Management Science

MRP, ERP & EDI

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Session Objectives

- Discuss ABC Inventory
- Describe the use of material requirements planning (MRP) in solving dependent-demand inventory problems
- Discuss just-in-time (JIT) inventory concepts to reduce inventory levels and costs
- Discuss enterprise resource planning (ERP) systems
- Discuss electronic data interchange (EDI)

- Should a company do formal inventory control for all items that they sell ?

ABC Analysis

- The purpose of ABC analysis is to divide the inventory into three groups based on the overall inventory value of the items
- Group A items account for the major portion of inventory costs
  - Typically about 70% of the dollar value but only 10% of the quantity of items
  - Forecasting and inventory management must be done carefully
- Group B items are more moderately priced
  - May represent 20% of the cost and 20% of the quantity
- Group C items are very low cost but high volume
  - It is not cost effective to spend a lot of time managing these items

ABC Analysis (con't)

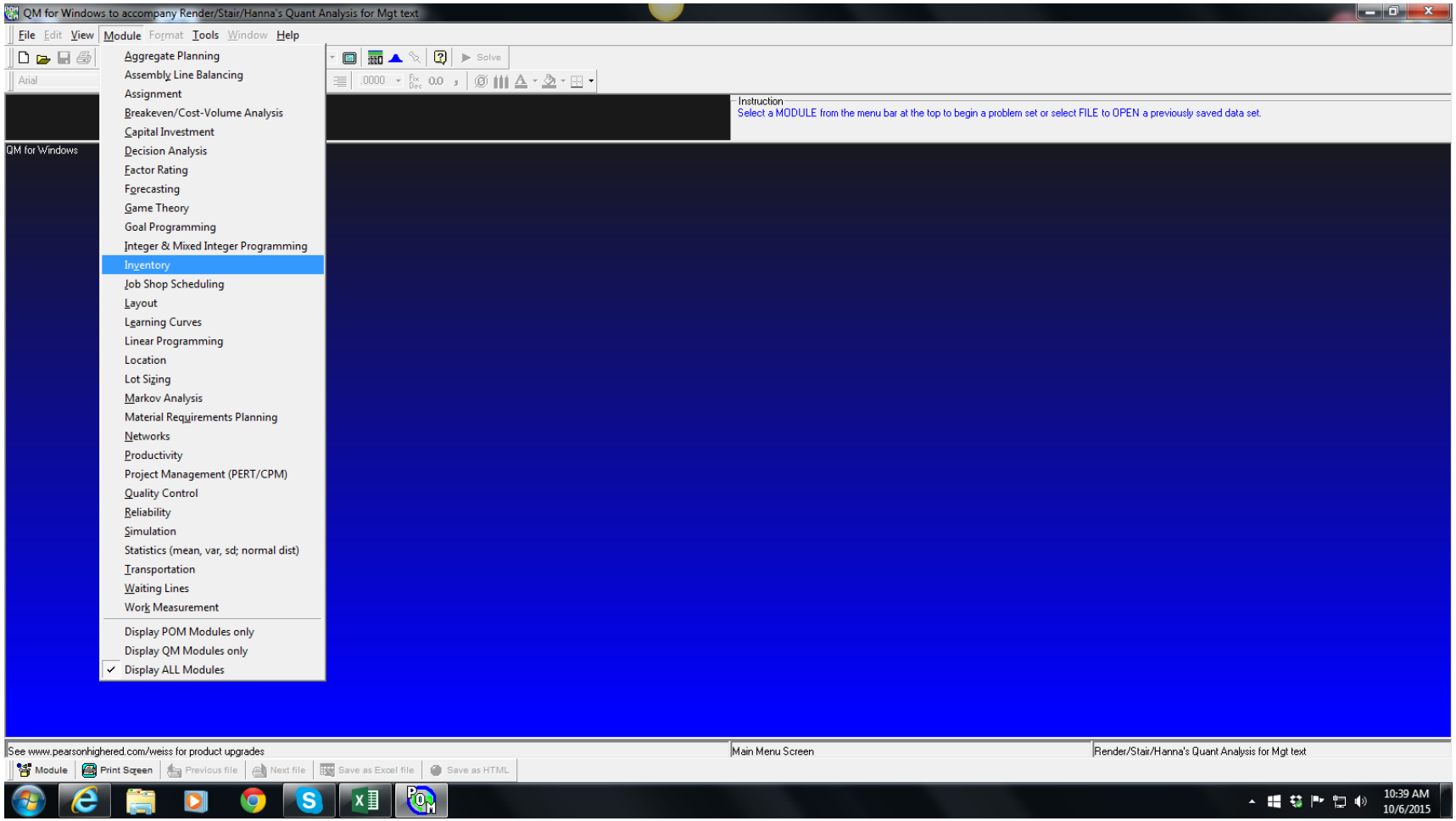
Group A	
Group B	
Group C	

INVENTORY GROUP	DOLLAR USAGE (%)	INVENTORY ITEMS (%)	ARE QUANTITATIVE CONTROL TECHNIQUES USED?
A	70	10	Yes
B	20	20	In some cases
C	10	70	No

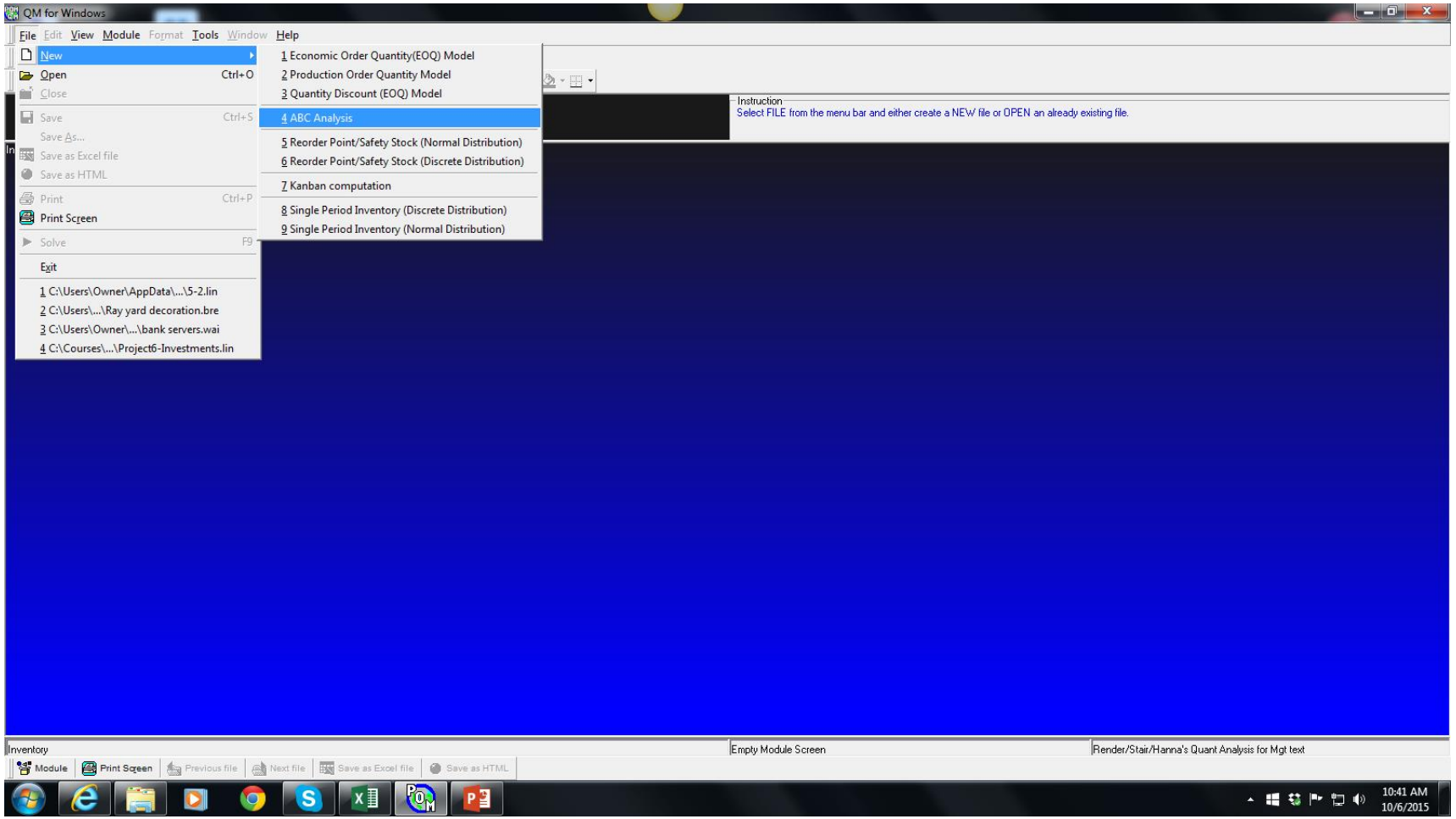
ABC Analysis (con't)

