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Implementation of a production planning and control system in a small manufacturing company

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ABSTRACT

Implementation of a Production Planning and
Control System in a Small Manufacturing Company

by

Carmelo Pernice

This thesis analyzed and discussed the implementation of a production control system in a small manufacturing firm. The basic concepts of production control were provided to give insight on the methodologies typically applied in production control systems. Overviews were presented on Material Resource Planning, Capacity Planning, and Shop Floor Control, as well as any supporting methodologies and technologies.

As with any project, some investigation was done in order to choose a system which best suits the company's needs. At Teledyne Adams, The DCD Shop Floor Control System was chosen since it is capable of handling batch manufacturing as well as mass production. Details of how the DCD software works were provided.

The actual implementation process experienced several difficulties. These difficulties arose from the basic problem of lacking the required background in the forementioned methodologies. Also, insufficient training proved to hinder the implementation. Much of the staff required training in produc-

tion control and computers. As a solution to the problems a plan to educate all involved was proposed. A person's involvement with the system dictated how much training they were to receive.

The thesis provides an excellent background in production control. It was shown that problems occur when any methodologies are implemented in a real situation. Additionally, the importance of commitment by management and patience were stressed in any implementation. At the writing of this thesis the implementation is still in progress. Therefore, the effectiveness of the proposed solution remains to be seen.

IMPLEMENTATION OF A PRODUCTION PLANNING AND CONTROL SYSTEM IN A SMALL MANUFACTURING COMPANY

by
Carmelo Pernice

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To Paul Labossiere,

who helped me in so many ways

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CHAPTER 1

INTRODUCTION

1.1 Competitiveness Through Computer Integrated Manufacturing

Foreign competition has forced the U.S. to re-evaluate manufacturing. In the 80's, companies invested large sums of money in new technologies. Most of these purchases were for automating existing plant equipment or for new automated machines. Many companies did not yield the anticipated returns or improvements, some even lost money as a result. The new buzzword became CIM, computer integrated manufacturing. The goals of CIM address the major problems facing U.S. manufacturers. Some of these problems are improving quality, reducing development and production lead times, and increasing flexibility. Although CIM does remedy the above problems, it is not a panacea. However, CIM is essential for improving U.S.' competitiveness.

By definition, a CIM system's functions are responsible for the integration and management of the new computer-aided technologies as well as traditional manufacturing functions. As shown in Figure 1.1, CIM integrates four major areas: Manufacturing Management, CAD, CAM, and Production Planning and Control. The design and manufacturing areas have been at a state of the art plateau and further developments are

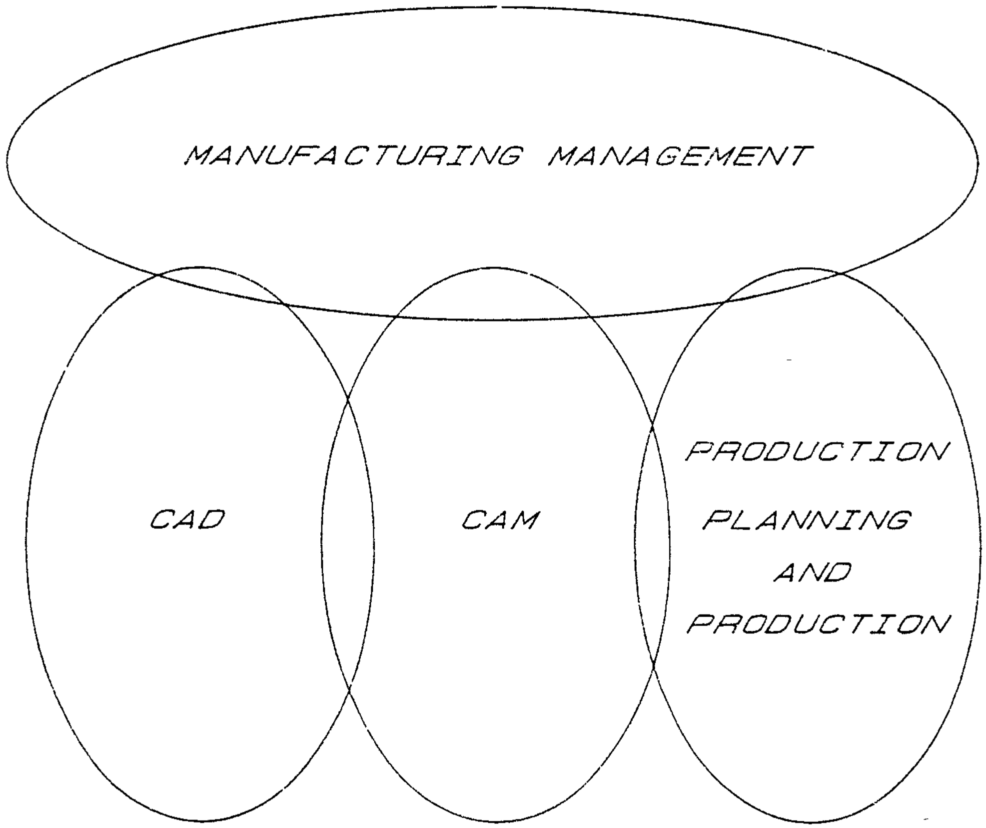

FIGURE 1.1 CIM ENVIRONMENT

being made every day. With the power PC's have now, anyone can afford a CAD system as well as, computer controlled equipment. Manufacturing Management is concerned with manufacturing decisions which are made at the corporate level. It is in this area where company strategic goals are formulated. This area has been automated for some time now. Many companies know this as a Management Information System (MIS) and have had such a system in place for years. The Production Planning and Control (PP&C) area does just what the name implies, plan and control production. However, in comparison to the other three areas companies did not seem to place any urgency in this area. This is partially due to the fact that this area requires new ways of thinking. An example of such thinking, JIT does not allow carrying inventory. This reluctance of changing ways can be easily seen in many plants. The methodologies which drive the PP&C system have been around for a while. These methodologies have also been computerized for years. CIM has forced the integration of the individual methodologies into one system.

1.2 Integrated Manufacturing

Today, the PP&C system is an information system which can fully integrate manufacturing with marketing/sales and finance/accounting. The information contained within the system can run an entire company, whether the factory floor is automated or not.

All of manufacturing is moving towards the concept of integration. These can be seen by the recent emphasis placed on simultaneous engineering. Design and manufacturing engineers working together, instead in their own realm. In integrated systems, components make decisions for the benefit of the entire system. It is not possible to have CIM with a manufacturing system which is not integrated. Integration does not necessarily mean that computers are required, but they are extremely valuable.

Computers play an important role in manufacturing. Their importance in data processing is tremendous. Their value carries over into the world of manufacturing. Their roles in manufacturing include automation control, information storage and retrieval, information transfer, and decision support. This is another case of computers processing data quickly, expediting decision making, and storing and retrieving information efficiently.

CIM is the ideal state which all manufacturing facilities steer towards. Of course, the extent of which each individual facility achieves the goal varies from near anarchy to a General Motors facility, a state of the art facility. However, in order to reach the CIM state, one must not forget the definition. One cannot have CIM without integrated manufacturing. Automating machinery is not difficult. Designing via CAD is commonplace. Computerized systems have been used for business information for decades. But, in production planning and controls, unless the company is an IBM or GM, very few companies have advanced in the planning and control area.

1.3 Manufacturing Information Systems

Over 75% of US companies are small to medium size. Very few companies have the means of an IBM or GM. These companies have limited capital. A handful of these companies can afford a full blown CIM system. In addition, some of these companies probably would not get the full benefits of such an implementation. Nonetheless, this does not mean that they cannot modernize their control of the factory floor. With all the recent advances in computers, even the smallest shop can afford a small PC based system to be used for CAD, CNC, accounting or inventory control.

In manufacturing the ability to trace orders through the plant is some of the most important information which needs to be reported. With all the recent emphasis on updating manufacturing facilities, most concentrated on the hardware, such as machinery and computers. Now, equal importance has been placed on the information systems. For smaller companies this comes in the shape of Closed-loop Material Requirements Planning.

This thesis deals with the implementation of a closed-loop MRP system in a small manufacturing company. Background information on production control systems will be presented to provide a basis by which the implementation can be gauged. A brief discussion about the company, Teledyne Adams, will illustrate the way the company operates. A discussion on the production control system, DCD, will provide the basics for its operation. Having laid all of the above groundwork, the implementation will be discussed. The discussion will detail the problems encountered and the solutions utilized.

CHAPTER 2

PRODUCTION PLANNING AND CONTROL SYSTEMS BACKGROUND

A Production Planning and Control System (PP&CS) is an information system for manufacturing. As the name implies, the system is used for planning and controlling. In the planning aspect, the system acts as a buffer and translator between a company business plan and the factory. It attempts to execute the goals set by the management. The control aspect of a PP&CS, is concerned with getting information to and from the factory floor. A PP&CS coordinates the decision-making processes used in manufacturing. Because of the interdependencies of the different modules, any change can affect more than one module. Refer to Figure 2.1. The system assures that all related modules receive the information.

Any planning and control system's main objective is to plan so that all contingencies will be avoided and if such problems do occur, remedies are readably available. The decisions which a PP&CS addresses include production activities, production scheduling and materials movement. The major problems or issues the PP&CS must deal with are:

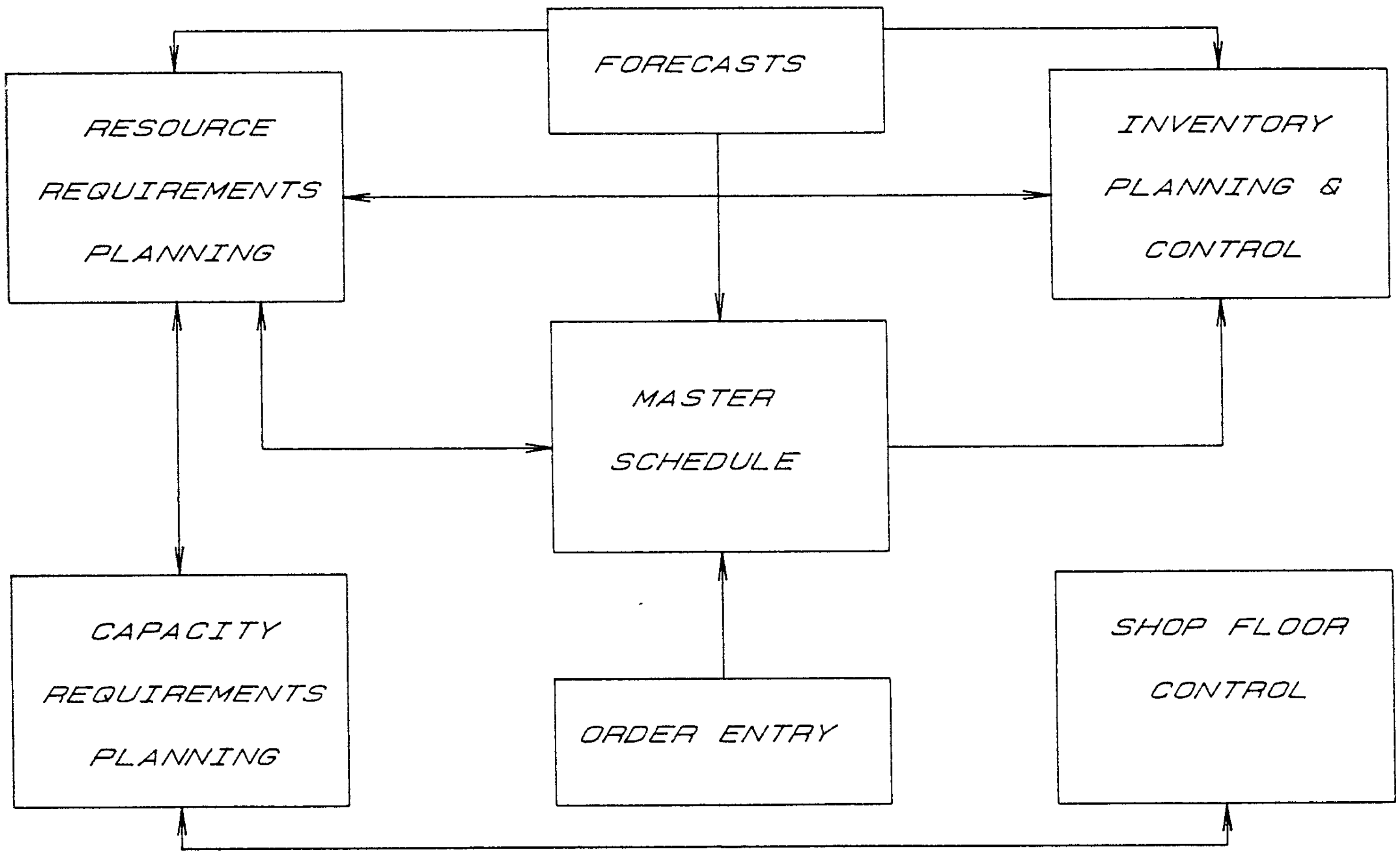

FIGURE 2.1 INTERDEPENDENCY OF MODULES

1. Plant capacity - Production cannot meet schedules due to insufficient labor and/or equipment.

2. Suboptimal production scheduling - Job scheduling is mishandled because of unclear order priorities, insufficient scheduling rules and changing job status.

3. Long manufacturing lead times - Lead times are extended in order to compensate for scheduling and capacities problems.

4. Inefficient inventory control - Too much WIP and finished goods inventory is carried so that increases in demand are covered. Stockouts occur because of late deliveries and inaccurate records of raw materials.

5. Low utilization - Poor scheduling and unforeseen problems such as breakdown and reduced product demand. (1)

In simplified terms a production control and planning system answers the following questions:

1. What to produce?
2. How much to produce?
3. When to produce it?
4. Where to produce it?
5. When to do maintenance?
6. When to order materials?
7. How much inventory to carry?

There are two approaches to production control. The first is using frameworks. Frameworks implement independent methodologies to achieve planning and control. However, the integration of the different methodologies is difficult, and is usually shied avoided. The second is systems based on single methodologies. These methodologies provide the force by which the system is driven. Some of these systems include:

- MRP and MRPII
- JIT / Kanban
- OPT (Optimizing Production Techniques)
- HPP (Hierarchical Production Planning)

The system which will be the subject of this thesis is the first system listed, MRP and MRPII. However, an MRP driven production planning and control has varying levels of depth. There are three types of MRP implementation. These types are as follows:

TYPE I : Used primarily for inventory control
TYPE II: Includes a capacity planner
TYPE III: Full fledged production control system.
It links MRP to MRPII.

It can be seen that one may start out with a Type I system and in time upgrade to a Type II or Type III system. This paper will deal with a Type II system. A Type II system includes a capacity planner which verifies plant capacities. The DCD system being installed at Teledyne Adams is a Type II. This provides a closed loop control system. The American Production and Inventory Control Society defines closed-loop MRP as:

"A system built around material requirements planning and also including the additional planning functions of Production Planning, Master Production Scheduling, and Capacity Requirements Planning. Further, once the planning phase is complete and the plans have been accepted as realistic and attainable, the execution functions come into play. These include shop floor control functions of Input-Output measurement, detailed scheduling and Dispatching... The term "closed-loop" implies that not only is each of these elements included in the overall system but also that there is feedback from the execution functions so that the planning can be kept valid at all times." (APICS Dictionary. Falls Church, Va. American Production and Inventory Control Society, 1984. p 4)

The DCD Shop Floor Control system falls into this category. The DCD system is a PC (network) based production planning and control system. This system concentrates on the following four functions of a production system:

1. Master production schedule
2. MRP
3. Capacity planning
4. Shop Floor Control

Other production planning functions DCD handles include:

- Engineering and manufacturing database. Data needed to make components and assemble products. Production design, component material specifications, and bill of materials.
- Inventory management. Concerned with keeping investment in raw materials, work-in-process, finished goods, plant supplies, keeping spare parts stock low.
- Purchasing. Places orders specified by MRP system. Qualify vendors and keep a supply of sources for parts and components. (1) For details refer to Figure 2.2

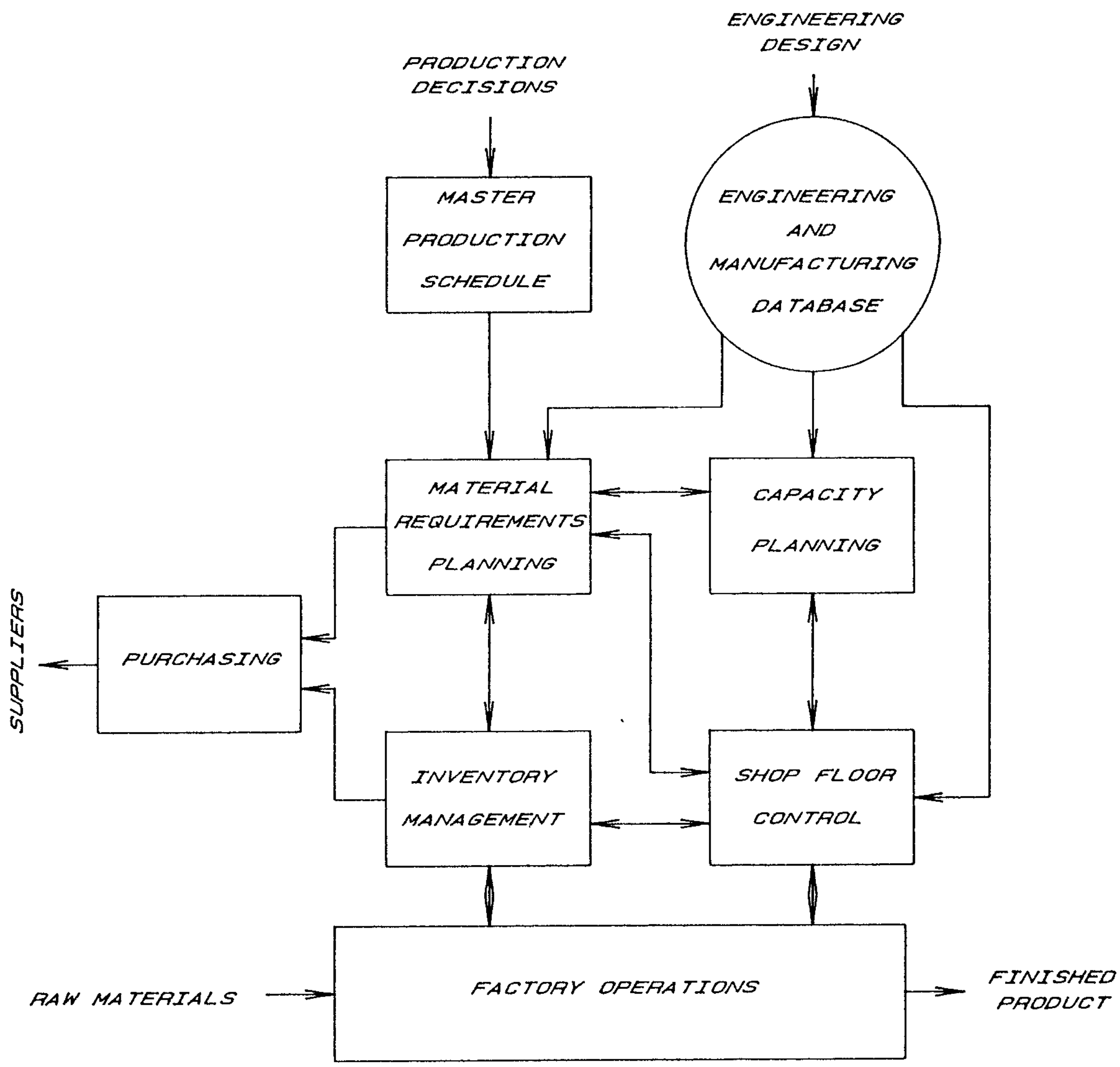

FIGURE 2.2 TYPICAL PRODUCTION PLANNING & CONTROL SYSTEM (1)

CHAPTER 3

MATERIAL REQUIREMENTS PLANNING

3.1 Introduction

The term MRP stands for material requirements planning. There are genuine MRP systems and psuedo-MRP systems. See Figure 3.1. Certain companies do some form of material requirements planning without having a real MRP system.

The common objective of all MRP systems is to determine the gross and net requirements for discrete time periods for each inventory item so as to generate the information required for the correct action or reaction.

MRP causes fear in the hearts of many uninitiated manufacturers. These fears arise because, there are several misconceptions. MRP is not complicated. It does not require a long time to implement and does have disastrous results. MRP systems are not costly. The fundamentals of MRP known intuitively to all manufacturers, small or large.

The simplest way to illustrate how easy MRP is, really, is through the use of an example. In Tooling & Production's July 1989 issue, "MRP was made easy".

"Let's take an imaginary Mr Jones, who owns the $5 million Widget Mfg. Co. He's convinced that MRP is far beyond his capabilities . Listen to how he responds when I ask him this question: " If I order 500 widgets today, could you deliver them in eight weeks?"

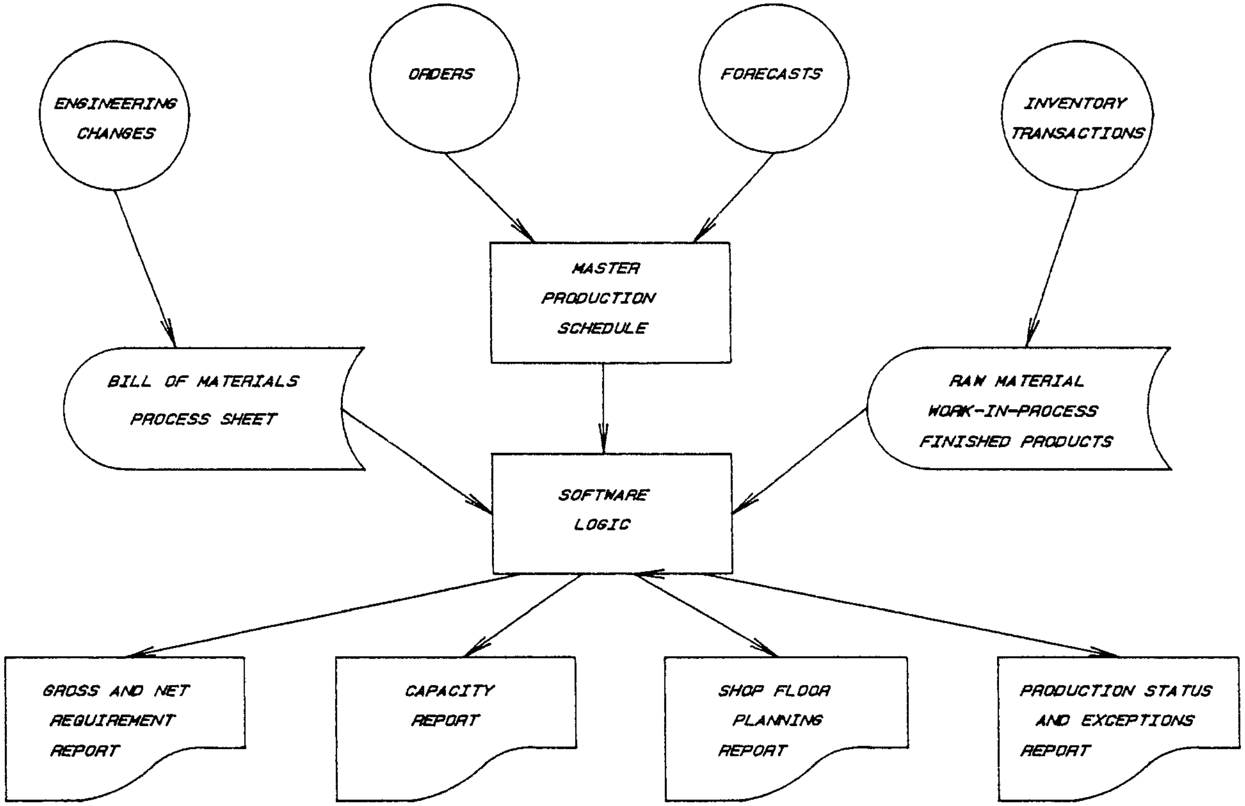

FIGURE 3.1 TYPICAL MRP-BASED PLANNING SYSTEM STRUCTURE

After some thinking the answer comes back, "Yes. I could deliver them in seven weeks."

"And how did you come to that conclusion?" I ask.

"Well," replies Jones, "I've got 200 on hand, so I still need to make 300. They'll take about a week to build. But I haven't got enough subassemblies to make 300 widgets, so I need to make some of them, and they will take about two weeks.

"Today, I'll order components that take about four weeks to get before I can build the subassemblies. So altogether, it will be about seven weeks to complete the order."

Without knowing it Mr. Smith has just performed MRP."

The example used was simple, but the logic remains the same for an assembly of a hundred components. Also, Mr. Jones did approximate the times. It also was one finished product, the company may produce several hundred. One should be able to see that the logic is not complex. The amount of data that makes things difficult. (2)

MRP's methodology is based on the answering of the following questions (2):

1. What do I need to make?
2. When do I need to make it?
3. What do I need to buy?
4. When do I need to make it?

Four of the seven questions addressed by a production control system are accounted for by MRP.

