MODULE B1 MANUFACTURING RESOURCE PLANNING (MRP II)

Module B1: Contents

Exercises and projects

Throughout this Module you will find exercises and (at the end) a Project. All are designed not just to test your learning, but also to enable you to start applying your newly-acquired knowledge to your own workplace.

Some exercises are more demanding than others, and so suggested task times are shown in the margin, like this example:

90 mins

Exercise B2-5

Give a few examples of the forms of forecasting and data collection used in your organization.

You need not stick too rigidly to the timings for individual exercises, as you will probably find that you can complete some in less than the suggested time, while others take longer. Try to balance your time so that your total exercise and project time comes close to the total of study hours recommended by your tutor.

Introduction to MRP II

Until the 1960s many manufacturing organizations used manual manufacturing systems usually called reorder point (ROP) systems. These worked on the principle that component stocks were maintained by reordering whenever stock fell to a pre-set reorder level. Components were often ordered when not actually needed, and so ROP systems tended to result in very high inventory levels.

This was not a major problem at a time of static products, undemanding customers and low interest rates. But during the 1960s, this cosy situation started to change. Keener competition started to change attitudes, and businesses began to realize that their future depended on developing a much better response to customer needs. At the same time interest rates rose sharply, turning money tied up in inventory into a serious financial burden for manufacturing organizations.

Fortunately, IT came to the rescue. It gradually became possible to use computers as planning and production aids. As a result, several new manufacturing systems were developed. This Module deals only with MRP II, but the full list of significant systems is:

- **Material requirements planning systems**

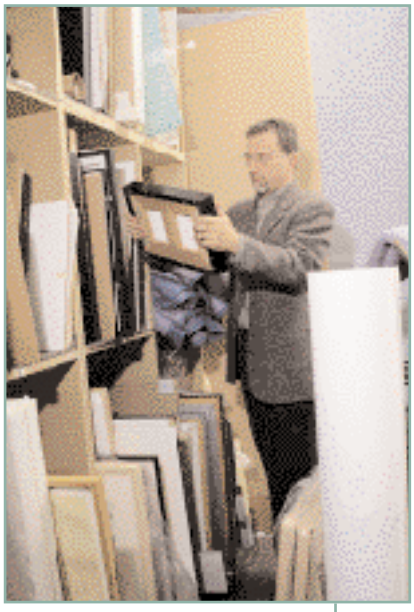
  Heavily reliant on computers, and most frequently applied to batch or mass production.

  Comprising:

  Material requirements planning (MRP or MRP I)

  Closed loop material requirements planning (Closed Loop MRP)

  Manufacturing resource planning (MRP II)



- **Just-in-time (JIT)**

  Used most often in repetitive manufacturing but can be used in almost any environment. An essentially simple concept of eliminating all forms of waste by doing nothing until it becomes absolutely necessary.

- **Optimized Production Technology / Theory of Constraints (OPT/TOC)**

  For batch production line environments. Aims similar to JIT, but there the resemblance ends. Primarily a software system based on hugely complex maths.

- **Project control**

  For custom-built or one-off products and non-production projects such as plant relocations. The more detailed the project, the greater the need for the use of a computer system.

All are valid ways of scheduling and managing manufacturing production. All aim to plan and control production to give reliable delivery dates to customers. Many are implemented in large part by workplace IT systems running specific software packages.

It does not have to be a case of choosing one system and ignoring the rest. Many organizations use a combination of systems: for example, MRP II at planning level and JIT at production level. Others cling on to their manual manufacturing systems; these are however usually purpose-built and specific to that organization and its products.

Because combined or wholly manual systems are so specific to the organizations which use them, they are not referred to again in this Module.

45 mins

Exercise B1-1

Data accuracy is crucial to the success of MRP II systems. Given the reliability of modern software, it can be assumed that data errors are most frequently human errors. Identify the main potential sources of human error and make recommendations for reducing them.

The evolution of material requirements planning systems or...
How material requirements planning led to closed loop material requirements planning, then to manufacturing resource planning

To recap a little: until the 1960s many manufacturing organizations used manual production control systems. These had to be very simple, or much of the data would be out of date before calculations based on them could be completed. Nor did early computer systems bring much relief; hardware and software were too rudimentary to allow the holistic approach to business control that we now take for granted. Mostly they could only handle one thing at a time: for example, they might keep the order books straight but be useless for stock control.

Material requirements planning was the first successful computerized production control system. Unfortunately, the failure rate of implementing it was too high for comfort. MRP consultants found that operations managers needed a lot more than a program that simply calculated material requirements; they needed a system capable of painting a much bigger picture. This led to the development of **closed loop material requirements planning (closed-loop MRP)**, followed by **manufacturing resource planning (MRP II)**. Material requirements planning is still in use, but effectively as the central software module in the much wider-ranging MRP II systems.

The following pages explain how this evolution happened.

Evolution Stage 1: Material requirements planning

All manufactured items are made up of component parts and/or raw materials required at different stages of production. Information about these components and raw materials is the basic information used by the MRP system.

An MRP system can be paper-based, but computer-based systems are more usual and clearly preferable given the volumes of information that need to be stored and retrieved. Such systems can be used in the following types of manufacture:

- **Made-to-order, custom-built products.**
- **Batch manufacture of low- and high-volume products.**
- **Process industries.**
- **Repetitive mass production.**
- **Assemble to order.**
- **Make-to-stock products.**

The inputs and outputs of MRP can be seen in this diagram:

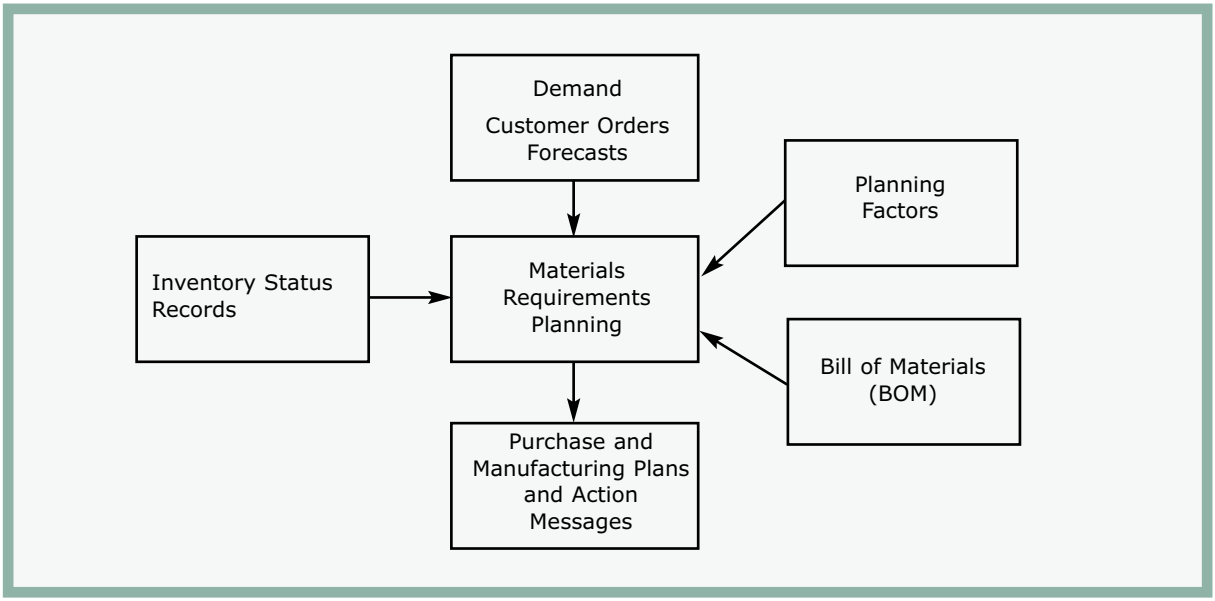


Fig B1-1 Material requirements planning - basic inputs and output

As can be seen, MRP requires input from the *demand*, structured *bill of materials* (BOM) and *lead times*, and *inventory status records*. From these a detailed *purchasing and production plan* is produced. This shows:

- What parts/materials need to be purchased and when.
- What is to be produced and when it will be required.
- Whether the current plan meets the demand on time.