ABC Analysis Template www.Planning-Templates.com A = 70% (7 Items) , B = 85 % (6 Items) , C = (37 Items), Total 50 Items					
Item	Consumtion Qty	cost/unit	Amount	Acc. Amount	ABC Class
R-005	5,200	320.00	1,664,000.00	1,664,000.00	A
R-041	5,000	200.00	1,000,000.00	2,664,000.00	A
R-036	2,000	325.00	650,000.00	3,314,000.00	A
R-016	2,000	320.00	640,000.00	3,954,000.00	A
R-008	2,500	200.00	500,000.00	4,454,000.00	A
R-050	2,346	200.00	469,200.00	4,923,200.00	A
R-014	1,400	325.00	455,000.00	5,378,200.00	A
R-030	2,000	200.00	400,000.00	5,778,200.00	B
R-025	900	325.00	292,500.00	6,070,700.00	B
R-032	4,500	50.00	225,000.00	6,295,700.00	B
R-024	2,000	100.00	200,000.00	6,495,700.00	B
R-003	450	325.00	146,250.00	6,641,950.00	B
R-009	3,000	44.00	132,000.00	6,773,950.00	B
R-013	1,300	100.00	130,000.00	6,903,950.00	C
R-027	400	320.00	128,000.00	7,031,950.00	C
R-019	600	200.00	120,000.00	7,151,950.00	C
R-010	2,000	50.00	100,000.00	7,251,950.00	C