3.2 MRP's Purpose

MRP systems are capacity-insensitive. This means that the system might call for the production of parts for which there is not sufficient capacity. Although, the system is really determining what capacity is required for the given production schedule.

MRP, if used properly, can be a highly effective tool in managing manufacturing inventory. These reasons include (3):

- Inventory costs can be held to a minimum. This can lead to Just-In-Time program.
- A MRP system is sensitive to change and reacts to such.
- The system can foresee any inventory problems which may arise in the future.
- Under MRP, inventory is controlled by actions rather than clerical bookkeeping.
- Quantities ordered are directly related to requirements.
- Timing is emphasized for requirements and coverage.

Because of its emphasis on timing, the system can generate outputs which serve as inputs to other area systems such as logistics, purchasing, shop scheduling, dispatching, to name a few. A good MRP system can form a foundation for other computerized functions in production and inventory control.

3.3 Time Phasing

The importance of up-to-date information or data must be stressed in the production environment. In an MRP system the data has a time component related to it. The calculating module in an MRP system looks at all the demands in the system. Then the program takes into account when the demands are scheduled, and how the due dates are spread out over time. This is called time-phasing. Time phasing is the incorporation of the time dimension to inventory data, by associating dates or time periods to the respective quantities. The classic inventory status equation is as follows:

$$A + B - C = D$$

where: A = quantity on hand

B = quantity on order

C = quantity required

D = quantity available

The quantity required is derived from either customer's orders or a forecast. If the availability is negative, coverage is lacking and an order would have to be placed. This answers the question of "what" and "how much". However the crucial question of "when" remains unanswered. This question breaks down into several:

- When is the quantity on order due?
- Are there multiple orders?
- When is the order actually required?
- Is the order needed all at once?
- Will a stockout occur? If so, when should it be replenished?

Before, these questions could not be answered, and the inventory planner had to depend on his own estimates, guesses or on rules of thumb. (3)

Time phasing is the development of the information on timing which answers all of the above questions. The data might be shown as follows:

On hand: 30	week: 1	2	3	4	5	6	7	8	9
Open orders due:	0	0	0	0	25	0	0	0	0
Quantities req'd:	0	20	0	35	0	0	0	0	10
Available:	30	10	10	-25	0	0	0	0	-10

In the fifth week, there is an open order for 25. In weeks two, four and nine, there are demands for quantities of 20, 35, and 10, respectively. The replenishment order need not be completed until week nine. This shows the latest release for that order. In this case the time phasing also shows that there is a stockout in the fourth week. The inventory planner sees the shortage before it actually happens, four weeks in advance. Therefore, he can reschedule the open order to be completed one week earlier.

The burden in maintaining all the time-phase data is tremendous. Unlike non-time-phased data, there are more elements to be concerned about with time-phased data, quantity and timing. Here is a classic computer application where the processing of large quantities of data is performed quickly and efficiently. Without a computer, the data manipulation is manually impossible. (3)

3.4 Prerequisites

Present-day MRP systems are based on certain fundamental assumptions which yield several prerequisites. These prerequisites are as follows:

- A master production schedule
- A bill of materials
- Each item has its own unique part number

- A process plan
- Inventory records
- Technically correct data
- Known lead times
- All the items in the assembly are available to be released to the factory for assembly.
- "Discrete disbursement and usage". This means the exact amount ordered is the amount required and the exact amount used.
- Process independence. This is where two parts are to meet at a certain operation for a mutual setup or process. An MRP system would have to be adapted for so-called mating part relationships. (3)

The above assumptions and prerequisites question the applicability to a given type of manufacturing. Even when most of the above requirements are not met, management can modify those things which do not fulfill the requirements. For instance, part numbers can be created, a bill of material can be drawn up, and file data integrity can be maintained. Whether or not the preconditions exist is a question of management practice rather than the type of business. It is clear that the application of MRP methods is generally limited to discrete process manufacturing. Material requirements planning can be said to be primarily a "component fabrication planning system". MRP can be used by anyone who is capable of having a master production schedule.(3)

3.5 Master Production Schedule

The master production schedule is a chart which displays what products are due for delivery. Although it may be extremely large for certain companies, the schedule is simply a calendar. Figure 3.2 shows the simplicity of the chart. The main objective is to assure that the plant satisfies customers by meeting delivery schedules. The master production schedule (MPS) answers the following basic questions:

- What is to be produced?
- How many to produce?
- When is delivery required?

The master production schedule is one of the three main inputs to a MRP system. The other two, inventory status and bill of materials, supply reference data. The MPS contains the input which drives an MRP system. All manufacturing companies have master production schedules in one form or another, although it may not be expressed in a formal document. For an MRP system, a formal document is a

PRODUCT	1	2	3	4	5	6
A	300			250		150
B		100		250	100	
C		450	100			200

FIGURE 3.2 SIMPLE MASTER PRODUCTION SCHEDULE

necessity. (3) For MRP, the time period of the schedule must be the same as those used in the system, usually in weeks.

The planning horizon is the period of time which the master production schedule covers. The planning horizon ranges from 2 weeks to 12 months. This span may be divided into a firm and a tentative portions. The firm portion represents the items already committed to production, while the tentative are items planned in the future. (3)

Two types of functions directly relate to the firm and the tentative portions of the MPS, short and long term. Short term functions include the basis for MRP, production of component-items, establishing order priority, and planning of short term capacity requirements. Long term functions include estimating long term demand on the company's resources. Although the firm portion is required in order to release orders, it provides visibility in the future on an item-by-item basis. The MPS is updated monthly. The reason for the monthly updating is so that the schedule can be easily coordinated with the forecasting cycle, which is usually in months. However, occasions do arise where various unplanned developments incur the need to revise the schedule between the planned revisions. It is highly desirable for the MRP-based (PP&C) system to be able to update on a more frequent basis than the forecasting cycle. The system loses its effectiveness if it is not used to replan at least once a week.

3.5.1 Master Schedule Development

There is no standard method in developing a master production schedule. However, referring to Figure 3.3, there are a number of logical steps which can serve as a guide in developing a schedule. Modifications can be made accordingly from company to company or from the different types of manufacturing. The MPS is basically a report of the future load on a company's resources. The load is derived from requirements put on the plant, which must satisfy the demand of particular products. The MPS draws its product demand from three sources. The first source is customer orders. These are the typical orders which are promised to the customer for a particular date. The second source is forecasted demand. The forecasts may be based on statistical methods or sales estimates. For certain industries, the MPS is primarily derived from forecasted demand. The third source is demand for component parts. These components are used for service parts and are usually made to stock. This category may be excluded from the MPS. (1)

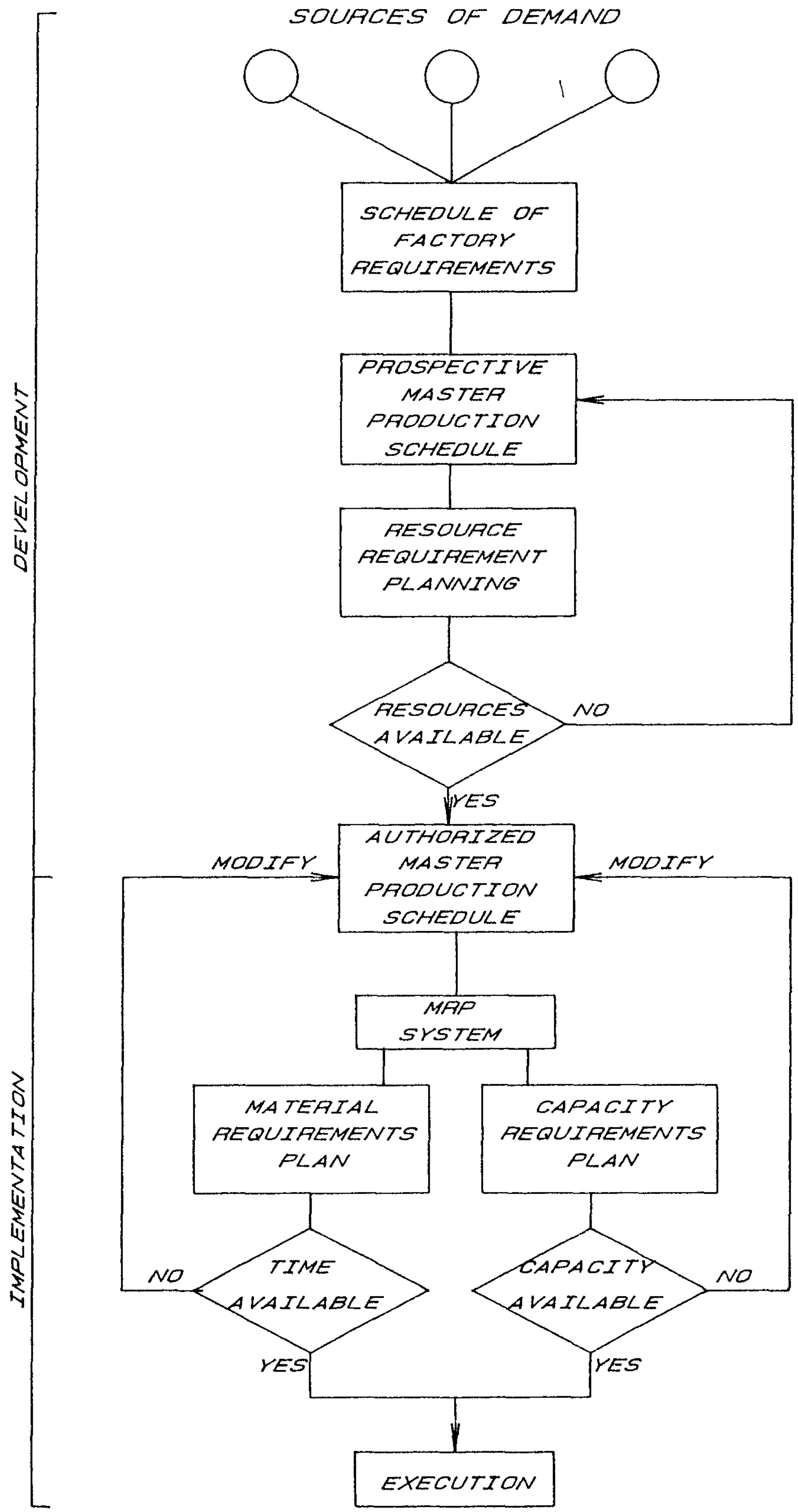

FIGURE 3.3 MPS DEVELOPMENT AND IMPLEMENTATION (3)

3.5.2 Making A Feasible Master Schedule

The master production schedule must be realistic. Before MRP and computers the schedule could not be monitored easily. The schedule was a goal that the plant attempted to reach but never fulfilled. Thanks to closed-loop MRP, a master production schedule can be realistically formulated. It is also accurately monitored and thus, may be adjusted accordingly. Today, the MPS is a closed loop system, having inputs and feedback.

3.5.3 Management And The Master Schedule

It has been suggested that the master production schedule be automated and control given completely to the computer. This includes preparation and maintenance. However, the schedule is the plan of production from which all planning is derived. All actions and reactions cannot be left to a computer program. Management still must make the decisions and initiate changes in production. Nonetheless, research in AI has recently been aimed towards production control functions. The schedule only provides direction. This demonstrates that the MPS is not a goal not subject to change, which can be overambitious and unrealizable. The schedule should be feasible, flexible, adapting to changing conditions. With a MRP system an inflexible master production schedule will produce invalid capacity planning. (3)

3.6 Configuring A System

The production control methods used are based on the machine technology base and the way production is organized. This is performed by the use of a database. This database details the product, its manufacturing processes required, and the flow of the product in the production system. The main sources for this information are:

1. Bill of Materials
2. Production Routing Sheet
3. Process Plan
4. Standard Time
5. Standard Cost Database

How the system is tailored affects the system's effectiveness. It is critical how the system is configured with respect to the following six setup parameters:

Planning Horizon Span

Obviously, too short of a planning horizon will cause problems. The timing of releases for low level items may be such that they would have to be released some time before the present. See Figure 3.4. Other problems include the inability to apply lot-sizing techniques which can incur unnecessary costs because of insufficient net requirements data. Also, because of the lack of visibility, the capacity requirements planning will yield inaccurate load reports. (3)

Size of the Time Bucket

The time-bucket size selected by the user can affect timing. Since the MRP system is based on timings of releases/orders, having too course (long) of a time-bucket will yield imprecise results. For example, one month periods are too course when orders are based on monthly requirements. On the other hand, having too small a time-bucket would produce a large number of data elements which would have to be processed by the system. The size selected must be compromised. A one-week bucket size has been found to be practical for most manufacturing firms. (3)

System Coverage of Inventory Classes

The ABC classification system was developed to reduce the computational burden of accounting for inventory. Its logic is based on Pareto's law, "The vital few and the trivial many". This system arranges inventory so attention

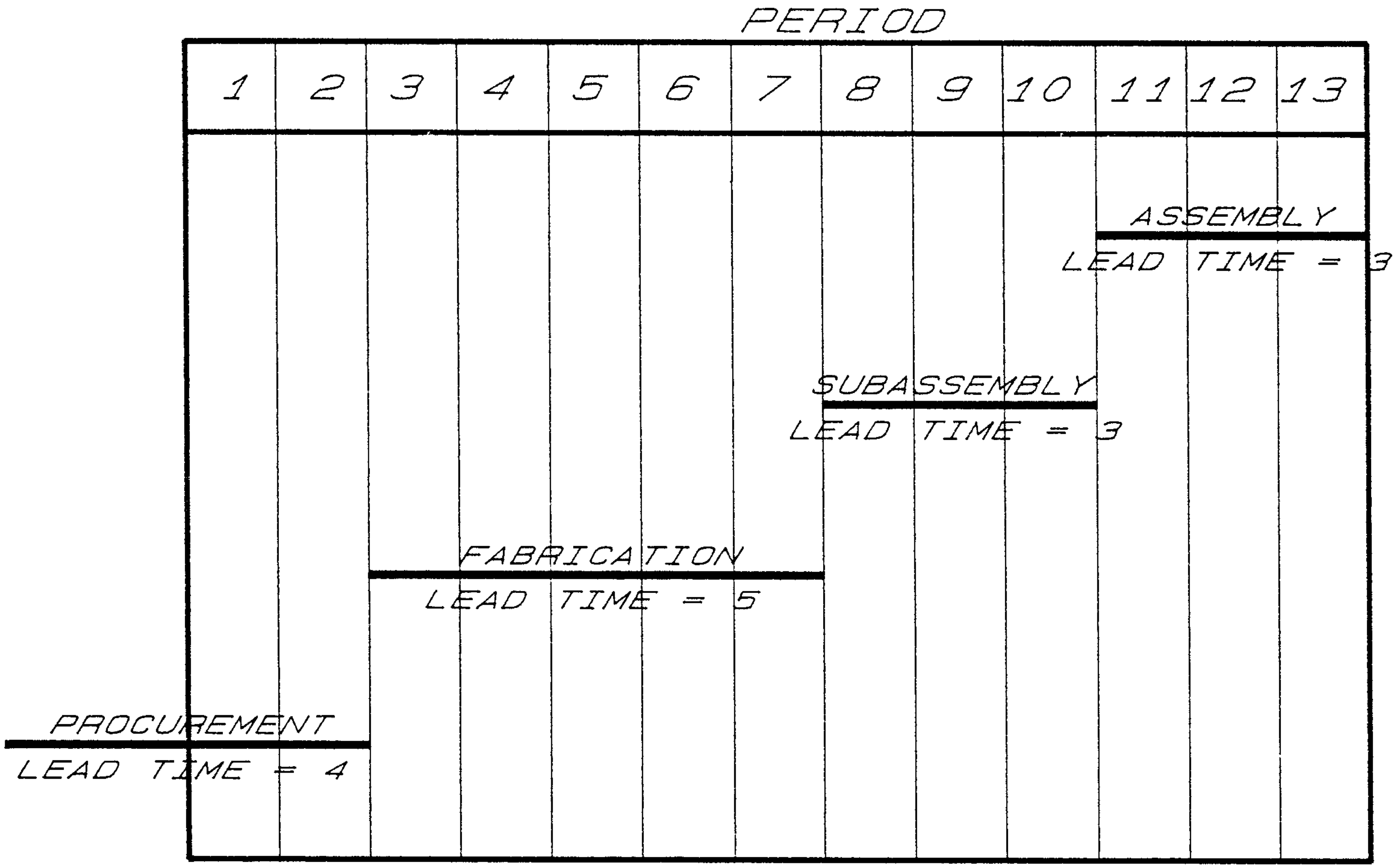

FIGURE 3.4 PLANNING HORIZON AND CUMULATIVE LEAD TIME (3)

is focused on the higher priced items. The following is a typical breakdown of the classes:

Class A: Top 50-60% of investment containing 5-10% of items

Class B: Next 25-40% of investment containing 20-30% of items.

Class C: Final 5-15% of investment containing remaining 60-75% of items.

One can see that most of the inventory investment lies in a small percentage of the items. So to control inventory costs the system concentrates on the higher priced items. By having tight control on 30-40% of the items, over 75% of the investment is controlled. See Figure 3.5. The classes also dictate the stringency of the control for the classes. Class A has strict control while class C allows overstocking. This safeguards against the possibility of delaying production because of not having a low cost component in stock.

Replanning Frequency

The frequency of the replanning determines the "up to dateness" of the system. The replanning frequency is one of the most important factors in the system's performance, especially when priority planning is used. The more dynamic the environment the more often replanning should be

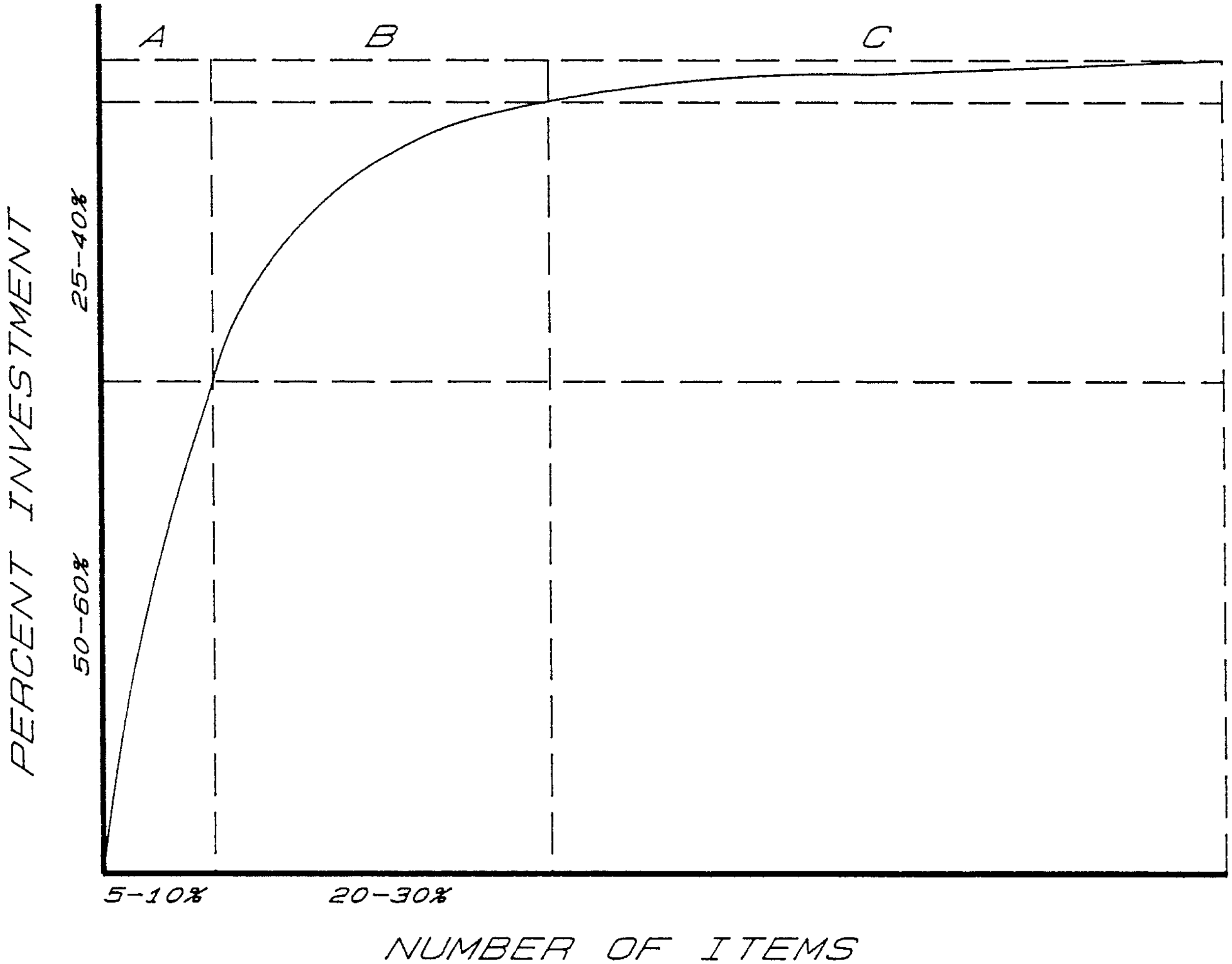

FIGURE 3.5 ABC CLASSIFICATION

performed. Most MRP systems replan cyclically rather than continuously. Therefore, the inventory status is actually a photograph at that particular moment in time. The validity gradually deteriorates the moment after replanning is performed. If it is not done frequently enough, priorities become invalid making the load projection invalid. (3)

Pegged Requirements

The pegging of requirements is the ability to trace an item's gross requirements to its sources. This should not be confused with a where-used file, since there is one distinctive difference. The normal where-used file lists all parent items which uses the item. The pegged requirements file lists the parent items for which their are orders. It also reports the specific orders from which the requirements originate. (3)

Firm Planned Order

This is the ability by the system to freeze the quantity and/or the timing of a order release. The schedule is revised as net requirements change. This results in moving orders around and perhaps changing their quantities. Sometimes this occurs several times before the order is ready for release. By establishing a firm planned, order the system must work around that order. This capability usually is available in all MRP systems. (3)

3.7 MRP Inputs

An MRP system is a valuable tool in reporting needed production information. This is accomplished through the information it can output. However, this is only possible when certain information is inputted. Figure 3.6 demonstrates these inputs. (3)

Master production schedule

As discussed previously, this schedule is the overall plan for production. It only specifies end items, which are shippable finished products or high-level sub-assemblies which are used later in varying configurations.

Miscellaneous Orders

These orders originate from sources outside the plant. This includes service part orders, interplant orders, original equipment manufacturers (OEM) orders. The system treats this category as additions to the requirements of the specific component parts.

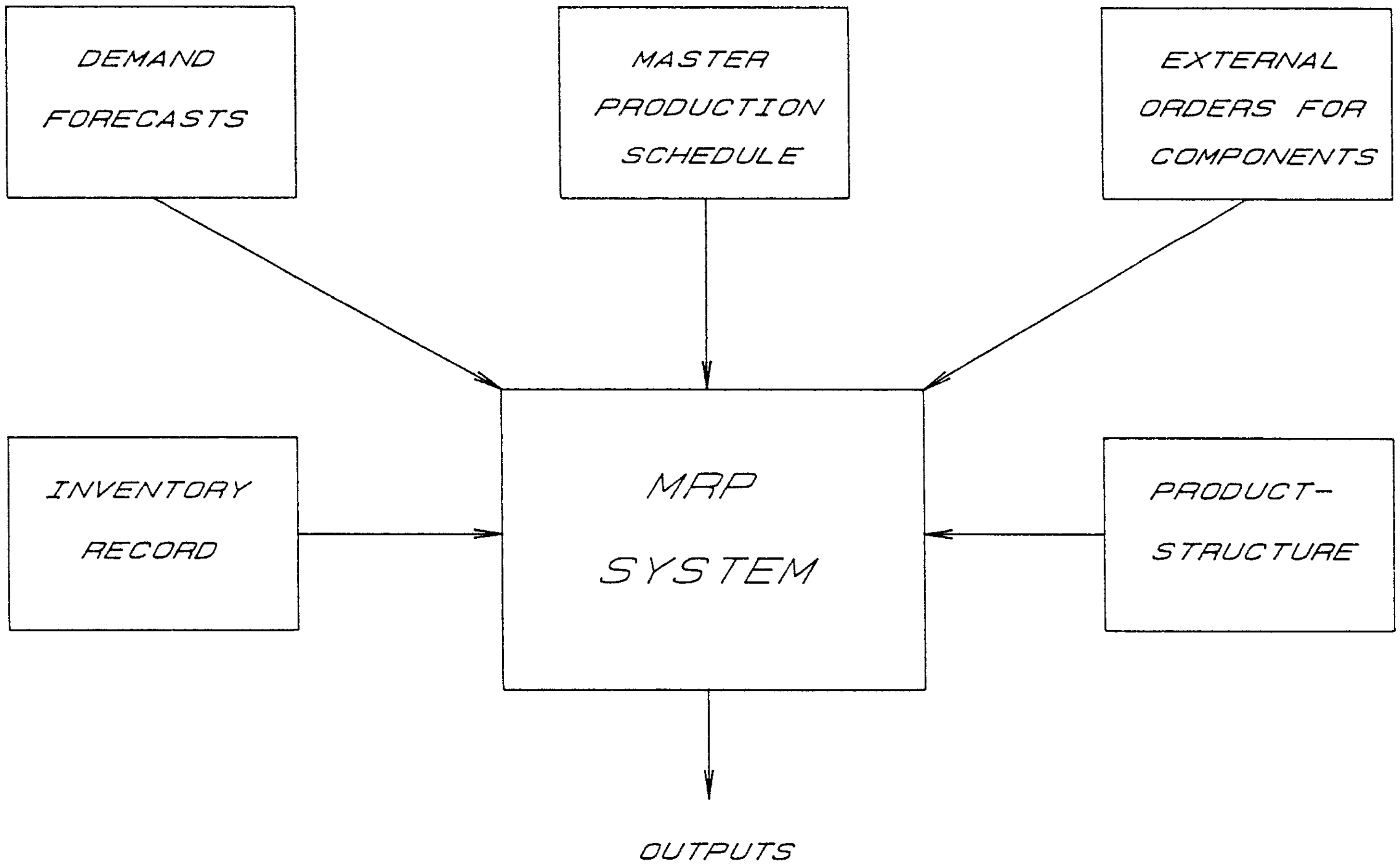

FIGURE 3.6 INPUTS TO MRP SYSTEM (3)

Forecasts

Some systems have the capability to generate forecasts. Forecasting, in manufacturing, is an estimate of how much of a particular product will be sold in the future. This is performed by using statistically based forecasting techniques and software.

