As MRP became known for problems in dealing with capacity and uncertainties, it became apparent that enhancements were necessary. Manufacturing Resources Planning (MRP II) came about in response to these concerns. MRP II embeds planning and control functions around the MRP functionality to make it more responsive to these problems.

**MRP II Hierarchy**

- Long-range planning
- Resource planning
- Bill of Materials
- Inventory status
- Capacity requirements planning
- Job release
- Job dispatch
- MRP
- MPS
- Aggregate planning
- Feeds Demand Management function (Intermediate)
- Aggregate planning
- Production, staffing, inventory, overtime levels over long term
MRP II

- **Intermediate Planning**
  - Demand Management
    - Actual and anticipated orders
    - ‘Available to promise’ (ATP)
      - Compares committed production to available and planned production
  - Master Production Scheduling (MPS)
    - With help of rough-cut capacity planning to create a capacity-feasible MPS
  - Rough-cut Capacity Planning
    - Quick check of critical (bottleneck) resources check capacity feasibility of potential MPS
    - Uses Bill-of-Resources for each item on the MPS (hours required on critical resources)

- **MRP II**
  - MRP module performs the MRP functions we discussed earlier
    - Feeds the job pool
    - Job release function (short-term control) decides how to allocate parts to jobs
  - Capacity requirements planning (CRP)
    - More detailed check of production schedule output from MRP
    - Does not generate a capacity-feasible plan; rather it displays the required resource commitments given the MRP output
    - Helps user identify problem sources
    - Generates load profile for each processing center

- **MRP II**
  - Short-term Control
    - Shop floor control
      - Job dispatching (sequencing jobs)
      - Shop/output control (WIP level monitoring to determine whether job release rate is too fast or slow)
      - We will cover shop floor control in more detail towards the end of this course

- **Just-in-Time (JIT) Manufacturing**
  - JIT in its broadest sense consists of a manufacturing paradigm quite different from the MRP paradigm
    - JIT encompasses a variety of ideas and manufacturing principles and practices
    - The origins of JIT are typically attributed to Toyota’s manufacturing systems
    - The success of Japanese auto manufacturers in the 1970’s and 80’s is largely attributed to JIT practices
    - Deteriorating performance of U.S. and European firms led to a desire to understand the source of the Japanese competitive advantage and eventually resulted in implementation of JIT (with varying success) at many U.S. firms
JIT Manufacturing

- JIT goals: The seven zeroes:
  - Zero defects
  - Zero excess lot size
  - Zero setups
  - Zero breakdowns
  - Zero handling
  - Zero lead time
  - Zero surging
- Unachievable goals, but the point is clear

JIT Manufacturing Enablers

- JIT is often seen as synonymous with the Kanban 'pull' production system (we will look at this in more detail later).
- Requires 'smooth production' levels
  - Translate monthly output requirements into an hourly production rate
  - Mixed model lines necessitate low setups for this to work
- Dealing with variability: capacity buffers
  - Plan buffer capacity in each day for possible disruptions

Setup Reduction

- U.S. manufacturers typically regarded setup times as 'given' constraints
- Japanese (Toyota) continuously strived to create new ways to reduce setup times
- Internal vs. external setups
- Make as much of setup external as possible
- Standardize product designs (commonality)

Cross training

- U.S. traditionally held workers at one task
- Japanese focused on enabling workers to perform multiple tasks, which reduces boredom, increases flexibility, and gives workers broader view

Plant layout

- U-shaped cells became common for labor-intensive lines to enable workers to move quickly between stations
JIT Manufacturing Enablers

- Total Quality Management (TQM)
  - Probably the first elements of JIT to be adopted in the U.S.
  - Although much of this was initially rhetoric and not practiced
  - JIT requires a low amount of rework to be effective
  - To keep production levels smooth
  - Again, a case of U.S. manufacturers often treating rework as a necessary evil, while Japanese manufacturers took a more scientific ‘root-cause’ approach

- Seven principles essential to quality practice:
  - Statistical Process Control (SPC)
  - Easy-to-see quality (charts, displays)
  - Compliance to specifications at all stations
  - Line stopping (empowers line workers)
  - Correcting own errors (as opposed to U.S. rework lines)
  - 100% inspection (if possible, usually with automation)
  - \( N = 2 \) approach: Inspect first and last job on line
  - Continuous improvement
    - Always strive to the zero-defect goal

Kanban Production System

- Kanban is an alternative to MRP for controlling production flow
  - Kanban is loosely translated from Japanese as ‘card’
  - Kanban systems use kanban cards to drive production
  - Systems control WIP through number of cards – no working ahead of downstream stations

Kanban Schematic

- One-card system (Fig. 4.5 in Text):
  - Production card authorizes start of work
  - When stock is removed, put production card in hold box
  - Completed parts with cards enter outbound stockpoint
  - Kanban systems attach Kanban cards to jobs in the system; these cards are used to authorize production
  - Systems control WIP through number of cards – no working ahead of downstream stations
Problems of the Past