Problems with open loop material requirements planning

Material requirements planning was the first attempt many manufacturing organizations made to deal with change in a controlled way, by using available information to plan and forecast rather than by simply reacting to events in the market-place. Its inputs included demand information from sales and marketing, and bill of material information. After many calculations it produced a plan of order releases for material buyers and production planners, and generated action messages indicating where the current plan did not meet the demand on time.

Its limitations soon became apparent. It was an 'open loop' system - a one-way street that sent plans to buyers and production personnel but could not receive feedback. As a result, adjustments could not be made to plans in order to keep schedules valid. For example, it assumed that infinite capacity was available, and that suppliers always delivered correctly and on time. And when the ever-changing sales demand was fed directly into the system it became very 'nervous', causing an excessive amount of replanning. Also, much of the demand from other sources was left out of the system and shortages became inevitable.
Material requirements planning generates valid schedules in the sense that they follow logically from the demand. But after planned orders are launched, some of the planning factors may begin to stray off course. For example:

- **Lead time estimates turn out to be wrong**

  Machines break down, deliveries are delayed, goods are damaged, power fails etc.

- **Quantities are wrong**

  If the system plans for 1000 of a component but 200 fail a quality inspection, the order may be on time but short.

- **Demand changes**

  The demand that drives material requirements planning consists of both forecast orders and actual customer orders. The forecasts may turn out to be wrong and customers may change their actual orders, for example by asking for earlier or later delivery. This throws out all component orders.

- **Information in input data files is inaccurate**

  For example, engineering personnel may tinker with product designs and change the components used, but fail to update the bills of material used by the system. If instances of poor data accuracy arise frequently, trust and confidence in the system will end and an 'unofficial' planning system may take over.

In summary, 'open loop' material requirements planning could result in some or all of these problems:

- **Uncontrollable costs.**
- **Late deliveries to customers.**
- **Late deliveries from suppliers.**
- **Unplanned overtime/offloading.**
- **High work-in-progress levels.**
- **Mismatched inventories.**
- **Over- or under-utilized resources.**
- **Disruptions on the shop floor.**
- **Many full-time expeditors.**
- **Customer complaints.**
- **High 'past dues'.**
- **Long queues.**
- **End-of-month crunches.**
- **A blame culture.**
- **Low morale.**

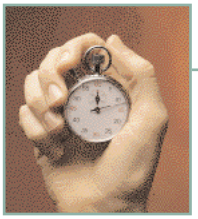
This is clearly not a list that any manufacturing organization could regard as acceptable. Something had to change, and so open loop MRP evolved into closed loop MRP.

Master production scheduling and bills of materials are covered later in this module.


Wider Reading

You'll find a fuller treatment of material requirements planning (MRP) in Module C.


Wider Reading


30 mins

Exercise B1-2

What did material requirements planning calculate?

Evolution Stage 2: Closed loop MRP

Material requirements planning was useful but limited, as it lacked awareness of other related production and business functions. Increased computing power soon made expansion possible. The next diagram shows the much wider data horizon that now opened up for organizations which started using better information technology to upgrade their MRP system.

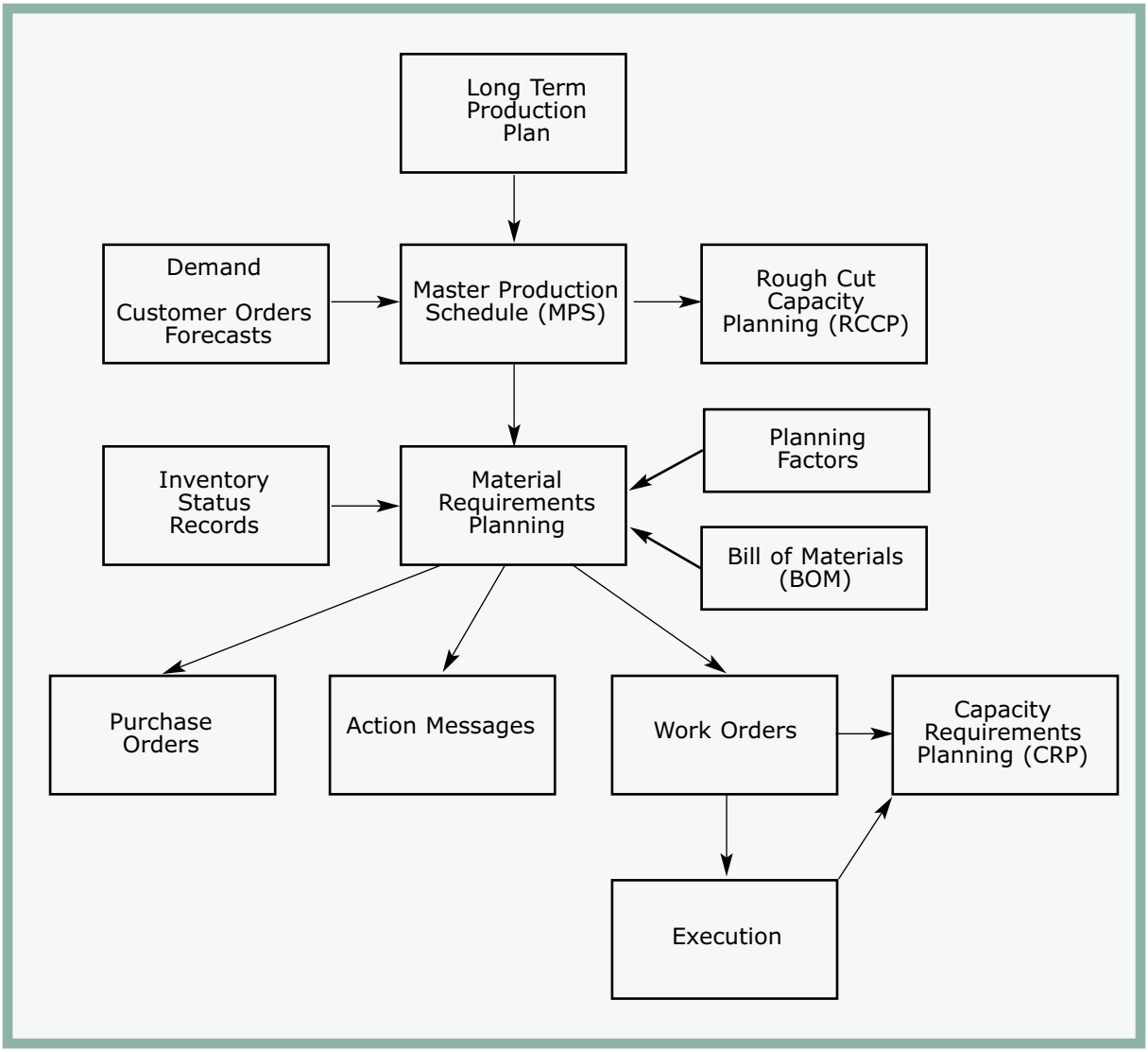


Fig B1-2 Closed loop MRP: basic structure, shown for clarity without feedback loops

Closed loop MRP made feedback possible by including the new functions of file control, a master production schedule, rescheduling actions and shop floor control. It thus 'closed the loop', overcoming the fundamental weakness of 'open loop' material requirements planning.

Such a high level of feedback could usually only be achieved by using computers to process the larger amounts of production and business data now required by the system.

- **File control**

File information must be updated regularly, but only by approved personnel - and in the case of design changes, only after approval by the change committee. Changes in scrap rate, lead time, order quantity and other planning factors must be entered into the item master file; and order completion data into the open-order file. Stockroom inventory must be checked regularly to ensure that inventory records in the item master file remain accurate.

- **Master production schedule (MPS)**

The MPS is a statement of the planned production of finished products that will meet the demand on time, within the organization's capacity.