Part master file

This is made up of the individual item inventory records. The records contain the status data needed for the determination of net requirements. There are records for everything and anything which is assigned a part number, from raw materials to purchased components to subassemblies to the finished product. These records are kept up to date by inputting all inventory transactions, such as stock receipt, scrap, and disbursements.

Bill of Material file

This file is also known as the product-structure file. It contains the information which describes the relationship of components and assemblies. The BOM is not only a listing of all materials, components, and assemblies required for a particular end product, but it also details all the operations and/or processing required for the manufacture of the product. Also, it is possible that the operations are listed separately in a process plan.

Process Sheet (Methods File)

This document details the processes or operations required to produce a specific part. It may be incorporated into the BOM or or as a separate document.

3.8 Computing Requirements

The are six factors necessary for the computation of requirements. (3)

Product Structure

The arithmetic involved in MRP is simple. However, the procedure can become tedious when an item can exist as a raw material, component or subassembly, under its own identifying part number, and it also can be an end product. For example, a gear which is identified by its part number loses its identity when used in a gearbox which has its own exclusive part number. In order to determine the net requirements of a part, first the individual part be accounted for. Then all other quantities required for other subassemblies and/or end products where the component part is used also must be included. The task becomes more tedious when more levels of the product are involved. A level is defined as each stage required in the manufacturing process where a "material" is converted into product. In other words, when labor is performed on raw materials or a component before putting it into a subassembly for further operations it is "moved up" one level. See Figure 3.7.

The bill of materials lists all materials, components, and labor to produce a part. Any part which has labor associated with it has a bill. For subassemblies and assemblies individual bills are linked together. When this occurs a pyramidlike structure is formed. This structure intrinsically will display the product's levels. The levels are numbered from top to bottom, where level 0 is the final end product. Thus, raw materials will always have the lowest level number for that respective assembly (Note: the lowest level carries the highest number). When the net requirements are to be determined for a low level item, the quantity that is in stock as well as any quantities in work-in-process (WIP), must be accounted for. The following example demonstrates this.

Ordered Quantity	200 transmissions	
On Hand Quantity	Transmission	2
	Gear Box	15
	Gear	7
	Forging Blank	46

Transmissions required	200	
Transmissions in inventory	2	

	198	Net Requirements, Transmission
	198	Gear Boxes required for 198 Transmissions
Gear Boxes in inventory	15	

	183	Net Requirements for

		Gear Box
	183	Gears required for 183 Gear Boxes
Gear in Inventory	7	

	176	Net Requirements for Gears
	176	Forgings required for 176 Gears
Forgings in Inventory	46	

	130	Net Requirements for Forging

(3)

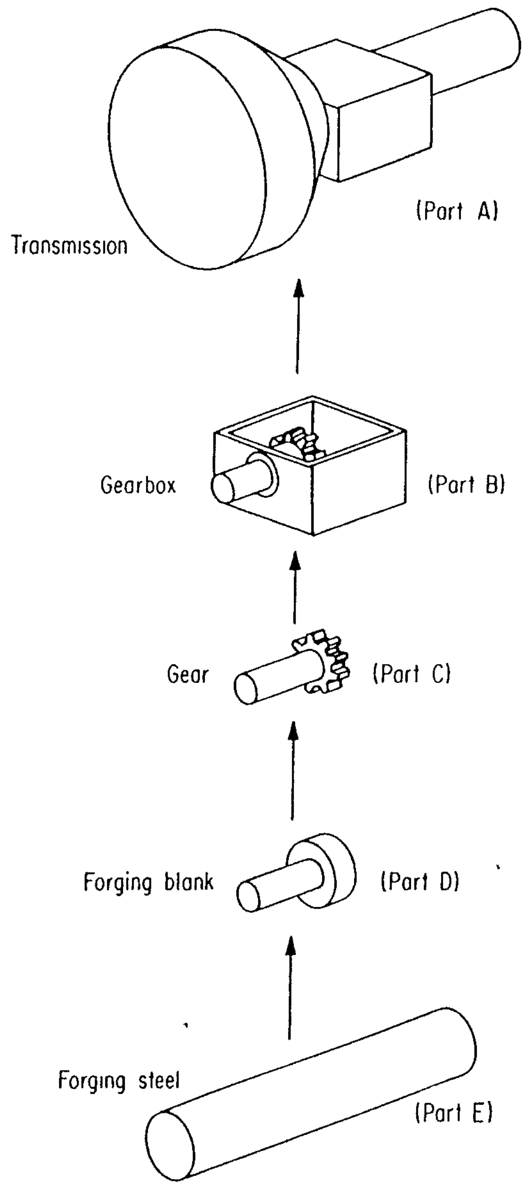

FIGURE 3.7 PROCESSING LEVELS (3)

The procedure was carried from top to bottom, level by level. It "flushed" out the low level item, for example. the forging in its "consumed state, where it hides in higher level items, for example. gear, gearbox, and transmission. This downward progression from one product level to another is known as an explosion.

Lot Sizing

By using lot sizing techniques order quantities must be in multiples. For instance using Fixed Quantity lot sizing method, with multiples of five, a net requirement of 26 parts would require an order of 30. Subsequently any other component item would also be increased as to produce the 30 parts. For a MRP system to carry out such procedures, algorithms which use the respective lot-sizing rules must be incorporated into the requirements computation program. One should note that there are several lot sizing techniques. It is not unusual to have different lot sizing techniques within the system. Criteria such as set up and ordering costs dictate which techniques are best for a given part.

Lead Time of Individual Items

The example in section 3.8 was simplified ignoring among other things, lead times. The item lead times determines the timing of order releases and scheduled order completions. A component-item order must be completed before the parent-item order can be started. The back-to-back lead times of the required items or components make up what is known as the cumulative lead time. If the lead times for the previous example were as follows: Forging, 3 weeks; Gear, 6 weeks; Gearbox, 2 weeks; Transmission, 1 week, then the cumulative lead time would be 12 weeks. See Figure 3.8. If any of the gross requirements can be satisfied from inventory, the timing would be less than the cumulative lead time and therefore, the order would be completed in less time than the cumulative lead time. If the gross requirements could not be satisfied from inventory, the timing of the net requirements would be the same as that of the gross requirements. Lead time values must be supplied to the system. The system then uses these values to figure out the proper alignment of the requirements and planned-order data.

Recurrence of Requirements

The master production schedule usually has a long time span, six months to one year on average. This is very likely that multiple orders are received for a given end part. To determine lot requirements component inventories have been allocated according to their chronological order in the master production schedule. If the sequence of the lots changes, the timing and quantities all must change. In addition, the component net requirements must also change

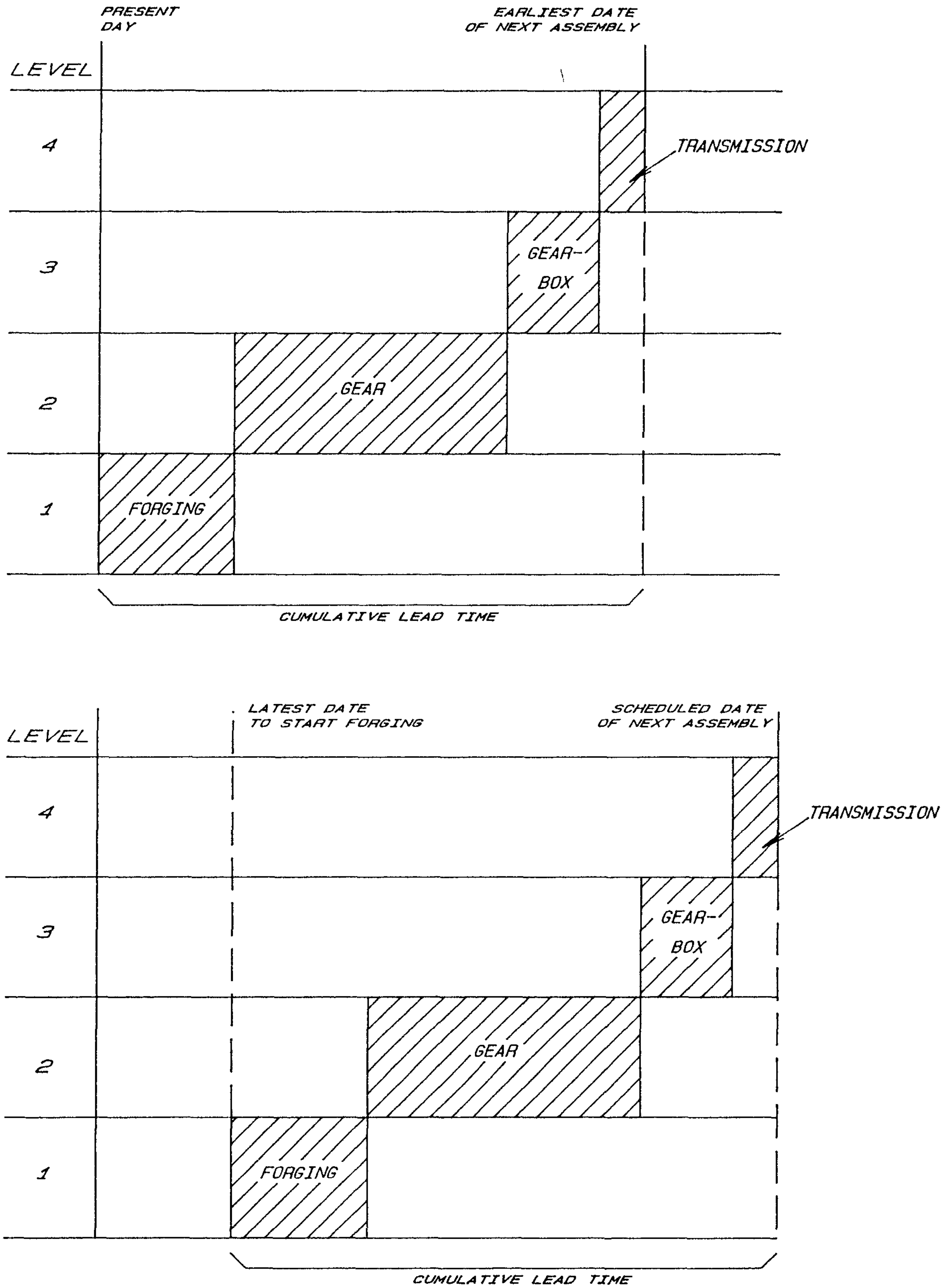

FIGURE 3.8 CUMULATIVE LEAD TIME (3)

because of the redistribution of the on-hand inventories to the resequenced lots.

Common Usage

A component may be used in several parent items. This is another factor which complicates requirements computation. It is not uncommon that many components will be found to have multiple parents. The lower the level the component has, the more parent items it is likely to have. An example of this a common screw used for assembly. See Figure 3.9. In having a common usage item, another complicating factor is that the items' several parents may be on different levels. Since by definition a component item is always on the next level below its parent, if the parents are multi-level so must be the component. There are two possibilities in this case:

1. An item can exist in two separate end parts on different levels. See Figure 3.10.
2. An item can be used twice in the same end part at different levels. See Figure 3.11.

An example of this is shown in the case of the screw which is used in a sub-assembly and further down the line in other assembly operations. This is sometimes handled by using a technique called low level coding. The lowest level at

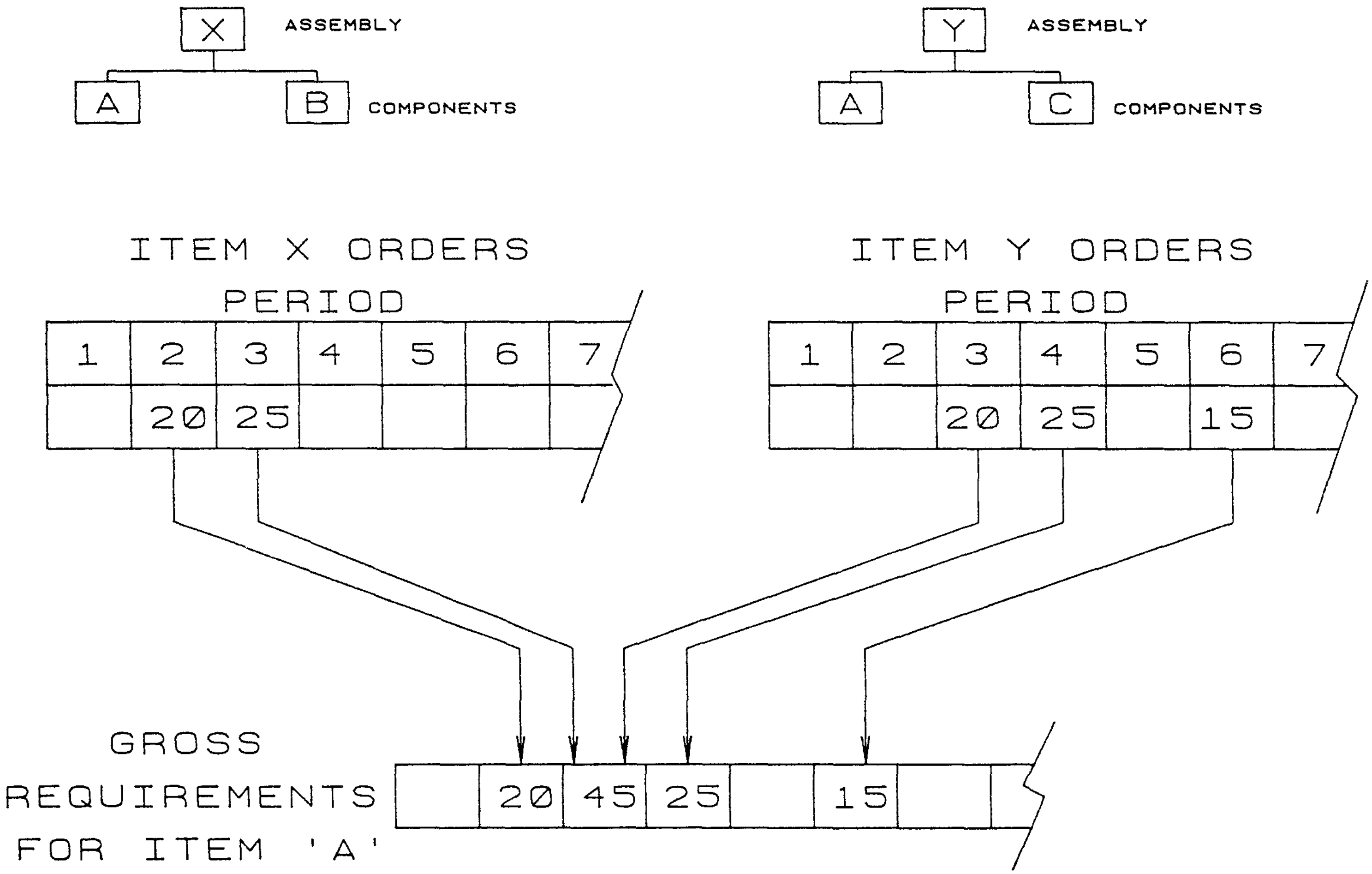

FIGURE 3.9 MULTIPLE SOURCES (3)

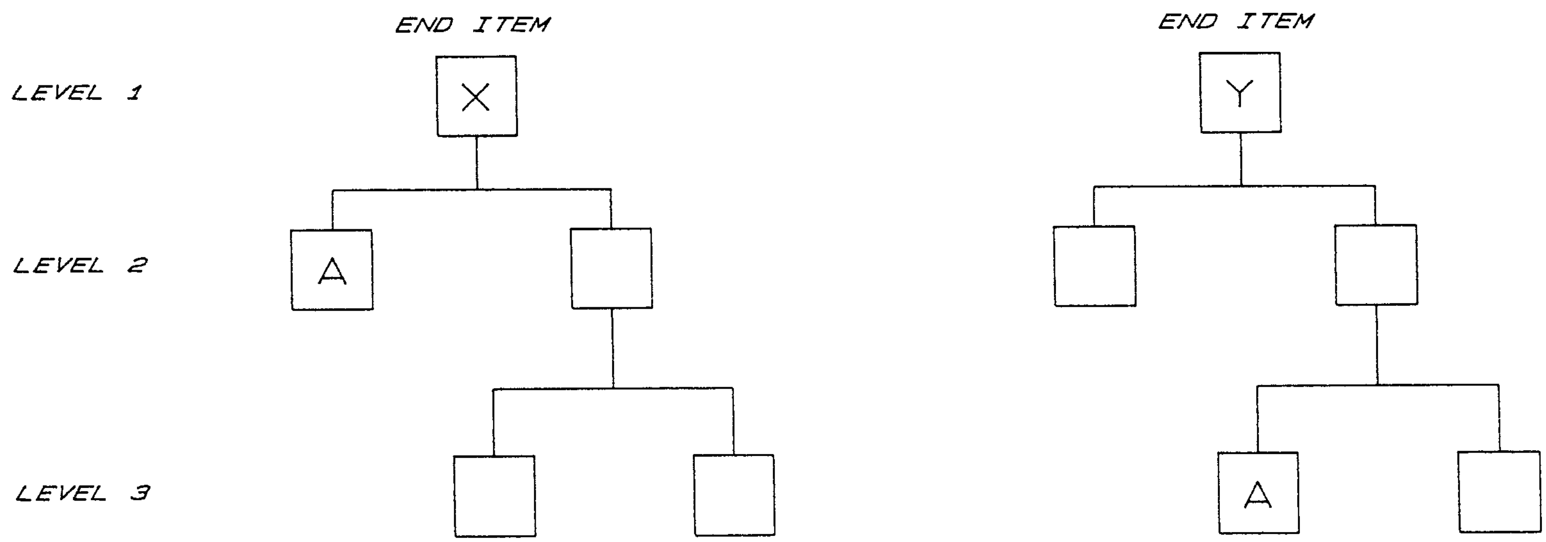

FIGURE 3.10 COMMON COMPONENTS ON DIFFERENT LEVELS (3)

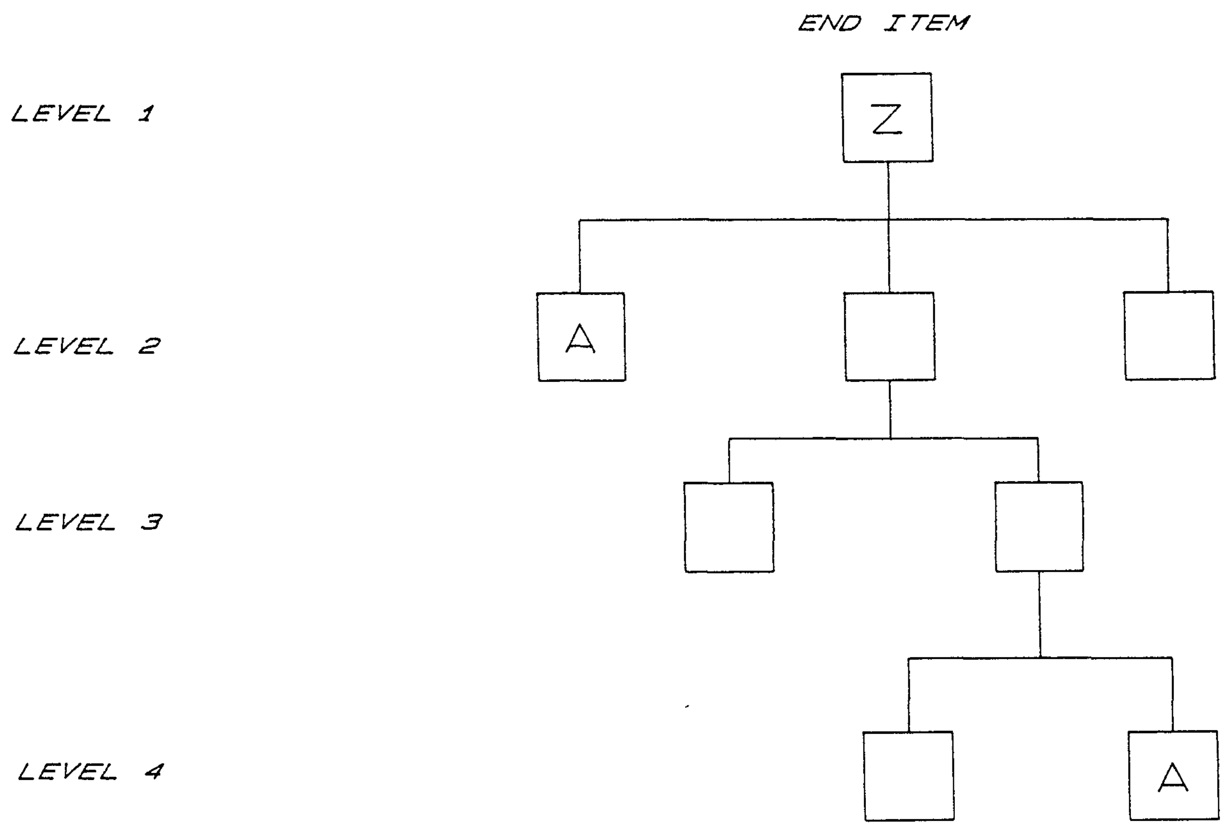

FIGURE 3.11 MULTIPLE LEVELS (3)

which a specific item appears is used as a "standard" level for that item throughout the MRP system. See Figure 3.12. This technique is only advantageous if the benefit of higher process efficiency outweighs the development and maintenance of the low level coding.

The six factors discussed above complicate the MRP process. How each one is dealt with affects the MRP system's effectiveness. In todays MRP systems the above complications are easily handled. The algorithms can trace a component throughout the system's database. A "where-used" report is a compilation of this data.

3.9 MRP OUTPUTS

An MRP system can provide output for other uses which may be used for planning. A system's database holds an abundance of information. By extracting and/or further processing the data, a whole array of outputs are possible. There are six typical outputs which may be found in a MRP system. (3)

Outputs for inventory order action

Inventory order actions are increases, reductions, cancellations and planned order almost ready for release.