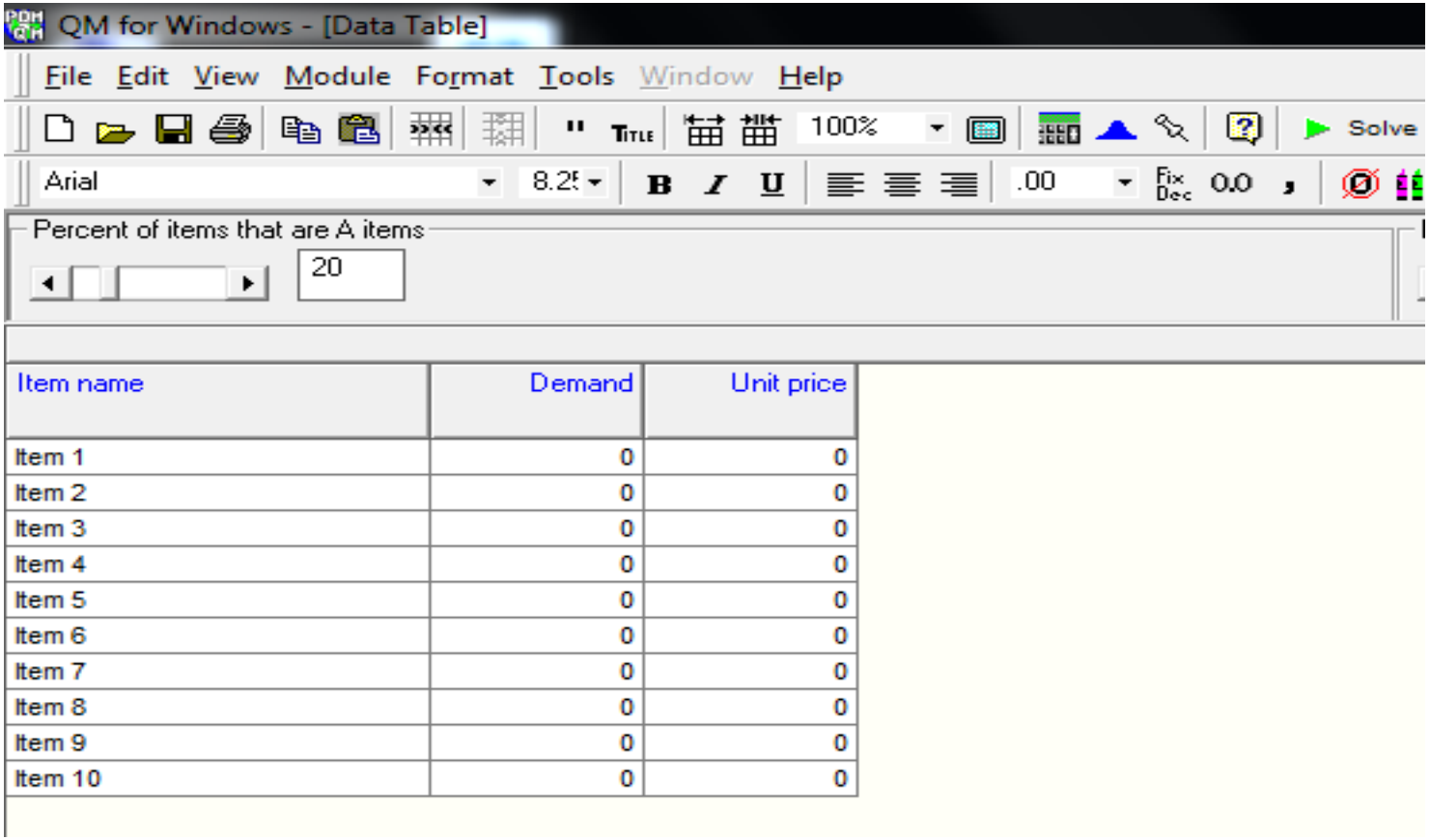
ABC Inventory in QM



ABC Inventory in QM (con't)



ABC Inventory in QM (con't)



Item name	Demand	Unit price
Item 1	0	0
Item 2	0	0
Item 3	0	0
Item 4	0	0
Item 5	0	0
Item 6	0	0
Item 7	0	0
Item 8	0	0
Item 9	0	0
Item 10	0	0

Dependent Demand: The Case for Material Requirements Planning

- All the inventory models discussed so far have assumed demand for one item is independent of the demand for any other item
- However, in many situations items' demand is dependent on demand for one or more other items
- In these situations, Material Requirements Planning (*MRP)* can be employed effectively

