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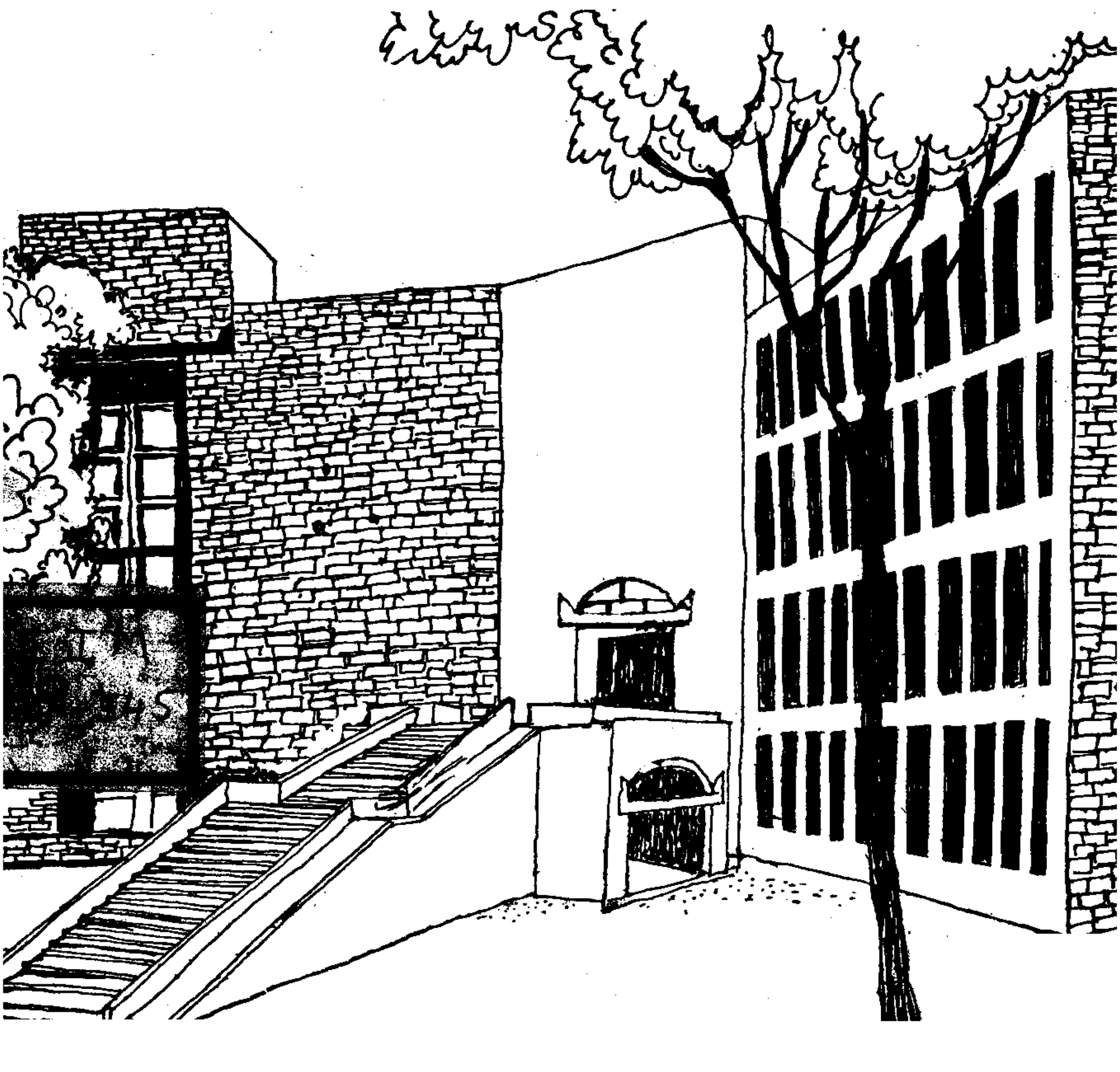

MANUFACTURING RESOURCES PLANNING--A STUDY

By

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MANUFACTURING RESOURCES PLANNING - A STUDY

by

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Manufacturing Resources Planning can be said to be one of the most significant developments to have taken place in the area of manufacturing software in recent years. It is also termed as MRP - II, to distinguish it from Materials Requirement Planning (MRP), from which it evolved. In effect, MRP-II provides a comprehensive framework for integrative planning and control of manufacturing resources, within the context of a specific type of industry and for a given firm. Typically it adopts a modular approach and generally includes the following main planning and control modules:

1. Resources Requirement Planning (RRP)
2. Production Planning (PP)
3. Master Production Schedule (MPS)
4. Materials Requirement Planning (MRP)
5. Capacity Requirement Planning (CRP)
6. Shop Loading and Shop Floor Control (SFC)
7. Inventory Control (IC).

MRP-II framework attempts to integrate the above planning and control modules into a single whole. Like every good system for manufacturing planning and control, MRP-II too focusses on the key manufacturing tasks of dependability, flexibility and cost. The central concern of MRP-II could be summed up as one of ensuring manufacture in the right quantity, of the right product, at the right time with right quality.

1. Manufacturing Resources Planning in different Industries

MRP-II as a broad comprehensive framework of resources planning is applicable to any type of industry. Nevertheless, special characteristics of a specific type of industry or firm need to be taken into account so that the framework could be modified to make it most appropriate for the industry under consideration.

In the subsequent discussions we attempt to discuss salient aspects of MRP-II as applicable to different types of industries. For the purpose of this discussion, we find it convenient to classify the types of industries as follows:

1. Continuous Process Industry like chemicals, pharmaceuticals, etc.
2. Industries engaged in repetitive manufacture like consumer durables, electronic products, mass produced items, etc.
3. Industries engaged in speciality manufacture like speciality metals etc.
4. Jobbing type engineering industries like machine building, custom built products, etc.

MRP-II began its early evolution in the jobbing type industry, wherein it comprises of all the modules mentioned above. In this industry it was looked upon as a natural successor to material requirement planning. Soon its relevance started being recognized for other industries as well, although the special characteristics of these industries necessitated some revisions in the framework.

2. MRP-II In Process Industry

Important characteristics of the process industry with reference to manufacturing environment could be briefly summarised as follows:

- Manufacturing capacity is well defined
- they frequently have dedicated storage facilities
- they require long lead times for procurement of new equipment
- they have a shallow bill of material
- the product yields often tend to vary widely
- they often experience large demands for intermediates.

- the generation of by-products complicates inventory management
- the product routings are often fixed by process design.
- they generally do not allow warehousing of work in process (WIP)
- they often have in house computer systems
- they have to deal with situations involving variability in raw material quality, variability in bill of material, limited shelf life of products and raw materials.

Manufacturing Resources Planning therefore needs to be adapted o suit the above mentioned characteristics. In particular, there hould be complete clarity as to the nature of the important interfaces hich MRP-II should have with production and inventory control (PIC) n the process industry. Table 1 summarises one possible approach to nterfacing MRP-II with the PIC environment in process industry.

Table 1: Process Production & Inventory Control Problems and MRP-II

rocess Shop Situation	Interface with MRP
Allocation of production among various plants and machines	Uses DRP outputs/sales forecasts as Inputs to Master Production Scheduling.
Economical uses of Bye Products	Time phases gross requirements generated for bye products provide planning information for scheduling the bye-product processes.
Components (liquids, rolls, etc) stored on shop floor	Provides floor bucket as well as store room bucket in inventory record to maintain data integrity.
Poor batch quality resulting in entire batch scrapped	Maintain safety stock at economical plant or increase lead time to keep schedules valid.
Definition of units for Master Production Schedule and Bill of material	Use same units as DRP Units/customer order.
Portion of Output sold or transferred at various points in production processes	Treat demand for output as service part demand in standard MRP
Nature of materials regarding handling costs, shelf life, storage, etc.	Determine overhead costs of such factors based on historical data and factor into planning lot sizes.

Based upon the above considerations of industry characteristics and MRP-II interfaces a suggested framework for manufacturing resources planning in Process Industry is depicted in Figure 1 below:

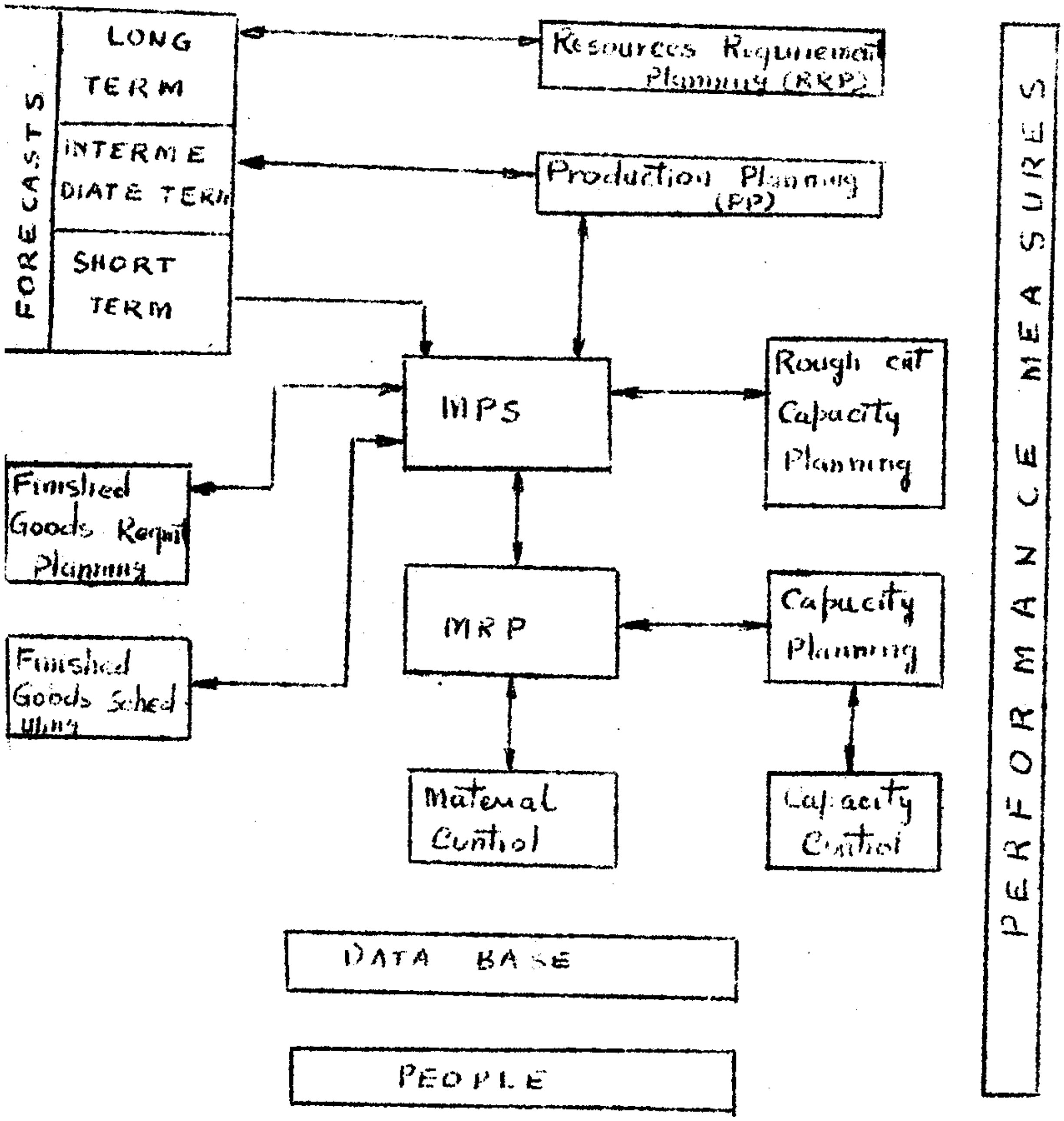

Figure 1: Suggest Framework for manufacturing Resources Planning in Process Industry

MPS - Master Production Scheduling

MRP - Material Requirement Planning

In the above framework, hierarchical integration is provided by the relationships between the long range resource requirement plan, the intermediate range production plan, and the modules for short range planning, scheduling and control. Table 2 gives a comparison of levels in a hierarchically integrated production planning system.

Table 2: Comparison of levels in the hierarchically integrated system of MRP – II

	Resource requirement Planning (RRP)	Production Planning (PP)	Production Schedule
Classification	Strategic	Tactical	Operational
Output	Resource Acquisition Plan	Resource Utilization Plan	Execution Schedules
Time Horizon	Long	Intermediate	Short
Detail	Highly Aggregated	Moderately Aggregated	Detailed
Managerial Level	Senior	Middle	Low
Degree of Uncertainty	High	Medium	Low

While RRP and PP modules provide for planning of entire material flow, operational integration is necessary for co-ordinating the short range plans of purchasing manufacturing and distribution. The material flow is ususally from purchasing to manufacturing to distribution. The information flow is however in the reverse direction. Often the short range planning and scheduling modules are divided into functional areas. Figure 2 shows a possible division of short range planning and scheduling modules into functional areas of purchasing, manufacturing and distribution.

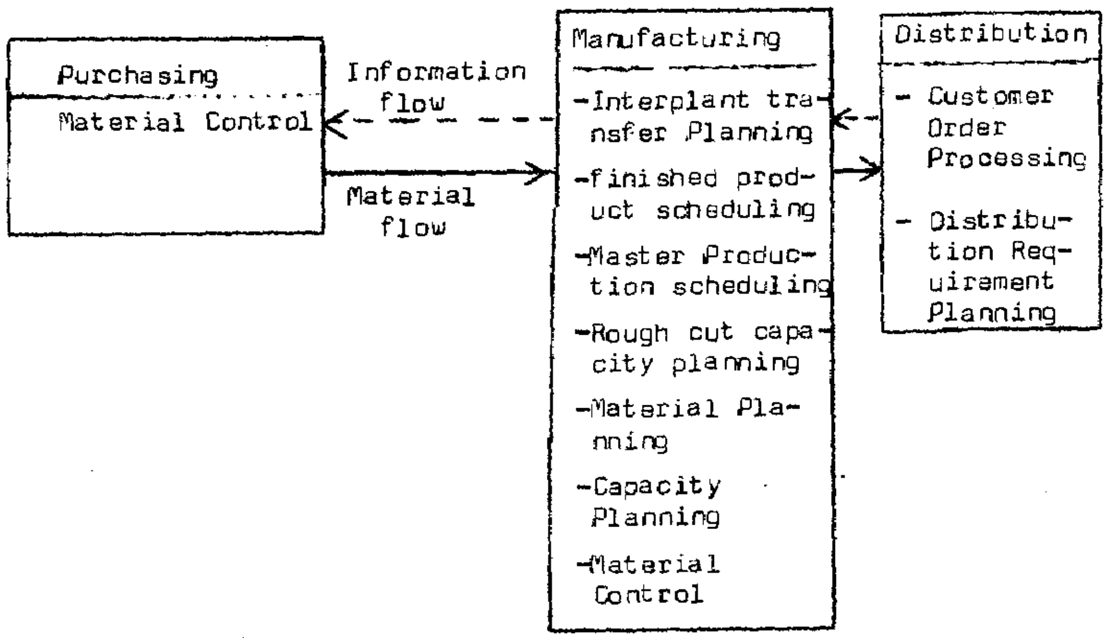

Figure 2: Operational Integration of short range plans

Since MRP-II adopts an essentially modular approach, it is of crucial importance to keep in mind detailed design considerations for each of the modules. Table 3 provides a summary of specific design considerations involved in each of the modules of MRP-II, particularly with reference to process industry, although the considerations are general enough to be applicable to the manufacturing industry in general.

TABLE 3: DESIGN CONSIDERATIONS INVOLVED IN VARIOUS MODULES OF MRP-II

MODULE FORECASTING

- whether to forecast demand, sales or both
- what level of product and geographic detail is required
- what time horizon should be covered
- what time intervals should be used
- How frequently forecasts should be updated
- Accuracy of alternative forecasting techniques
- Cost of alternative forecasting techniques

- Cost of forecast errors
- Availability of historic data
- Ability to combine managerial judgement and market intelligence with Quantitative techniques
- Motivation for sales and marketing personnel to provide detailed and accurate judgemental forecasts
- Responsibility for each forecasting activity
- Performance measures for each forecast.

MODULE: RESOURCE REQUIREMENT PLANNING

- What resources need long range planning
- What time horizons should be used
- What level of product, time and geographic detail is required
- How frequently should plans be updated
- What modelling techniques can be used to aid decision making
- How should probabilistic events be considered in the decision making process
- What data is required
- What costs are associated with wrong decision
- Who should be responsible for each planning activity
- How closely linked are the Long Range Resource Requirements Plans and the Intermediate range production plans.

MODULE: PRODUCTION PLANNING

- What time horizon and update intervals should be used
- What levelof product, process, time, and geographic detail is required
- How should demand be allocated among multiple plans.
- What strategy should be used for meeting seasonal demand.
- How should aggregate production be matched to aggregate demand
- How should safety stocks be determined
- What is the customer service policy regarding stock availability.
- How should probabilistic events be accounted for in the production plans
- How much cycle stock is required
- Where should inventories be positioned in the material flow
- What products should be made-for-stock and what products made to order.

- Can the sales mix of finished products be optimized
- Can finished product Recipes (blends) be optimized
- Is there a natural production scheduling sequence.
- Should requirements for Major Raw Materials be planned directly from production plan?
- What is the cost of obtaining and maintaining the required production planning data
- Who should be responsible for each production planning activity.

MODULE: DISTRIBUTION (FINISHED GOODS) REQUIREMENT PLANNING

- How many distribution centres are required and in what locations
- Should Private, Public, or Leased Facilities and Equipment be used for storage and transportation activities
- What transportation mode should be used for replenishing each warehouse.
- How should bethe primary supply point and transportation mode for each customer location be determined
- How should the size, timing, and mix of replenishment shipments be determined.
- How much in transit inventory will be required?
- How should safety stocks be determined
- Will emergency shipments be permitted from near-by warehouses or only from the Master Warehouse.
- Who should be responsible for each activity.

MODULE: MASTER PRODUCTION SCHEDULING (MPS)

- What items should be master scheduled
- What time horizon should the MPS cover
- What time horizons should be used
- What time fences should be used
- How frequently shouldthe schedule be updated
- How closely should the schedule be linked to the Production Plan
- Will the schedule be disaggregated further before its execution
- Can quantitative methods, such as LP, help in developing a schedule?
- What techniques should be used for Lot sizing and sequencing
- Which activities should be computerized and which should be manual.
- What is the cost of Obtaining and Maintaining Scheduling Data
- Who should be responsible for MPS

MODULE : MATERIAL REQUIREMENT PLANNING (MRP)

- What items should be included in MRP
- What time horizon should the MRP cover
- What time intervals should be used
- How frequently should the plan be updated
- Should a net change or regenerative approach be used
- Should forward or backward scheduling be used?
- What techniques should be used for Lot sizing and Sequencing products on machines
- How should safety stocks be determined
- Where in the Processing sequence are inventories required to buffer sequential operations
- Should Material Planning be computerized
- Who should be responsible for material planning activities.

MODULE: MATERIAL CONTROL

- Is a final schedule having smaller time increments than the master production schedule or the material plan required
- What formal procedures and documents are required to give operating personnel the authority to produce or purchase materials.
- How should production and consumption of materials be measured and reported.
- How should receipts of purchased materials be reported
- What techniques should be used for verifying inventory record accuracy.
- How frequently should inventory records be verified.
- How should customer service data on stock availability be captured and reported.
- Should inventory investment be reported by replacement cost as well as book value
- What systems and procedures should be used to monitor and control yield, scrap, and quality
- How should productivity be measured and controlled
- Who should be responsible for each activity

MODULE. CAPACITY PLANNING AND CONTROL

- Are master production schedules and material plans feasible
- What factors constrain operations
- What capacities will be required of equipments, storage facilities, work force size and skills, effluent and noise restrictions, energy availability, limitations on exposure of employees to toxic substances.
- Are resource loads in conformity with the available capacities
- How is monitoring and control achieved of i) equipment utilization and mechanical down time, ii) man power utilization, iii) energy utilization, iv) waste generation and disposal.
- How should the necessary data be captured. How should it be reported.
- Who is responsible for each activity
- Are lead times, work in process and capacities in conformity?

