MRP and ERP

MRP

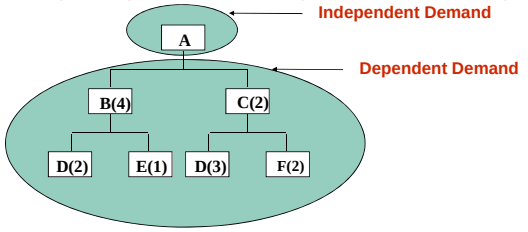
Material requirements planning (MRP): Computer-based information system (i.e. glorified database) for ordering and scheduling of *dependent demand* inventories

It is a production planning process that starts from the demand for finished products and plans the production step by step of subassemblies and parts.

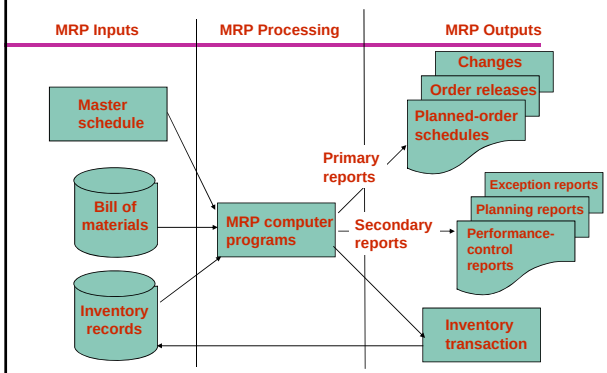
Independent and Dependent Demand

Independent demand: Demand for final products.

Dependent demand: Demand fort items that are subassemblies or component parts to be used in production of finished goods.



Independent demand is uncertain.
Dependent demand is certain.



MRP Inputs: 1. MPS

- Master Production Schedule: MPS
  - Time-phased plan specifying timing and quantity of production for each end item.
  - MPS comes from sales and marketing
  - MPS covers about 1-3 months into the future
    - Must cover cumulative lead time

Cumulative lead time: The sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.

  - From Now until Cumulative lead time plans are generally frozen
- Sometimes MPS is capacity filtered; MPS is curtailed after taking the available capacity into account.

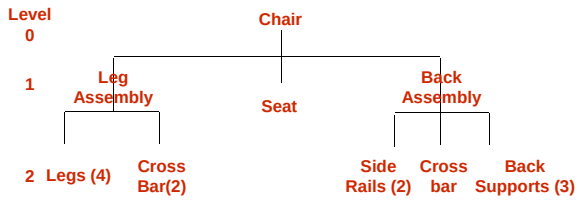
MRP inputs: 2. BOM

Bill of materials (BOM): A listing of all of the raw materials, parts, subassemblies, and assemblies needed to produce one unit of a product.

Product structure tree: Visual depiction of the requirements in a bill of materials, where all components are listed by levels.

Most often people do not use the term product structure tree. Instead use BOM to mean the product structure tree.

Product Structure Tree

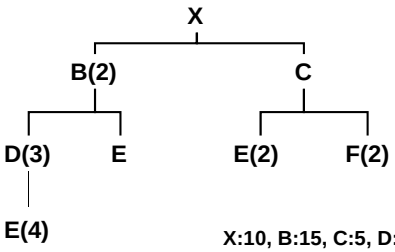


Explosion Example

- How many leg assemblies are needed for 1 chair?
- How many Cross bars are needed for 5 chairs?
- Computing how many parts are required per a final product is called BOM explosion.
- MRP answers these questions by taking production lead times into account: Not only it tells how many, but also when.

Bill of Materials – Example 1

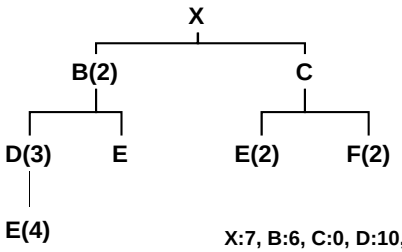
How many more of each component is needed to make 15 Xs if there are 5 of each already in stock?