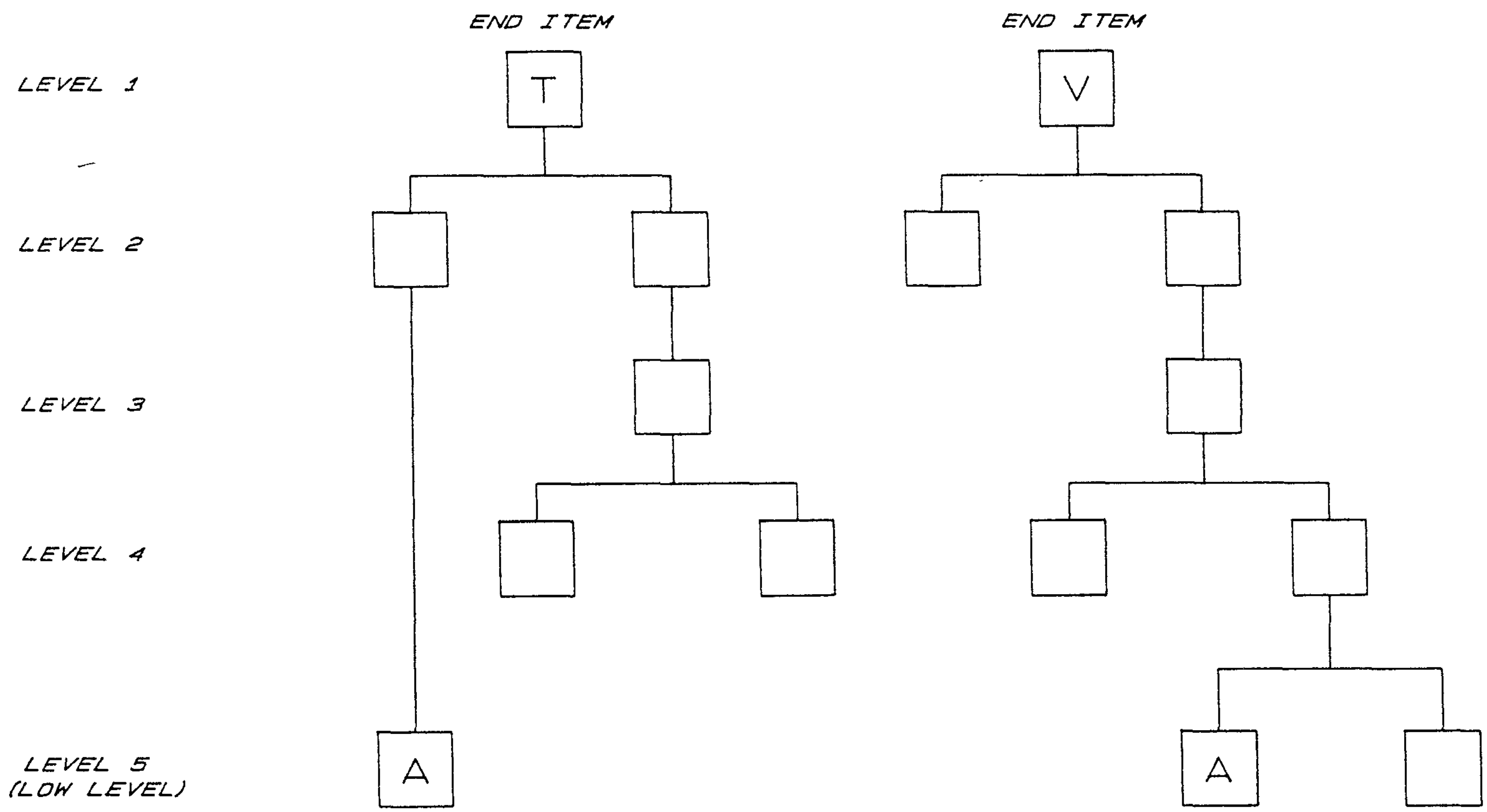

FIGURE 3.12 LOW LEVEL CODING (3)

Outputs for replanning order priorities.

These outputs alert the inventory planner in cases where open due dates and actual date required are diverging. The MRP has the capability to calculate how many time periods: days, or weeks, each item affected should be rescheduled and in what direction.

Outputs to Maintain Priority

These outputs keep priorities in order and honest. Honest priorities can only be achieved when end-item requirements are possible. For instance, sufficient capacity, materials, or lead times are required. These reports can be used in segregating deliveries for specific customers' orders.

Outputs for Capacity Planning

The system has the ability to generate a load report which is detailed enough to allow adjustments to be performed so as to avoid potential problems. It is important to keep the load projection up to date in order to be valid. Capacity planning is discussed in more detail later on.

Outputs Assisting in Performance Control

These outputs allow management to monitor performance of inventory planners, buyers, the shop, and vendors. Financial or cost performance may also be monitored. Two important performance reports generated are load and efficiency reports.

Outputs Which Report Discrepancies

Some of these outputs include dates outside the planning horizon and quantity errors. (3)

3.10 Efficiency Of A System

How effective a system is depends on two factors: the design of the system and how well a system is being utilized. There are not too many customized MRP systems. The designs have become standard as far as functions are concerned. The tailoring of a system is achieved by the user requirements through which (functions) modules the user obtains. In addition, there are certain parameters within the program that must be set up by the user as previously discussed.

3.11 COVERAGE OF NET REQUIREMENTS

A MRP system detects the possibility of a shortage and counteracts by planning coverage so that an actual shortage never occurs. Net requirements are covered by planned orders. Planned orders are orders which are scheduled for release in the future. The lead time for planned orders may have a safety lead time added to the end of its regular lead time. This serves the purpose of completing an order ahead of its required date. This, of course, inflates the lead time artificially. (3)

Safety stock planning obviously affects the net requirements calculation. The safety stock quantity is either subtracted from the on hand quantity or added to the gross requirement. Either method produces the same end result, increasing the net requirements. In MRP, when safety stock is added, the system's logic tries to protect and conserve the stock from being used up. This "protection" will always ensure that the quantity is on hand. It creates dead inventory that is carried but never used. Safety stock forces the MRP system to overstate the requirements, which leads to distorted timing. It does not really have a legitimate reason to be in a MRP system. Safety stock's primary purpose is to compensate, or anticipate fluctuations in unforeseen demand. Forecasting errors are such unforeseen circumstances. However, in a MRP system demands on individual components are derived from master production schedule not from forecasts. Safety stock should only be carried for purchased items. This stock should also be constantly rotated. This is especially important with perishable items. It usually is not advisable to carry WIP safety stock since not only would the material inventory be lost but also labor.

CHAPTER 4

CAPACITY PLANNING

4.1 Introduction to Capacity Planning

An MRP system is concerned with having sufficient materials in order to meet customer requirements through the master production schedule. Having all the materials in the plant does not guarantee that the production schedule will be satisfied. A plant's resources are not infinite. Capacity planning verifies the availability of the plant's resources. This planning introduces reality into the production control system. The real world places constraints and limitations on the plant. Some of these limitations include (4):

- Varying output levels from different machines
- Availability of secondary resources
- Required product sequencing
- Product families that are always produce together
- Limited storage space
- Tightly coupled processes

A capacity plan links the MRP system to the production floor via a two step plan. The first step, is the long term portion which checks the feasibility of the proposed production schedule. The second, is the short term portion which fine tunes the plan and adjusts it to the present environment. These two portions are known as resource requirement planning and capacity requirement planning, respectively. See Figure 4.1.

4.2 Resource Requirement Planning

Consideration must be given to the load a master production schedule places on a plant's resources. A plan should be drawn which increases and decreases the resources when needed. That is the purpose of resource requirements planning, (RRP) also referred as rough cut capacity planning (RCCP). In order to plan, management needs to define the resources to be considered. What is considered a resource varies. For example, a resource can be cash, floor space, capital equipment, or engineering. Resource requirement planning's main purpose is to evaluate the load on the master production schedule at the management level. (5) This translates to evaluating the load on the plant or specific departments. One often neglected aspect are the resource requirements placed on the plant from salvage and rework. As much as one does not design products or

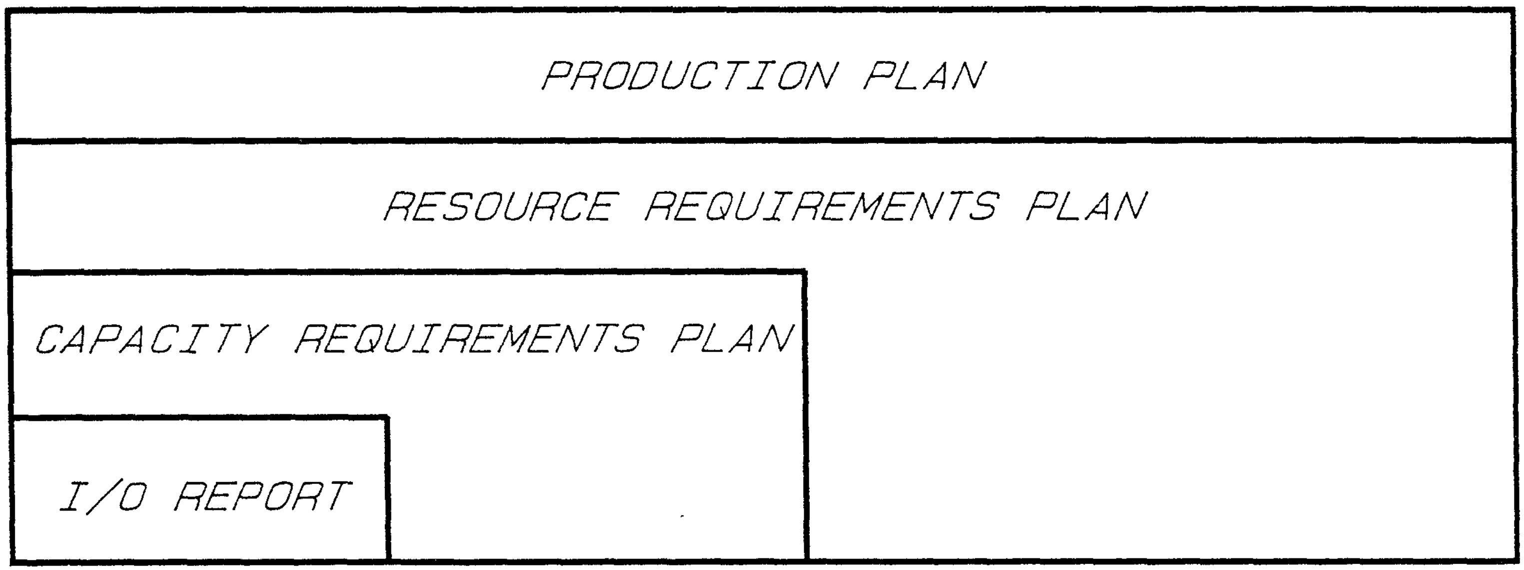

FIGURE 4.1 CAPACITY PLANNING HORIZONS (5)

processes to yield such rework, it is a reality. Rework requires extra labor which takes away from the labor planned for normal production. No one knows the amount of rework which will be required in the future. For planning purposes, a percentage is factored in based on historical data.

The load for a specific product is based on the assumption that the load profile is the same if based on one unit or the entire lot, as long as the profiles are measured in consistent units. The profiles may be computed for the total fabrication or for a single resource.

Load profiles may be extended by quantities and summarizing them by product. See Figure 4.2. This report, which is known as the resource requirement profile, shows the effect of what is on the master production schedule over the entire planning horizon. The loads are also graphed by lots to show potential capacity problems.

If a load report shows potential capacity problems, the schedule is changed or certain resultant actions are taken. These actions include purchasing new equipment or plants if overloaded or closing a plant if underloading. This is usually performed by trial and error. The MRP system has the ability to process any master production schedule and produce its respective load report. Thanks to computers, many possible master production schedules may be sampled in a short period of time by using "what-if" analysis.

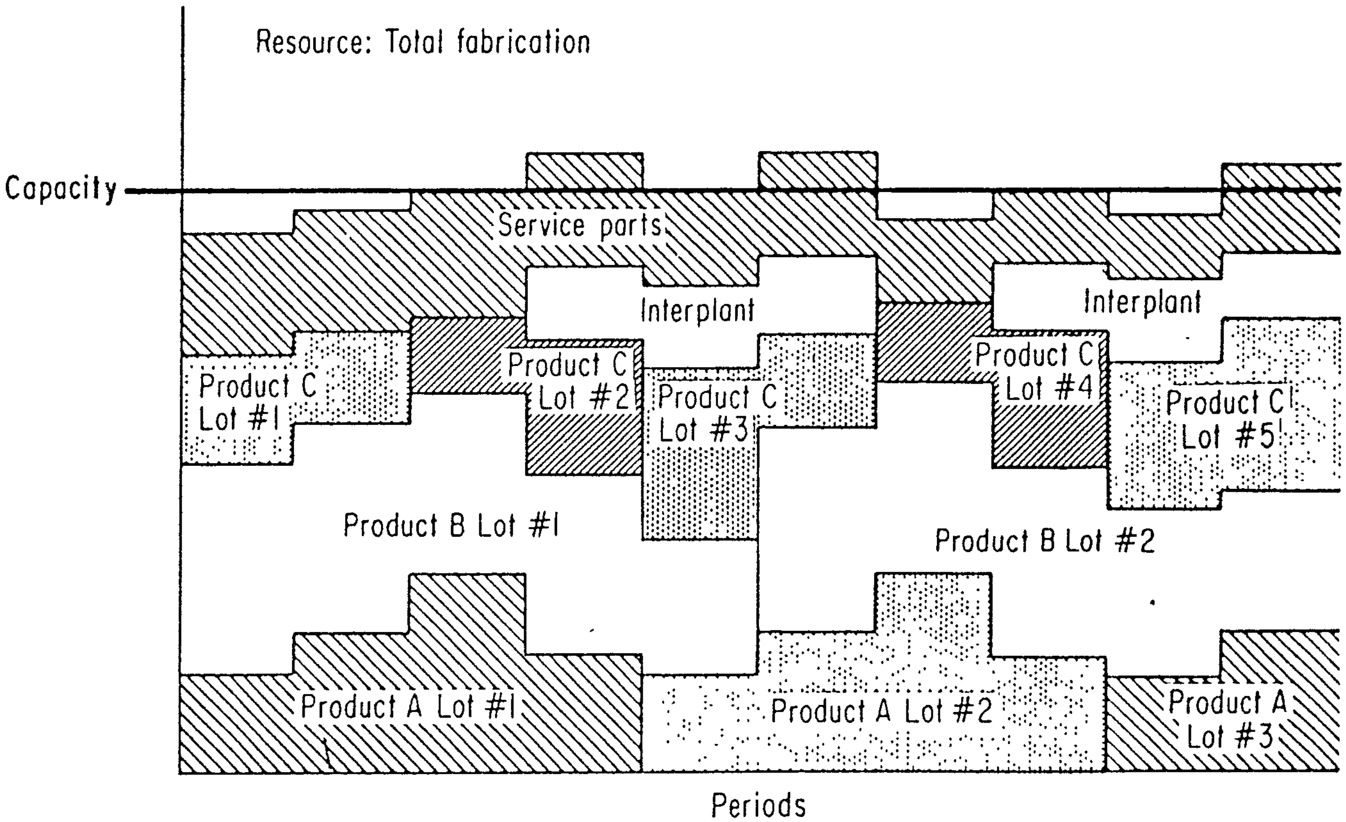

FIGURE 4.2 RESOURCE REQUIREMENT PROFILE (3)

Once a plan is accepted a feasible master production schedule is chosen. The schedule chosen roughly fits capacity constraints. Short range capacity adjustments may be done. This is the function of capacity requirements planning (CRP).

4.3 Capacity Requirements Planning

As stated previously, MRP system is not sensitive to capacity. Its only function is to determine what materials and parts are required to produce what is on given master schedule. However, the system output can be converted to yield machine or work load. This function is known as capacity requirements planning. These results can help answer some of the following daily operating questions (3):

1. Is overtime needed?
2. Should we transfer people or work from one department to another?
3. Should any work be subcontracted?
4. Is another shift required?
5. Hire more people?
6. Should the hours per shift be increased?
7. Should inventory be stockpiled?
8. Can order backlogs be tolerated by customer?

The load report has been the traditional tool used to answer the above questions. It is generated by the scheduling and loading algorithms in the systems. Each required part is broken down by its required operations. Then machines and/or work centers are loaded. See Figure 4.3. These load reports differ from those of the RRP. While the later shows departmental or plant loads, CRP loads are concerned with specific machines.

As previously mentioned, CRP and RRP produce load reports which show potential problems. CRP handles the reporting of the discrepancies on a day to day basis. However, if such a problem keeps recurring, then the cause may be at a higher level. This would lead to replanning the resource requirements plan. (3)

Demonstrated Capacity: 500 Standard hr/wk.

Week	*Hours*	*0%* *100%* *200%*
Past due	150	XXX*
9/15	550	XXXXXXXXXXX
9/22	600	XXXXXXXXXXXX
9/29	500	XXXXXXXXXX
10/6	400	XXXXXXXX
10/13	550	XXXXXXXXXXX
10/20	250	XXXXX
10/27	150	XXX
11/4	850	XXXXXXXXXXXXXXXXX

* X = released order load; X = planned order load.

FIGURE 4.3 SAMPLE LOAD REPORT

CHAPTER 5

SHOP FLOOR CONTROL

5.1 Introduction to Shop Floor Control

In a production control system, shop floor control is the vital link to the production floor. This "subsystem" known as the shop floor control system (SFCS) in one of the most underemphasized elements in production control. (6) A SFCS is the entrance point for all manufacturing operations data. This data is used to compare the status and progress of production to the predetermined plans. If discrepancies occur between actual and planned performance, then changes are to be made to the CRP or MRP generated plans. The other control (sub) systems, for example. MRP, CRP, quality control, maintenance, require accurate and prompt feedback on current performance. The SFCS must route current and pertinent data to the higher levels of the production control and planning system. (7) The data is used to generate reports which measure performance. Some of these performance measures include:

- Actual labor hours consumed
- Material used
- Set-up time required

- Actual completion date
- Rework and scrap quantities

5.2 Phases of a Shop Floor Control System

A typical SFCS consists of three phases, as shown in Figure 5.1. (1) These phases are as follows. The first is order release. In this phase the documentation required to process an order through the plant is produced. This group of documents is known as a shop packet. The documents in a shop packet include:

- Route Sheets
- Material Requisitions
- Job Cards (to report direct labor and job progress)
- Move Tickets (to authorize transport between workcenters)
- Part Lists (for assembly)

Through the use of computers and other automated methods, some of the paper documents become unnecessary. As shown in Figure 5.1, the release or an order requires two inputs: The authorization to produce and the engineering and manufacturing database. The authorization comes from the master schedule. The database is made up of BOM's and

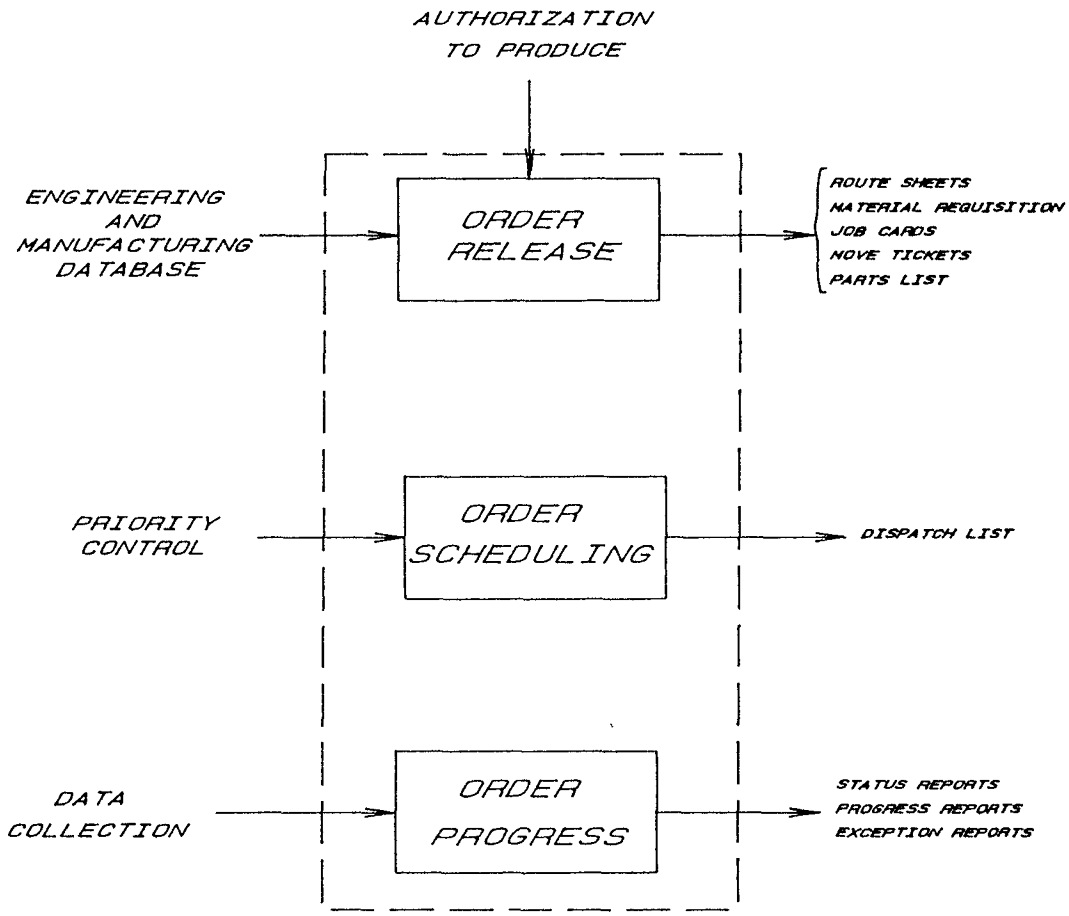

FIGURE 5.1 PHASES OF SHOP FLOOR CONTROL SYSTEM (5)

process plans. Both of these inputs are necessities for the MRP system.

The second phase is order scheduling. Its main concern is to assign or dispatch the orders to workcenters. Order scheduling should solve the problems associated with machine loading and job sequencing. In order to assign work, the following three things must be available:

1. Work assignments
2. The work content of the assignments
3. Nature of assignment

The work assignment must be assigned to a specific machine or department or work center. Standard process sheets show all operations and work centers which perform the work and the time required. (5) Job sequencing is obviously the determination of the order by which the jobs will be processed for a given workcenter. Related to sequencing is priority control. Priorities are determined by using sets of rules. Some of these rules are: earliest due date, shortest processing time, and least slack time. (It is beyond the scope of this paper to discuss these rules.) The main concern of priority control is to keep the priorities valid. Since the priorities of orders can change, resequencing is necessary. Changes in demand, equipment breakdown and order cancellation are a few examples which can cause changes in priorities.

The third and most important phase of a SFCS is order progress. This is where data is collected for monitoring the status and performance of the plant. The order progress phase has three components related to the collection of data. (7) The first of the three components is the actual data collection from the production floor. The second is data processing. In the data processing, the task of preparing and organizing data for use in other modules is performed. In other words data is transformed to a usable form, information. It is also here that the data is validated and screened for errors. The third component is data communication. The gathered processed information needs to be sent to their applicable modules. Also, different computers and software may use different networking criteria, such as protocols or data transmission standards. The SFCS provides a means of realizing a unified database of information that feeds the higher systems. See Figure 5.2

5.3 Hardware

The hardware for different components are all computer-based. The hardware must be industrially hardened in order to withstand the harsh conditions found in some of today's factories. These hostile environment produce smoke,

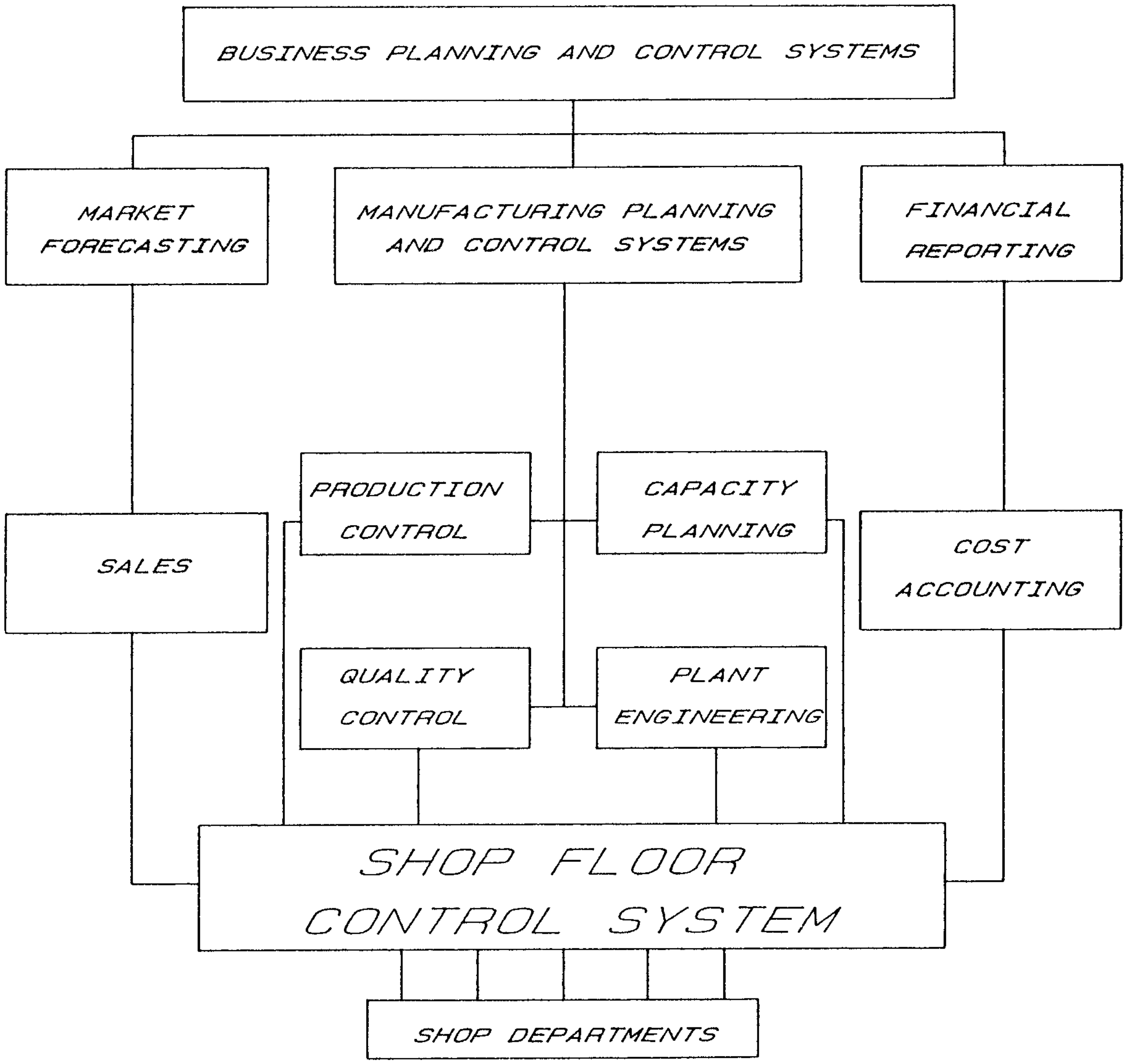

FIGURE 5.2 DATA INTEGRATION OF SFCS (7)

metal chips, grease, dirt, vibration, or electromagnetic fields. The data collection is physically done through VDT's and automated data acquisition devices. Here is a brief list of such data collection devices (7):

- Bar coding
- Magnetic coding
- Keypads
- Optical Character Recognition (OCR)
- Voice recognition
- Machine mounted sensors

As more developments occur, data collection devices will eradicate transcription errors and increase the frequency of collection. One such development is real time data collection. Today, bar coding seems to be the most cost effective and reliable method. Data entry errors are eliminated and bar codes are able to withstand harsh industrial conditions.