It will be observed from the detailed description of the considerations of various modules of manufacturing resources planning, that the framework lays special emphasis on certain areas in planning, scheduling and control of process industry operations. Mention may be made of the following such areas:

2.1 Production Plans: 1) Sourcing decisions; ii) sequencing products through facilities; iii) optimizing product blends, iv) determining target safety stocks; v) coordinating production and maintenance plans; vi) temporary shut down of plant or line to reduce inventory; exchange or swapping agreements; vii) determining material requirements; viii) developing aggregate production plans.

.2 Scheduling and Control - 1) Greater use of capacity oriented MPS methods, ii) more emphasis on DRP and Interplant transfer planning; iii) closer coupling of MPS with forecasts, production plans, and DRP; iv) Less customer interference with MPS, v) Lot sizes dictated by facilities design or manufacturing practices for ensuring product quality; vi) schedule is in reality the authority to produce; vii) sequencing generally accomplished in PP/MPS; viii) schedules generally have smaller time intervals.

3. Manufacturing Resources Planning in Repetitive Manufacture

The important characteristics of repetitive manufacture could be described as follows:

- Long continuous production runs of high volume, rather than runs of discrete lots

- production lines tend to be fixed, machines and people grouped according to the product produced.

- Standardized products are produced.

- There are blanket schedules instead of manufacturing orders

- internal lead times are relatively short

- products are commonly processed in line

- operations are often combined

- In a steadily flowing process, lead times are difficult to be associated with products.

- For operations, capital intensive and special purpose equipment is often used.

- work centres provide highly specialised operations

- fixed costs are relatively high, but still direct costs are low.

Figure 3 gives the framework of manufacturing resources planning suitable for repetitive manufacturing situation. It is noteworthy that in this case, it is the marketing plan and the operating budget derived therefrom which drive the MRP-II. The other modules remain more or less similar to those of process industry case.

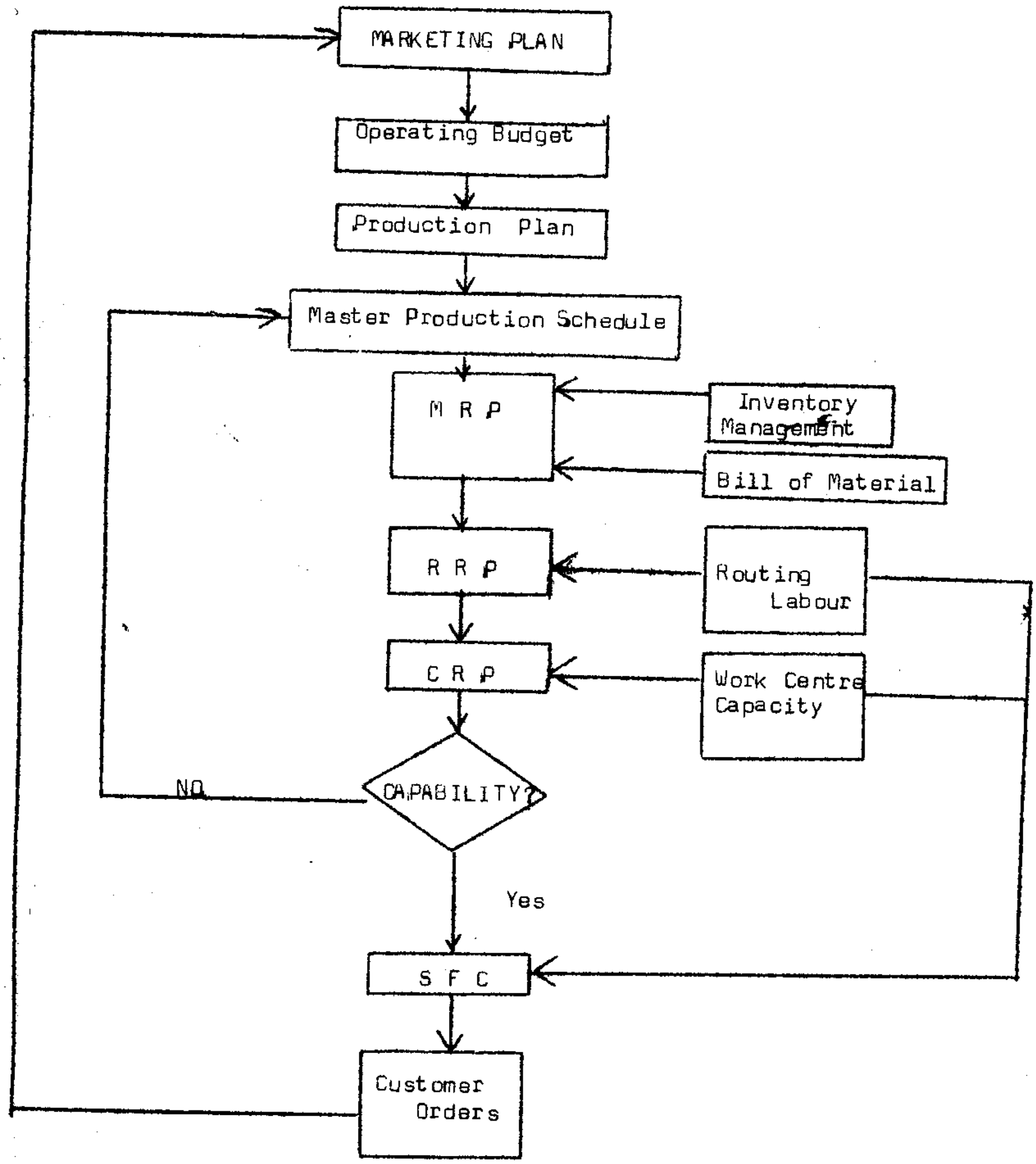

Figure 3: MRP-II Framework for Repetitive Manufacture

MRP - Material Requirement Planning

RRP - Resources Requirement Planning

CRP - Capacity Requirement Planning

SFC - Shop Floor Control.

The implementation of MRP-II in the repetitive manufacturing environment must be modified to deal with the highly specialised problems created in such a system. Some of these problems are as follows:

- Material lot integrity is not always maintainable
- Maintaining shop floor reporting is difficult
- Detailed job status reporting is not possible
- Performance must be monitored without dependence on discrete manufacturing order mechanisms.
- Work performed (but not completed) against one schedule is often transferred to updated schedule.
- Inventory record balances are often less accurate than those kept by discrete manufacturers.
- Schedule changes may be frequent and are very rapid.

We now briefly discuss the MRP-II modules for repetitive manufacturing situation.

3.1 MODULE : MASTER PRODUCTION SCHEDULING (MPS)

The main goals of the MPS module are: i) to translate the production plan into a manufacturing rate, ii) to validate the available plant capacity at a gross level, iii) to assist in resource planning, Translating the production plan into a manufacturing rate is accomplished by exploding the production schedule using the standard bill of materials to create gross requirements for the MPS. The results of MPS are:

- Component issue requirements for items on production schedule
- Regenerative system which relieves the user from having to maintain requirement records.
- Provides a safety stock of 20 - 25% of WIP inventory

The method is reasonably accurate but doesn't require any massive record keeping effort.

3.2 MODULE: RESOURCE REQUIREMENT PLANNING

The RRP analyses a manufacturing facility's capability to execute the MPS. This allows the management to examine the impact that critical resources have on the proposed schedule. RRP generates a resource loading report that summarizes the resource requirements of the MPS, which helps locating areas where resource constraints will most likely take place. RRP defines the supply and consumption of the critical resources in the manufacturing facility, and indicates the best implementation of the MPS to fit the capacity limits. The main purpose is thus to evaluate the overall impact of a given MPS. In repetitive manufacture, RRP is conducted at a macrolevel by using rough approximations of load. It is accomplished by exploding load profiles and bills of labour from the MPS. Some positive features include the following:

- Since RRP utilizes load profiles which identify only a few key resources, massive supporting data is not required.
- RRP's planning horizon, unlike other MRP II modules is unlimited
- Rescheduling the MPS to compensate for over/under loads is relatively easy.
- Routings are not essential for every item on the MPS.
- Quick simulation of capacity requirements is provided since RRP is the only available tool which permits advance testing of the MPS.
- RRP is gross hours analysis in which all hours or capacities required for the MPS are included in the construction of load profiles.

Because RRP is a pre-MRP analysis, the load projections do not reflect 'on-hand' component balances or completed WIP. In addition since MRP assumes capacity is available, RRP is the only available tool which permits advance testing of Production Plan and MPS. RRP's purpose over the short horizon is to keep loads within the bounds of available capacity. Over the long run, it helps in decisions as to wher if any, additional capacity will be needed.

3.3 MODULE: MATERIAL REQUIREMENT PLANNING (MRP)

The purpose of the MRP is to determine the materials needed at each point in the production process from procurement through work-in-process to end product shipment. To be effective in repetitive manufact

MRP must recognize that tracking material by location against requirements in that location is more meaningful than tracking component issues to specific manufacturing orders. This status information is provided by establishing WIP inventory, buckets and tracking the moveme of material through the WIP buckets as it is issued and consumed on the manufacturing floor. Material requirements will determine the number of WIP buckets in each case. Items are assigned to WIP buckets as a function of item inventory control classification.

- Controlled items are specific line items on MPS. Quantity required to support the MPS regulates the quantity issued.

- Bulk items used in general support of manufacturing activities are issued in convenient quantities and are not tied to requirements in the MPS.

- Expensed items issue requirements are assumed to be met when issued to the shop floor.

Figure 4 shows the material flow model for MRP-II in continuous production. The model provides a definite distinction between the WIP inventory buckets where material control is difficult, and the stores inventory buckets where maintaining tight control is common. As degree of control increases, so does the precision and integrity of data required. This inuvitably involves increased paperwork, time and money.