X:10, B:15, C:5, D:40, E: 180, F:5

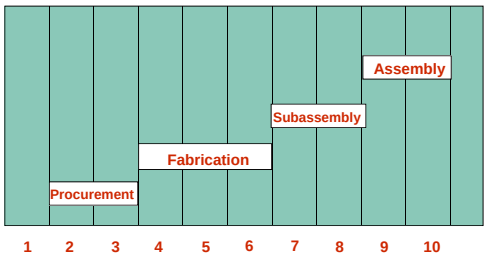
Bill of Materials – Example 2

How many more of each component is needed to make 15 Xs if there are 8 of each already in stock?

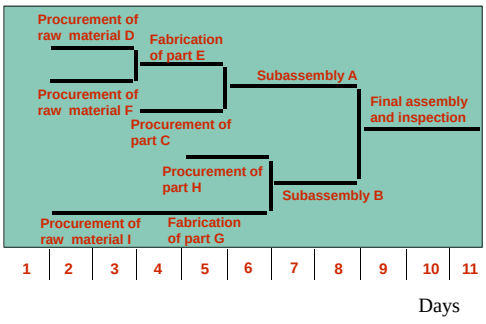


X:7, B:6, C:0, D:10, E: 38, F:0

Lead Times



Assembly Time Chart



MRP input: 3. Inventory levels

- Beginning inventory on hand
- Scheduled receipts
  - Pipeline inventory not received yet but it is in the process of coming to the inventory. We know when this will be available for use.

MPR Processing

- Gross requirements
  - Total expected demand
- Scheduled receipts
  - Open orders scheduled to arrive
- Planned on hand
  - Expected inventory on hand at the beginning of each time period
- Net requirements
  - Actual amount needed in each time period
- Planned-order receipts
  - Quantity expected to received at the beginning of the period
  - Offset by lead time
- Planned-order releases
  - Planned amount to order in each time period

MRP Processing

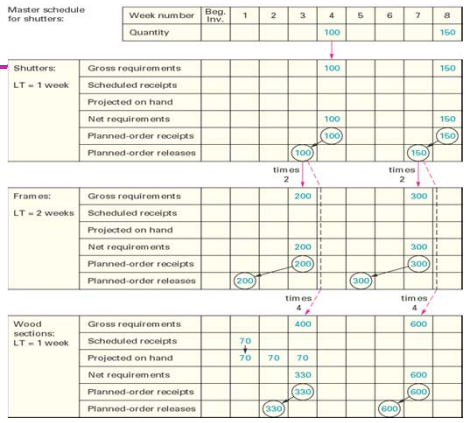
- Gross requirements: (Forecasted)Demand period by period
- Net requirements(t)
  =Gross requirements(t)-Projected inventory(t-1)
  -Scheduled receipt(t)
- If Net requirement(t) > 0
  set Planned order receipts(t)>=Net requirement(t)
- Planned-order receipts is the production planned
- Projected inventory(t)
  =Projected inventory(t-1)+Scheduled receipt(t)
  +Planned order receipts(t)-Gross requirements(t)
- Planned order release(t-LT)=Planned-order receipts(t)

MRP example with LT=2 and 1 level

Periods	0	1	2	3
Gross requirements		6	11	7
Scheduled receipts		2	3	0
Projected on hand	10	6	0	0
Net requirements		0	2	7
Planned order receipts			2	7
Planned order releases	2	7		

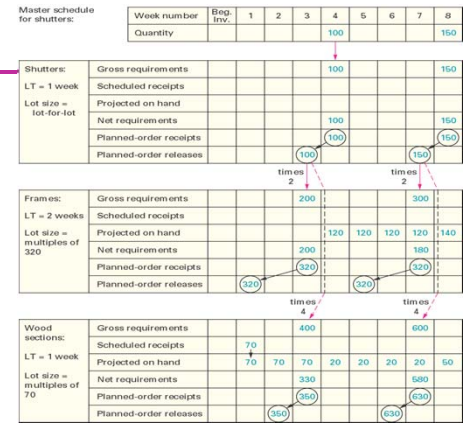
Inputs

Outputs



Other Considerations

- Safety Stock
  - Not much for items with dependent demand
- Lot sizing
  - Lot-for-lot ordering
  - Economic order quantity
  - Fixed-period ordering
  - Part-period model