- **Rescheduling actions**

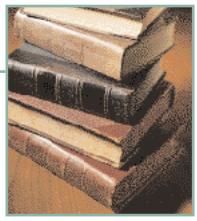
Although closed loop MRP can generate rescheduling notices, these are sometimes ignored to prevent 'nervousness' in the system. But if rescheduling action is necessary, only the master scheduler should make changes to the MPS. Otherwise, for example, a buyer who finds the schedule impossible to meet might reschedule part of an order without realising that the next computer run will recalculate due dates for all parts affected by the change.

- **Shop floor (or production activity) control**

After rescheduling, new due dates and quantities go out to the factory and supplier companies, who must act on them so that the previous schedule, with the jobs in progress, is updated. In a loop-closing MRP subroutine known as **shop floor** or **production activity control**, the computer is told **how many** units were sent onwards and the **date** as each work centre completes a job. That information is enough to enable the MRP system to provide each work centre with daily notices of priority changes.

Fig. B1-2 shows several additions to the basic Fig. B1-1 system:

1. The **long-term production plan**. This feeds information into the master production schedule about the organization's long-term manufacturing expectations.
2. The **master production schedule** passes information to a separate **rough cut capacity planning** module, which estimates the amount of work achievable in a given time period.
3. Orders generated by MRP are split into **purchase orders** and **work orders**.
4. Manufacturing orders are passed to the **capacity requirements planning** module to see if there is sufficient labour and machine time available to carry them out in the time proposed by the master production schedule. This is a more detailed evaluation than rough cut capacity planning; it looks at individual work centres and their proposed workloads.
5. The shop-floor **execution** phase is also shown; this is used to control the on-time completion of work orders.


Wider Reading

Rough cut capacity planning is dealt with in Module B2.

The essence of the closed loop MRP system is that **each module assesses the feasibility of the information it receives from other modules and reports on any problems found**. This reporting is called **feedback**. Our next diagram s hows the **feedback information loops** which close the loops opened by the initial or 'outgoing' transfer of information. This is how closed loop MRP gets its name.


30 mins

Exercise B1-3

From the list shown here, identify how many of these problems occur in your organization today and what steps can be taken to resolve them.

- Uncontrollable costs
- Late deliveries to customers
- Late deliveries from suppliers
- Unplanned overtime/off loading
- High work-in-process
- Mismatched inventories
- Over/under utilised resources
- Disruptions on the shop floor
- Many full-time expeditors
- Customer complaints
- High 'past dues'
- Long queues
- End-of-month crunch
- Finger pointing!
- Low morale

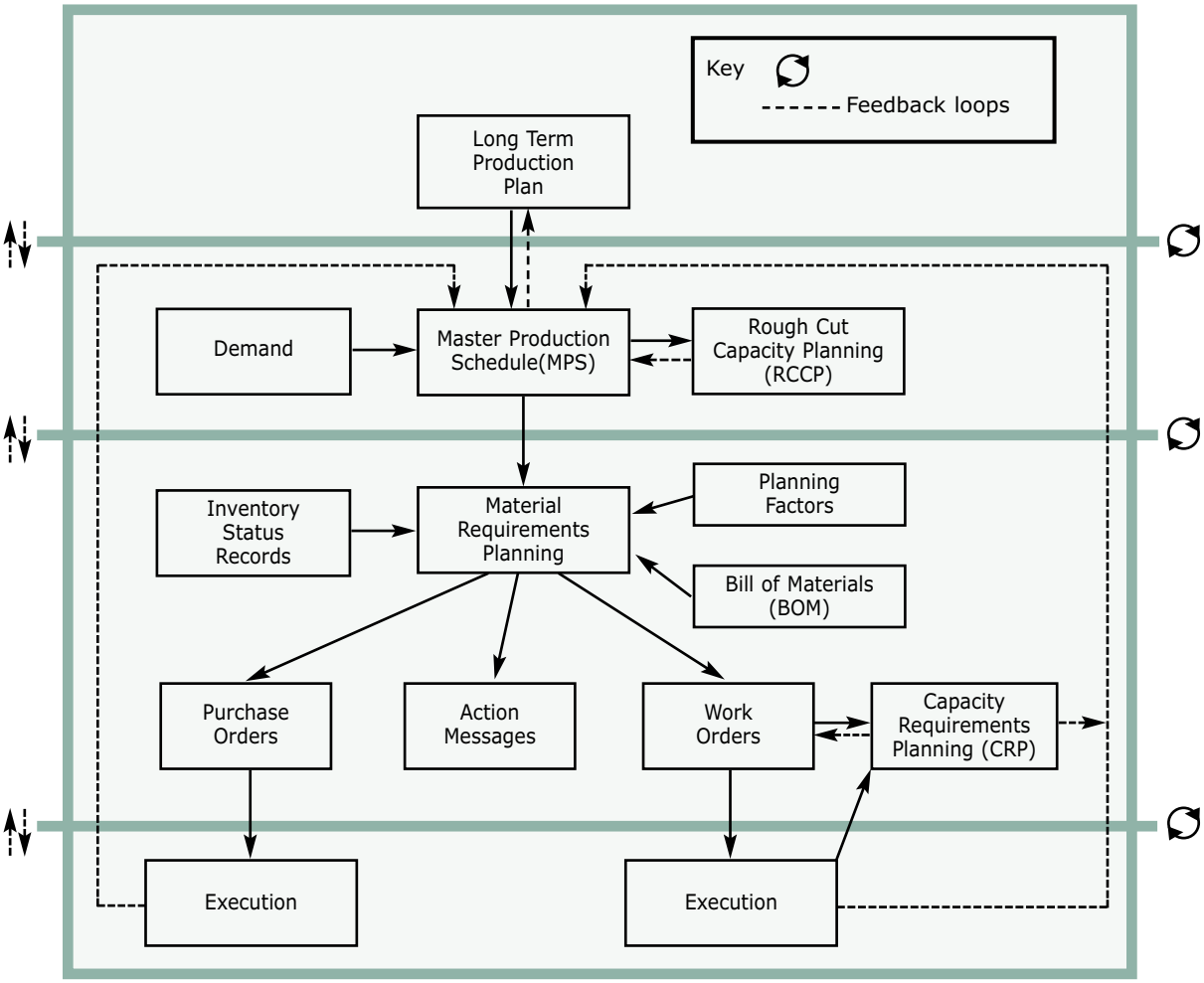


Fig B1-3 Closed loop MRP with feedback loops

A sequence of events that might take place in this type of system is as follows:

1. **The master production scheduler constructs the master production schedule.**
2. **The master production schedule passes information to the rough cut capacity planning module for evaluation.**
3. **Rough cut capacity planning gives feedback on the realism/achievability of the master production schedule.**
4. **The master production scheduler continues to use this information loop, modifying the master production schedule until it is achievable.**
5. **The revised master production schedule then drives MRP, which generates action messages and calculates (or recalculates) all purchasing and manufacturing needed to fulfil the MPS.**
6. **All orders to be manufactured in-house are passed to capacity requirements planning. Any mismatch between workload and ability to perform it is reported back to the planners, so that future plans can be suitably modified.**

7. There is a similar feedback loop from the purchase order function, which might report that planned requirements cannot be met by a supplier and that action is required to resolve the problem. Such a report could lead to changes to the purchasing plan.

8. The manufacturing process itself - the execution phase - may also fail to go to plan, generating yet more feedback.

9. As a result of the feedback within the system, changes may be required either to the master production schedule or to the resources required to execute the plans. The long-term production plan must reflect any changes to the master production schedule.

30 mins

Exercise B1-4

List the general effects on an organization using closed loop MRP if the rough cut capacity planning (RCCP) module became unavailable because of poor maintenance.

Evolution Stage 3: Manufacturing resource planning (MRP II)

MRPII overview and implementation

Manufacturing resources planning (MRP II) is essentially an extended form of closed loop MRP that also incorporates strategic planning processes, business planning, and a number of other business functions such as human resources planning, profit calculation and cash flow analysis.