As previously stated the recency and accuracy of data is essential to the entire production control system's effectiveness. If emphasis is not placed on the SFCS data collection function, then the production control system is rendered, for all intent and purposes, useless. Here is another example of the old adage "Garbage in, garbage out". (8) The SFCS has the significant role of integrating production data. As more automation is implemented in factories, the SFCS will also become more automated and more integrated. The time expended implementing a SFCS correctly, will have tremendous payback in terms of accurate and prompt data collected efficiently.

CHAPTER 6

INDUSTRIAL SCENARIO

6.1 General Situation

Teledyne Adams is a small manufacturer with diversified capabilities. The company is actually two different companies combined into one. As its name implies it is one of the over 140 subsidiaries of Teledyne Inc. In 1980, Teledyne purchased Adams Industries, in Union, New Jersey, and was joined with Teledyne Still-Man, located in Lakewood, New Jersey. Both facilities were joined and are now located in the Union location. The Adams portion of the company is a metal stamping and assemblies manufacturer. The Still-Man portion produces tubular heating elements for small household appliances.

Today, Teledyne Adams is a full service manufacturing facility. Heating elements can be shipped to the customer alone or in an assembly ready to use. Such an assembly may include brackets or termination, as well as other related components manufactured in the stamping department. Teledyne Adams also enjoys having in-house electroplating and high production brazing furnaces, which complement their capabilities further.

Stampings are also produced as single parts or as components of an assembly produced at Teledyne Adams. The assemblies are brazed together or by other assembly techniques. Some products may require electropolishing as a finishing operation. With all the foremetioned operations at Teledyne Adams, a customer can receive a completed assembly from one source. Lower costs and excellent part mating relationships are two benefits a customer may receive for an assembly produced entirely at one source. With today's competition, having diversified capabilities is a tremendous advantage.

There are three types of production based on quantities produced: Job Shop production, Batch production, and Mass production. At Teledyne Adams, the latter two are representative of heating element production and metal stampings, respectively. The metal stampings line uses mass production techniques with dedicated tooling and equipment. Monthly requirements for stampings usually range 20 to 50 thousand pieces. On the other hand, the heating elements line implements batch manufacturing. The tooling and equipment is reusable for several parts. Monthly requirements for heating elements are normally under a thousand pieces. Having such capability opens up the range in the production scale of economies for Teledyne Adams.

As a result of its varied capabilities, Teledyne Adams has customers in various fields. Teledyne Adams produces stampings for the automotive industry, for Chrysler, Ford and General Motors. Electropolished assemblies for coffee percolators are made for Farber and Regal. Brazed assemblies are manufactured from raw stock to the completed assemblies for customers including Purolator (Filter Products) and Farber. The Farber brazed assembly contains: a stainless steel well, a steel spacer, a steel housing, two different copper (brazing) rings, a heating element and terminal tabs. All of the above components are manufactured at Teledyne Adams and the assembly is a perfect example of the company's diversified capabilities. Figure 6.1 displays some of the various products produced at Teledyne Adams.

6.2 Background of Operations

All products produced at Teledyne Adams follow the same basic cycle with respective to planning. The sales department obtains requests for quote. Engineering quotes piece price and tooling required. Upon being awarded the job, engineering designs all tooling and fixtures and drafts the process sheet and bill of materials. After the tooling is built and qualified, it is released to production.

Sales draws up a master schedule based on all the customers orders placed for the given month. Production control charts a Manufacturing schedule based on the master schedule. All the orders are broken down into a weekly

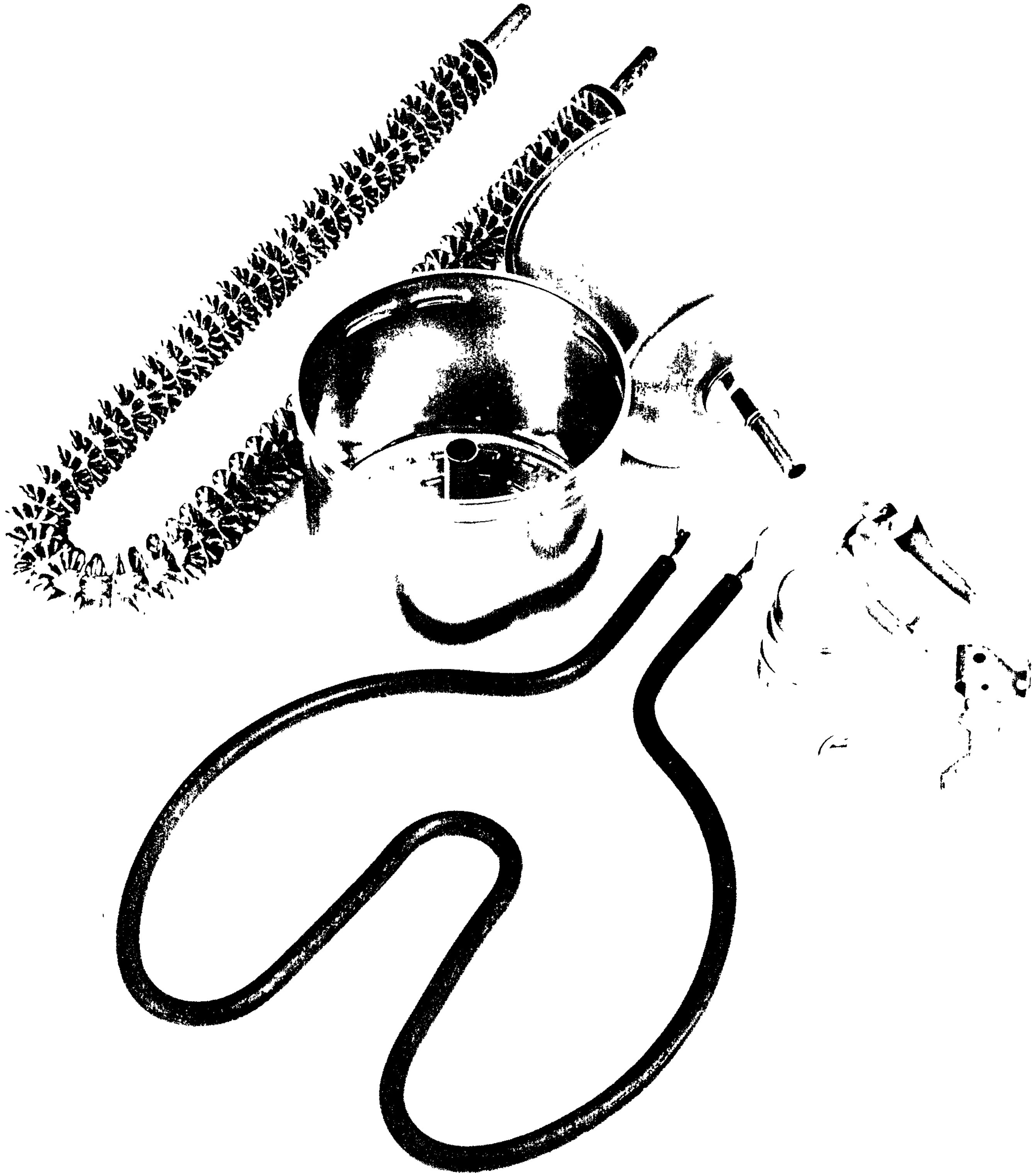

FIGURE 6.1 PRODUCTS MANUFACTURED AT TELEDYNE ADAMS

schedule. The manufacturing schedule takes into account past due orders and the plant capacity for that given week. This schedule plans the labor required in a manner equivalent to an material requirements plan, however, only considering the labor involved. It is a modified version of a capacity requirements plan. From this plan, area schedules dispatch the jobs for the given week to the respective department.

The purchasing department orders all required materials from sale orders. As each sales order is received the raw materials are ordered for the given quantity.

Unfortunately, until the recent implementation of the DCD control system, Teledyne Adams has not used true planning and control methods. For instance, purchasing does not order from a material requirements plan. Although, the scheduling methods described above have worked with some success, changes will have to be made in order to accommodate the computerized system. Furthermore, the lack of formal methodologies is company wide. Consequently, most production control functions are not executed the way they were meant to be.

In 1989, Teledyne Inc. put out a corporate wide memo which emphasized reducing costs through automation. Any project which can show a return on investment of 35% over 3 years would be subsidized by Teledyne Inc. Teledyne Adams has initiated some automation projects as a result of the corporate memo. However, due to the absence of a PP&CS, problems in inventory control and labor reporting cannot be alleviated. The DCD Shop Floor Control System was seen as a way to relieve some of the production control related problems. These problems will be discussed in more detail in Chapter 8. Obviously, factory automation only improves the processing aspect of manufacturing. A PP&CS is required to verify the company's performance with respect to manufacturing.

CHAPTER 7

DCD JOB SHOP CONTROL SYSTEM

7.1 Introduction to DCD

DCD Shop Control System has been misnamed. The company advertises the software as a job shop floor control system. The software is described as an "integrated system for job shop and custom manufacturers". On the contrary, the system is very well suited for batch and mass production setups. A production control system configured for a job shop usually lends itself to a mass production setup. However, the opposite is not necessarily true. The software's flexibility with respect to production configuration makes it appealing for Teledyne Adams' diversified abilities. As mentioned before, stampings and assemblies are mass produced while heating elements are manufactured in batches.

DCD Shop control System is down sized production control system. The software may be purchased complete or over time via a "building block" approach. (9) These modules consist of:

Estimating/Quoting	*
BOM	*
Job Costing/Production Control	*
Enhanced Scheduling	*
Inventory/Purchasing	*
Shop Floor Data Collection	*

Account Receivables
Account Payables
Payroll
General Ledger
Order Entry/Sales Analysis

This thesis is concerned with the modules directly involved with manufacturing. It is beyond the scope of this paper to analyze the accounting aspects.

As with all PP&CS, DCD is designed to increase productivity, profitability, and customer satisfaction. It addresses the typical control problems related to manufacturing management. According to its sales literature (9), DCD is concerned with:

- Underquoting prices
- Overloaded work centers
- Inaccurate standards
- Idle machines or employees
- Excessive rework
- Excess scrap
- Inadequate inventories
- Late materials
- Lack of timely labor reporting
- Poor productivity
- Management by crisis
- Late deliveries
- Inconsistent profits
- Losing repeat orders
- Incomplete part history
- Inaccurate records for repeat quoting

All of the above described are variations of the root problems of inaccurate and/or outdated information. DCD manages all the inputted data so as to update all of the relevant modules.

DCD uses a methodology of information flow very similar to that detailed in Chapter 2. Referring to Figure 7.1, the stages of the information flow are (9):

1. Estimate the job
2. Receive order and enter job
3. Schedule job
4. Print routing sheet
5. Determine material requirements
6. Issue materials
7. Update labor information
8. Track jobs in progress
9. Complete jobs
10. Ship and bill
11. Process accounting transactions

The following sections detail the modules are currently being implemented at Teledyne Adams.

7.2 How DCD works

7.2.1 Estimating/Quoting

Quoting jobs has always relied on the estimators knowledge of the plant's abilities. If more than one person quotes, then different estimates are possible for a given product. DCD allows more consistency through quoting with actual rates produced in the plant.

Estimates done through DCD have access to quote history, part history, inventory levels, and job status. With

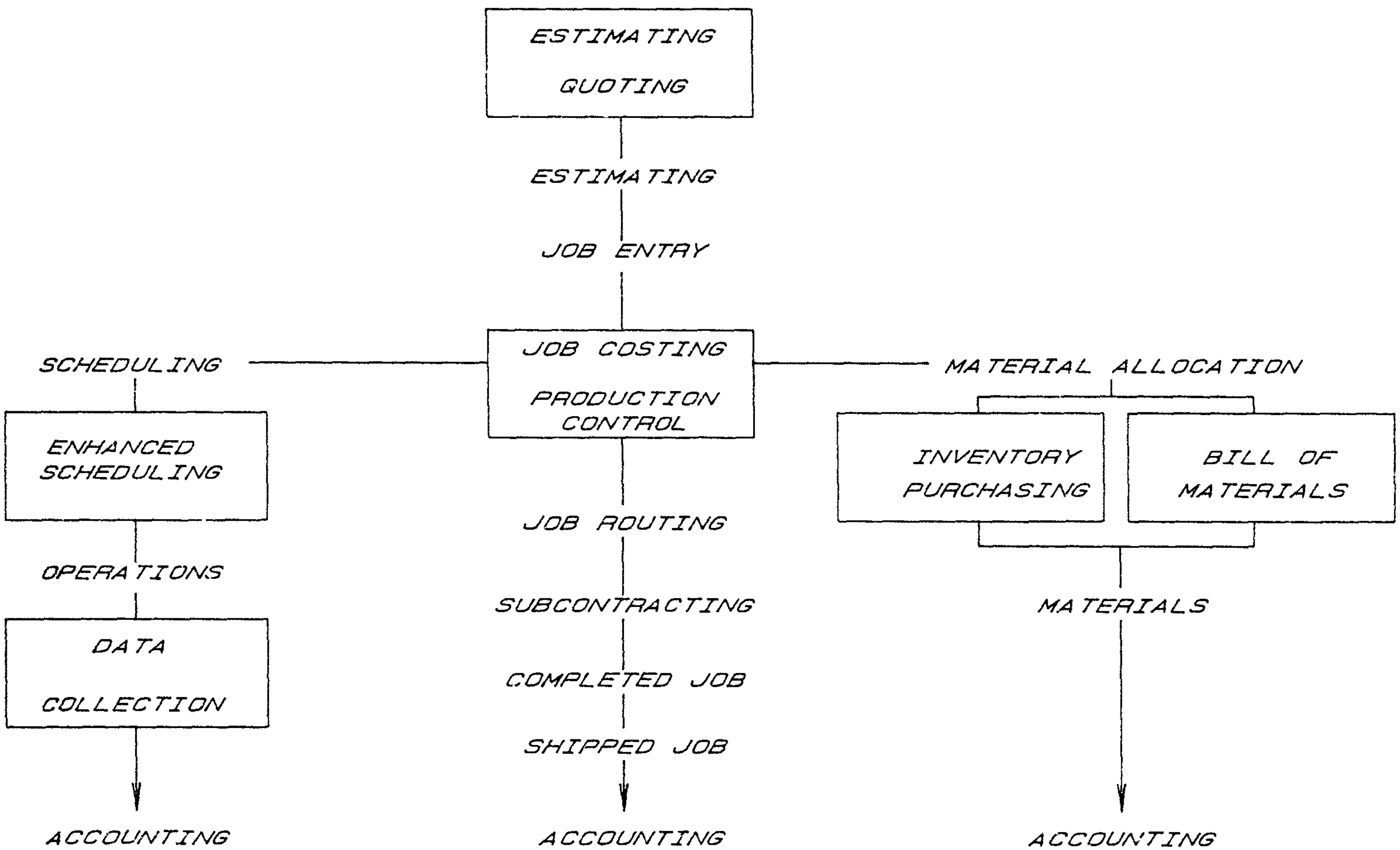

FIGURE 7.1 DCD MODULES AND INFORMATION FLOW (10)

all the above information at its disposal, delivery dates can be quickly determined. If a job is awarded and an order received, all the information (see Figure 7.2) used in the quote is transferred to the Job Entry module. Figure 7.3 traces through the quoting procedure.

7.2.2 BOM/Methods

The Methods file in DCD is actually the process plan for a given part. In DCD the Methods file and the Bill of Materials (BOM) file are combined into one file. This allows the user to see which operations are being performed on the respective materials. In "Methods", any subcontracting that may be required is listed. Examples of typical subcontracting include heat treating and plating services.

The Methods file lists all information related to a part's processing. Referring to Figure 7.4, it can be seen that pieces per hour or production standard, and setup standard are listed for each operation. Also, each operation has a preassigned operation number as well as, a department number and workcenter number. The numbering expedites the time required in inputting a process plan. Methods files or process plans for similar parts can be created quickly. Editing an existing part's information to fit a new one can guarantee accurate and up to date information.

QUOTE INQUIRY

DCD CO Date:

COMPANY: 1 DCD COMPANY

QUOTE #
154/00

QUOTE BY: 2 Rick Borg PART: DCD-1988 Rv: B Cust: 400/00 Dalton Manufacturing
DATE QUOTED..: 1/10/89 Frame Rail 1982 West 34th St.
EXPIRES.: 2/10/89 PRICED. 7/06/88 Amity
FOLLOWUP: 1/17/89 ISSUED.:
Contact·Martin Van Buren Ph 501-255-1475

SPECIAL COSTS:

DESCRIPTION	BILL	AMT	DESCRIPTION	BILL	AMOUNT	DESCRIPTION	BILL	AMOUNT
		00	Engineering Charges	N	180 00	Special Tooling	N	200 00
Programming Chrgs	N	150.00	Sample Lot Charge	Y	.00			.00

MATERIAL.

SFQ	PART NO.	PART DESCRIPTION	VEND	LEAD	QTY FAC	UM		ESTIMATED	COST	PFR	QUOTE	QUANTITY
5	79-125	1/8 Stainless Sheet	200	10	625	EA	50 0000	450 0000	400 0000	395 0000	50.0000	

SUBCONTRACT·

SEQ	VENDOR NAME	DESCRIPTION	VEND	QTY FAC	UM	ESTIMATED	COST	PER QUOTE	QUANTITY	
5	Acme Plating	Dip Braze 612/322-5247	400	100	EA	1 0000	.5000	.5000	.5000	5000

OPERATIONS·

SEQ	DEPT	W/C	OPR	DESCRIPTION	PCS/ASSY	S/U STD	RUN TIME	PLR	PBR	EST. UNIT COST	SETUP COST
5	2	20	20	Shear	1.00	2 50	.03333	10 00	20 00	.999900	75 00
10	2	21	22	Notch	1 00	.50	04166	9 50	25 00	1.437270	17 25
15	3	30	24	Form	1.00	.50	.07500	9 00	20 00	2 175000	14 50
20	3	39	33	Deburr	1 00	50	.03333	8 00	18.00	.866580	13 00
25	99	999	999	Outside Service	1.00	40 00				000000	.00
30	11	110	110	Inspct,Wrp,Shp	1.00	50	00833	13 00	25 00	_ 316540	_ 19 00

LEVEL TOTAL.

MATERIAL....	50 00	450.00	400 00	395.00	50.00
SUBCONTRACT:	1 00	50	.50	.50	.50
OPERATIONS :	579 29	650 00	780 21	921 93	1,059.62
TOTAL......:	630 29	1,100.50	1,180 71	1,317 43	1,110.12

MATRIX:

QUANTITY.. .. .:	100	250	350	500	1.000
MATERIAL MARKUP:	28.0%	23.0%	22 0%	20 0%	19 0%
SUBCONTR MARKUP:	28 0%	23 0%	22 0%	20.0%	19 0%
LAB/BUR MARKUP:	28 0%	23 0%	22 0%	20 0%	19 0%
SPECIALS MARKUP:	28.0%	23 0%	22 0%	20 0%	19 0%
MATERIAL COST .:	500 00	1250 00	1750 00	2500 00	5000 00
SUBCONTR COST..:	400 00	1000 00	1400.00	2000 00	4000.00
LAB/BUR COST..:	718.27	1587 57	2167 10	3036 39	5934 04
SPECIAL COST..:	530.00	530.00	530 00	530 00	530 00
TOTAL COST ...:	2148 27	4367.57	5847 10	8066 39	15464 04
TOTAL MARKUP...:	601.51	1004.54	1286 36	1613 27	2938 16
TOTAL PRICE ...:	2749.78	5372.11	7133 46	9679.66	18402 20
UNIT COST/ 1	21 4827	17 4703	16 7060	16 1328	15 4640
UNIT MARKUP $.:	6.0151	4 0182	3 6753	3.2265	2.9382
UNIT MARKUP %. :	28.00%	23 00%	22.00%	20.00%	19.00%
UNIT PRICE.....:	27 4978	21 4884	20 3813	19 3593	18 4022
REVISED PRICE..:	28.7000	22.5000	21 3500	20.3000	19 3000

MEMOS:

TYP---
C Competing with Acme Machine/they are 5% lower!
F Joe should wish Mr /Mrs Dalton Happy Anniversary!
G Be sure to initial all quotes before sending out!
P Parts will be specially packaged w/ plastic wrap!
X Despite higher price, we won the business due to diligent followup and professional service!

FIGURE 7.2 SAMPLE DCD QUOTE (10)

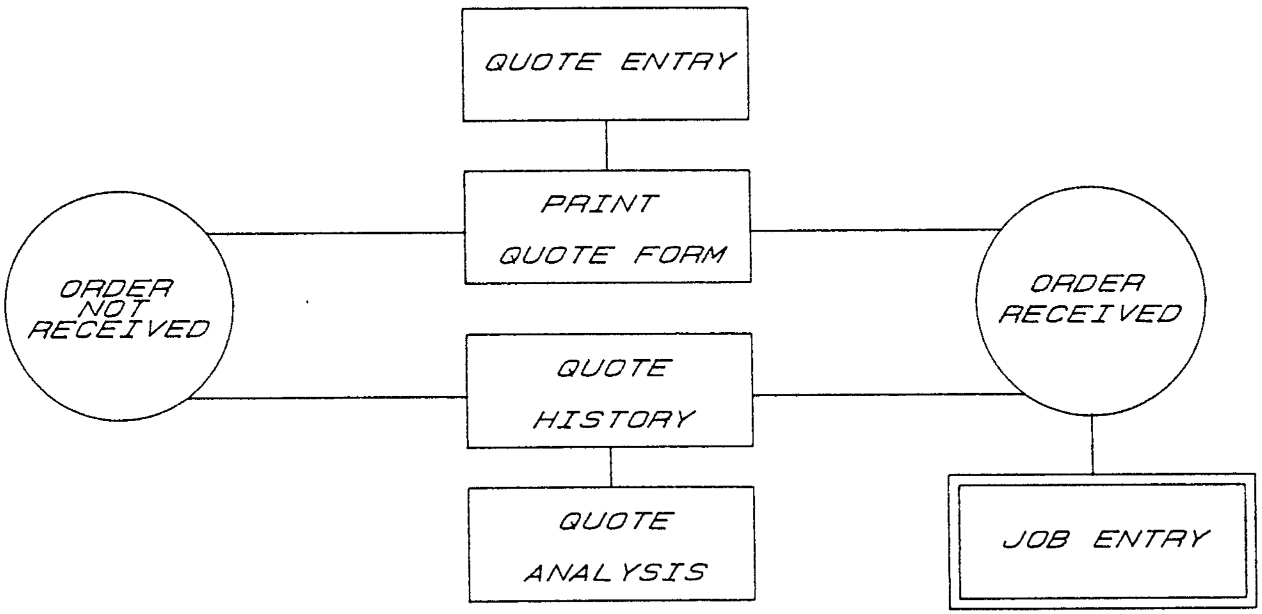

FIGURE 7.3 DCD ESTIMATING/QUOTING PROCEDURE (10)

```
                B O M / M E T H O D S   M A I N T E N A N C E    Time:  8.21
 User: W8         Zoom Mode   COMPANY NUMBER: 1    Inquiry Mode Date:  4/15/91
 DCD Inc.                                                               XA1300
Part Number                Rev #                           -- Unit Costs --
BPU510-001                 B02    Search               Bill of Mtl.  Invty Avg.
COVER ASS'Y                      COVER AS      Matl.:          .3211        .0000
Group: 10 ASSEMBLY & STAMPING                  Labor:          .0000        .0000
Cust#:                                         Burdn:          .0000        .0000
                                               Total:          .3211        .0000
Plant Runs: P/T  OPR.PCS. per HOURS            Last Calc. Date:  4/12/91

  OR                  O P E R A T I O N S    R E V I E W
    Seq.Opr.Description/Comment               Hrs/Pc     Prod.Std.  Set Up      W/C
      5 540 ASSM COV, RING, S/P, CONN                      460.00               052
     11 541 LOAD FURNACE BELT                             1393.00               052
     16 542 REMOVE BRAZED ASSY FROM BELT                   697.00               052


Seq:  21

          "N"         >>>>  END  OF FILE  <<<<                   0604
                F1-Assemblies,F3-Previous,F7-Screen 1,(H)-Access
```

FIGURE 7.4   SAMPLE METHODS FILE

The Bill of Materials file is the same as the Methods file. The file contains the required operations; this portion is the "Methods". The BOM file lists (raw) materials, components, and subassemblies required to make the given product. There is a BOM file for each "phase" a component goes through. For instance, referring to Figure 7.5, the cover assembly has four "subassemblies". Each "subassembly" is actually one component part with its own BOM. Since each component part has separate materials and labor which go into producing it, the final products BOM treats the component parts as subassemblies. The BOM file for the final cover assembly shows the operations required to join the four components.