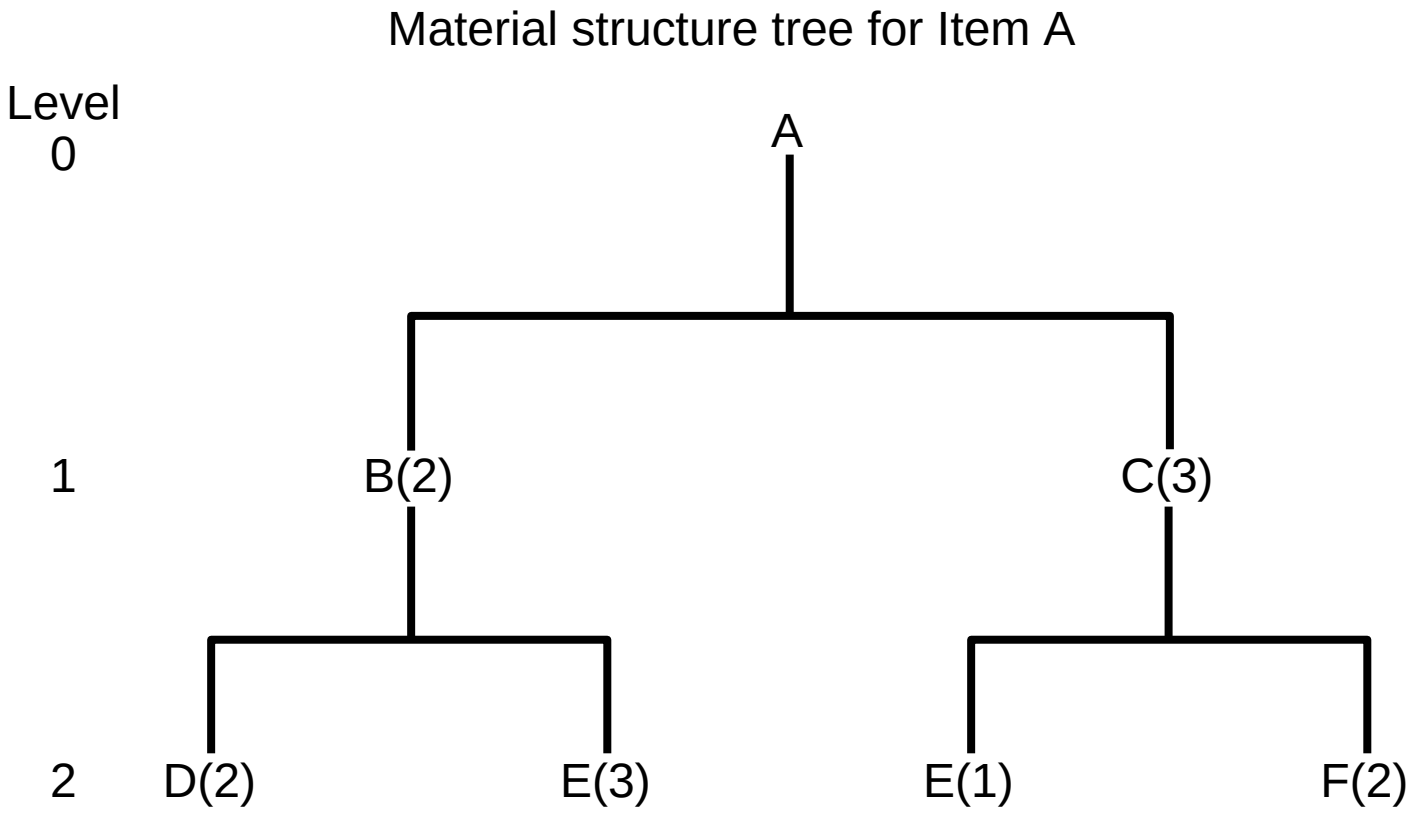
Dependent Demand: The Case for Material Requirements Planning (con't)

- Some of the benefits of MRP are
  1. Increased customer service levels
  2. Reduced inventory costs
  3. Better inventory planning and scheduling
  4. Higher total sales
  5. Faster response to market changes and shifts
  6. Reduced inventory levels without reduced customer service
- Most modern MRP systems are computerized, but the basic analysis is straightforward