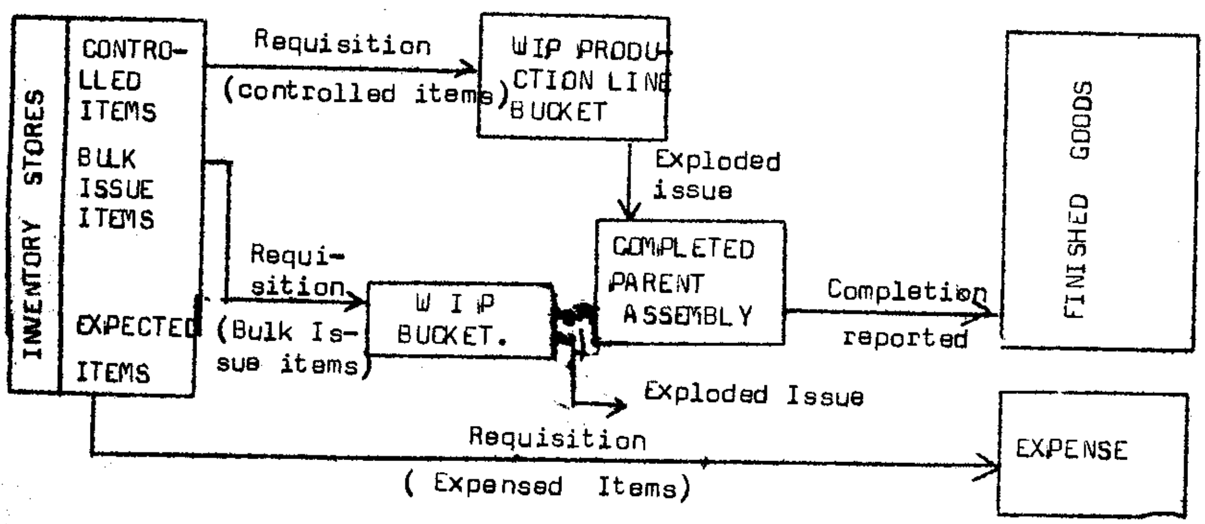

FIGURE 4: MRP Material flow model for repetitive manufacturing

3.4 MODULE : CAPACITY REQUIREMENT PLANNING (CRP)

CRP performs the function of establishing measuring, and adjusting levels of capacity that are consistent with the production plan. CRP is the process of determining the amount of labour and machine resources required to meet projected production levels. The basic tool which provides information on loads is the load report. After all load profiles are calculated through RRP, the resulting requirements are compared with known production capacity of the manufacturing area. For scheduling purposes, CRP assumes that there is infinite production capacity, and then after comparison with the known capacity indicates work centres with projected overloads or underloads. Like MRP, CRP also must recognize that tracking work load hours by location against requirements in that location is more meaningful than tracking time phased labour required by work centres to specific manufacturing orders.

When capacity requirements exceed available capacity, there are two alternatives: i) increase capacity, ii) revise the MPS. The alternative finally chosen must be determined from detailed studies of: i) the area in which excess capacity is required, ii) sales forecasts, iii) the economic status of the company, iv) availability of manpower, v) technological advances in production processes. CRP is an iterative process that considers capacity on three different time horizons: i) Long Range Planning, ii) Medium range capacity planning, iii) short range capacity planning. Exoected improvements are:

- Managing capacity improves the ability to control loads and inventory.

- All work centres that are defined on the load reports are considered.

- Better communication between manufacturing and marketing, resulting in lower inventory levels, fewer stockouts, decreased overhead costs.

3.5 MODULE : SHOP FLOOR CONTROL (S F C)

SFC is a control tool and contains only limited planning elements. Repetitive SFC is implemented through 5 functions:

- Data collection for feedback
- Monitoring progress of manufacturing orders
- Priority assignment and dispatching
- Monitoring work center performance
- Manufacturing order costing and analysis.

SFC must take into account special needs of mass production which include the following:

i) Meaningful data must be generated at reasonable cost
ii) WIP must be controlled
iii) Performance must be monitored without relying on the discrete manufacturing order mechanism.

Data Collection: Each employee completes a document indicating product, lot number, hours worked, quantity completed, for each day worked; and due dates, quantity required, and hours worked.

Monitoring progress: This is done through information on current schedule, routing and operation completions. Progress reports are normally work centre oriented or assembly oriented.

Priority assignment and dispatching - priorities are established and managed by the MRP system. SFC schedules and dispatches work in response to the priorities. The system can respond to priority changes by rescheduling and/or changing the product currently scheduled or in production.

Monitoring work Center Performance - To achieve this, routing and work centre files must exist in the system. If routings are detailed to the operation level, it will be necessary to identify each operation with the work center in which it is performed.

Manufacturing order costing and analysis - Costing and analysis by order is not possible in this system. Average costs are accumulated by product.

Utilization of this SFC module results in the following:

a) meaningful data is collected through employees completing daily reports.

b) product status is determined through a limited amount of information.

c) Lot integrity is not critical

d) The system can respond to priority changes by rescheduling, and changing the product currently scheduled.

e) Record keeping is minimised.

4. MANUFACTURING RESOURCES PLANNING IN BATCH PROCESS INDUSTRY - CASE OF METAL INDUSTRY

Some of the important characteristics of this industry are as follows:

- There are few bill of material levels.
- There are few raw materials but many finished goods items.
- There are dual units of measure (units and kg.)
- increasing pieces are produced at certain in process operations
- Trim and scalp (yield loss) are expected.
- the traceability is low
- The cost of equipment/labour hour is high
- The capacity is rather inflexible.
- The incidence of independent demand is at a high level
- Sometimes, product must be custom tailored to individual specifications.

Figure 5 shows the typical product flow through the various processes. The processes generally include smelting, refining, remelting, forging, extrusion, rolling, heat treating, pickling, and a wide variety of ancillary metal processes. In many cases, intermediate products are sold directly, creating lower-level independent demand similar to the spare/service part activities of many assembled product manufactures. The trim scrap is a normal and natural part of the process. It can total as high as 25-50% of the original raw material input, and needs to be tightly controlled. One of the major challenges is to manage the independent demand represented by finished goods and items and the first or second levels below that. Speciality metals is conceptually similar to other batch process industries such as manufacture of speciality chemicals.

Figure 6 shows a typical framework for manufacturing resources planning (MRP-II)/speciality metals. As will be seen in the figure, the MRP-II comprises of the following important modules:

1. Sales forecasts
2. Distribution Requirement Planning (DRP)
3. Budget and Production Plans; including validation for resource requirements
4. Master Production Schedule (MPS)
5. Material Requirement Planning (MRP)
6. Capacity Requirement Planning (CRP)
7. Shop Floor Control (SFC).

The sales forecast drives through DRP into MPS package for make to stock items and directly into MPS for make-to-order items. The forecast also drives a production planning process that operates at a level of aggregation of production families. MRP is driven by the MPS. It is used to control raw materials, to plan smelting and melting operations and to control two to three levels of lower level intermediate stock requirements. The combination of DRP/MPS/MRP assumes good response to the market place with a minimum of slack resources. CRP is used to control shop loading. It is based on standard infinite loading technique. The production control and operations management personnel then deal with over or under loads as they occur.

The most important module is Master Production Scheduling (MPS). It feeds the materials plan, manages independent demand and introduces capacity planning into the integrated system. MPS need not necessarily be done only at the end item level. Often it is performed at a level of aggregation of 'MPS items' in which each individual represents a group of end items all having common materials and capacity impact profiles, as shown in Figure 7.

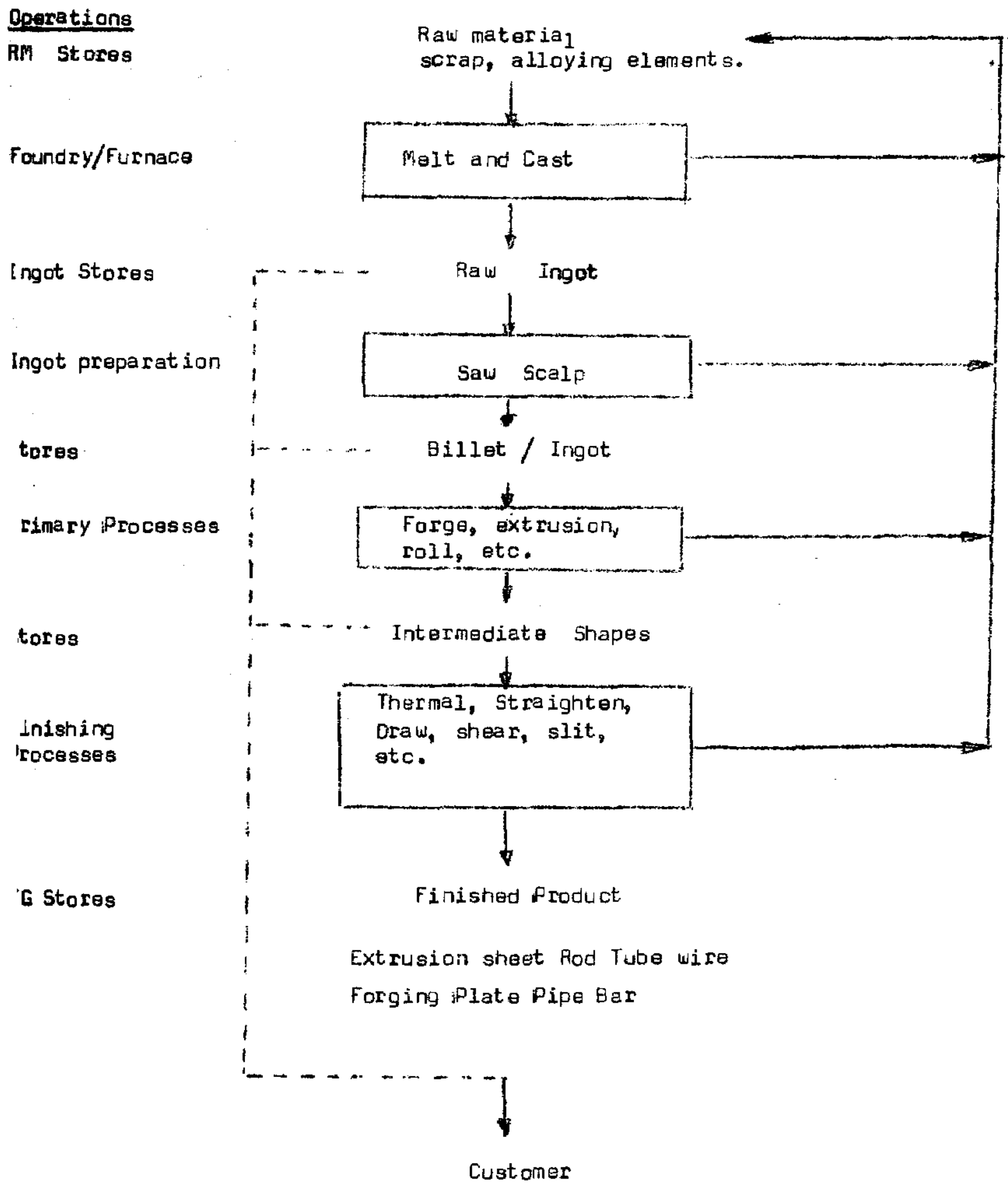

Figure 5: TYPICAL PRODUCT FLOW
(Speciality metals)