MRP II uses the master production schedule as the basis for scheduling capacity, shipments, tool changes, some design work, and cash flow. It therefore requires several additions to the reference files. One is a bill of resources, which details key resources needed to produce one unit of product. These resources may include labour, machinery, tools, space and materials. The MRP II system can use the bill of resources to project shortages at specific times, giving departments advance notice of required remedial action: for example, of the need to hire or train labour.

MRP II can also project needs for support resources; for example, design engineering support if a customer order entails prior design work. This additional resource is added to the bill of resources.

Given still more reference data, MRP II can keep track of tool wear and recommend when to replace or resharpen tooling. It can also keep track of machine loads and project machine capacity shortages, which may signal a need for more machines or a subcontractor.

For financial planning, MRP II treats cash flow almost like materials. The MPS is first exploded into component parts requirements; the system then calculates the cost and payment dates of all planned order releases, effectively creating a cash flow forecast. This includes not just payments to suppliers, but also wages, power and other consumables associated with production. Cash outflows may be projected for a year or more by expense category, work centre or department, making budgeting much simpler than it would be without an MRP II system.

The diagram overleaf shows how an MRP II system might operate.

Fig. B1-4 differs from the closed loop MRP diagram (Fig. B1-3) in that the long-term sales, operation and resource planning is an outcome from the business plan. An MRP II system also includes financial information about each operation; as in Fig. B1-4, in which it calculates profit levels based on financial data from other modules.

That's the theory. But when studying real-life MRP II systems, two important factors need bearing in mind. First, MRP II systems can be customized to some extent by adding only the modules an organization needs, and so will often differ from one organization to another. Second, what looks like a 'pure' MRP II system may not have started out as an MRP II system. It may instead have evolved from an existing system until something resembling an MRP II system is being used. What is important is how the system is used to plan and control the business.

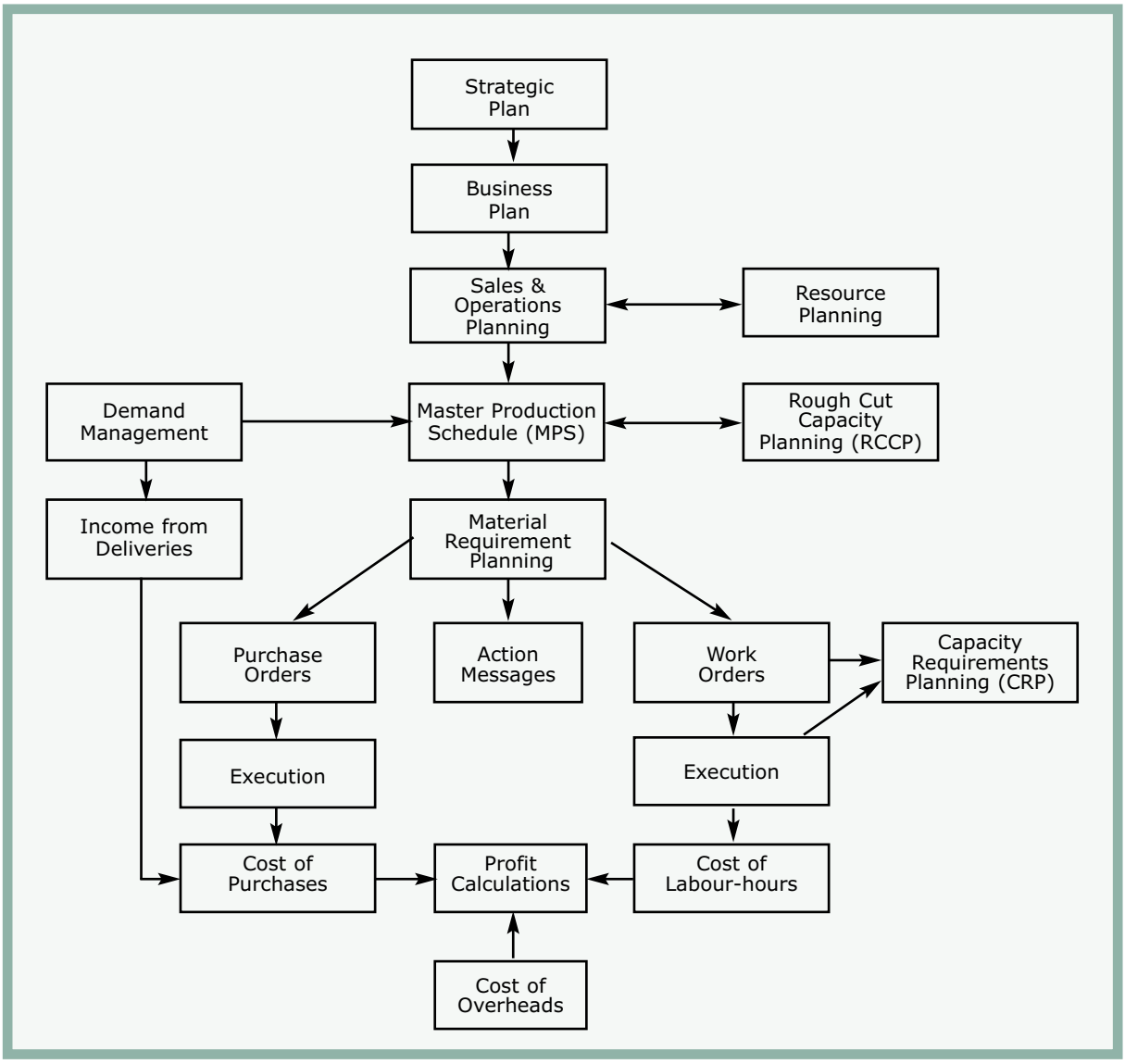


Fig B1-4 MRP II - a typical MRP II system shown for clarity without feedback loops

It is also essential to note that MRP II is not a computer-based production planning system. It needs to know the organization's overall business aims and objectives and pulls in many other business functions. These appear as additional functions to material requirements planning and closed loop MRP systems. As these extra modules generate extra feedback loops, it can easily be seen from the next diagram that an MRP II feedback system should significantly improve management's ability to plan and control the organizations activities.

30 mins

Exercise B1-5

A company produces bicycles using an MRP II system similar to that shown in Figure B1-5. A consignment of 5000 frames is inadvertently entered by the goods receiving department into the MRP I system as 5.000 frames. The computer reads this as five frames and logs the order as complete. Using the diagrams as a basis for your answer, track the effects of this error as it spreads through the MRP II system.