Amongst other reports the BOM provides an explosion of the components required for the given end part. See Figure 7.6. The report provides inventory information of the displayed components. A variation of this report yields a cost explosion and rollup for the components. This includes material, labor and overhead (titled burden in DCD).

7.2.3 Enhanced Scheduling

Scheduling is one of the most important areas in a PP&CS. In essence, the planning aspects are scheduling. In the Enhanced Scheduling module, DCD's goal is to meet customer delivery by providing optimal start and due dates

```
               B O M / M E T H O D S   M A I N T E N A N C E    Time:  9.16
 User: W8          Zoom Mode   COMPANY NUMBER: 1    Inquiry Mode Date:  4/02/91
 DCD Inc.                                                            XA1300
Part Number                Rev #                           -- Unit Costs --
BPU510-001                 B02     Search               Bill of Mtl.  Invty Avg.
COVER ASS'Y                           COVER AS      Matl.:        .3211       .0000
Group: 10 ASSEMBLY & STAMPING                       Labor:        .0000       .0000
Cust#:                                              Burdn:        .0000       .0000
                                                    Total:        .3211       .0000
Plant Runs: P/T  OPR.PCS. per HOURS                 Last Calc. Date:  3/20/91

  OR                    O P E R A T I O N S    R E V I E W
    Seq.Opr.Description/Comment                Hrs/Pc      Prod.Std. Set Up      W/C
      5 540 ASSM COV, RING, S/P, CONN                         460.00               052
     11 541 LOAD FURNACE BELT                                1393.00               052
     16 542 REMOVE BRAZED ASSY FROM BELT                      697.00               052
```

```
               B O M / M E T H O D S   M A I N T E N A N C E    Time:  9.15
 User: W8          Zoom Mode   COMPANY NUMBER: 1    Inquiry Mode Date:  4/02/91
 DCD Inc.                                                            XA1300
Part Number                Rev #                           -- Unit Costs --
BPU510-001                 B02     Search               Bill of Mtl.  Invty Avg.
COVER ASS'Y                           COVER AS      Matl.:        .3211       .0000
Group: 10 ASSEMBLY & STAMPING                       Labor:        .0000       .0000
Cust#:                                              Burdn:        .0000       .0000
                                                    Total:        .3211       .0000
Plant Runs: P/T  OPR.PCS. per HOURS                 Last Calc. Date:  3/20/91

 AR                       A S S E M B L Y    R E V I E W
    Seq Assembly Part Number Description                        Qty.Factor   UM
      5 PPU510-A01           COVER                                  1.0000   EA
     10 MPU510-A01           BRAZING RING                           1.0000   EA
     15 SPU510-A01           SUPPORT PLATE                          1.0000   EA
     20 A75101-PU01          CONNECTOR                              1.0000   EA
```

FIGURE 7.5   TYPICAL DCD BOM FILE (9)

```
BS            B O M / M E T H O D S   M A I N T E N A N C E      Time:  9.16
User: W8        Zoom Mode                      Inquiry Mode      Date:  4/02/91
DCD Inc.                                                                XA1300
                  B O M   S T R U C T U R E   R E V I E W

End Part: BPU510-001            COVER ASS'Y                  End Qty:          1

Layer  Typ Component Part Number             Quantity Component Description
   1   Asy .PPU510-A01                         1.0000 COVER
   2   Mtl ..J02362-E40Y                        .1390 S/S 304, DDQ, 1BA FIN, CO
   1   Asy .MPU510-A01                         1.0000 BRAZING RING
   2   Mtl ..X05044-I998                        .0007 CDA 102 OXYGEN FREE COPPE
   1   Asy .SPU510-A01                         1.0000 SUPPORT PLATE
   2   Mtl ..106262-A52Y                        .0120 S/S 304, #5 TEMP, 2B FIN,
   1   Asy .A75101-PU01                        1.0000 CONNECTOR
   2   Mtl ..PA75101-PU01                      1.0000 CONNECTOR
```

```
BC            B O M / M E T H O D S   M A I N T E N A N C E      Time:  9.17
User: W8        Zoom Mode                      Inquiry Mode      Date:  4/02/91
DCD Inc.                                                                XA1300
                     B O M   C O S T   R E V I E W
End Part: BPU510-001            COVER ASS'Y                  End Qty:          1

Layer  Typ Component Part Number Mtl$ / Sub$   Labor $     Burden $   Quantity
   1   Asy PPU510-A01                                                   1.0000
   2   Mtl J02362-E40Y                 .20                               .1390
   1   Asy MPU510-A01                                                   1.0000
   2   Mtl X05044-I998                                                   .0007
   1   Asy SPU510-A01                                                   1.0000
   2   Mtl I06262-A52Y                 .02                               .0120
   1   Asy A75101-PU01                                                  1.0000
   2   Mtl PA75101-PU01                .11                              1.0000


                              Mtl$ & Sub$   Labor $     Burden $
             End Part Costs.:                                         Total $
                   Totals:         .32                                    .32
    "N"          >>>>  END  OF FILE  <<<<                    0604
                    F3-Previous,F10-Zoom,(H)-Access
```

FIGURE 7.6   PART EXPLOSION AND COST ROLL-UP (9) based on the present factory environment.

As with any module in a PP&CS, the input information must be accurate. For Enhanced Scheduling, all operations and inspection times must be defined. Faithful estimates of outside services, setup, packing, and shipping times are also a necessity. (9) Schedules which are not realistically feasible arise from the following problems:

- Unrealistic delivery dates
- Inaccurate labor reporting
- Unplanned machine downtime
- Rework and other unplanned operations
- Late material delivery
- Inaccurate production standards
- Delinquent subcontractors
- Nonproductive employees

Through feedback obtained and performance reports generated by the system, potential problems can be anticipated. Figure 7.7 outlines the iterative process used in scheduling. A proposed schedule is analyzed on the impact its load would have on the plant's load at that time. The "what-if" analysis uses the same "screen" of the proposed schedule. Jobs may be forward scheduled into the future or backward schedule from some future point in time. The scheduling analysis may be performed on a departmental or plant wide basis. Also, scheduling can be performed in a finite manner, where the current shop level is taken into account, or in an infinite manner where load considerations are neglected. The module can schedule multiple jobs

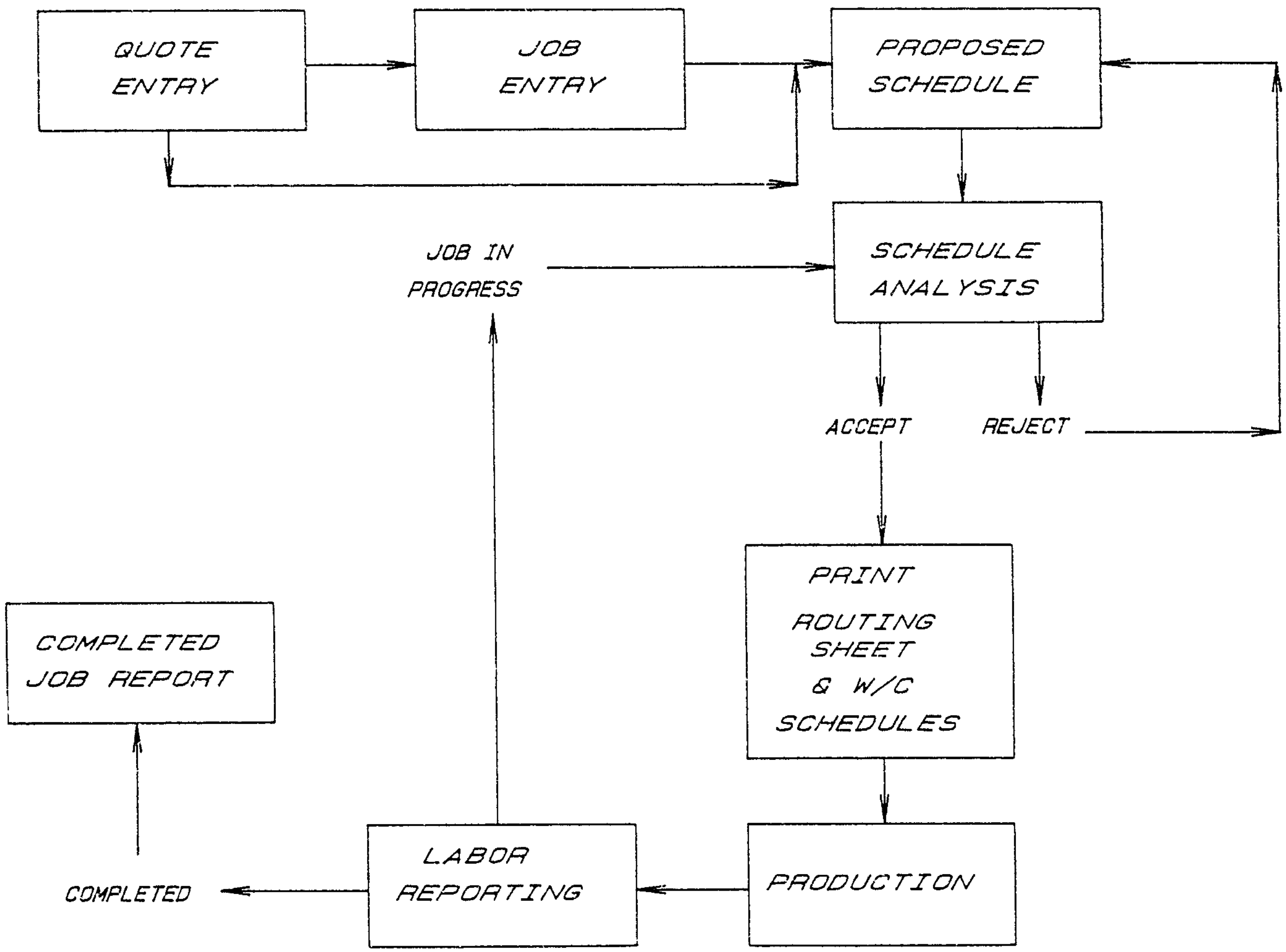

FIGURE 7.7 DCD SCHEDULING PROCESS (10)

simultaneously and with assigned priority codes. The schedule may be specified to an exact time of day a job is to start or finish. During the "what-if" analysis the user may manipulate factors which affect the schedule. Using different workcenters, different production standards, or overlapping operations are some factors which may be considered. (9)

After revising the schedule, or at any time for that matter, loads can be analyzed by workcenters or for the plant. In Enhanced Scheduling, a load graph can quickly display bottlenecked or underutilized workcenters. An excellent feature of the load graph is that not only are actual loads displayed, but, also loads on hold or in the production floor's queue. In addition, if a "what-if" analysis is being performed, its simulated load is superimposed as to show its effects. See Figure 7.8. Reports can also be easily generated for the the plant or for a given workcenter, as shown in Figure 7.9. Bottlenecks can be quickly pinpointed and thus appropriate actions taken.

To summarize, the Enhanced Scheduling module has the flexibility to analyze and optimally reschedule jobs so that production smoothing of peaks and valleys occurs. The modules most important feature is speed. Such a feature is imperative where dynamic shop conditions exist.

```
==========================================================================
02                      W O R K   C E N T E R   G R A P H          Time:  7.55
User:                             Company: 1                        Date:  2/07/89
DCD Inc.                  W/C: BB2 Horizontal Mill                        ES4040

  Hrs    A S H T   A S H T   A S H T   A S H T   A S H T   A S H T   A S H T

   10          T
    9    A     T         H
    8    A     T         H               T                       S   T
    7    A     T >       H     > A       T >       >   S   T >   S   T
    6    A S   T         H       A       T             S   T     S   T
    5    A S   T         H T     A       T     S   T   S   T     S   T
    4    A S H T         H T     A       T     S   T   S   T     S   T
    3    A S H T   A     H T     A       T     S   T   S   T     S   T
    2    A S H T   A     H T     A       T     S   T   S   T     S   T
    1    A S H T   A S H T       A       T     S   T   S   T     S   T
    0    A S H T   A S H T       A S     T     S   T   S   T     S   T

           thru    2/06/89   2/07/89   2/08/89   2/09/89   2/10/89   2/11/89
         2/05/89   2/06/89   2/07/89   2/08/89   2/09/89   2/10/89   2/11/89
   Act:     8.00      4.00      8.00       .00       .00       .00       .00
   Sim:     5.00      2.00      1.00      6.00      8.00      9.00       .00
   Hld:     3.00     10.00       .00       .00       .00       .00       .00
   Tot:    13.00      6.00      9.00      6.00      8.00      9.00       .00
 ≥ Cap:      .00      8.00      8.00      8.00      8.00      8.00       .00

F19=Left
F20=Right,F1=IDP,F2=Search,F3=Prev,F4=Chg Dates,F6=Chg Hours,F7=End,F10=Zoom
==========================================================================
```

FIGURE 7.8   DCD LOAD GRAPH (10)

Prog : ES4120	* P L A N T L O A D R E P O R T *	Page: 1
User : PC		Date: 3/30/89
Company: 1 DCD COMPANY		

		thru	3/30/89	3/31/89	4/01/89	4/02/89	4/03/89	4/04/89	4/05/89	4/06/89	4/07/89
	Date Ranges·	3/29/89	3/30/89	3/31/89	4/01/89	4/02/89	4/03/89	4/04/89	4/05/89	4/06/89	4/07/89
All Load Hours											
	Plant Capacity	++	8 00	8.00	00	00	8 00	8 00	8 00	8 00	8.00
WC 1 SHEARING											
		A:240.62	2.15	1 00	8 00	8 00	8.00	5.30			
		S:148 00	8 00	8.00	8.00	8.00	8 00				
		H.									
		Tot:388 62	2.15	9 00*	16.00*	16.00*	16 00*	13.30*			
		Cap: 8.00	8 00	8 00	8.00	8 00	8 00	' 8 00			

Prog: ES4110	* W O R K C E N T E R L O A D R E P O R T *	Page: 1
		Date:3/30/89
Company: 1 DCD COMPANY		
HOURS REMAINING		

Date Ranges:						thru	3/30/89	3/31/89	4/01/89	4/02/89	4/03/89	4/04/89	4/05/89	4/06/89	4/07/89
						3/29/89	3/30/89	3/31/89	4/01/89	4/02/89	4/03/89	4/04/89	4/05/89	4/06/89	4/07/89
Plant Capacity:						++	8.00	8.00	.00	.00	8.00	8.00	8.00	8.00	8.00
Job	Lot	Lvl	Seq	Mch	Typ										
WC: 1 SHEARING															
25884		A	5	0	A	61.18									
25884		C	5	0	A		6.33								
25884		C	11	0	A		4.20								
25884		D	5	0	A			8.30							
25884		E	5	0	A			4.31							
25884		G	5	0	A				7.30						
						=====	=====	=====	====						
						61.18	10.53	12.61	7.30						

FIGURE 7.9 SAMPLE LOAD REPORTS (10)

7.2.4 Routing Sheet

As previously defined in Chapter 2, a routing sheet gives detailed set of instructions by which production floor personnel follow. As shown in Figure 7.10, the routing sheet identifies (9):

- Customer
- Delivery
- Subcontracting schedule
- Planned materials
- Schedule of operations

In addition, memos and extended operation descriptions allow the user to add any additional information or instructions which are distinctive to the part. Also, note that information may be suppressed so confidential information such as costs are not released to the production floor. The routing sheet shows the delivery of the materials and the start and due dates of each operation. These dates are derived from the enhanced scheduling module.

7.2.5 Job Costing/ Production Control

This module is concerned with providing accurate managerial reports. (9) The reports assist production control in the following key areas:

- Job Status
- Shop Status
- Productivity

ROUTING SHEET
--- OFFICE COPY --- DATE: 1/13/89

COMPANY: DCD Company

JOB/LOT NUMBER	JOB TITLE	PART NUMBER	PART DESCRIPTION	REV #	JOB	USER	CUST.P.O.NO.
S-26956	D.N. 6988-HAB	DCD-1988	Frame Rail		B	R	32452

(- CODES - : JOB, USER)

ORDER QTY	PROD QTY	U/M	UNIT PRICE	E.U.C.	--- EXTENDED --- COST	PRICE	--- ESTIMATED --- P/L $	P/L %
250	250	EA	22.50	18.27	4567.50	5625.00	1057.50	23.15

BILL TO:400/00 CONTACT:Martin Van Buren
Dalton Manufacturing
TERMS: 01 NET DUE
1982 West 34th St. SLS: 03 John Koski
Amity NY 10112 REG: 03 New England

---------- D A T E S ---------- ORDER	REQ.SHIP	PROD START	PROD DUE
1/13/89	2/10/89	1/16/89	2/10/89

DELIVERY SCHEDULE:

SEQ	SHIP DATE	SHIP QTY	U/M	UNIT PRICE	EXTENDED PRICE	VIA	TAX	MISC AMT	SHIP TO / COMMENT
5	2/10/89	250	EA	22.50	5625.00	01	00		Dalton Manufacturing

MATERIAL:

SEQ	OPR	PART NUMBER	PART DESCRIPTION	QUANTITY	U/M	VENDOR	LEAD	ORDER BY	PO NO.	DUE IN	REQD	EST.COST
5	20	79-125	1/8 Stainless Sheet	1562.50	EA	200			22517	1/05/89	1/16/89	1250.00

SUBCONTRACT:

SEQ	OPR	VENDOR NAME	DESCRIPTION		QUANTITY	VENDOR	PO NO.	DUE OUT	DUE IN	EST.COST
5	999	Acme Plating	Dip Braze	612/322-5247	800	400	22520	2/04/89	2/10/89	1000.00

OPERATIONS:

SEQ	W/C	OPR	DESCRIPTION	DEPT	PCS/ASSY	OP. QTY	OVERLAP	S/U STD	PROD STD	EST HRS	START DATE	DUE DATE
4			MATL- 5 REQ. 79-125	1/8 Stainless Sheet								
5	20	20	Shear	2	1.00	250		2.50	2.00	4.50	1/16/89	1/20/89
10	21	22	Notch	2	1.00	250		.50	2.50	6.00	1/20/89	1/23/89
15	30	24	Form	3	1.00	250		.50	4.50	11.25	1/23/89	1/30/89
20	39	33	Deburr	3	1.00	250		.50	2.00	4.50	1/30/89	2/03/89
25	999	999	Outside Service	99	1.00	250		40.00			2/04/89	2/10/89
30	110	110	Inspect,Wrap,& Ship	11	1.00	250		.50	.50	2.50	2/10/89	2/10/89

MEMOS: ***CABINETS NEED TO BE POSITIONED HEAD TO HEAD IN SHIPPING CARTONS WITH FOAM IN BETWEEN. (NPT 1/13/89)

FIGURE 7.10 SAMPLE ROUTING SHEET (10)

- Sales Analysis
- Profitability

Job Status

The Job status report provides information on jobs sorted by a variety of options. For instance, sort may be performed by customer, job number, days delinquent, due dates or percentage of estimated time. The report can quickly summarize information such as job location in the plant, hours remaining and variance from scheduled due date.

Shop Status

The Shop Status report differs from Job Status in that it is concerned with workcenters and machines rather than particular jobs. The Shop Status report provides details to engineering for reviewing, revising and fine-tuning standards when necessary. In this module, shop load can be analyzed to point out bottlenecks due to particular jobs. In addition, because of dynamic conditions which exist on the production floor, schedules and priorities can be examined easily and quickly.

Productivity

In this area, DCD provides reports which detail performance of employees, departments or workcenters. The module also provides itemized reports for direct and indirect labor. Two reports mentioned above which have major importance in production control are employee efficiency and resource performance. In an employee efficiency report, a workers direct labor can be analyzed for different attributes. Of course, efficiency is the main concern. In addition, rework, scrap, and any additional operations added will also be displayed. The above attribute may also be listed by job for that particular employee. See Figure 7.11. A resource performance report summarizes the same attributes listed above for employee labor reports. More importantly with "resources" is the utilization of a workcenter. This confirms the relationship to machine loading. A typical performance report is exhibited in Figure 7.12. The reporting of direct and indirect labor produces the labor distribution for workcenter within departments. Furthermore, the respective costs are accounted. Both reports compile data so management can calculate workcenter rates that are closer to actual manufacturing costs. Figure 7.13 displays sample reports of direct and direct labor.

Sales Analysis

The sales analysis report draws total sales by month or year. This function allows the user to view sales activity by customer, part number or order date. Additionally, the

OPEN JOB LABOR DETAIL
(Foreman's Copy)

DATE: 1/16/89

COMPANY: DCD Company

EMPLOYEE: 195 Jeno Jalouski

JOB/LOT NUMBER	LVL	SEQ	DP	W/C	OPR	HOURS	SETUP STD.	PROD.STD.	EST.HRS	T/D QTY	WRK QTY	SCRAPPED	EFF%	CODES
S-26956		5	2	20	20	2.50	2.50			100%	100%		100	
S-26956		5	2	20	20	4.50		2.00	3.53	106	106		79	

	TOTAL HOURS	DIRECT	REWORK	TOOLING	ADDED OPR	EFF%
1/16/89 TOTAL HOURS	8.00	7.00	.00	.00	.00	86
EMPLOYEE TOTAL HOURS	8.00	7.00	.00	.00	.00	86

EMPLOYEE: 265 Clara Bean

JOB/LOT NUMBER	LVL	SEQ	DP	W/C	OPR	HOURS	SETUP STD.	PROD.STD.	EST.HRS	T/D QTY	WRK QTY	SCRAPPED	EFF%	CODES
S-27116		2	1	14	17	1.30								T
S-26831	D	8	1	14	17	2.10		2.00	2.20	110	110		105	A
S-26888/1		10	1	11	14	.80				122	13			R
S-26905		5	2	20	20	3.60		12.00	2.28	78	18		63	O
S-27007		1	1	13	12	.70		5.00	1.00	35	20		143	U
S-27010/3		13	3	39	33	1.20		2.50	1.00	94	40	7	83	S

	TOTAL HOURS	DIRECT	REWORK	TOOLING	ADDED OPR	EFF%
1/16/89 TOTAL HOURS	9.70	5.50	.80	1.30	2.10	85.26
EMPLOYEE TOTAL HOURS	9.70	5.50	.80	1.30	2.10	85.26
DEPARTMENT TOTAL HOURS	17.70	12.50	.80	1.30	2.10	89.73
SPREAD:	100.00%	70.63%	4.52%	7.34%	11.86%	

FIGURE 7.11 REPORT WHICH SHOWS EMPLOYEE EFFICIENCIES (10)

WEEKLY RESOURCE PERFORMANCE SUMMARY
(February Analysis)

DATE: 2/27/89

COMPANY: DCD Company

WORK CENTER	DESCRIPTION	PERIOD END DATE	DIRECT	INDIRECT	REWORK	TOOLING	TOTAL	ADDED OP	EFF%	% USAGE OF CPCTY
			---------- ACCRUED HOURS OF ----------							
11	Vertical Mills	2/06/89	131.20	13.50			144.70		109	96
		2/13/89	126.40			8.60	135.00	6.30	96	90
		2/20/89	108.50	12.90	15.90	4.30	141.60	3.60	95	94
		2/27/89	142.80	1.30			144.10		113	96
	*Work Center Total...		508.90	27.70	15.90	12.90	565.40	9.90	103	94
	% Spread...		90.01	4.90	2.81	2.28	100.00	1.75		
20	Press Brake	2/06/89	61.70				61.70	6.80	79	77
		2/13/89	42.50	9.10			51.60		82	65
		2/20/89	57.60	3.70	2.90	1.20	65.40	11.20	83	82
		2/27/89	32.30		6.30	2.40	41.00	.50	75	51
	*Work Center Total...		194.10	12.80	9.20	3.60	219.70	18.50	80	69
	% Spread...		88.35	5.83	4.18	1.64	100.00	8.42		
40	Automatic Grinding	2/06/89	63.60	17.60		8.60	89.80		86	75
		2/13/89	49.60	21.30		12.30	83.40		82	70
		2/20/89	81.30			3.40	84.70		90	71
		2/27/89	70.20	9.80		6.90	86.90		87	72
	*Work Center Total...		264.90	48.70	.00	31.20	344.80	.00	86	72
	% Spread...		76.82	14.13	.00	9.05	100.00	.00		
	**Report Totals...		967.90	89.20	25.10	47.70	1129.90	28.40	93	81
	% Spread...		85.66	7.90	2.22	4.22	100.00	2.51		

FIGURE 7.12 TYPICAL RESOURCE PERFORMANCE REPORT (10)

DIRECT LABOR REPORT
(February Analysis)