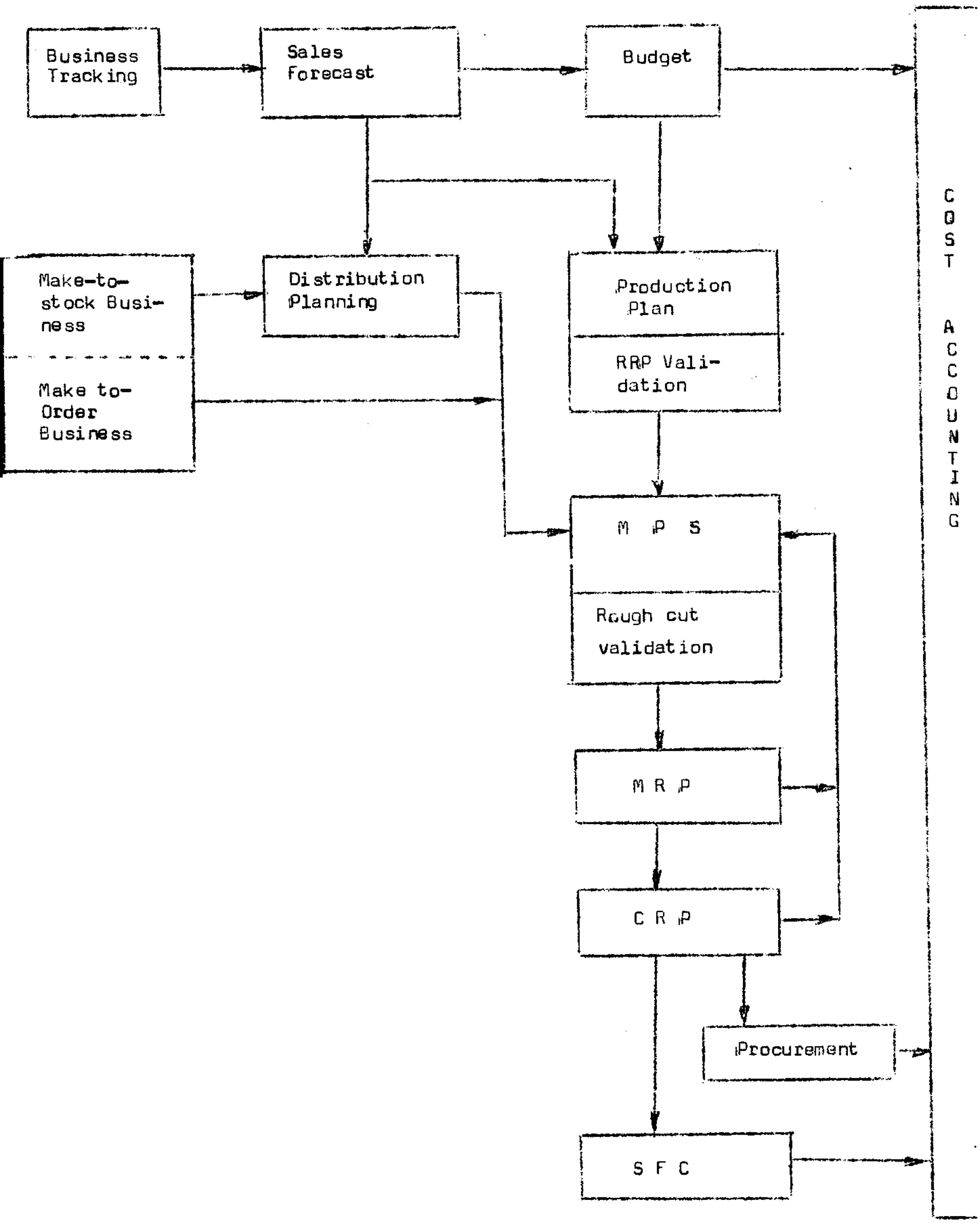

Figure 6: MRP II for SPECIALITY METALS

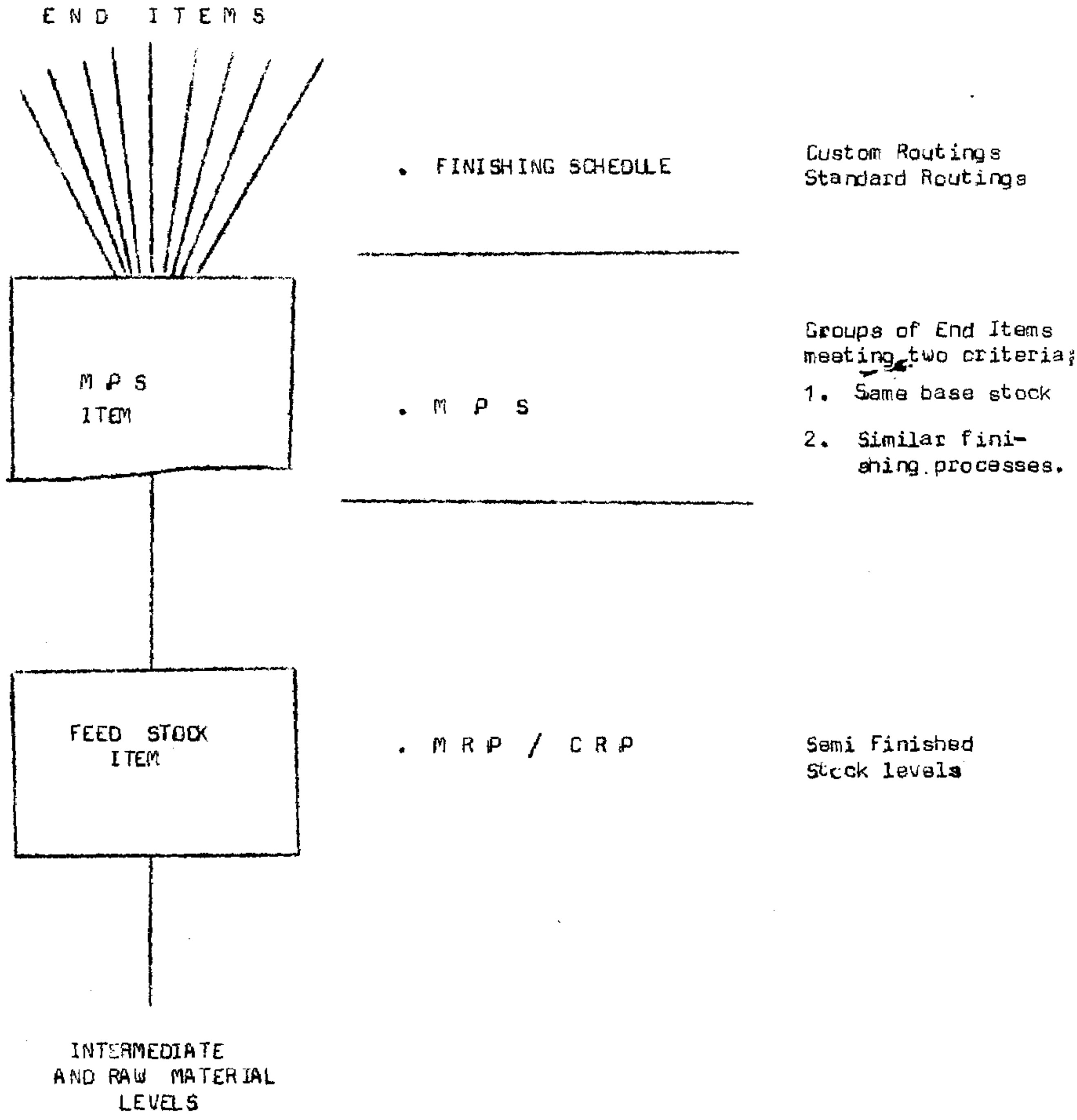

Fig. 7: MASTER SCHEDULING IN A METALS PLANT

Certain other characteristics of manufacturing resources planning in batch process industry (like speciality metals) are noteworthy.

1. Metals industry is heavily dependent on capacity management. Capacity normally comes in very large pieces. It is often relatively inflexible. This is because of long and expensive set up times on mills need to optimise furnace temperature changes whileplanning rolling sequences, continuous operation of processes like smelting, etc. Thus, the important issue is how to change capacity that outwardly appears to be inflexible into a relatively flexible system. Hence, the emphasis is on modules like shop-floor control and plant loading rather than planning as such. This points to capacity control as one of the central tasks of MRP-II in metal industry.

2. The metal industry lends itself to optimization of operations through techniques like linear programming. LP models find application in optimisation of mix of raw material and scrap used in a **heat** in the melt shop; calculation of real-time least cost adjustments based on molten metal analysis; development of sequencing models, etc.

3. In the metal industry, like every other industry, lack of adequate planning systems must be compensated for by addition of slack resources. This can take the form of either invested capital (extra capacity), working capital (extra inventory), or extra manpower. The cost of slack is much more significant in metals than it is in assembly and fabrication. Hence, the need for a good planning system.

5. IMPORTANT PREREQUISITES FOR MRP-II

The MRP-II operates the production/operations system on a time critical basis. There is a need to have strong temporal synchronization at all levels. Figure 8 shows the major decision areas and how MRP creates temporal dependence between them. A pre-requisite for the MRP system to be able to maintain the temporal dependence is that

- there should be sound lead time estimates for all decision levels from capacity planning to purchasing, and each decision level must deliver on these lead times.