MRP Outputs

- Planned orders - schedule indicating the amount and timing of future orders.
- Order releases - Authorization for the execution of planned orders.
- Changes - revisions of due dates or order quantities, or cancellations of orders.
- Performance-control reports
- Planning reports
- Exception reports

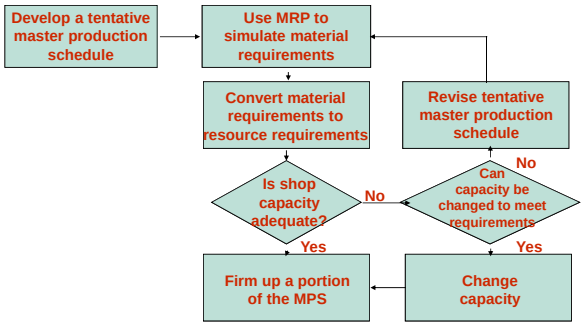
Capacity Planning

Capacity requirements planning: The process of determining short-range capacity requirements.

Load reports: Department or work center reports that compare known and expected future capacity requirements with projected capacity availability.

Time fences: Series of time intervals during which order changes are allowed or restricted.

MRP Planning



MRP in Services

- Food catering service
  - End items are the catered food
  - Dependent demands are ingredients for each recipe, i.e. bill of materials
    - Taco Bell menu items
- Hotel renovation
  - Activities and materials “exploded” into component parts

Benefits of MRP

- Low levels of in-process inventories
- Ability to track material requirements
- Ability to evaluate capacity requirements
- Means of allocating production time

Eventually it is a database with limited decision making capability

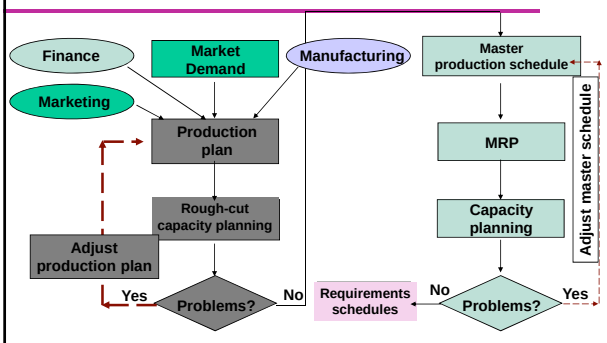
Requirements of MRP

- Computer and necessary software
- Accurate and up-to-date inputs:
  - Master schedules
  - Bills of materials
  - Inventory records
- Integrity of data

MRP II

- Expanded MRP with and emphasis placed on integration
  - Financial planning
  - Marketing
  - Engineering
  - Purchasing
  - Manufacturing

MRP II



ERP

- *Enterprise resource planning (ERP):*
  An **expanded** effort to integrate standardized record keeping that will permit information sharing throughout the organization
- Strategic considerations
  - High initial cost
  - High cost to maintain
  - Future upgrades
  - Training

Summary

- MRP:
  - Dependent vs Independent demand
  - Inputs (BOM),
  - Processing,
  - Outputs
  - Benefits and requirements
- Capacity planning
- MRP-II and ERP

Just-In-Time Systems (Lean Production)

JIT/Lean Production

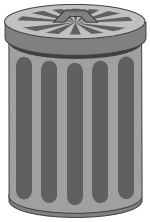
- *Just-in-time*: Repetitive production system in which processing and movement of materials and goods occur just as they are needed, usually in small batches
- JIT is characteristic of lean production systems
- JIT operates with very little “fat”

JIT Goals

- Eliminate disruptions
- Make system flexible by reduce setup and lead times
- Eliminate waste, especially excess inventory

Sources of Waste

- Overproduction
- Waiting time
- Unnecessary transportation
- Processing waste
- Inefficient work methods
- Product defects

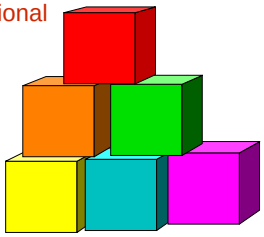


Big vs. Little JIT

- Big JIT – broad focus
  - Vendor relations
  - Human relations
  - Technology management
  - Materials and inventory management
- Little JIT – narrow focus
  - Scheduling materials
  - Scheduling services of production