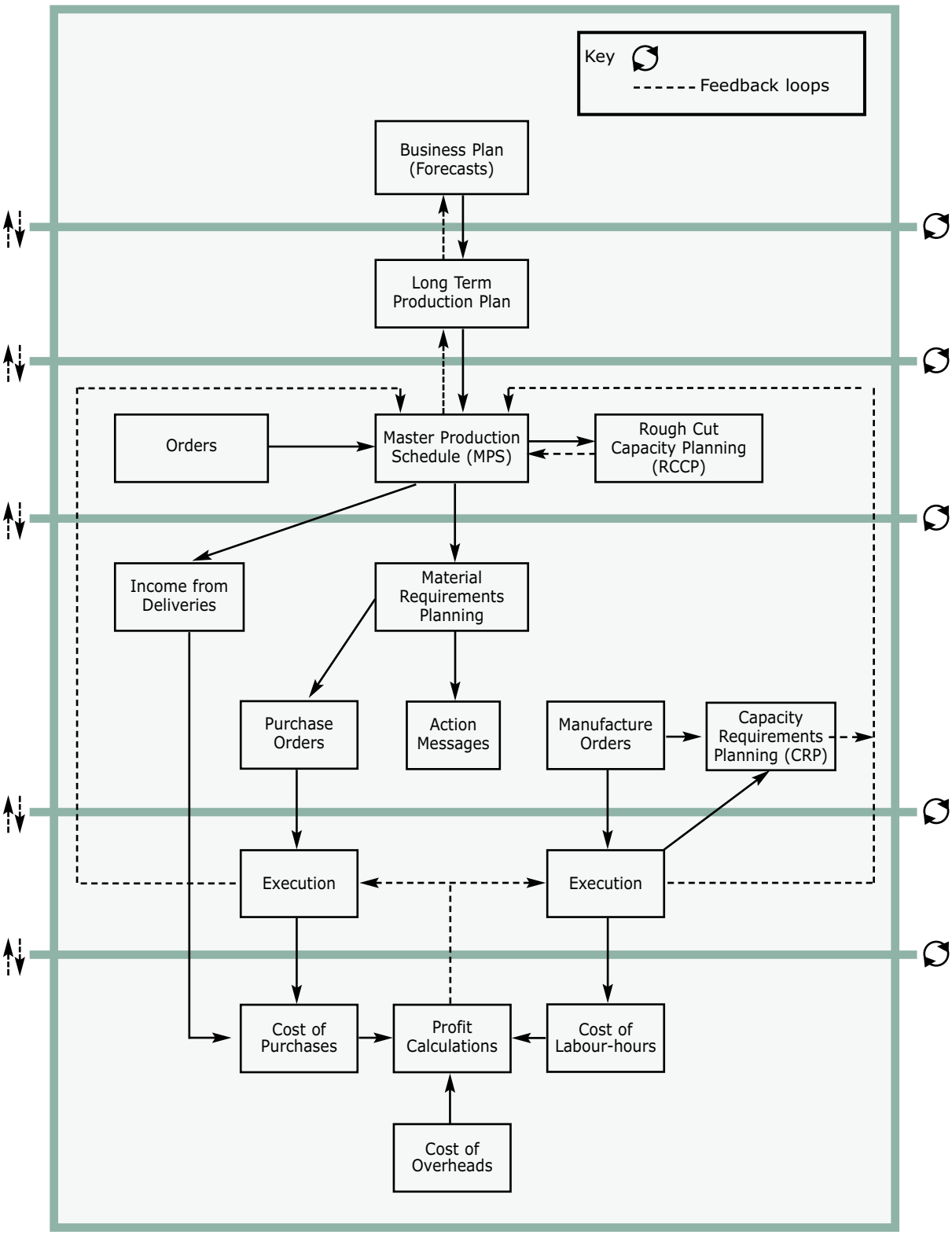


Fig B1-5 MRP II - a typical structure including feedback loops

Feedbacks added since the closed loop MRP diagram (Fig B1-3) include:

- Feedback from the **long-term production plan** to the overall business plan.
- Feedback from **profit calculations** to check that the organization is getting the profit it wants from its total manufacturing process.

In operation, MRP II is much more than just material requirements planning or closed loop MRP with add-on functions. **It is a way of running the entire organization with one consistent set of figures.** It is also significantly better than closed loop MRP at overcoming the basic drawbacks of material requirements planning, which to recap were:

- Uncontrollable costs
- Late deliveries to customers
- Late deliveries from suppliers
- Unplanned overtime/off loading
- High work-in-progress levels
- Mismatched inventories
- Over-or under-utilized resources
- Disruptions on the shop floor
- Many full-time expeditors
- Customer complaints
- High 'past dues'
- Long queues
- End-of-month crunches
- A blame culture
- Low morale

With MRP II, a proposed master production schedule can be assessed not just in terms of material requirements and capacity, but also in terms of resource requirements (such as labour), potential income and probable costs.

Master Scheduling

For a full understanding of MRP II it's worth examining the work of the master scheduler, who plays a key role in the operation of an MRP II system. Let's look first at the objectives of master scheduling. In the view of The Institute of Operations Management these are:

> *To create and maintain a valid master schedule for material and capacities by effectively balancing supply and demand for product. A valid master schedule is one in which priority due dates equal need dates, and planned capacity equals required capacity.*

So what does a master scheduler do? Typically, he or she will:

- Develop in-depth knowledge of the company's products and processes to ensure optimal master schedule stability, order creation, rescheduling, load levelling etc.
- Work with sales, marketing and manufacturing to (a) develop a clear understanding of competitive lead times for master scheduled items, and (b) seek ways to reduce both internal lead times and lead times to the customer.
- Conduct rough cut capacity planning before publishing a significantly changed master schedule.

- Summarize daily and weekly master schedules for released and firm planned orders; and compare these to the production plan to ensure that the master schedule is in line with the company's sales and operational policy.
- Identify and, through negotiation, resolve any conflict between material and capacity availability and order promise.
- Maintain planned lead times, lot sizes, safety stocks, delivery times and order file data for all MPS items.
- Create a master schedule that satisfies customer demand without exceeding levels of inventory and resource utilization established by company policy.
- Ensure that a common master schedule governs all company priorities in manufacturing, marketing, sales, engineering and finance.
- Maintain planning bill structures.

The master scheduler clearly has to be someone of outstanding experience and ability; and such a challenging job description speaks volumes about the importance of master scheduling to the commercial success of a manufacturing organization.

Wider Reading

Master production scheduling is dealt with in more detail in Module B2 Master planning.

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The feedback loops in an MRP II system can also do more than those in a closed loop MRP system. **MRP II effectively builds a computer-based model of the organization** and assesses the effects of a provisional master production schedule applied to that model. Several different master production schedules can be simulated in this way. Whichever best meets the needs of both the customer(s) and the organization's higher level plans can then be used for the 'live' MRP II run.

MRP II systems are also highly flexible. Fig B1-6 shows how easily the differing units of measure used by different MRP II modules convert as information moves round the system.

30 mins

Exercise B1-6

What types of information do MRP II systems require in order to operate?

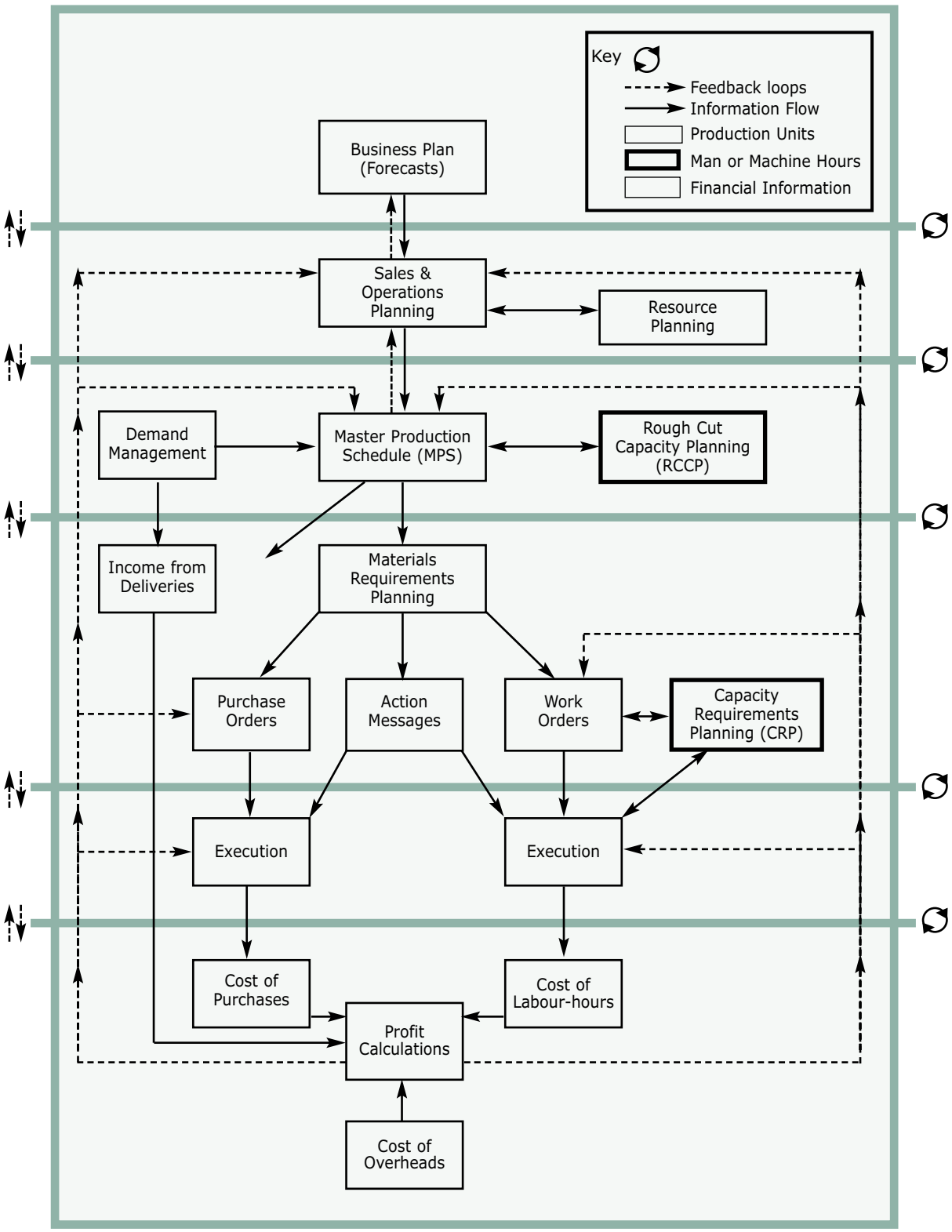

Fig B1-6 An MRP II structure showing different modules using differing units of measurement

