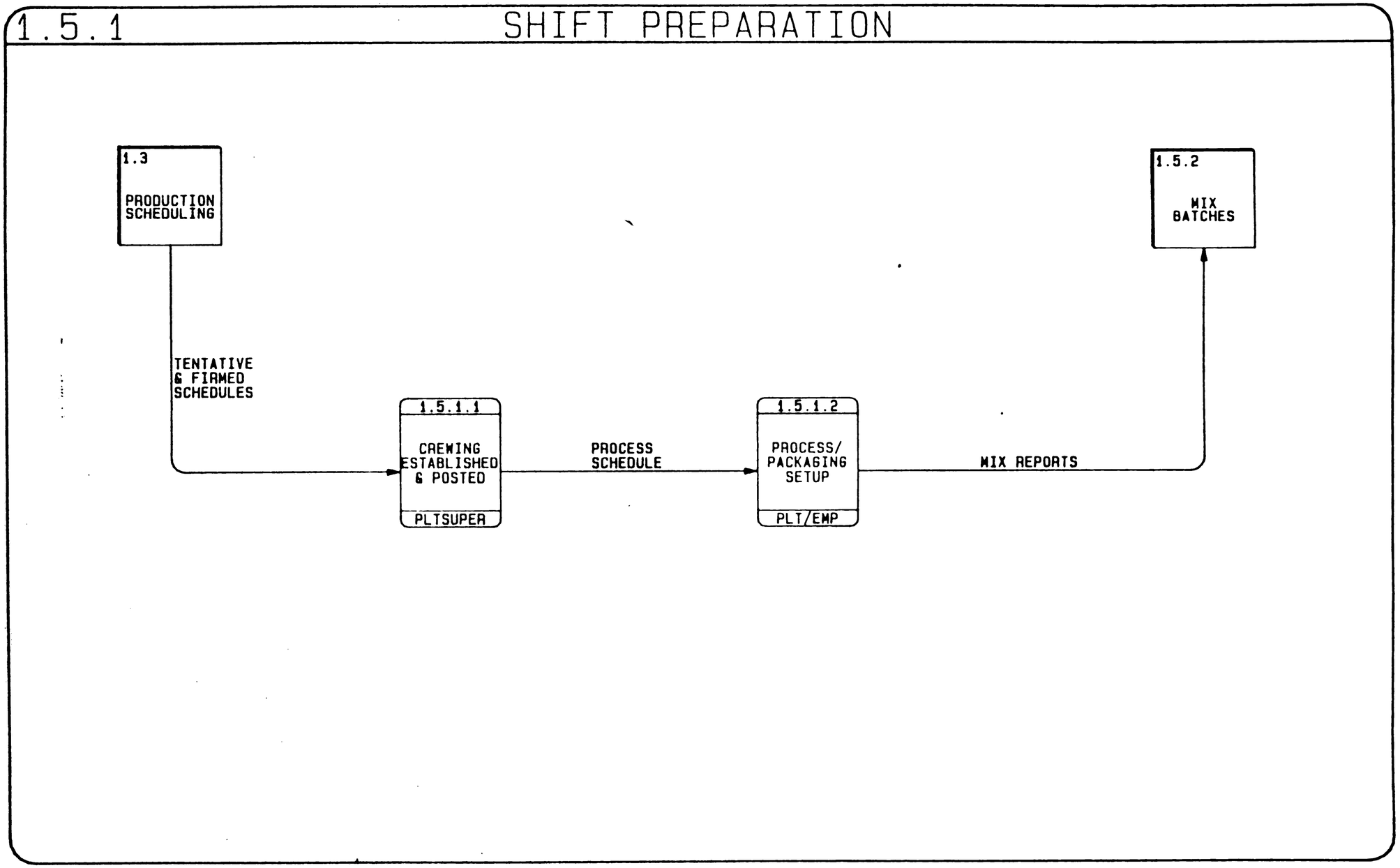

Figure 12 1.5.1 Shift Preparation

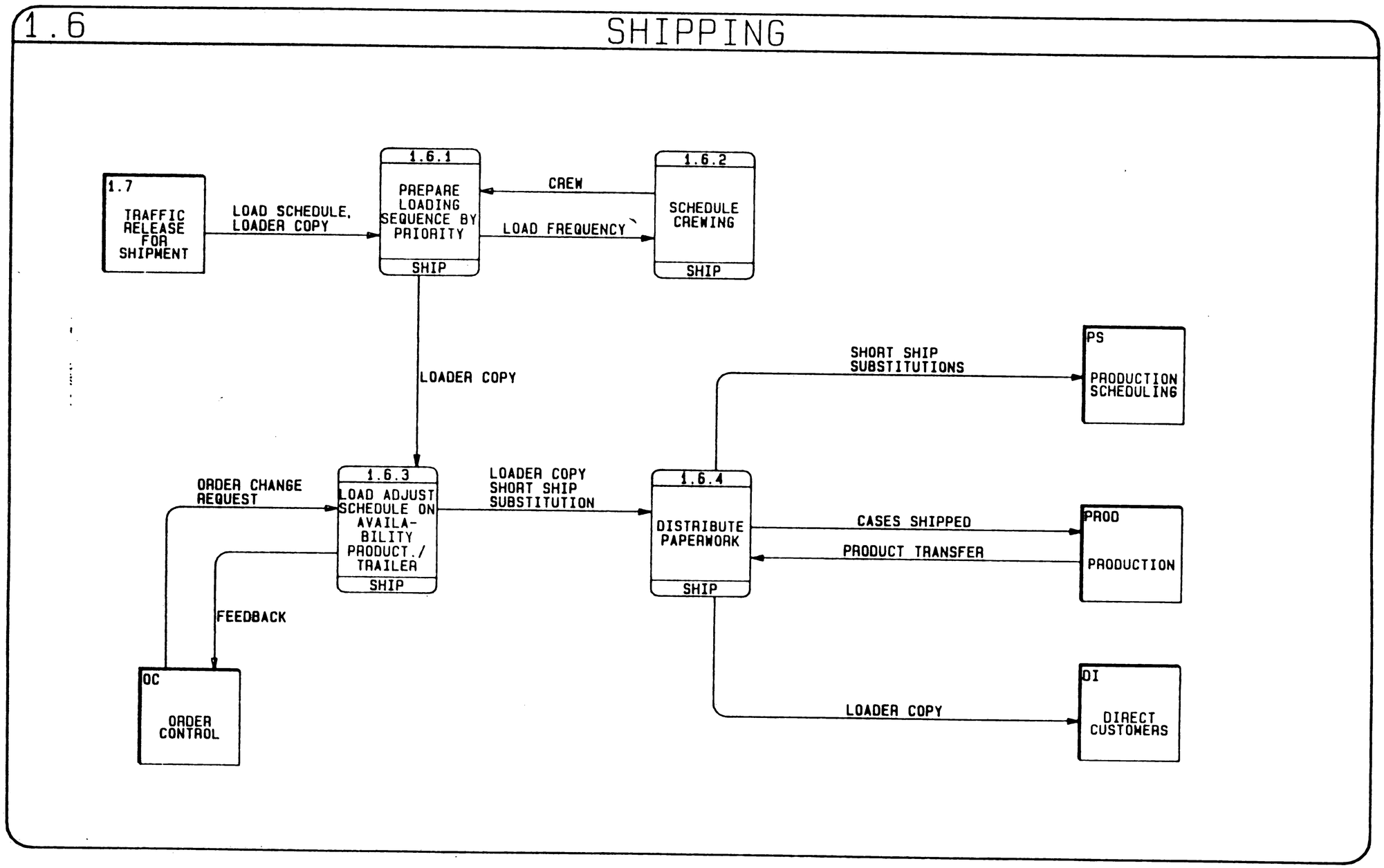

Figure 13 1.6 Shipping

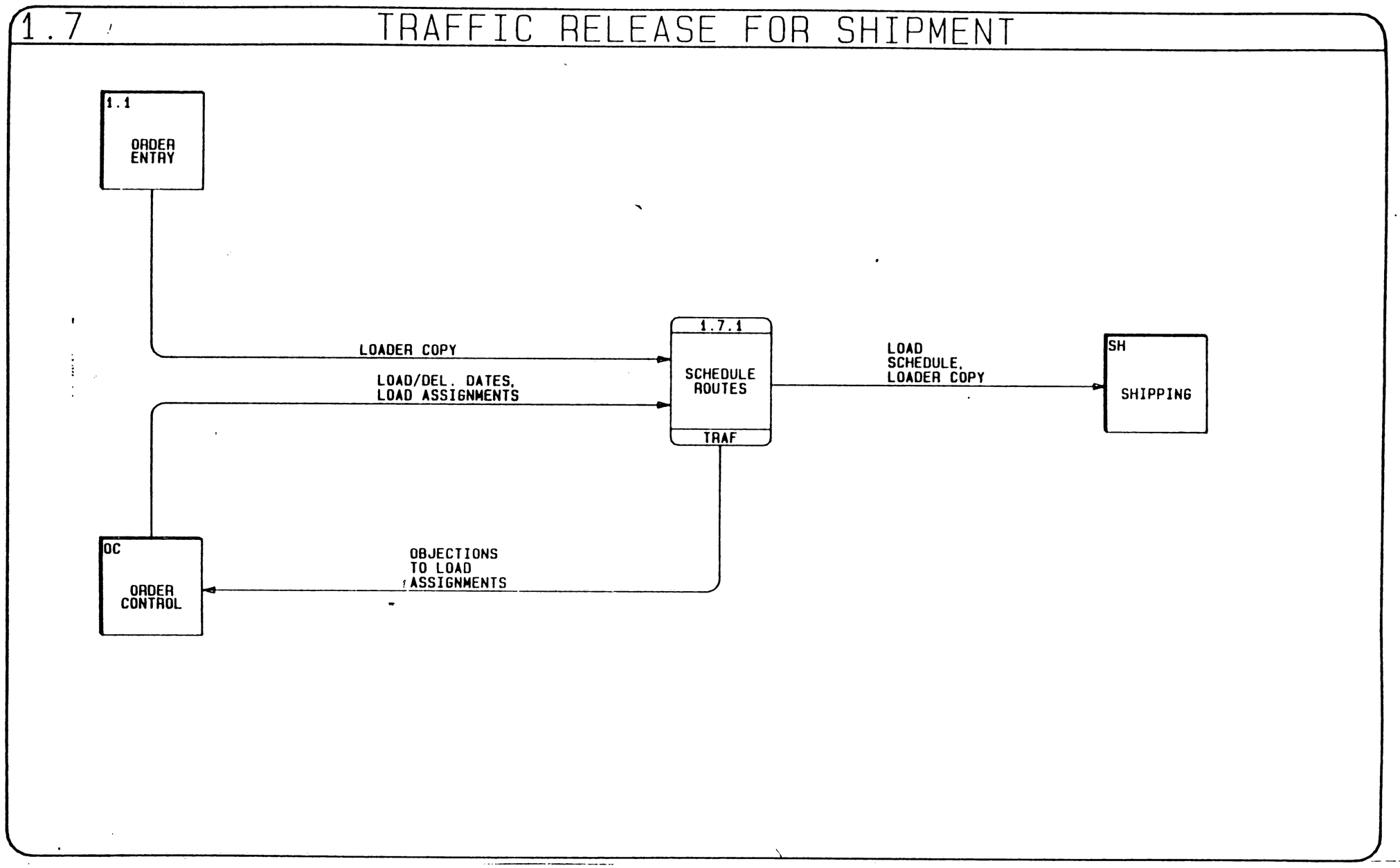

Figure 14 1.7 Traffic Release for Shipment

VITA

Faith Dauberman Clark was born in Selinsgrove, Pennsylvania to Ammon and Celesta Dauberman on February 21,1954. She attended Abright College in Reading, PA. where she received a Bachelor of Science degree in Biochemistry in 1976. Her education was furthered at Lehigh University receiving a Master of Science degree in Chemical Engineering in 1978.

Upon completion of the degree, she was employed by The Proctor & Gamble, Co. in Research & Development-Industrial Foods Process Development for four years. Upon resignation, she was employed by Frito-Lay, Inc. in the Muncy, Pa. Grandma's Food Bakery as the Quality Assurance Manager. During the last year of her three year tenure, she worked solely on systems development for the manufacturing facility.

Currently, Faith is attending Lehigh University in the Manufacturing Systems Engineering program and is expected to graduate with a Master of Science degree in May 1987.