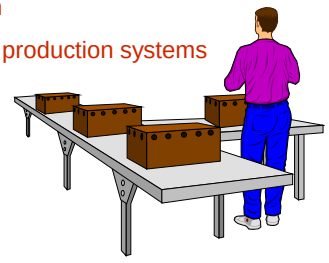
JIT Building Blocks

- 1. Product design
- 2. Process design
- 3. Personnel/organizational elements
- 4. Manufacturing planning and control



1. Product Design

- Standard parts
- Modular design
- Highly capable production systems



2. Process Design

- Small lot sizes
- Setup time reduction
- Manufacturing cells
- Limited work in process
- Quality improvement
- Production flexibility
- Little inventory storage

Benefits of Small Lot Sizes

- **Reduces inventory**
  - **Less rework**
    - **Less storage space**
  - **Problems are more apparent**
- **Increases product flexibility**
  - **Easier to balance operations**

Production Flexibility

- Reduce downtime by reducing changeover time
- Use preventive maintenance to reduce breakdowns
- Cross-train workers to help clear bottlenecks
- Reserve capacity for important customers

3. Personnel/Organizational Elements

- Workers as assets
- Cross-trained workers
- Continuous improvement
- Cost accounting
- Leadership/project management

4. Manufacturing Planning and Control

- Level loading
- Pull systems
- Visual systems
- Close vendor relationships
- Reduced transaction processing
- Preventive maintenance

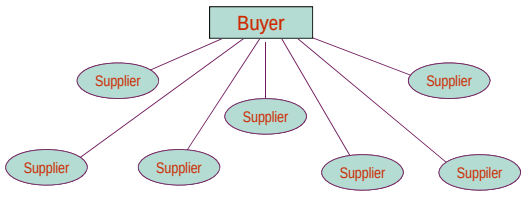
Pull/Push Systems

- *Pull system*: System for moving work where a workstation pulls output from the preceding station as needed. (e.g. Kanban)
- *Push system*: System for moving work where output is pushed to the next station as it is completed

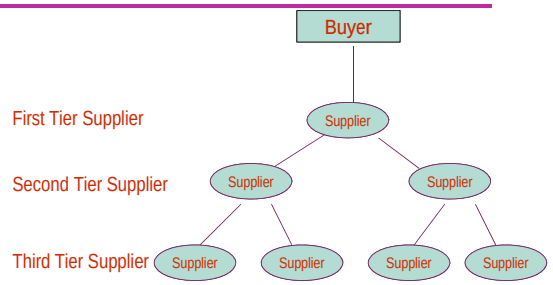
Kanban Production Control System

- *Kanban*: Card or other device that communicates demand for work or materials from the preceding station
- Kanban is the Japanese word meaning “signal” or “visible record”
- Paperless production control system
- Authority to pull, or produce comes from a downstream process.

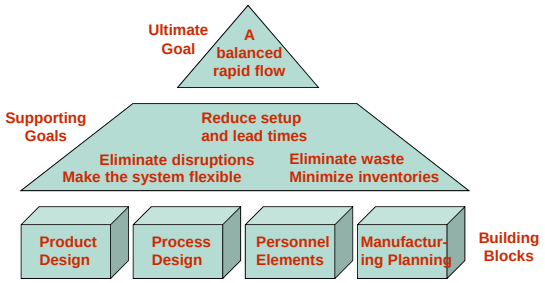
Traditional Supplier Network



Tiered Supplier Network



Summary JIT Goals and Building Blocks

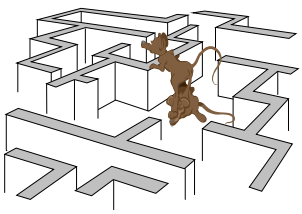


Converting to a JIT System

- Get top management commitment
- Decide which parts need most effort
- Obtain support of workers
- Start by trying to reduce setup times
- Gradually convert operations
- Convert suppliers to JIT
- Prepare for obstacles

Obstacles to Conversion

- Management may not be committed
- Workers/management may not be cooperative
- Suppliers may resist



JIT in Service

The basic goal of the demand flow technology in the service organization is to provide optimum response to the customer with the highest quality service and lowest possible cost.