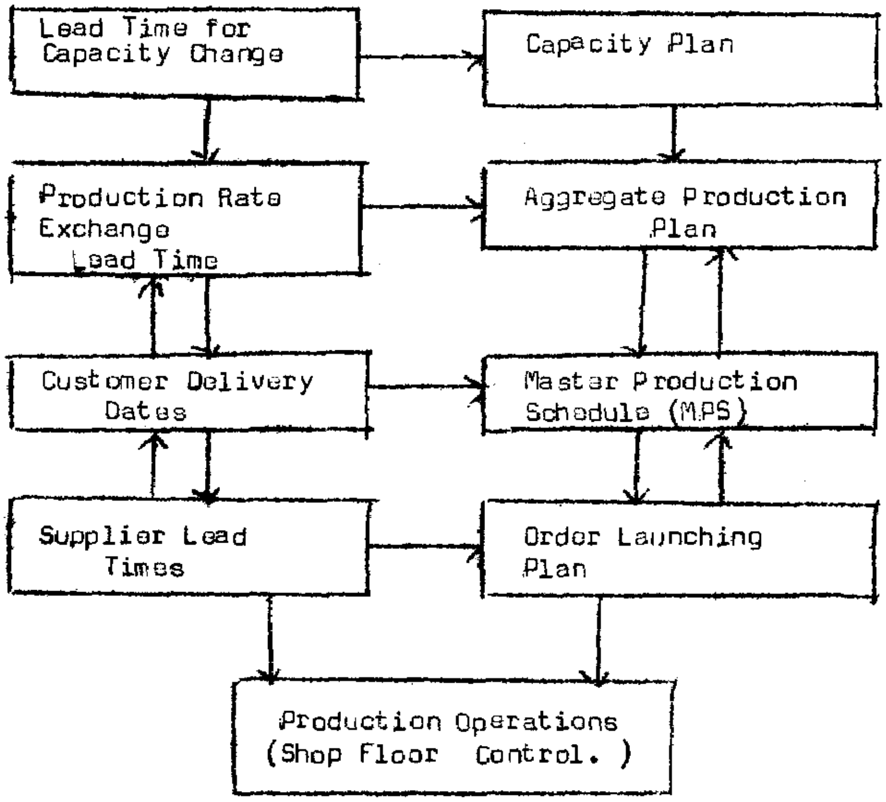

Figure 8: Model of temporal dependence in MRP

A second prerequisite is a natural consequence of the MRP-II approach. This can be simply stated as :

- Strong interfunctional interdependence is absolutely necessary for MRP-II philosophy to succeed.

MR P—II forces coordination of lead times at different planning and control levels. Each type of lead time is affected by decisions taken by different functional groups in the firm. Thus, because of two way interlocking of lead times, there follows a two-way interlocking of functions. Thus, MRP - II leads to a tight couplin of all decisions affecting the level and flow of materials in the system. Hence the need for interfunctional interdependence. Figure 9 shows the model of inter-functional interdependence in MRP-I I.

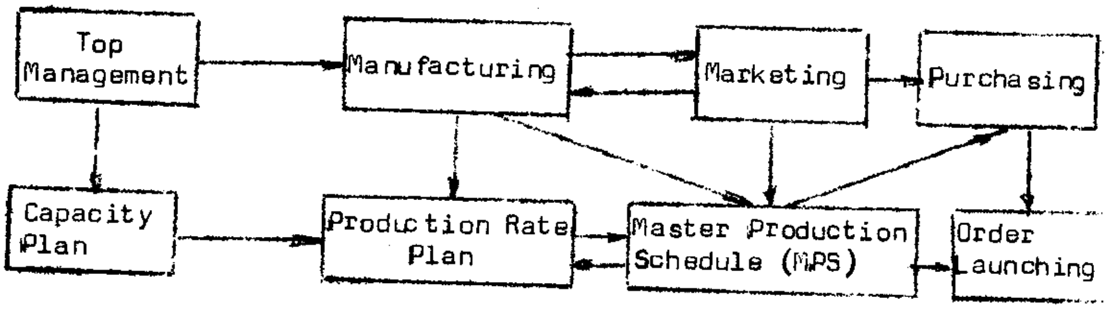

Figure 9: Model of inter-functional interdependence in MRP-II

The third prerequisite for MRP-II is what can be referred to as: the existence of Management Discipline. This has six elements.

1. discipline required to make frequent, accurate forecasts
2. discipline to make frequent and timely revisions of all plans, particularly of MPS.
3. development and maintenance of current and valid bills of materials.
4. discipline to extend supervision of MRP-II needs beyond the boundaries of a given company into supplier organizations.
5. discipline to quote valid customer delivery dates cleared with production
6. discipline to apply constant and detailed supervision of MRP-II system at all planning levels.

Apart from the prequisitės discussed above, it may be worthwhile to note that some other factors also determine the suitability or otherwise of MRP-II approach. Among these are:

1. Bills of materials complexity
2. Continuous versus intermittent production.

Bills of materials (BOM) complexity - A bill of materials is complex if:

1. There is a large number of end products that are candidates for the MPS.

2. Each product uses a large number of different materials

3. The materials composition of each product is to some extent, unique.

A bill of materials is simple if:

1. There are very few materials even if there is a large number of products.
2. Most materials are common to most end products.

MRP-II approach is almost inevitable, when the bill of materials is complex. However, if the same is simple, MRP-II may be replaced by the traditional Order Point Order Quantity (OPOQ) systems. For instance, electronics/electrical components manufacturing involves complex bill of material. By contrast it is simple in petroleum refining, despite a large number of products. Thus, OPOQ systems could be used in the latter case while the former will need the MRP-II approach.

Continuous versus Intermittent production - the traditional OPOQ systems can be used quite effectively in case of continuous production. But when production is intermittent, MRP-II is far more suitable. For our purposes, continuous production is said to exist when the production rate is relatively fixed over the medium term and the demand rate is very close to the production rate.

It must, therefore be appreciated that while MRP-II undoubtedly leads to tighter and more efficient control of operations, it imposes certain management requirements that cannot readily be met by some companies in the short run. These requirements for coordination and discipline need to be met if MRP is to be successfully implemented.

6. PLANNING, ORGANIZING AND IMPLEMENTATION OF MRP-II PROJECTS

Implementing a Manufacturing Resources Planning (MRP-II) system is a major programme which will affect and involve people from all areas of the company. Hence, it is important to consider the people oriented side of planning, organizing and developing an MRP II system. The process of planning involves setting goals, selecting and developing methods to achieve these goals, and presenting the plan to begin its execution.

6.1 <u>The process of organizing MRP II Projects</u>

The process of organising comprises of:

1) specifying the task to be performed
2) Breakdown of the total task into manageable components
3) Establishing clear responsibilities
4) Selecting people to execute the task.

Figure 10 shows a typical organization chart for execution of MRP-II project.

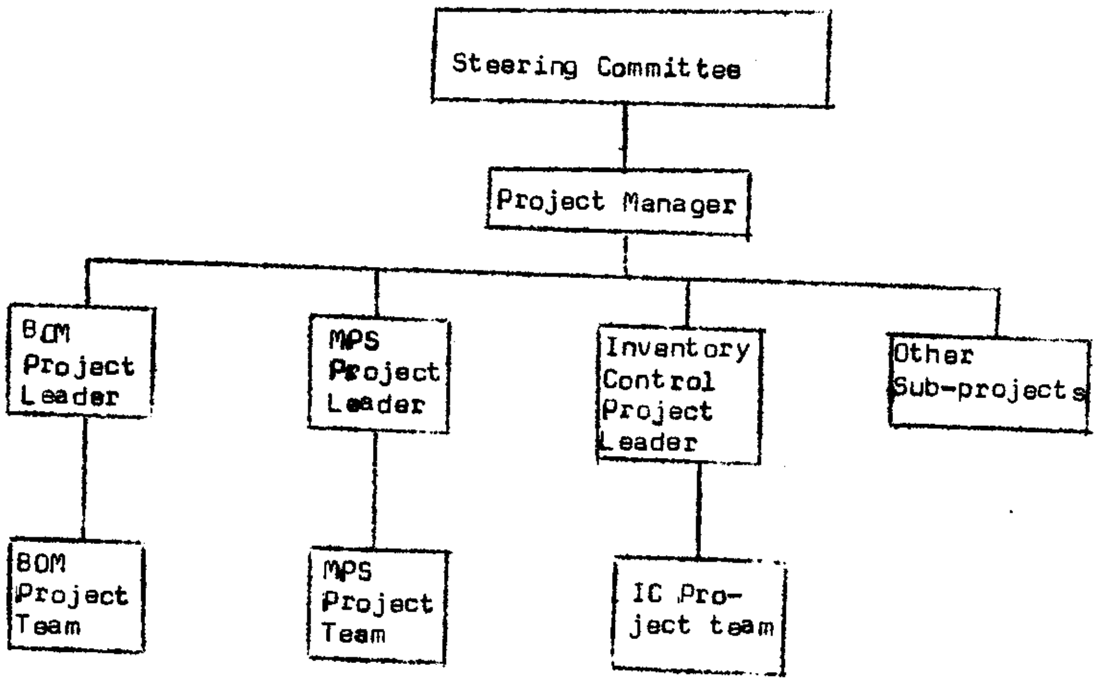

Figure 10: Typical Organization chart for MRP-II Projects

Steering committee: The steering committee is responsible for overall management of MRP-II project. It may comprise of the heads of manufacturing, engineering, finance, marketing and the MRP-II project manager. The primary function of the steering committee is:

i) to provide active leadership for the project
ii) to staff the project team
iii) to define the project scope.

iv) To stimulate company commitment and dedication to the goals.

v) To allocate resources

vi) To approve project budgets

vii) To develop overall strategies and policies

viii) To review project status on a regular basis

ix) To attend top management classes.

6.2 Project Manager Assignments:

The project manager has two basic functions: to develop a project plan and to implement that plan the specific responsibilities include:

i) Organising the project and coordinating the efforts of team members and other departments.

ii) Calling and chairing team meetings.

iii) Monitoring and reporting project status to top management

iv) Obtaining policy decisions from top management

v) Identify resource requirements

vi) Providing the project schedule and ensuring compliance with schedule dates.

vii) Coordinating user education and training programmes.

viii) Representing the team to other functions.

ix) Ensuring that problems outside the scope of the project do not distract team efforts.

x) Identifying critical issues and ensuring that the right people are involved with these issues.

Ideally, the project manager should combine in him abilities as organizer, motivator, communicator, diplomat, and educator. He should be persistent and knowledgeable about the company and MRP-II.