Benefits of MRPII

In the narrow sense, the main benefit of MRP II is its ability to generate valid schedules and keep them valid. But valid schedules have broader benefits for the whole organization. These include, more or less in order of importance:

1. **Improved on-time completion**

   A typical manufacturing organization using MRP II should be able to achieve on-time completion rates of 95 per cent or more, because completion of a parent item is less likely to be delayed for lack of a component. On-time completion helps improve customer service.

2. **Reduced inventories**

   Inventory falls - typically by 20-35 per cent - because parts are not ordered until needed.

3. **Capacity requirements planning data**

   Work centre capacity requirements can be planned for many periods into the future.

4. **Improved direct labour productivity**

   Fewer shortages means significantly less lost time and overtime, and less disruption to accommodate shortage-list jobs.

5. **Improved productivity of support staff**

   MRP II cuts expediting (or 'firefighting') and allows more time for planning. For example, purchasing can start looking for alternative or better suppliers; materials management can plan inventory needs better.

6. **Total business planning**

   The ability to use one common set of data to help plan and control the whole business.

Drawbacks of MRPII

There is no getting away from the fact that MRP II is complex. As we'll see shortly in A typical MRP II implementation programme, it takes a lot of time, effort and commitment at all levels of the organization to set up a successful MRP II system. The benefits, however, should very quickly make the exertion worthwhile.

MRPII implementation levels

MRP II systems can be implemented at different levels with varying rates of success. Most MRP II experts use The Oliver Wight ABCD Checklist for Operational Excellence - also known as ABCD classification - to identify these different levels. The ABCD Checklist is a comprehensive list of questions that organizations can use to rate their MRP II capability or potential.

According to Oliver Wight, the characteristics that put an organization into category A, B, C or D can be summed up as:

Class A

Planning and control processes are effectively used company wide, from top to bottom. Their use generates significant improvements in customer service, productivity, inventory, and costs.

Class B

These processes are supported by top management and used by middle management to achieve measurable company improvements.

Class C

Planning and control system is operated primarily as a better method for ordering materials; contributing to better inventory management.

Class D

Information provided by the planning and control system is inaccurate and poorly understood by users; providing little help in running the business.

(From T*he Oliver Wight ABCD Checklist for Operational Excellence* Oliver Wight Publications Inc, USA - ISBN 0-939246-30-9)

Class A is the level most likely to produce maximum benefits to an organization as a whole. It can be defined as MRP II implemented throughout the organization, generating significantly improved customer service and productivity with lower inventory and costs. At Class A level, the organization is run with one set of figures from top management plans down to shop-floor operating schedules, and managers make extensive use of computer simulation for 'What if?' situation analysis.

Benefits Class A users can expect from an MRP II system include:

- **Better customer service: more on-time deliveries etc.**
- **Shorter manufacturing and administration lead-times, resulting in a more responsive business.**
- **Less work-in-process as work is not released until demand requires it.**
- **Steadily diminishing inventory levels and associated costs.**
- **Better balanced inventory, with less obsolete stock and fewer stock shortages.**
- **Increased productivity and less waste, as materials and labour are used only to fulfil orders and not on production for stock.**
- **The ability to simulate 'What if?' situations, especially as a way of keeping production in line with profit targets.**

Data accuracy

MRP II systems do however require large amounts of data, so it is vital to keep all information accurate. Consider for example a very simple system comprising a stock inventory of current component parts and raw materials, a bill of materials for each item or product to be produced, and a master production schedule detailing all production work to be carried out. Suppose we then evaluate the accuracy of system information with the following result:

Master production scheduling accuracy	98%
Inventory accuracy	95 %
Open orders	95%
Lead times	90%
Bill of materials accuracy	97 %

Individually, these figures seem quite respectable; but as MRP calculations involve all five sources of data, *overall* accuracy is:

$$\frac{98}{100} \times \frac{95}{100} \times \frac{95}{100} \times \frac{90}{100} \times \frac{97}{100} = 77\%$$

This means that in every hundred MRP calculations there will be 23 errors, caused by a combination of MPS, inventory, open order, lead time and BOM errors. Thus, data which appears acceptably accurate in isolation can result, when combined, in an unacceptable level of wrong orders issued to production departments or to suppliers.

Worse: in most MRP II systems, different people will enter different types of data at different points. For example:

Master production schedule	: master production scheduler
Bill of materials	: design/engineering department
Inventory records	: storekeeper
Open order and lead times	: planner/buyer

Planners and purchasers who rely on data from the MRP II system rarely know what the inputs were. They are therefore likely to miss all except the most grotesque errors.

As the functionality increases in an MRP II system, so does the amount of data required; and without vigilance, data inaccuracies will also increase. It is worth noting that our example above, in which individual accuracy percentages of 95-98 per cent fell to an overall 77 per cent, could have incorporated many more calculations and resulted in even lower overall accuracy. And this is but one example of a calculation. Across MRP there are many calculations – MPS, CRP, scheduling – and so data accuracy is extremely important if the outputs from all these processes are to be trusted.

45 mins

Exercise B1- 7

How do you increase data accuracy in your own organization and how are errors detected?

30 mins

Exercise B1-8

What inputs does MRP require in order to function?

45 mins

Exercise B1- 9

How long a period should the planning horizon cover?

Implementing MRPII

Research suggests that the successful implementation of MRP II only happens after a lengthy period - typically 12-24 months - of intensive planning, preparation and teamwork involving personnel at every level in the organization.

- **Audit/assessment**

The first stage is to assess the organization's readiness to adopt MRP II. Recommended practice is to use the Oliver Wight ABCD Checklist mentioned earlier. This exercise not only forces managers to take a hard look at existing practices, but also forms a valuable baseline for measuring the success of MRP II (if indeed it is implemented).

- **'First cut' education**

Senior and operating managers learn what MRP II is, how it works and how it might benefit the organization. A final decision on implementation can however only be made after three critical tasks have been performed, usually in parallel: cost/benefit analysis, development of performance measures, and project organization. Let's look at these in more detail.

- **Cost/benefit analysis**

The costs of implementing MRP II are considerable and obvious. They typically include the time of every manager and specialist in the organization - spent attending meetings, finding and analysing facts, writing reports etc - and the costs of IT hardware and software, consultancy, education and training, systems analysis, improving data accuracy etc. By contrast, the potential benefits are less obvious. This makes it all the more important to identify and assess both costs and benefits in an unbiased way, then communicate the findings to everyone concerned. The easiest way to lose support for a good programme is to fail (a) to fully and openly justify its costs and (b) to clearly spell out its importance to the organization.

In most cases the main categories of cost are people, data and IT; while the main categories of benefit are sales and various aspects of material and labour costs. The best people to quantify costs and benefits are those closest to the facts: so ask the sales director how much sales might rise if more deliveries to customers were on time; ask the materials manager the cost of bringing inventory record accuracy up to a Class A level; and so on. Asking them for cost/benefit data is also the best way to secure their commitment to those costs and benefits when the programme is fully implemented.