DATE: 2/27/89

COMPANY: DCD Company

H/C	WORK CENTER DESCRIPTION	#OF MCH	MONTH TO DATE HOURS	MONTH TO DATE BURDEN HRS	MONTH TO DATE LABOR COST	MONTH TO DATE BURDEN COST	YEAR TO DATE HOURS	YEAR TO DATE BURDEN HRS	YEAR TO DATE LABOR COST	YEAR TO DATE BURDEN COST
	DEPT: 1 MACHINE									
11	Vertical Mills	2	49.70	71.60	475.10	2506.00	106 00	157.50	1013.30	5512.50
13	Lathe	1	26.50	36.30	231 80	1089.00	56.20	84 60	491.80	2538.00
14	Drill Press	4	75.90	104.20	723.30	2605.00	166.90	210.20	1590.50	5255.00
	DEPARTMENT TOTALS...		152.10	212.10	1430.20	6200.00	329.10	452.30	3085.60	13305.50
	DEPT: 2 SHEET METAL									
20	Press Brake	1	54.60	61.00	437.30	1830.00	109.20	122.00	874.60	3660.00
21	Punch Press	1	63.30	101.10	507.00	3538.50	132.90	232 50	1064.50	8137.50
22	Band Saw	1	104.20	136.20	781.50	3405.00	197.90	286.00	1484.20	7150.00
	DEPARTMENT TOTALS...		222.10	298.30	1725.80	8773.50	440.00	640.50	3423.30	18947.50
	DEPT: 3 STAMPING AND DEBURRING									
30	Form Press		73.20	89.60	740.70	3138.00	153.30	178.00	1551.40	6230.00
32	120-ton Press		64.20	154.30	609.90	6172.00	147.20	294.40	1398.40	11770.00
34	240-ton Press		60.90	104.20	578.60	4689.00	126.00	208.10	1197.00	9364.50
38	Tumbler		79.60	81.30	805.60	1626.00	181 70	162.70	1838.80	3254.00
39	Deburr		82.80	84.40	838.80	1688.00	172.20	165.20	1744.40	3304.00
	DEPARTMENT TOTALS...		360.70	513.80	3573.60	17311.00	780.40	1008.40	7730.00	33922.50
	DEPT: 9 ASSEMBLY									
93	Bench Work I		85.00	96.10	739.50	1922.00	178.50	201 80	1553.00	4036.00
95	Bench Work II		75.60	83.70	612.40	1674.00	157.50	175.70	1275.80	3515.00
99	Final Assembly		116.40	116.00	1061.60	1740.00	267.70	243.60	2441.60	3654.00
	DEPARTMENT TOTALS...		277.00	295.80	2413.50	5336.00	603.70	621.10	5270.40	11205.00
	PLANT TOTALS...		851.30	1320.00	9143.10	37620.50	2153.20	2722.30	19519.30	77380.50

INDIRECT LABOR REPORT
(February Analysis)

DATE: 2/27/89

COMPANY: DCD Company

H/C#	WORK CENTER DESCRIPTION	CODE	CODE DESCRIPTION	MONTH TO DATE HOURS	MONTH TO DATE COST	YEAR TO DATE HOURS	YEAR TO DATE COST
11	Vertical Mills	10	Misc. Labor	3.70	34.22	6 80	59.16
		30	Machine Maintenance	6.20	46.19	6.20	46.19
			WORK CENTER TOTALS...	9.90	80.41	13.00	105.35
12	Brown and Sharpe	30	Machine Maintenance	4.80	41.28	15.90	144.69
			WORK CENTER TOTALS...	4.80	41.28	15.90	144.69
34	240-Ton Press	10	Misc. Labor	2.90	22.62	2.90	22.62
		20	Downtime	12.70	100.33	18.40	145.36
		30	Machine Maintenance	6.40	57.60	9 30	83.70
			WORK CENTER TOTALS...	22.00	180.55	30.60	251.68
			REPORT TOTALS...	36.70	302.24	59.50	501.72

INDIRECT LABOR REPORT -- ACCOUNT RECAP

CODE	CODE DESCRIPTION	MONTH TO DATE HOURS	MONTH TO DATE COST	YEAR TO DATE HOURS	YEAR TO DATE COST
10	Misc. Labor	6.60	56.84	9.70	81.78
20	Downtime	12.70	100.33	18.40	145.36
30	Machine Maintenance	17.40	145.07	31.40	274.58
	RECAP TOTALS.....	36.70	302.24	59.50	501.72

FIGURE 7.13 DCD LABOR REPORTS (10)

module furnishes management with a log of all orders booked and reports total backlog by time period. (9)

Profitability

In this area several reports are crossovers from different modules. Strictly speaking, all the compiled information is directly related to profit or loss. Some of these reports include: WIP, Completed Job and Part History. The WIP report represents the actual value of all work currently in the plant which is not a shippable product. Additionally, WIP dollars which have been relieved as they are shipped can be disclosed. (9)

Referring to Figure 7.14, on can see how the WIP report unveils the profit margin and capital currently tied up in WIP inventory. A nice feature of the WIP report is the exposing of jobs which are losing money. Such a job which is to be billed for less than the cost of producing is denoted on the report with an asterisk.

The Completed Job report shows all production costs and performance data accrued for jobs which have been completed. In this report it can be seen how the integration of modules accelerates data processing and information transfer. See Figure 7.15 for an example of a Completed Job report executed on a monthly basis.

W O R K   I N   P R O C E S S   R E P O R T
(January Analysis)

DATE: 1/30/89

COMPANY: DCD Company

JOB/LOT	PART NUMBER	DUE DATE	LABOR	BURDEN	MATERIAL	CONTRACT	RWK/TOOL	TOTAL COST	AMT BILLED	RELIEVED
S-26956	DCD-1988	2/10/89	598.84	1378.76	1236.00	.00	142.20	3355.80	.00	0
		COST OF SALES:	.00	.00	.00	.00	.00	.00		
		WORK IN PROCESS:	598.84	1378.76	1236.00	.00	142.20	3355.80	5625.00	250
S-26981	79862GD22	2/27/89	249.50	982.47	516.50	65.00	89.20	1902.67	470.00	5
		COST OF SALES:	12.48	49.12	25.83	3.25	4.46	95.14		
		WORK IN PROCESS:	237.02	933.35	490.67	61.75	84.74	1807.53	8930.00	95
S-27302	7986775	3/12/89	586.00	1742.42	230.00	.00	.00	2558.42	4562.00	25
		COST OF SALES:	293.00	871.21	115.00	.00	.00	1279.21		
		WORK IN PROCESS:	293.00	871.21	115.00	.00	.00	1279.21	4562.00	25
S-27323	36512	2/20/89	1858.89	5496.87	2873.20	620.00	269.50	11118.46	15873.00	225
		COST OF SALES:	1858.89	5496.87	2873.20	620.00	269.50	11118.46		
		WORK IN PROCESS:	.00	.00	.00	.00	.00	.00	.00	0
S-27340	B7963	2/25/89	1879.00	5279.00	2571.42	500.00	782.00	11011.42	.00	0
		COST OF SALES:	.00	.00	.00	.00	.00	.00		
		WORK IN PROCESS:	1879.00	5279.00	2571.42	500.00	782.00	11011.42	9800.00	7500*
		TOTAL COSTS:	5172.23	14879.52	7427 12	1185.00	1282 90	29946.77	20905.00	
		TOTAL COST OF SALES:	2164.37	6417.20	3014.03	623.25	273.96	12492.81		
		TOTAL WORK IN PROCESS:	3007 86	8462.32	4413.09	561.75	1008.94	17453.96	28917.00	

* TOTAL OF WORK IN PROCESS EXCEEDING PROJECTED BILLINGS
WORK IN PROCESS: 11011.42
PROJECTED BILLINGS: 9800.00
DIFFERENCE: 1211.42

FIGURE 7.14 WIP REPORT (10)

COMPLETED JOB REPORT

COMPANY: DCD Company — CODES —

JOB/LOT NUMBER	PART # / DESCRIPTION	REV #	JOB USER	CUST.NO.	CUSTOMER NAME
8-26956	DCD-1988	B	R	400/00	Dalton Manufacturing
	Frame Rail			PO#:	32452

SALESPERSON	DATES: ORDER	REQ.SHIP	PROD STRT	PROD DUE	ORDER QTY	PROD QTY	COMP QTY	U/M	PRICE
01 John Koski	1/13/89	2/10/89	1/16/89	2/10/89	250	250	250	EA	5625.00

DELIVERY SCHEDULE: --- SHIPMENT STATUS ---

SEQ	SHIP DATE	QTY	U/M	UNIT PRICE	EXT.PRICE	SHIP TO	VIA	PS.NO.	INV.#	DATE	AMT BILLED	LAST DATE	QTY.TODATE	QTY.REM.
5	2/10/89	250	EA	22.50	5625.00	1	01	169	16732	2/13/89	5625 00	2/13/89	250	0

MATERIAL:

LVL	SEQ	OPR	PART NUMBER	PART DESCRIPTION	VEND#	-ESTIMATED- QTY	COST	-- ACTUAL -- QTY	COST	DUE DATE	DATE RECEIVED
	5	20	79-125	1/8 Stainless Sheet	200	1562.50	1250.00	1562.50	1236.00	1/16/89	1/16/89

SUBCONTRACT:

LVL	SEQ	OPR	VENDOR NAME	DESCRIPTION	VEND#	-ESTIMATED- QTY	COST	-- ACTUAL -- QTY	COST	DUE DATE	DATE RECEIVED
	5	999	Acme Plating	Dip Braze 612/322-5247	400	250.00	1000 00	250.00	1017.00	2/10/89	2/13/89

OPERATIONS:

LVL	SEQ	DP	W/C	OPR	OPER.QTY	SETUP HOURS EST.	ACT.	PROD HOURS TOT.EST	ACTUAL	PROD QTY	SCRAP QTY	-HOURS- RWK	TOOL	-- COSTS -- LABOR	BURDEN	STANDARD EST.	STANDARD ATTAINED
4	MATL - 5 REQ. 79-125							1/8 Stainless Sheet									
	5	2	20	200	250	2.50	2 50	16 00	20.00	250	0	2	4	227.70	609.30	2.00	2.50
	10	2	21	210	250	.50	.80	20.00	29.50	250	0	2	0	205.60	615.70	2.50	3.69
	15	3	30	301	250	.50	1.00	36 00	40.50	250	0	0	0	257.30	668.10	4.50	5.06
	20	3	39	302	250	.50	.50	16.00	15.80	250	0	0	0	88.60	256.20	2.00	1.98
	25	99	999	999	250	40.00	40.00	.00	.00	250	0	0	0	.00	.00	.00	.00
	30	11	110	102	250	.50	.50	4 00	4.00	250	0	0	0	53.90	121.50	.50	.50
					TOTALS:	4.50	5.30	92.00	109.80		0	4	4				

	LABOR $	REWORK $	TOOLING $	BURDEN $	MATERIAL $	SUBCONT $	TOTAL COST	BILLING $	P&L $	P&L %	U/COST
JOB TOTALS:	803.10	102.40	80.15	2128.25	1236 00	1000.00	5349.90	5625.00	275.10	4.89	21.40

LABOR DETAILS:

LVL	SEQ	DP	W/C	OPR	EMPLOYEE	LABOR DATE	SETUP	PROD	DESCRIPTION	QTY WK	SCRAP	EFF %
	5	2	20	20	Jono Jalouski	1/16/89	2.50		Setup Complete	100%		100
	5	2	20	20	Jeno Jalouski	1/16/89		4.50	Production Partial	106		79

M O N T H L Y C O M P L E T E D J O B S S U M M A R Y
(February Analysis)

DATE: 2/28/89

COMPANY: DCD Company

CUST NO.	CUSTOMER NAME / JOB/LOT NO	PART NO	DATE COMPLETE	VARI DAYS	QTY ORD	QTY COMPLETE	QUANTITY SHIPPED	- ESTIMATED - P/L $	P/L %	-- ACTUAL -- P/L $	P/L %
360/00	Base Line, Inc. S-27340	B7963	2/10/89	7-	7500	7510	7510	1960.00	20.00	963.20-	9.84-
400/00	Dalton Manufacturing S-26956	DCD-1988	2/13/89	3	250	260	250	1057.50	23.15	275.10	4.89
900/00	Merrick Manufacturing S-26923	A5022	2/23/89	19	30	10	30	680.00	22.80	1126.00	43.70
700/00	Johnson Engineering S-27323	36512	2/23/89	3	225	210	210	4975.00	31.00	5024.04	32.00
510/00	Fabtron S-26981	79862GD22	2/27/89	0	100	98	98	2240.00	24.00	847.12-	9.00-
	AVERAGE DAYS VARIANCE. 4						RUN TOTALS...	10912.50		4614.82	
								HI	31.00		43.70
								AV	24.19		12.35
								LO	20.00		9.84-

FIGURE 7.15 COMPLETED JOB REPORTS (10)

Part History is what the name implies. This report details the information by customer, part number or product group. The report points out which jobs are consistently profitable. Thus, the company can steer towards a advantageous part mix. See Figure 7.16

7.2.6 Inventory/Purchasing

Lacking inventory and purchasing controls can hinder efficient production. By integrating inventory control and purchasing functions with the rest of the production control modules, command is obtained over inventories.

With DCD's Inventory/Purchasing module control over inventories is acquired. Referring to Figure 7.17, the process by which the Inventory/Purchasing modules uses is demonstrated. The module provides the facilities necessary to maintain raw material and finished goods inventory quantities and costs current. When a new job is entered, all material requirements allocate inventory. As issues occur, inventory is relieved or purchases are released. From Job Costing and Scheduling material requirements are generated. Material then is issued from inventory for jobs ready to start. Also from the schedule, material is "put in reserve" for scheduled jobs. If inventory is lacking, then a material requirement is generated and a purchase order is authorized for the purchase. (9) The process sounds simple,

PART HISTORY REPORT
(By Customer)

DATE: 2/27/88

COMPANY: DCD Company

JOB/LOT	REV	ORDER DATE	ORDER QUANTITY	PROD QTY	EST HOURS	ACT HOURS	EFF PCT	UNIT PRICE	UNIT COST	TOTAL PRICE	P&L MARGIN	P&L PCT
CUSTOMER: 400/00 Dalton Manufacturing												
PART: DCD-1988		PRODUCT GROUP: 03										
S-10065	A	1/11/86	250	250	140.00	163.00	84	20.80	19.20	5200.00	416.00	8
S-13740	A	3/25/86	500	500	240.00	287.50	88	21.00	17.33	10500.00	1782.00	17
S-14544	A	7/13/86	600	600	259.00	280.70	92	21.00	15.83	12600.00	3102.00	25
S-16573	B	8/10/87	350	350	125.50	132.50	96	22.00	17.14	7700.00	1689.00	22
S-19008	B	12/20/87	500	500	205.00	210.10	97	21.00	15.80	10500.00	2522.00	24
S-21026	B	2/15/88	400	400	183.00	185.40	98	22.00	16.25	8800.00	2287.00	26
PART: 5014		PRODUCT GROUP: 03										
S-15213		8/10/85	200	200	83.00	93.00	89	119.00	101.20	23800.00	3560.00	15
S-16219		3/03/86	150	150	68.00	72.00	94	123.00	97.85	18450.00	3772.50	20
S-25110		12/03/86	220	220	92.00	90.00	102	125.00	98.31	27500.00	5871.80	21
		CUSTOMER: 400/00 TOTALS...			1395.50	1514.20	93			125050.00	25002.30	20
CUSTOMER: 510/00 Fabtron												
PART: 191856		PRODUCT GROUP: 02										
S-18216	C	5/10/86	300	500	162.00	196.30	82	37.50	39.30	11250.00	540.00-	5-
S-19113	C	7/01/86	500	300	98.00	121.40	81	37.50	39.60	18750.00	1050.00-	6-
PART: 803215		PRODUCT GROUP: 02										
S-17222	B	4/02/86	3000	5000	326.00	391.50	83	4.40	4.53	13200.00	390.00-	3-
S-18316	B	5/20/86	5000	5000	326.00	398.40	82	4.25	4.57	21250.00	1600.00-	8-
S-19980	C	8/27/86	8000	10000	663.00	892.70	74	4.10	4.61	32800.00	4080.00-	12-
		CUSTOMER: 510/00 TOTALS...			1575.00	2000.30	79			97250.00	7660.00-	8-

FIGURE 7.16 SAMPLE PART HISTORY REPORT (10)

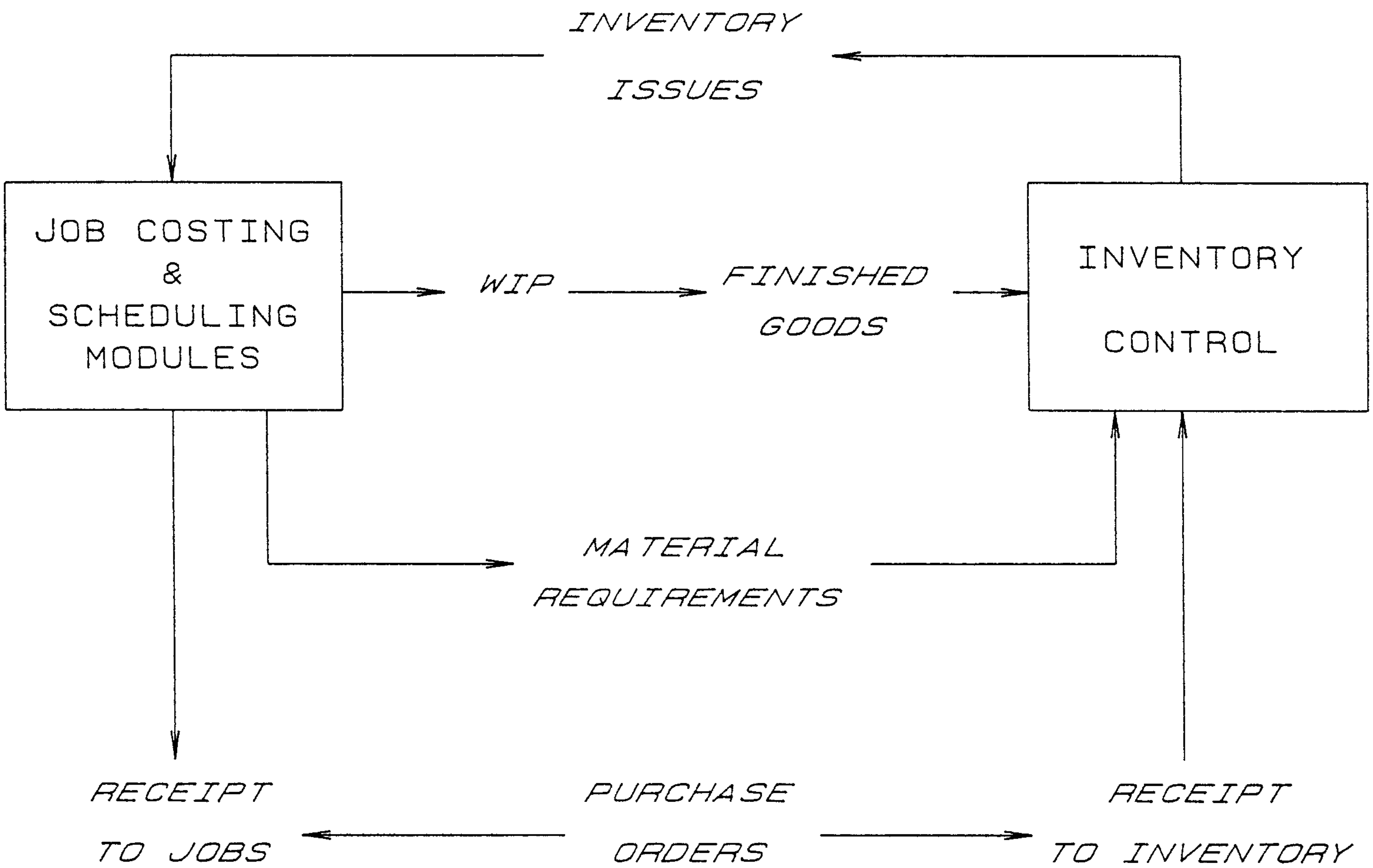

FIGURE 7.17 DCD INVENTORY/PURCHASING MODULE (10)

nonetheless, with the number of different materials for so many different jobs, the task becomes overpowering. DCD's integrated features permits all necessary input information to be automatically transferred from the generating module.

The Inventory/Purchasing module has additional features. Accounting information is available. For instance, on-hand, on order, minimum and maximum quantities are all kept current. Items can be costed for average, last or standard. ABC class codes can be used as a basis for reports and analyses. For purchasing related functions, purchase orders can be tracked by P.O. number, job, or part number. In addition, histories may be retained for vendors in order to analyze vendor performance. (9)

As stated earlier, lacking stock can delays production and delivery schedules, thus, causing irate customers. Excessive inventories tie up capital and floor space. With DCD's integrated system inventory control should become a thing of the past.

7.2.7 Shop Floor Data Collection

In order to have current rates and other production information, data must be collected from the employees. The workers must record their time against jobs and/or indirect labor. The data essential from the employees consists of the following (9):

- Direct or indirect labor
- Job number
- Operation number
- Set up or production
- Quantity produced and scrapped
- Start and end times

The above data is usually collected via labor cards which the workers fill out. The data then is entered manually through a terminal. DCD offers an automated alternative with its Shop Floor Data Collection module. Through the use of bar codes and a specialized version of the routing sheet, data is entered at a tremendous time savings. Once the above is entered, the data collection module can provide an audit of all transactions inputted. The input data is checked and verified by the module. Any labor entry with severe errors is disallowed and brought to the attention of the user. Once the data is accepted into the system labor and burden costs are classified. If the Payroll module has been installed, the employees' hours are automatically transferred. (9)

As discussed in Chapter 2, automatic data collection yields significant savings. The information in the Job Costing is updated almost instantaneously. Furthermore, with constant updating, the timeliness of information is tremendously improved. Not only is the scanning of the bar code simple, but accuracy is increased with the elimination of human error.

CHAPTER 8

IMPLEMENTATION

8.1 Goals

If one observes the benefits gained by DCD and compares them to the company goals, the differences between the two are negligible. All manufacturers would like to be technologically up to date. With proper installation and implementation of a new system, efficiencies are noticeably improved in all affected areas. It has been seen many times how a computerized information system allows companies to become more efficient. The efficiency is gained through the information that becomes readably available with the reports that can be generated. One of the most important benefits is the ability of management to foresee problems and plan in order to avoid such problems. At Teledyne Adams, such a system was not present and many decisions were made after the problems began. In this section the problems which Teledyne Adams would like to overcome via DCD will be itemized. In other words, the objectives Teledyne Adams hopes to achieve with the implementation of DCD will be defined. These objectives are:

1. Gain better control over inventory
2. Be able to perform labor and product analysis

3. Improve scheduling
4. Improve quoting and product cost analysis
5. Automate accounting system
6. Automate purchasing related functions
7. Be able to handle the proliferation of information as the company grows

In any company with many products and a manual accounting system, several areas of the company suffer. One area which feels the effects is inventory control. Recollecting that inventory control (in manufacturing) has been defined as the science of optimizing inventory levels so production can continue without interruption while minimizing inventory related costs. At Teledyne Adams, inventory management is based on a combination of dependent and independent demand. Materials' orders are generated to supply production. In order to take advantage of price breaks larger lot sizes may be purchased. However, production quantities are not increased to use up the excess. The excess inventory is stored for the next order. Although Teledyne Adams does not account for carrying costs, this inventory system is contrary to typical control procedures. Issues and receipts are recorded up to two days after the transaction occurs. As a result, is not up to date. This inaccurate account of capital influences as much as 75 percent of a company's sales dollar.

When an inventory control system is present, any job, material, or part can be traced. At Teledyne Adams, before DCD, no inventory control existed whatsoever. With DCD's inventory control module, the company hopes to gain perpetual inventory control. Teledyne Adams desires the ability to track where materials are being consumed and in what quantities. Previously, registering took place when materials were received and when products were shipped. As far as material tracking was concerned, the factory was a "black box". Unfortunately, because of the absence of control material orders had safety factor quantities to handle any contingencies. Of course, this incurs higher inventory costs.

Labor and material costs are not easily identified when a manual system is used. Teledyne Adams wishes to accurately segregate and allocate costs of the products and between product lines: metal stampings and heating elements. By automating, such as with DCD, Teledyne Adams hopes to tracks and report labor more efficiently. Aside from labor costs, are material costs. The load reports which have been shown as a necessary tool in production planning and control, would be a fringe benefit for Teledyne Adams. Even though they are not presently used at Teledyne Adams, DCD's ability to provide such reports and graphs should make them appealing for managers to use.

Teledyne Adams wants to improve scheduling. As described in Chapter 6, scheduling is performed manually in a hierarchical step by step method. Three schedules are drawn from one master, manually. With DCD, one schedule is produced and released. The schedule is only released after it has been analyzed using present floor conditions. Furthermore, any backlogged orders or partially completed orders which require rescheduling are automatically considered because of the data collection which takes place.

At Teledyne Adams, the quoting system used is very efficient. The major concern is the time required for obtaining raw material or component prices. With DCD, any existing price is readably available. Another benefit mentioned previously is the systems ability to quote using actual production rates. Even though quotes are done conservatively, using actual rates may guarantee accurate pricing. Accurate quotes do not use rates which are too conservative that results in increased prices, thus losing the bid for the job. On the other hand, if the rates quoted are to high, the profit may be decreased at the expense of getting the job awarded.