- Eliminate disruptions
- Make system flexible
- Reduce setup and lead times
- Eliminate waste
- Minimize WIP
- Simplify the process

JIT II

- JIT II: the practice of allowing vendors to manage some aspects of buying their products or services for the buyer

Benefits of JIT Systems

- Reduced inventory levels
- High quality
- Flexibility
- Reduced lead times
- Increased productivity

Benefits of JIT Systems (cont'd)

- Increased equipment utilization
- Reduced scrap and rework
- Reduced space requirements
- Pressure for good vendor relationships
- Reduced need for indirect labor

Elements of JIT

- Smooth flow of work (the ultimate goal)
- Elimination of waste
- Continuous improvement
- Eliminating anything that does not add value
- Simple systems that are easy to manage
- Use of product layouts to minimize moving materials and parts
- Quality at the source

Elements of JIT (cont'd)

- Poka-yoke – fail safe tools and methods
- Preventative maintenance
- Good housekeeping
- Set-up time reduction
- Cross-trained employees
- A pull system

Case Study based on a trip on Nov 19, 02

NUMMI

History/Products

- Late 70's oil crisis
- GM closes Fremont, CA plant firing 6000 in 1982
- Toyota approaches GM to set up Toyota production system at a GM plant, United Auto Workers accepts the deal
- GM and Toyota put together $400M in 1984. GM owns the infrastructure, Toyota is the tenant.
- Nummi = New United Motor Manufacturing, Inc is born in 1984 as the unique example of a Toyota – GM joint venture
- Products: Toyota Corolla, Tacoma Trucks, Pontiac Vibe (Toyota bottom, GM top) and Toyota Voltz (Toyota bottom, GM top, sold in Japan) , GM Prism until 13/12/01

Workers

- Nummi has about 4500 unionized workers
- Workers are under two types:
  - Production, high school graduates
  - Maintenance
- Workers work in teams of 4-6
- Workers in a team rotate the tasks every 1-3 hours
- Team leader is responsible for the rotation.
- Team leader withdraws parts from the inventory (every 1-2 hours) and provides the tools as necessary
- Workers make $17 per hour

Capacity

- Nummi has a cycle time of
  - 60 seconds for Corolla, 1 body
  - 82 seconds for Tacoma, 3 bodies (only cabin is produced at Nummi, the bottom and the back are bought from suppliers)
- Nummi works in two shifts
  - I: 6:00-14:30, II: 16:30-1:00
  - Each shift has 1 hour lunch/dinner break
  - Starting the first shift at 6:00 workers avoid heavy morning traffic
  - Two hours between shifts I and II is to allow for overtime after the first shift when necessary

Work Flow

- Stamping: Forming metal (side, back, front) panels with presses
- Body & Weld: Putting panels together
- Paint: Paint inspection is the current bottleneck
  - Primer body paint applied by robots (chemically hazardous task)
  - Door jambs painted manually
- Plastics: Making bumpers, inside panels
- Assembly: Putting in tires, engine, seats, bumpers, harnessing. Cars , trucks on 2 km , 0.8 km conveyors
- Cars contain Building manifest = BOM = Ingredients list at every step of these operations

Just in time

- Kaizen: continuous improvement
- Kanban: replenishment every 1-2 hours
- Jidoka: Assure 100% quality. Otherwise pull the Andon chord
  - 1000 times per shift
  - 9% of line stops are longer than 30 seconds
  - Line stops longer than an hour once every month
- Muda: Waste to be eliminated
- Genchi Genbutsu: Go to the source to learn and to solve the problems
- This Japanese terminology is all over the boards in the plant

Creative Tool / Work Place Design

- Die change at the stamping in 3 hours
- Tilted storage bins for ease of access
- Collapsing storage boxes when empty
  - To reduce the empty box storage requirements in trucks returning to suppliers, say in Indiana
  - These boxes save about $10M annually
  - The worker who suggested the boxes earned several thousand points. 1 point = $1.
- More info www.nummi.com