- **Performance measurement**

Senior management will know what it wants the new system to achieve; but goals are only helpful if progress towards them can be measured. The project team must therefore develop a set of performance measures. First, a set of basic 'checklist' questions must be asked:

- **What is being measured?**
- **Why is it being measured?**
- **Whom or what does the measurement affect?**

- Who does the measuring?
- How is measurement data collected?
- What is the relevant performance target?
- How is performance calculated?

Once a measurement system has been established, operators need to know what constitutes good and bad performance. This is done by setting performance targets. For example, performance targets for the master schedule might be defined as:

Minimum acceptable performance : 92 per cent

Satisfactory performance : 95 per cent

Target performance : 98 per cent or better

But: 92, 95 or 98 per cent of what? Tolerances must be determined. For example, we might rate completion of a master scheduled item within 2 days after its scheduled completion date, and to within ±4 per cent of its scheduled quantities, as acceptable. Any completion falling outside those ranges would be rated a failure. By that measure, if performance to the master schedule is 95 per cent or better, production is operating at a satisfactory or Class A level of performance.

- **Project organization**

Preparing the organization for conversion to MRP II involves many activities including:

1. Creating a detailed implementation plan.
2. Educating and training all personnel.
3. Converting sales, logistics and manufacturing processes in line with MRP II.
4. Documenting or rewriting company planning and control policies and procedures.
5. Developing a reliable database for inventory records, bills of material, routings etc.
6. Searching for process improvements that will make the entire system more efficient.
7. Sourcing and installing the software and technical backup needed to support MRP II.
8. Identifying ways of measuring and tracking performance.

It now becomes easy to see why a typical MRP II implementation takes 12-24 months! Once all these tasks are more or less complete (they will never be totally complete), the organization is ready to 'go for it'.

- **Activation**

There are three basic methods for 'switching on' the new MRP II system:

1. **The cold turkey approach**

   The old system is switched off and the new system is switched on. This is rather like jumping out of an aircraft at 5,000 feet wearing a new type of parachute that has never been tested. It might work; it might not.

2. **The parallel approach**

   The new system is operated 'off line' and its performance compared with that of the existing system. When the new system can consistently provide at least the same information as the existing system, the latter is switched off and the new system goes fully 'on line'.

3. **The 'live pilot' approach**

   A small part of the new system is piloted 'on line', with a very high level of control and monitoring to minimize any possible damage to the operation of the business. Even if the pilot is outstandingly successful, caution advises against a sudden total changeover. There should ideally be a planned programme of live pilot exercises so that the old system is replaced stage by stage.

The live pilot approach is recommended above the other two because:

- It offers 'real life' testing of policies, procedures, software and hardware.
- Personnel can learn to operate the system using the organization's own data.
- Problems can be identified and solved at minimal risk to the overall business.
- The organization has an opportunity to gain confidence in the new system.

- **Ongoing audit/assessment of MRP II**

Once the MRP II system is up and running, the obvious question is: 'How well is it performing?' This involves comparing actual performance against the expected or desired performance levels established at the original evaluation stage. No matter how favourable the comparison, the next question should always be: 'What can we do to improve the system?' Or - much better - 'What can we do to continuously improve the system?'

The model Class A organization maintains an ongoing education programme that continues to develop MRP II expertise through courses, seminars, reading lists, certification programmes and regular internal meetings. To get the maximum benefit from MRP II, this process of continuous performance measurement, continuous reassessment and continuous education must never stop.

The ongoing assessment process will of course reveal problems, typically to do with the realism and achievability of the master schedule. For example:

- **Ignorance**

  Things are done wrong by people who don't understand the principles and details of master scheduling. Solution: more education.

- **Not all of the key people are on board**

  Master scheduling is not just a production issue. If sales and marketing don't understand the issues or don't get involved in demand management and sales and operations planning, there will be persistent problems with plant overloading, over-promising etc.

- **Sales and operations planning is delayed**

  The earlier the sales and operations planning, the better the master production schedule. Planning is the province of senior management, so the earlier they start, the clearer is the signal that the organization means business.

- **There is too little rough cut capacity planning**

  Rough cut capacity planning is a quick and indispensable 'reality check' on the production plan. It prevents an unrealistic master schedule from getting on to the shop floor.

MRPII summary

If an MRP II system is correctly and fully implemented, improvements automatically follow. Significant benefits include better delivery performance, reduced inventory, shorter lead times, lower operating costs and - ultimately - increased profits.

MRP II principles can be applied to all forms of manufacturing. Commercial MRP II software was originally designed for mass or batch production, but systems are now available for most forms of production.

However, organizations should not leap straight into MRP II. Senior managers must have a clear and detailed understanding of what MRP II is and how it works, and of its potential benefits, before deciding whether it is right for their organization.

Let's now look at how an organization might reach a decision to implement (or not!) MRP II, and how an effective implementation programme might be planned and carried out.

A typical MRP II implementation programme

It should be evident by now that **MRP II should not be implemented just because it sounds like a good idea!** It must first be correctly identified by senior management as the right way to strengthen the organization's structure and build for the future. Though different organizations will implement MRP II at different times in their development and for different reasons, a typical decision to go ahead will be based on preconditions such as these:

- The organization's market share is growing.
- Its product range is expanding.
- It needs to keep stockholding to a minimum to improve cash-flow.
- Market pressures are growing to reduce lead-times and prices.
- It wants to build a solid foundation for future growth.

Most implementation programmes will bear some resemblance to the following train of events in a fictitious pen company that you will meet again in Module C.

See the 'rolling' example of our pen company in Module C1 ***Material requirements planning.***

Wider Reading

First steps

Once the principle of implementing MRP II has been agreed, a steering committee is set up to ensure that the project is managed in line with project objectives. The steering committee is a representative cross section of the senior management team. It in turn establishes a project team with cross-functional membership, representing production, materials, marketing, finance and quality. Some members are seconded full time to the project; others are part time.

Key project tasks

The steering committee identifies these key areas for the project team to work on:

1. **Input data system: establish the expected benefits and the costs, milestones and date of implementation**
2. **Identify a performance measurement system and the data required for it.**
3. **Education and training requirement (at all levels including senior management).**
4. **Identify weaknesses in current systems that need improvement to ensure effective MRP II implementation and maintenance.**
5. **Identify a suitable input data computer system.**

Expected benefits

The expected benefits of an MRP II system are identified as:

1. **Minimum reduction of 20 per cent of inventory holding throughout the process: that is in raw materials, work in process and finished goods.**
2. **Improved materials and production planning reduces rush orders, resulting in overtime down by five per cent and efficiency up by five per cent.**
3. **Customer service improved by increased on-time deliveries and shorter lead-times.**
4. **Improved supplier relations, as longer visibility enables the company to give suppliers regular forecasts of demand.**

Project costs

Principal project costs are identified as:

1. **MRP II software package.**
2. **IT hardware.**
3. **Staff education and training.**
4. **Staff secondment.**

Board approval

The timetable for full implementation is estimated at 18 months. This is presented to the board for approval before too much of the other work is carried out. The board approves the investment but wants implementation in 15 months with minimal additional cost. This is evaluated and agreed.

Performance measurement identification

The performance measurement sub-group reports on the performance measures required to monitor the MRP II system's implementation and to gauge the extent to which performance actually improves. It also identifies which measures need monitoring but are not currently being monitored.

The sub-group identifies the required performance measures as:

1. **Inventory holding by value and by sections: that is, raw materials, work in process and finished goods.**
2. **Stock turns, both in total and by sections.**
3. **Stock accuracy measured as a percentage of cycle count adjustments.**
4. **Numbers of sales orders shipped on time, and late (measured in weeks).**
5. **Forecast accuracy.**
6. **Internal and external lead-times.**
7. **Work orders completed on time.**
8. **Accuracy of open work orders and purchase orders.**
9. **Works order lead-times: planned compared with actual.**
10. **Purchase orders on-time delivery.**
11. **Purchase order lead-times: planned compared with actual.**
12. **Number of orders rescheduled or cancelled.**
13. **Bill of material accuracy.**
14. **Number of MRP action messages**

It is felt that monitoring these measurements will ensure that MRP II functions to its fullest potential; and that any dip in performance will quickly be identified and corrected.