It is obvious that the accounting system at Teledyne Adams needs to be automated. The recording of transactions is performed manually and needlessly repeated. Receivables are recorded at shipping then the paperwork is logged in accounting. Purchase orders are typed in the purchasing department and then distributed to shipping and accounting. Payables require paperwork from shipping and copies of the purchase orders. These are a few basic examples. Anyone familiar with "manual" accounting knows the amount of paperwork required. With DCD, the automation is inherently done with ease. All the required data and information for inventories, billings, disbursements, and other related activities are taken care of through the systems integration. Although, accounting aspects have not been discussed, the preceding should demonstrate DCD's ability to link the company's "business" functions with the PP&CS.

When a company grows, it is usually through increased sales. Obviously increased sales means an increase in the number of products manufactured. As the number of different products grows, the amount of related data and information multiplies. Eventually, a manual control system will not be able to manipulate the vast amounts of data and information. With a computer system, increasing disk capacity can be easily done so it can handle increases in data and information. In addition, the processing of the data into information, is quickly performed with computers. A computerized PP&CS also yields the benefits from the multitude of reports available.

8.2 Implementation Process

As shown in Figure 8.1, the schedule of events which actually occurred is shown. As with all (capital) projects, a request is submitted to corporate for financing. This entailed preparing a report which shows what returns or

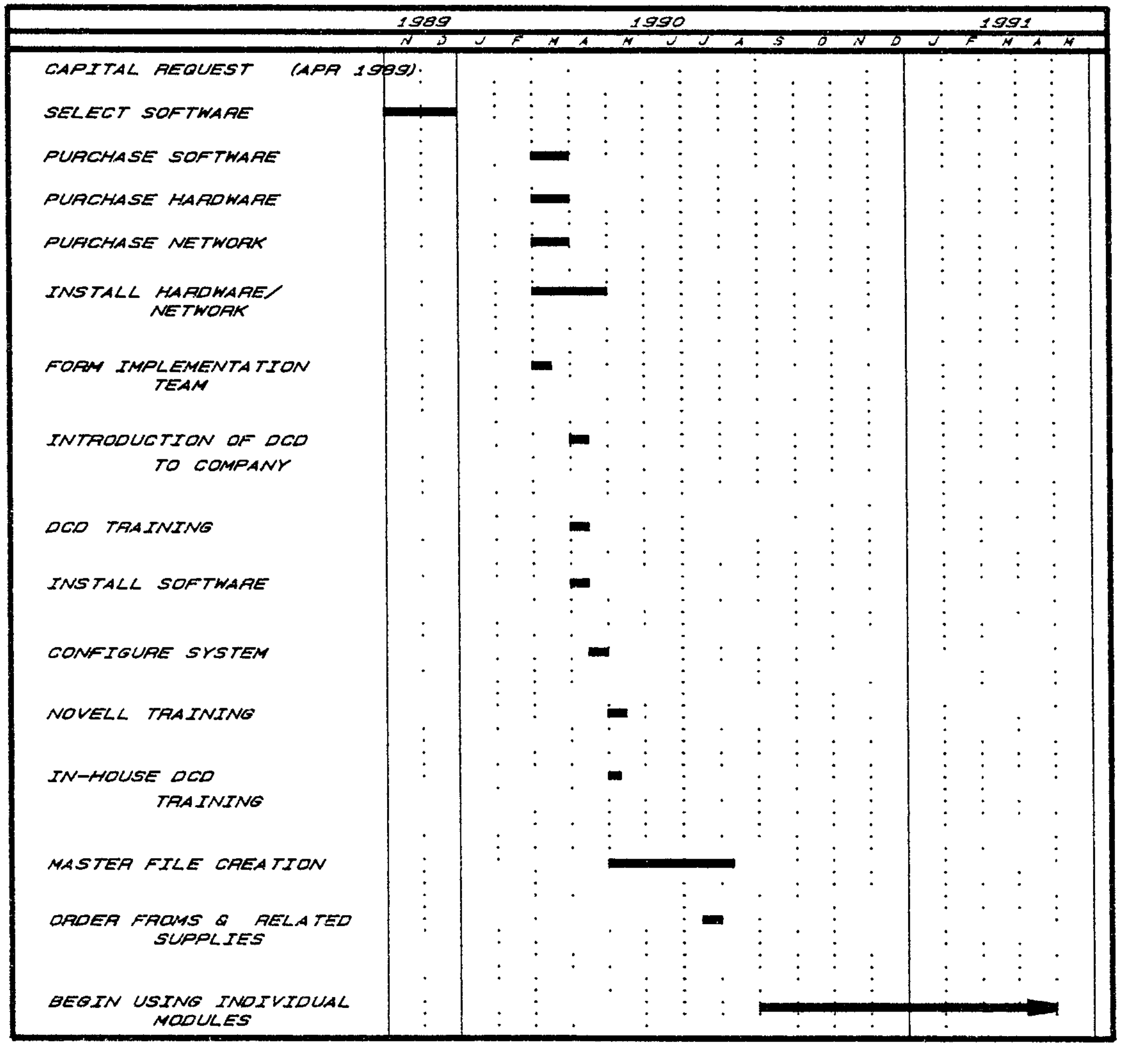

FIGURE 8.1 SCHEDULE OF EVENTS FOR ACTUAL IMPLEMENTATION

benefits were expected. For the DCD system, the benefits Teledyne Adams hoped to achieve were "intangibles". As with any computerization of a information system most of the benefits are difficult to quantify in dollars and cents. Once the project was funded, the selection of the software took place. In section 8.3 a detailed discussion is presented.

The next group of events were concerned with the purchasing and installation of the system. The system consists of the DCD software, the computer hardware, which included the PC's, printer and the file server, and the Novell network. The ensuing steps consisted of the training. The project managers attended formal training for DCD and the Novell network. After a brief company-wide introduction, a three day in-house training session was held. Staff members were encouraged to attend as much of the session as possible, not only the training for their particular departments module of interest.

The most time consuming and labor intensive event of the implementation process was the creation of the master files. All production planning and control information had to be transposed from the manual system to the DCD system. Section 8.4 details what steps were taken for the transposition.

The DCD system has been ready for full implementation since September of 1990. However, in section 8.5, the problems encountered will be discussed. These problems are an important issue which will be addressed later in the thesis.

8.3 Selection of Software

Whenever any project is undertaken, it is normal to look at several paths in order to accomplish the objectives. For projects which pertain to software, one must survey as many packages as possible. These packages can differ in price, functions available, implementation requirements, or hardware needed. For Teledyne Adams' objectives two software packages were reviewed. DCD Job Shop Control and FOURTH SHIFT were the two systems considered. Usually at least three different packages are compared. The two systems have been widely implemented and are established in the PC based PP&CS arena.

Before discussing the reasons why the DCD system was chosen, a brief overview of the FOURTH SHIFT system will be presented. The FOURTH SHIFT manufacturing software is similar to the DCD system. FOURTH SHIFT has the following modules/functions:

- Inventory Control
- Bill of Materials
- Product Costing
- Manufacturing Order Management
- Purchasing
- MRP

- Order Entry
- Accounting

The above modules when compared to DCD's modules have the same basic functions. Consequently, FOURTH SHIFT provides the same benefits the DCD system can. So why was the DCD system chosen? The following answers the question posed.

The software selection was done by the company president. The decision was made after attending seminars and demonstrations of the two systems. Additionally, both vendors demonstrated their systems to the department managers of Teledyne Adams. The managers were encouraged for any feedback which could affect the selection. In summary, the selection was made by carefully weighing all important factors after obtaining all necessary information.

The DCD system was designed for the make-to-order manufacturer, while FOURTH SHIFT was designed for a manufacturer with standard product lines. Teledyne Adams produces based on customers' orders and does not stock any of its production. As a result, DCD seems to be the logical choice. FOURTH SHIFT is more suitable for companies for companies which have standard product lines and carry stock ready to be shipped when an order is placed. Other reasons for not selecting FOURTH SHIFT include:

1. Cannot split an order in progress so as to put sublevel components into stock in case of an over run.

2. Cannot ship from WIP inventory if you are in the standard products module.

3. Report system is inadequate.

In an overall comparison between DCD and FOURTH SHIFT, DCD was chosen for the following reasons:

1. Products can be sorted by type and/or class.

2. Works better with available inventory status.

3. User friendly.

4. Easy to extract information from. Report module is very extensive.

By observing the last two reasons in the above list, the decision should automatically lean towards the DCD system. Of course, the software's applicability for make-to-order manufacturing is of extreme importance. However, one cannot forget that a PP&CS is an information system. Having information readily available is an inherent feature. By making this feature easier and more user friendly the control system's effectiveness is boosted.

8.4 Startup

Just as with any project, planning the implementation is a necessity. For a successful installation, goals must be defined as in the previous section, a time frame for achieving the goals must be fixed, and a plan which specifies what and how the implementation is to be carried out must be drafted. As with all projects, two ideas must be prevalent: commitment by management and communication. Management cannot only authorize the purchase of a system and then expect everything to fall into place. Management must be committed to the project providing all resources necessary for a successful implementation. Communication is one of the most important requirements when more than one person is involved with a project. Problems can be remedied quicker. Efforts will not be duplicated, needlessly. Every one involved can see the entire project's progress, not only their assigned tasks. Furthermore, not only is intra-company communication a precondition, but communication must be maintained between Teledyne Adams and DCD. Who better to simplify solving installation problems than the supplier of the software.

The DCD manual suggests forming an implementation team. The team concept may be casual. In other words, each company should form the team according to its goals and schedules. The concept aids in assigning specific tasks and holding some one accountable. This ensures the project's success. The DCD manual provides a planning checklist. See Figure 8.2. Basically the checklist demonstrates the five major steps required for the implementation. (10) The steps are:

Task	Scheduled Completion	Actual Completion	Respon. Person
1. Identify Implementation Team, including Project Leader, Department Leaders, and System Operators.	________	________	________
Project Leader ______________________________			
Department Leaders __________________________			
__________________________			
__________________________			
__________________________			
__________________________			
System Operators __________________________			
__________________________			
__________________________			
__________________________			
__________________________			
__________________________			
2. Review and discuss hardware training necessary, and schedule accordingly.	________	________	________
3. Review forms and supplies necessary, and purchase.	________	________	________
4. Decide the order in which modules purchased are to be installed, and schedule accordingly.			
Security	________	________	________
Job Costing	________	________	________
Order Entry	________	________	________
Accounts Receivable	________	________	________
Accounts Payable	________	________	________
General Ledger	________	________	________
Payroll	________	________	________
Inventory	________	________	________
Purchasing	________	________	________
Estimating	________	________	________
Data Entry/Data Collection	________	________	________
Enhanced Scheduling	________	________	________
Bill of Materials	________	________	________
5. Establish schedule for periodic meetings of the Implementation Team, to continuously review installation progress.	________	________	________

FIGURE 8.1 INSTALLATION PLANNING CHECKLIST (10)

1. Form an implementation team
2. Hardware training
3. Review supplies necessary
4. Schedule installation of modules
5. Hold periodic progress meetings

At Teledyne Adams the five implementation steps have been loosely followed. The implementation is being managed by two people the office manager and the president. At the present moment three modules are being installed. The modules are inventory/purchasing, BOM, and general ledger. Obviously, accounting and inventory control are the first two areas being considered.

However, even though the accounting aspects are being considered, the BOM module is a major module. The importance of the module can be seen in the data and information it contains. Not only are materials and components that are required for assemblies detailed, but also operations. Most of the work implementing DCD is in the creation of the "master files". In essence, the files contain details and assign numerical codes for their respective subject. For the three modules currently being implemented, the following master files were set up:

For BOM:	Workcenter Operations Part master Department Inventory class

For Inventory/Purchasing:	Part master Vendor Inventory class Warehouse locations
For General Ledger:	Department Division Period balance Journal Account budget

Due to the fact that DCD modules are integrated, master files are shared. For instance, the Part Master and Inventory Class files are employed by both BOM and Inventory/Purchasing modules. In another example, the department master file is used by both General Ledger and BOM.

The following briefly describes the master files listed above. In the BOM module, the workcenter file contains the workcenter data. The data consists of a numerical code assigned to the workcenter and a "home" department. Also, the burden (overhead) rate, quoting rate, lag time between workcenters and number of machines are contained within the file. The operation file provides descriptions of operations, also with a assigned numerical code. Data in the file includes labor rate, set up standard and production standard. The operation standard can be edited for individual parts to give more detail about the process. The part master is one of the most significant master file because it drives several modules with the data it contains.

Besides part description, inventory related data is in the file, such as if the part is a purchased item or manufactured. Inventory class, order and inventory units of measure, (primary) vendor, ABC code and warehouse location are other data related to inventory in the master file. Costs are maintained in the file. The unit costs include labor, burden and material. These unit costs are recorded for average, standard and last. The Department and Inventory Class master files are lists of department numbers and inventory class numbers, with their respective description. The files primarily provide the modules with descriptions of departments or inventory class when the appropriate number is entered in the respective field. As previously listed the Inventory/Purchasing module uses the part master and inventory class files. In addition, the vendor and warehouse master files are used by the module. The warehouse (location) master file is a list of different storage locations the company may have. The file is a list which assigns numerical codes to the locations. The vendor master file is used by purchasing and accounting. Vendor data such as address, contact name and discount are used by purchasing. However, for accounting purposes, additional data is stored in this file. This data includes objects such as, last invoice number, expense account number, month-to-date and year-to-date order data.

8.5 Implementation Problems

There has never been any installation of a system that has not encountered some problems, whether major or minor. Of course, in implementing a PP&CS such as DCD, typical problems occur which are distinctive to production control systems. As will be shown, Teledyne Adams has experienced such problems. The major problems encountered are as follows:

- No manual PP&CS was present.
- No reports or any type of feedback existed from the production floor.
- Too much personnel lacking experience in computers.
- Accurate labor reporting not emphasized.
- Limitations of part numbering system exposed.
- Insufficient training.

In the following paragraphs these problems are discussed in detail.

Teledyne Adams' problems are severely magnified by the fact that no formal (manual) PP&CS existed. This produces much more reluctance by personnel than normal. Most people by nature resist change. This resistance arises from the fear of the unknown. People become comfortable with the status quo and thus, reject change. Unfortunately, at Teledyne Adams, the supervisors and production line workers are accustomed to working to their department schedule only. They attempt to achieve the schedule and only report discrepancies as a last resort. There is no feedback information or job status reporting. For instance, material is pulled from inventory as needed without any recording of the transaction. Such actions are not tolerable by any PP&CS, computerized or not. This lack of background in production control systems on a plant wide basis is a tremendous obstacle for the implementation.

The problems of "computer-phobia" are characteristic in any application of computers. With all due respect, most personnel directly linked to the production floor, see computers as a threat to their job. They do not perceive computers as a tool to enhance their job and increase their productivity. The fears stem from their "computer ignorance". More important is the "ignorance" which is found in the office environment. Some managers find their current methods of handling information sufficient, if not efficient. As a result, the managers are not committed to the success of the implementation. Support from the different disciplines (engineering, purchasing, production management, and inventory management) is not evident.

The production control system's effectiveness is based on the data supplied to it. For instance, labor rates and material prices must be kept up to date. At this time the data collection has been planned to be recorded by the workers on a daily labor (report) sheet and then entered into the system via a terminal. Therefore, the operator must submit these sheets with accurate information. Presently, some workers do not submit any labor sheets. Some of those who do fill out the sheets do so to keep their supervisor quiet. Obviously, the consequences of haphazardly reporting labor is not realized by the workers.

The installation of DCD has compelled Teledyne Adams to re-evaluate the way things are done. The revaluation uncovers problems in the techniques being used currently. One such problem is the part numbering system. The system employed at Teledyne Adams is very explicit. However, no part number was assigned to customer supplied materials. Thus, Teledyne Adams had no way of tracking these materials or how much labor was being expended. The new system forced Teledyne Adams to fix such loopholes, and have things performed in a correct manner. At times, people take shortcuts in order to expedite things. Although their intentions are good, it is rarely understood that more harm is being done. The harm is not realized until it is too late.

As a result of accurate information another type of fear is created. This fear of accuracy may reveal problems never thought existed. Now, the list of problems increases. Furthermore, conditions may be bad when thought to be good.

As an extreme example, because of the accuracy of labor reporting, what were seemingly profitable jobs may actually be losing money.

Another problem experienced at Teledyne Adams was the implementation process itself. No formal training was presented for DCD. The in-house training only provided overviews of the functions of the system. No hands-on training was provided. As a result, managers and supervisors have very little familiarity of the methodologies used by the DCD software. The personnel assigned the physical task of starting up the system labored to learn by self taught methods. These people read the vaguely written manuals which explain how but, not why. Most of their education was "on-the-job-training". In summary, they learned by doing. Due to the lack of training, three more problems emerged. The first was assigning the correct personnel for specific tasks. For instance, engineers created the BOM files instead of data entry clerks; a highly inefficient use of resources. The second problem was using the system for what it was designed for. For example, utilizing modules partially, when more benefits can be derived from full use. Arbitrary labor rates were entered with the intention of using the rates for reporting instead of the actual rates. The third problem is a result of the lack of training and misusing the system. Unless, stumbled upon by adventurous users, certain functions will not be used. Of course this diminishes the system's efficiency. Knowing all available functions allows the company to use the system to its fullest capabilities.

Some of the problems described above are typical for installing new systems. The other problems are distinctive to Teledyne Adams. In the next chapter possible solutions or how the problems could have been avoided will be explored.

CHAPTER 9

RESULTS

The installation of any type of system in a company, requires patience. To get a system fully implemented usually requires years. Today, too many companies require quick returns on their investments'. One cannot overemphasize that patience and commitment are needed in any system which drastically changes the way a company thinks or works. In the following, several recommendations will be made which address the problems described in the previous chapter. In any case, one must realize that any suggestions or solutions will require time before any benefits can be realized.

Since no manual PP&CS existed, no comparison can be made. For example, the computerized system cannot be compared to the manual system. Therefore, the benefits cannot be quantified, such as labor savings. As mentioned previously, the benefits realized are "intangibles". The following lists what has been accomplished by Teledyne Adams with the current implementation of the DCD system:

1. The computerization has proven to provide inventory information quickly.
2. Purchase order turnaround time streamlined due to clerical time savings.

3. Accurate material receipts.
4. Quoting procedure made more efficient and accurate.
5. Inventory problems easily traceable.
6. General ledger automated.

The list will be lengthened as time goes on and more modules are utilized. Additionally, with more experience with the system the utilization and efficiency will increase.

A PP&CS is a group of methodologies integrated together into a system. Each methodology outlines procedures for achieving their respective goal. In order to use such a system and methodologies, the users must be versed with the system. At Teledyne Adams most managers do not understand production control systems. For a successful installation and implementation of the DCD system, the managers and supervisors of Teledyne Adams should be introduced the fundamentals of production control systems. The training should provide background in PP&CS methodologies. More defined training should be provided to managers whose department lies in the heart of the respective methodologies. For instance, production schedulers and purchasing should be acquainted with material requirements planning. Capacity planning should be understood by production managers and supervisors. Purchasing should know how to control inventory. Hopefully, having management and the staff educated in production control should yield favorable results. The day to day operations regarding production control should be practiced with ease. Examples include the use of move tickets, dispatching routing sheets, establishing stockrooms, using stock requisitions. These seemingly minor activities are the inputs which drive their respective methodology.

In order to obtain accurate labor reports, the factory workers must be disciplined in their reporting. Perhaps through the use of an incentive plan, the preceding may be accomplished. As an alternative, is to label the machines with the necessary data. The burden would rest on the department supervisor to supply the necessary data. For instance, if a particular workcenter was used for several jobs, the supervisor would be responsible in making sure the correct information was given to the operator. As a check, the supervisor would also be required to sign off each sheet for proper data. Hopefully, in time the workers would not require constant checking.

All of the foregoing paragraphs do not mention DCD or the use of computers. It may be beneficial, if at first a manual production control system was initiated for a period of approximately a year. Then when DCD is installed the burden would be diminished. The methodologies which are used by DCD would already be understood. The shift would be from a manual system to an automated one.

Once Teledyne Adams becomes comfortable with the manual system discussed above, only then should the implementation of DCD take place. In this period, training should be provided for the DCD software. Anyone involved working with DCD should first be given an overview of computer basics. The overview should include basics of computer hardware, fundamentals of MS-DOS, and an overview of computer networks. Knowing the essentials should dispel some of the fears associated with first time computer users. The next step is to provide an overview of DCD. All managers and staff involved in any capacity should be acquainted with DCD and its logic. The more interaction a person will have with DCD, the more training they should receive. For instance, any staff responsible for supervising data entry personnel or will use any of the reports available from DCD's modules, will necessitate intensive training.

Nevertheless, the start up outlined may require hiring additional personnel with the primary responsibility of operating and maintaining the system. Obviously, the ultimate goal to implement the DCD control system will require a few years to reach. With patience and commitment, many benefits and returns will be realized.

CHAPTER 10

CONCLUSIONS

The installation and implementation of a production control system in a diversified manufacturing company has been analyzed. As with any project which impacts an entire company, problems were encountered. At Teledyne Adams the task of implementing the DCD Shop Floor Control System the task was compounded due to the lack of background in production planning and control systems. No formal production control system existed at Teledyne Adams. The proposal was made to introduce a manual production control system before implementing any computerized system. Consequently, the date for achieving full implementation will be pushed back. It was noted that company wide commitment and patience was required for a successful implementation. At the writing of this paper the implementation of the DCD system is still currently in progress. Should any of the recommendations presented be utilized, the outcomes remain to be seen.

The fundamentals of production planning and control systems were presented. The discussion served two purposes. First, to provide background on generic production control systems. Second, to serve as a meter by which the implementation may be measured by.

A systematic approach is essential to implementing a production planning and control system. A two step process was suggested for implementing the DCD Shop Floor Control System. First, introduce a manual production control system and practice it until the company becomes comfortable with such a system. At the same time, educate everyone in the essentials of production control systems. Providing in-depth training for personnel directly involved. Second, supply formal training to all personnel involved with DCD. Additionally, give overviews in the principles of computers to anyone interacting with the DCD system directly.

Once the DCD Shop Floor Control System is fully implemented, more optimization can be achieved by installing automated data collection. The data collection can be performed via bar coding. It will be shown, in the discussion of Future Work, that data can be collected more quickly any efficiently. However, the employment of a bar coding system would entail another comprehensive implementation task.

In summary, in order to implement any system in a company, patience and commitment are necessities. By furnishing personnel with proper training and education ideal conditions can attained so time can be save and difficulties avoided.

Another concluding note is about the thesis itself. The background research provides an excellent base and overview in the area of manufacturing management. The application of such methodologies was found in the logic employed by the DCD Shop Floor Control System. From the actual implementation, two important lessons were learned. First, the necessity of commitment by management so as to succeed in any project. And second, problems will always arise when attempting to apply theoretical methods in a real life situation.

CHAPTER 11

FUTURE WORK

Teledyne Adams will be required to investigate its options with regard to educating the staff. Since the implementation has already been started, the company may change its current plan to the one proposed. The course to be taken at this point needs to be addressed by management. Again, patience and commitment are necessities no matter what management decides.

After the DCD Shop Floor Control System is fully implemented, the next logical step is to streamline the system. The area which impacts the system the most is data collection. Production systems require accurate data to work efficiently. Since production systems are essentially information and decision systems, if the system is supplied with bad data, then bad decisions are made. Automated identification systems tremendously reduce the amount of bad data. These automated systems are faster to automate than other types of automation. If applied properly, high returns and fast paybacks can be realized. Of course, the most important payback is the reduction of errors in collecting data. Automated identification system's main purpose is to collect data, it cannot solve production problems, However, it helps in finding where the problems are. (11)

Automated identification systems use different technologies. Some of these technologies include bar coding, radio frequency (RF), magnetic stripe, and optical character recognition (OCR). Bar coding is the most suited to withstand factory floor conditions. In the following, the benefits of implementing a bar coding data collection system are discussed.

In collecting production data manually, production workers are forced to do some clerical tasks. The workers must take time out from their production duties in order to fill out forms, such as labor sheets. Unfortunately, this task has a cost associated with it. IN order to avoid using shop clerks or supervisors as means to collect the data, production workers are required to do some of a clerk's duties. Consequently, many production workers are inept or reluctant to do the required tasks. This can result in bad data. Bad data comes from two sources, lack of accuracy and lack of timeliness. (8) The lack of inaccuracy is primarily transcription errors, from mistyping or decoding poor handwriting. The lack of timeliness is due to "batching" of data entry sheets. The sheets are allowed to accumulate and then entered in a periodic fashion. Obviously, the information the production control system gives may not be up to date. Also, it is possible that the product is shipped before the related data is entered into the system. These actions defeat one of the purposes of a production control system.

Anyone can pass a wand over a label. No errors are produced in the collection process. Bar code errors occur 10,000 times lower than entering the same data via a keyboard. Additionally, the speed at which that data is entered is ten times faster. (1) Another benefit is the reduction of paper on the factory floor. For instance, routing or labor report sheets. are no longer required. In addition, productivity and utilization of production workers are increased, since much less time is spent doing clerical tasks.

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