- We have now covered standard, traditional inventory control methods, MRP and MRP II, and JIT
  - Each of these systems has improved productivity relative to past practices
  - Each system has brought about a new set of problems and challenges
  - We briefly consider why these different methods have been successful in some cases and failed miserably in other cases

Traditional Methods

- Pros:
  - Take a scientific approach to management
  - Sharpen managerial insight by characterizing critical tradeoffs
- Cons:
  - Traditional inventory models and methods optimize costs under the model assumptions
  - Model assumptions fail to hold in practice
  - Constant demand rate, fixed and known setup cost, infinite capacity, complete shortage backlogging
  - We often generate an optimal solution for the wrong problem
  - Models typically assume a single-stage or product-stage or product
  - Real production systems are much more complex

MRP Paradigm

- Pros:
  - Perform extremely well in make-to-order systems with limited uncertainty and ample capacity
  - Deterministic demand is not a poor assumption
  - Efficiently encodes the relationships and interdependencies of highly complex production systems
- Cons:
  - MRP systems have been hugely successful in terms of industry usage and sales
  - Users have more often than not been less than pleased with the problems associated with MRP
  - MRP is based on a flawed model
  - Limited capacity, deterministic demand and linear times

JIT Issues

- Pros:
  - Emphasis on quality control and improvement, setup reduction, WIP reduction, tight supplier relationships
  - Pull system responsive to state of the system
  - Complete paradigm and attitude shift for workers
- Cons:
  - Implementation is long term investment
  - Reliance on supplier relationships
  - Requires continuous attention to detail
  - Requires real management commitment, not rhetoric
ERP systems integrate all enterprise-wide systems:
- Finance
- Accounting
- Manufacturing
- Human Resources
- Marketing & Sales

It provides consistency across the enterprise in terms of user interfaces, data, and vendor and customer relations.

For example, when sales closes a deal and enters it in the system, it automatically shows up as an order for production and increases the accounts receivable.

Not every user has been happy with ERP system implementation:
- In October of 1999, Hershey’s transition to SAP ran into a system glitch and shut down Hershey operations for a long period of time (note that October is the profitable Halloween season for Hershey).
- Many executives have complained that they are not seeing the impact they expected relative to the price they paid.
**ERP Problems**

- Disadvantages of ERP systems have been:
  - Incompatibility with legacy systems
  - Long and expensive implementation
  - Inflexibility to adapt to existing management practices (difficult to customize)
  - Long payback period
  - Lack of technological innovation
  - In a survey of Fortune 1000 firms that implemented ERP, 44% reported spending 4 times as much as was spent on the software on ERP related consulting

Despite these drawbacks, SAP alone sold more than $3.2 Billion in software in 1997. Many companies do report significant productivity improvement and inventory reduction due to ERP.

**From ERP to APS Systems**

- ERP systems still at best only contain the basic MRP II logic for planning and controlling production
- More advanced production planning logic requires customized development within the ERP system
- Advanced Production and Scheduling (APS) systems complement ERP systems by providing more sophisticated production planning and scheduling logic
- Firms such as I2 Technologies and Manugistics have enjoyed tremendous growth in the late 1990’s due to their APS systems

**APS Systems Capabilities**

- Demand Planning – Sophisticated forecasting techniques to analyze customer buying patterns
- Supply Planning – Synchronizes operations of manufacturers, suppliers, and logistics service providers through information exchange. Provides better, more accurate information for managing incoming materials
- Demand fulfillment – Provides more accurate estimates of order fulfillment dates, manages order promising, provides backlog management, and tracks order fulfillment
- APS’s have modules for managing pull systems and can dynamically track WIP, throughput, and cycle times

**What is the role of B2B e-Commerce?**

- ERP systems integrate information across the enterprise
- The key to effectively tapping into the power of ERP and APS systems is to enable information sharing across enterprises
- For the Supply Planning module of an APS system to have the greatest impact, it must integrate up-to-date information from manufacturer, supplier, and logistics service provider
- For the Demand Planning module of an APS system to have the greatest impact, it must integrate up-to-date information from customers and retailers
- The big challenge is to integrate information from various systems and to interpret it so that it is meaningful to all of the enterprises involved – this is the task of B2B e-commerce system developers and information hubs
What is the role of B2B e-Commerce?

- The more accurate, up-to-date information the firm has, the more effectively it can predict and respond to demand,
- Predict material availability
- Predict more accurate order lead times
- Real-time information sharing between firms decreases the amount of uncertainty in the system
- B2B eCommerce service providers have the task of receiving information from different sources and interpreting that data so that it is useful to the participants

What is the role of B2B e-Commerce?

- eCommerce systems can decrease ordering costs by decreasing the time it takes to place an order and removing manual order entry which leads to more accurate order information
- eCommerce systems can lead to improved customer service and satisfaction by providing instant (and more accurate) price quotes and due dates
- eCommerce systems decrease the costs of shopping for vendors by providing more information at lower cost
- Discussion: What additional potential does the Internet provide for improving operations?