6.3 Team member assignments

The teams should be made of key users - representatives from many-facturing, production and inventory control, design engineering, accounting, purchasing, industrial engineering, marketing and data processing. Team members should have the following desirable qualities:

i) positive attitude, ii) good conceptual ability, iii) be good communicators, iv) ensure availability to contribute effort in tasks, v) be dependable, vi) have complete understanding of MRP-II, vii) be knowledgeable about the company. Generally a team of 5-8 members is desirable.

6.4 Project Charter: A project charter is a formal document which gives the project team authority and defines its responsibilities. The project is best organised into several sub-projects, corresponding to functions of the system or modules of the software package. These include:

i) Master production schedule
ii) inventory control
iii) Bill of Material
iv) Routings
v) Costing
vi) Capacity Planning
vii) Shop Floor Control,
viii) Data accuracy, etc.

Figure 11 gives an example of a charter of Bill of material project team.

Figure 11: Charter of Bills of Materials Project Team

Charter:

- Define system objectives and requirements
- Develop and implement an automated bill of material
- provide education and training for all users affected by the system.
- Disband when the system is running to the steering committee's satisfaction.

An Example of Individual member responsibilities

A. Design Engineering representative

1. Establish and maintain BOM structure
2. Devise engineering change control system
3. Ensure 99% BOM accuracy
4. Administer part numbering and revision level assignment
5. Coordinate user accessibility of BOM data.

6. Define engineering department data requirements
7. Responsible for all design engineering facets of the project.
8. Coordinate user sign-off approvals of system designs and specifications
9. Approximately 20 hours/week will be required to complete the project.

- -

6.5 <u>Using a Consultant</u>: If no one on the project has had previous experience in successful installation of an MRP-II system, qualified consultant could be used. His role should nevertheless be limited to:

- perform an objective business analysis to determine system requirements
- plan and assist the education program
- guide the process of project planning
- review the project plan to ensure that it is complete and realistic.
- provide professional advice to prevent expensive mistakes
- act as a catalyst to get things started
- prevent reinventing the wheel.

6.6 <u>The Project Plan</u>

The project plan should be completely reviewed at each phase of the project. As the project progresses, the plan must be updated, to reflect any significant changes. A technique like Gantt chart can be easily used for this purpose. The purpose of the project plan is to:

- to identify required tasks
- communicate the tasks and estimated mandays
- assign work to project team members
- determine target dates
- Coordinate work activities
- provide a basis for estimating due dates and cost
- provide a means to control project performance
- provide a means for determining resource requirements.

7. PROCESS OF PLANNING FOR MRP INCORPORATING SYSTEMS VIEW POINT

In effect the process of planning for MRP-II can be looked at from a system viewpoint. The process is based on 3 principles:

1) The planning process is an iterative process and sequential in nature. The process begins with a 'where are we'? analysis and progresses to addressing objectives, costs, resources, etc.

2) The planning process can be converted to a PERT-type diagram: project review must take place in a formalized fashion, no less frequently than once every 3 months.

3) The planning process will progress through a series of 'refinement' stages.

Figure 12 illustrates the logic and the iterative nature of the planning process.

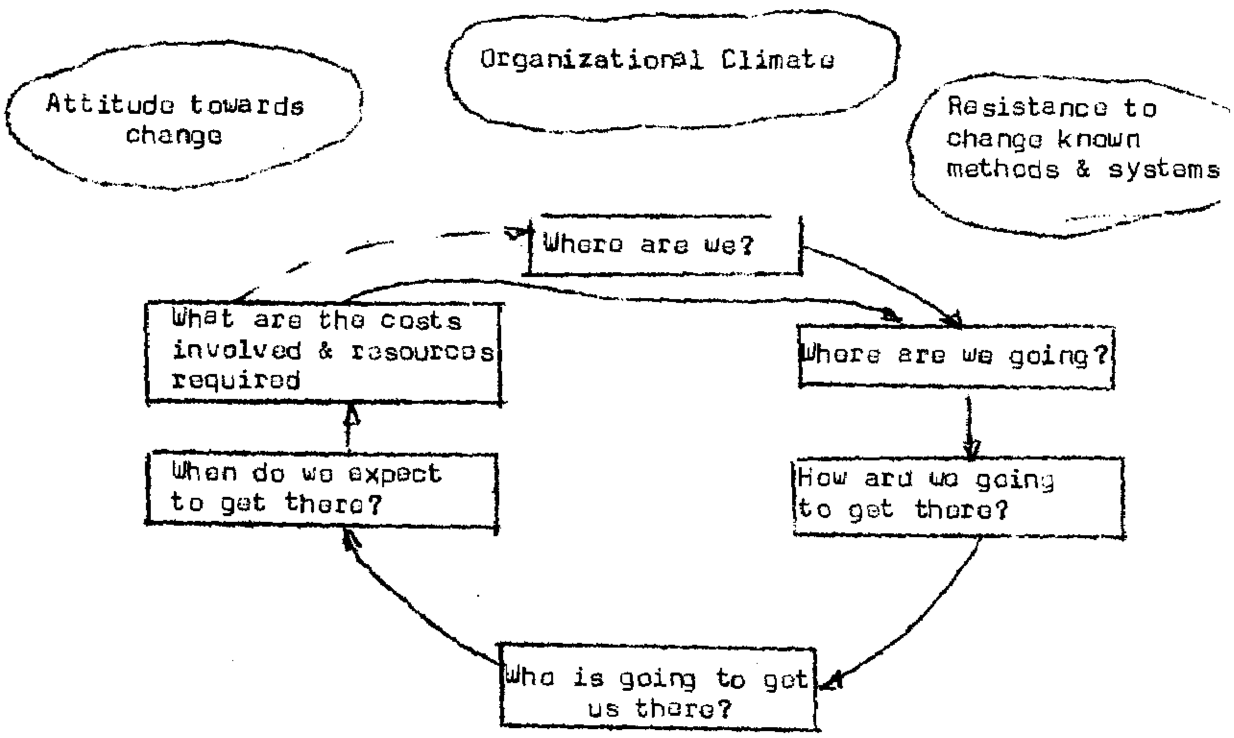

Figure 12: Iterative Planning Process

The significance of the above steps to MRP-II is as follows:

7.1 Where are we ? - Why MRP-II is being investigated. Reviews the current optional practices and procedures, etc. In short, this step aims at self-assessment.

7.2 Where are we going? - This step aims at definition of quantifiable, achievable objectives such as:- 90% on time deliveries within 9 months after MRP is implemented; 15% reduction in inventories during 1st year of installation, 20% increase in inventory turns, and the like.

7.3 How are we going to get there? - what has to be done in order to effectively implement MRP-II. Such considerations as cleaning up and/or properly structuring BOM, building the item master file, defining work centres, establishing routings and standards are included in this category. There are vendors manufacturing software packages. Not all these packages are designed for the same size and type of uses. Therefore a comprehensive review of hardware/software combinations is essential in assessing the 'How are we going to get there'? question.

7.4 Who is going to get us there? - This step addresses to the 'people' decision including composition of steering committee, project manager, project teams, etc. The selection of people involved must be done with extreme care.

7.5 When do we expect to get there? - This addresses to the timing aspect of MRP-II implementation plan. Specific time goals need to be established for the accomplishment of project tasks. Every one involved in the project needs to know when a specific activity is expected to be accomplished and how the timing of one activity relates to other activities.

7.6 What are the costs involved and resources required? - Installing an MRP-II system is not cheap. Planning time does not come cheap - nor do the software and related hardware costs. Resource requirements in terms of incremental costs of manpower, training, vendor classes, consulting time, hardware and software related costs, etc., should be thought through and itemised.