45 mins

Exercise B1-11

What key areas did the MRP II implementation project team identify to work on?

Education and training

An education and training task group is set up to ensure that all company staff are informed of the project and its progress, and that they receive appropriate education and training. The task group decides to split education and training and devises an education programme even before board approval. **It realises that the key to success is to get everyone enrolled and willing to accept the changes MRP II will bring**. The task group:

- Holds small briefing sessions to inform staff and deal with queries and misgivings.
- Distributes a monthly newsletter about the project's progress.
- Runs a pre-training session to identify the levels of individual training needed.

Once the overall training need is known, a training scheme is devised which includes six separate programmes for different groups of personnel:

Programme 1

To give senior management an overview of the MRP II system and their part not just in its implementation but in its continued success.

Programme 2

MRP II and project management training for the steering group and the cross-functional implementation teams.

Programme 3

Specialized courses for key staff in forecasting, master scheduling, inventory management and MRP.

Programme 4

An MRP II overview for everyone, with sessions designed to show:

Where individuals fit into the big picture.

What is expected of them.

The benefits of MRP II operating - **thanks to teamwork** - at its full potential.

Programme 5

Extensive hands-on training for users of the software package.

Programme 6

Dress-rehearsal (sometimes called a 'conference room pilot') on a simulated MRP II system loaded with data.

Input functions

At the same time, another task group looks at all the key input functions to MRP II. Its aim is to identify and correct any weak links prior to implementation. They analyse:

1. **The master schedule**

To ensure that:

- **It reflects true customer demand.**
- **It is stable.**
- **It is attainable in terms of both capacity and material availability, and is not merely a 'wish list'.**
- **Its planning horizon covers at least the total lead-time of the longest component.**
- **Overloads are managed and a clear sense of priority is communicated to everyone.**
- **Forecasts are reasonably accurate and effective.**

2. **Bills of materials**

To ensure that:

- **All parts requiring planning have bill of materials.**
- **All bills of materials contain the correct components to manufacture the parent item.**
- **All units of measurement and quantity are correct.**
- **There is a correctly functioning system to control changes to bills of material.**

3. **Stock control system**

To ensure that:

- **Data entry is accurate for all computer transactions: sales orders, purchase orders, works orders, stock receipts and issues etc.**
- **Planned lead-times for both manufacturing and purchasing are as close as possible to actual lead-times.**
- **Lot size rules suit revised stockholding policies.**
- **Stock on hand figures and cycle counts are accurate.**
- **A reliable reporting structure for scrap, rework and independent demand usage is in place.**

Success!

Getting the inputs right is a slow and at times unrewarding process, but it is crucial to MRP II success or failure. Areas identified as weak can be audited more frequently until they became more reliable.

Once all the work is complete, the company implements its MRP II system over a weekend, downloading all data into the new system and running diagnostic checks. This process goes very well, justifying all the hard work put in over the past 14 months.
Overall, decisive factors are:

- **A senior management that is not only willing to invest, but is also totally committed to the project's success and to the MRP II system's continued success.**
- **A well-directed project team which covers all areas methodically.**
- **The support of all staff, who come to see the project as 'ours' rather than 'theirs'.**

Expectations

The desired output expected by everyone involved in the implementation is 'Success', but a word of caution – things can, and do, go wrong.

Why should this be the case?

There are a number of things that can happen and some typical problems are listed below:

1. **Unrealistic plans and conflicting priorities**
   - **Tendency to manage by 'fire fighting' and 'seat of the pants'**
   - **Little formal planning and control**
   - **Will not change how the business is run**

2. **General lack of visibility**
   - **Data is not believable because of poor record accuracy**
   - **User departments don't believe in the system and rely on their old formal method**

3. **Lack of proper disciplines, procedures and controls**
   - **Little management appreciation for the importance of data accuracy**
   - **Few formal policies and procedures**
   - **No accountability**
   - **No accuracy measurements and performances reporting**

4. **Little attention to formal education and training**
   - Little appreciation for the extent of education/training required
   - Not dedicated to a company-wide education program

5. **Unrealistic implementation expectations and scheduling**
   - Think the system can be Installed In only a few months
   - Don't realise the amount of change that may be required
   - Little understanding of how long it takes to train everyone
   - Little planning and scheduling of resources
   - Tendency to de-commit resources when it becomes difficult

6. **Lack of proven software and documentation**
   - Didn't understand MRP II at selection time
   - Didn't thoroughly research with references the proven nature of the software
   - Inadequate controls built into the software
   - Poor documentation on how the system actually functions

7. **Lack of top management commitment and leadership**
   - Top management refuses to attend MRPII education
   - Doesn't really believe in the potential payoffs
   - Provides only lip service attention to the project
   - Tendency to want a quick painless fix
   - Not aware of the extent of preparation and resources required
   - Unwilling to change how the business is run

Class 'A' status

Many organizations will aspire to Class 'A' status, but what do they need to do to achieve this recognition?

It can be achieved by meeting the criteria listed overleaf:

MRP II Classification checklist

A methodology for assessing the MRP II classification of any organisation.

Technical

1. **Time Periods for MPS and MRP are WEEKS or smaller**
2. **MPS and MRP run weekly or more frequently**
3. **System includes firm planned order and pegging capability**
4. **The MPS is visibly managed, not automatic**
5. **System includes CRP**
6. **System includes a daily dispatch list**
7. **System includes Input / Output control**

Data integrity

8. **Inventory record accuracy is 95 % or better**
9. **BOM accuracy 98 % or better**
10. **Routing accuracy 95 % or better**

Education

11. **Initial education of at least 80 % of all employees**
12. **An ongoing education programme**

Use of the system

13. **The shortage list has been eliminated**
14. **Vendor delivery performance is 95 % or better**
15. **Vendor scheduling is done out beyond the quoted lead times**
16. **Shop delivery performance is 95 % or better**
17. **Master schedule performance is 95 % or better**
18. **There are regular, at least monthly, production planning meetings with the General manager, his staff including: manufacturing, P. & I.C., engineering, marketing, finance**
19. **There is a written Master scheduling policy which is adhered to**
20. **The system is used for scheduling as well as ordering**
21. **MRP is well understood by key people in manufacturing, marketing, engineering, finance and top management**
22. **Management really uses MRP to manage**

23. Engineering changes are effectively implemented
24. Simultaneous improvement has been achieved in at least two of the three following areas: - Inventory, Productivity, Customer Service
25. The operating system is used for financial planning

MRP II classification:

Class A status requires 23 of the above 25

Class B status requires 20

Class C status requires 17

Ongoing audit and assessment

The task groups continue to meet regularly for the next six months, reviewing the system's operation and fine-tuning it to optimize the organization's performance.

60 mins

Exercise B1-12

What key performance measures can you identify as necessary to measure and monitor the performance of an MRP II system in your organization?

45 mins

Exercise B1-13

What were the key reasons for the project's success?

Project

6 hours

You are an operations management consultant. You are asked to advise ABC Ltd, whose senior management has decided to introduce an MRP II system.

ABC Ltd has 300 employees, of whom 150 are direct labour. Annual turnover is £16m. The company manufactures a range of products assembled from both 'bought out finished' and 'made in house' components.

The business is currently managed by a manual data system, and supplier schedules are produced manually. There is however some computer support of the planning process: for example, stock management and bills of material.

You have been given these specific tasks:

1. **To advise on the preparations ABC Ltd should make before embarking on its MRP II project.**

2. **To identify and suggest measures by which the new system can be monitored to ensure optimum performance.**

3. **To advise on how the workforce might be encouraged to use the new system to best effect, and to identify the key issues to be considered in winning their commitment to it.**

4. **To identify what should be done to ensure consistent optimum performance from the new system, and to minimize the possibility of 'bad practices' creeping in.**

Please note

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