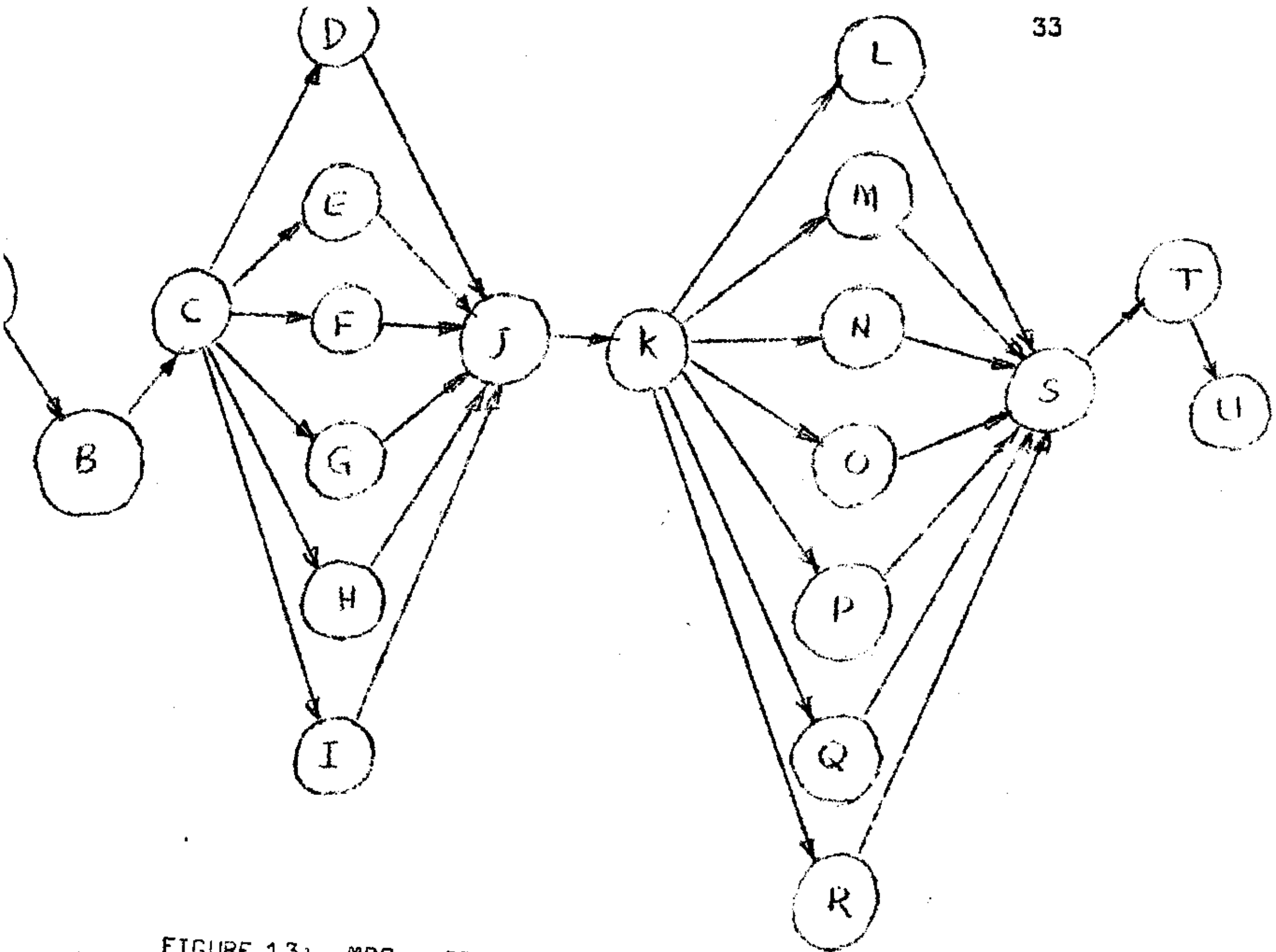

FIGURE 13: MRP - II PERT PLAN

A - MRP-II needs investigation
B - Preliminary education
C - Commit to Project
D - Hardware/Software review
E - Clean up BOMS
F - Clean up Routings
G - Clean up Standards
H - Work centre definition
I - Define capacity
J - Project Review
K - Education
L - MRP Module
M - Master Production Scheduling module
N - Capacity Requirement Planning module
O - Shop floor control module
P - BOM module
Q - Inventory control module
R - Work in process module
S - Education
T - Pilot Run
U - Implementation.

The same plan can be put on a time scale by converting it into a gantt chart. Figure 14 shows the MRP-II PERT Plan converted to Gantt Type Chart.

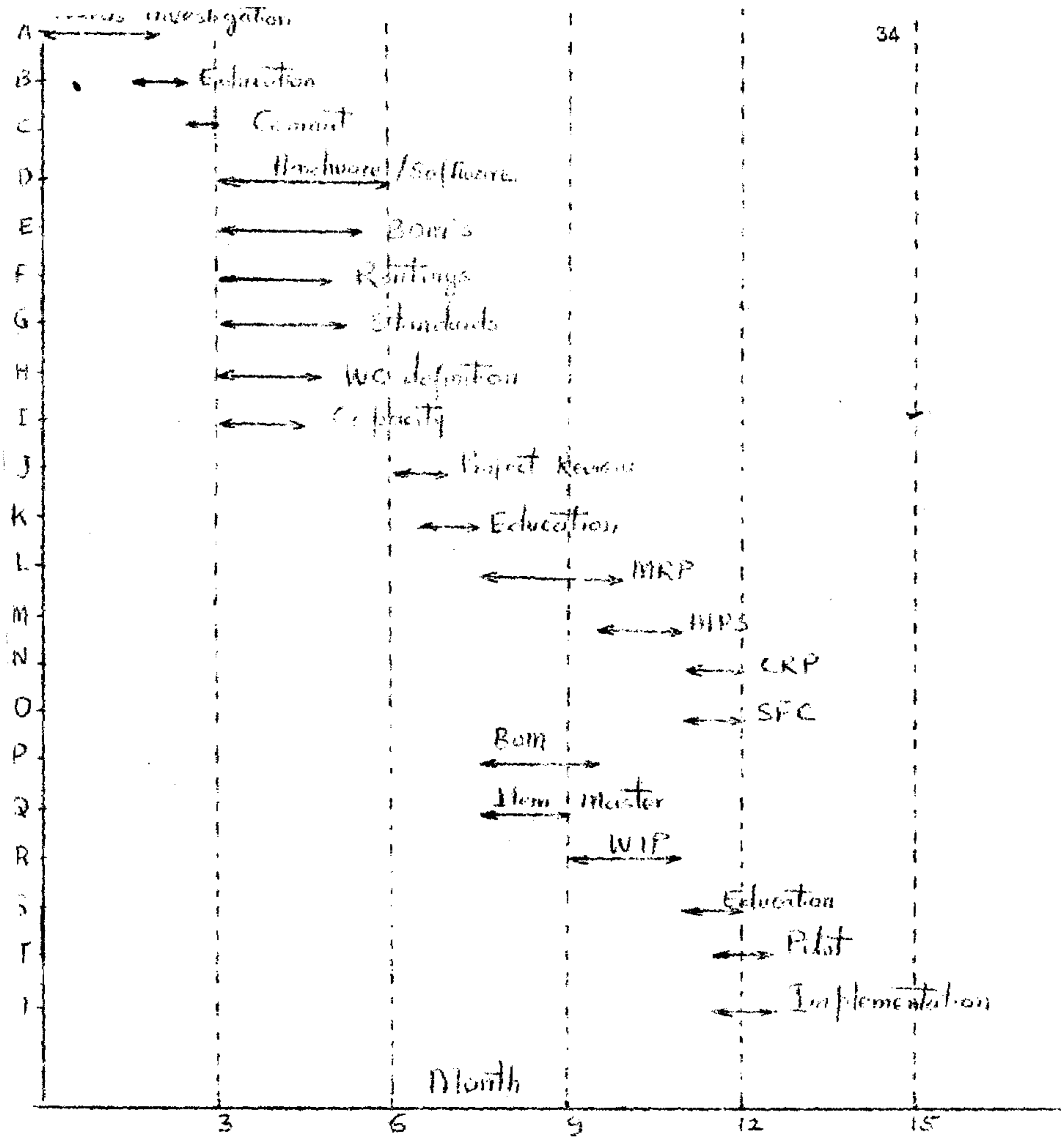

FIGURE 14: MRP II PERT PLAN CONVERTED TO GANTT TYPE CHART

TIME PHASING OF PROJECT ACTIVITIES

For ease of monitoring and review during implementation, the MRP-II plan should be converted into time phased action plan. This may resemble either a PERT Chart, a Gantt chart or even a milestone chart. Figure 13 gives PERT chart for a project implementation plan.

8. BEHAVIORAL DIMENSIONS OF MRP CHANGE

While MRP-II is without doubt one of the most significant developments in manufacturing software system, attempt to actually implement it in-house have not always met with unqualified success. We have already discussed earlier the prerequisites of MRP-II. MRP-II success depends on fulfillment of those prerequisites. Furthermore, analysis of implementation failures has brought out some other factors as the main culprits causing MRP-II failure. These may be classified as:

i) Technical inadequacies - inaccurate bills of materials, and inventory records; infeasible master production schedules; unrealistic lead times; lengthy time buckets; and poorly designed computer systems, to name a few.

ii) Ineffective organizing and managing (leadership) - lack of top management support; absence of full time task forces or project schedules; absence of education and training; and lack of coordination of affected departments.

iii) Human resistance to change - management and workers' preference for the informal system or the status quo.

For successful implementation, it needs to be recognized that MRP-II implies a major change process. The nature of change brought about by MRP-II needs to be thoroughly understood. For instance, it is of importance to analyse questions such as the following:

i) does the change effort involve multiple subsystems?

ii) Does the change involve learning new techniques and assimilating new information

iii) Are some members likely to perceive a loss in power or status?

iv) Is the change complex?

v) Are the results of the innovation immediately visible?

vi) Will the change make end results or performance more visible or measurable?

vii) Is the change likely to require more than compliance i.e., a high level of personal commitment?

viii) Is the change high in trialability?

ix) Is the change logical and tied to organization objectives?

It is, therefore desirable to undertake an MRP assessment to determine the organization's potential for installing MRP II. An MRP Assessment questionnaire may be used for the purpose. While such a questionnaire can be tailor-made to suit the specific organization under consideration, it could be preferably designed around the following key items of interest, namely:

i) nature of planning process in the organization

ii) communications within the organizations

iii) Significant changes brought about within the organization, in the past

iv) Support for change effort and quest for change in the organization.

v) extent of use of computer data processing and information systems.

vi) general attitude to present system of handling materials/production requirements.

vii) reputation of the organization vis-a-vis competitors (as innovator, leader, etc.).

viii) reward system for people significantly associated with MRP-II.

ix) Technological and market environments of the business/industry under considerations.

x) Situation in the organization with reference to customer service, inventory imbalances, change in product costs, shipping performance, nature of lead times allowed for purchasing and manufacturing, imbalance in manufacturing loads, level of manufacturing efficiencies.

SUMMARY

In summary, this study has attempted to discuss salient aspects of a major manufacturing software development to have taken place in recent years - namely Manufacturing Resources Planning (MRP-II). Being a modular in nature, it lends itself to flexibility in adaptation.

The central aim of MRP-II can be described as ensuring manufacture of the right product, in the right quantity, at right time and right quality. The main modules of MRP-II include: Forecasting, Production Plan (PP), Resource Requirement Planning (RRP), Master Production Scheduling (MPS), Capacity Requirement Planning (CRP), Material requirement Planning (MRP), Shop Floor Control (SFC) and Inventory Control(IC). MRP-II is applicable to any type of industry i.e., continuous process, batch process repetitive manufacture and job lot type. The general MRP-II framework can be easily modified to suit the special characteristics of each industry type. However certain prerequisites and conditions must prevail if success is to be ensured in MRP-II implementation. Failures are known to have occurred in the absence of fulfillment of such prerequisites and conditions. Furthermore a systematic approach needs to be adopted to plan, organize and implement MRP-II projects, with meticulous attention being given to every detail. It is useful to look at the process of planning for MRP-II as an iterative process which centres around the 'where, why, how, when, what, and who' aspects of the process. For proper monitoring andcontrol of the project during implementation, it is useful to convert the MRP-II project plan into a time phased action plan in the form of either a PERT plan, or Gantt chart type time phased schedule. Finally, it is important to recognize that MRP-II involves, in most cases a major, significant change and the nature of the change brought about needs to be thoroughly evaluated before implementation. For this purpose, it is useful to assess the potential of the organization for successful installation of MRP-II. A suitable MRP Assessment questionnaire can be designed and used for this purpose. Benefits from MRP-II have been known to be many and very significant. These are mainly in the areas such as - i) improvement of customer service, ii) Reduction/lead times, iii) Reduction of inventory imbalances, iv) improvement in shipping performance, v) reduction of product costs, vi) balancing of manufacturing loads, and capacities vii) increase in manufacturing efficiencies.

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