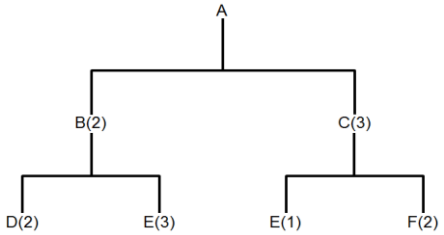
Material Structure Tree

- The first step is to develop a *bill of materials* (*BOM*)
- The BOM identifies components, descriptions, and the number required for production of one unit of the final product
- From the BOM we can develop a material structure tree
- As an example, consider the following data
  - Demand for product A is 50 units
  - Each A requires 2 units of B and 3 units of C
  - Each B requires 2 units of D and 3 units of E
  - Each C requires 1 unit of E and 2 units of F

Material Structure Tree (con't)



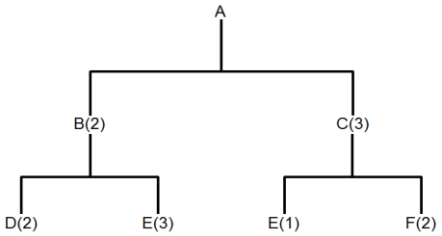
Material Structure Tree (con't)



- It is clear from the tree that the demand for B, C, D, E, and F is completely dependent on the demand for A
- The material structure tree has three levels: 0, 1, and 2
- Items above a level are called *parents*
- Items below any level are called *components*
- The number in parenthesis beside each item shows how many are required to make the item above it

Material Structure Tree (con't)

- We can use the material structure tree and the demand for Item A (50) to compute demands for the other items



Part B: $2 \times$ number of A's $= 2 \times 50 = 100$

Part C: $3 \times$ number of A's $= 3 \times 50 = 150$

Part D: $2 \times$ number of B's $= 2 \times 100 = 200$

Part E: $3 \times$ number of B's + $1 \times$ number of C's
$= 3 \times 100 + 1 \times 150 = 450$

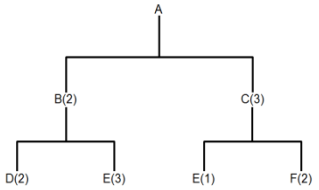
Part F: $2 \times$ number of C's $= 2 \times 150 = 300$

Gross and Net Material Requirements Plan

- Once the materials structure tree is done, we construct a gross material requirements plan
- This is a time schedule that shows when an item must be ordered when there is no inventory on hand, or
- When the production of an item must be started in order to satisfy the demand for the finished product at a particular date
- Suppose the lead times for each of the items is:

Item A – 1 week
Item B – 2 weeks
Item C – 1 week
Item D – 1 week
Item E – 2 weeks
Item F – 3 weeks

Gross Material Requirements Plan



		Week						
		1	2	3	4	5	6	
A	Required Date						50	Lead Time = 1 Week
	Order Release					50		
B	Required Date					100		Lead Time = 2 Weeks
	Order Release			100				
C	Required Date					150		Lead Time = 1 Week
	Order Release				150			
D	Required Date			200				Lead Time = 1 Week
	Order Release		200					
E	Required Date			300	150			Lead Time = 2 Weeks
	Order Release	300	150					
F	Required Date				300			Lead Time = 3 Weeks
	Order Release	300						

Net Material Requirements Plan

- A net material requirements plan can be constructed from the gross materials requirements plan and on-hand inventory information

ITEM	ON-HAND INVENTORY
A	10
B	15
C	20
D	10
E	10
F	5

Net Material Requirements Plan (con't)

- Using this data we can construct a plan that includes
  - Gross requirements
  - On-hand inventory
  - Net requirements
  - Planned-order receipts
  - Planned-order releases
- The net requirements plan is constructed like the gross requirements plan

Net Material Requirements Plan (con't)

Item		Week 1	2	3	4	5	6	Lead Time
A	Gross						50	1
	On-Hand 10						10	
	Net						40	
	Order Receipt						40	
	Order Release					40		
B	Gross					80^{A}		2
	On-Hand 15					15		
	Net					65		
	Order Receipt					65		
	Order Release			65				

Net Material Requirements Plan (con't)

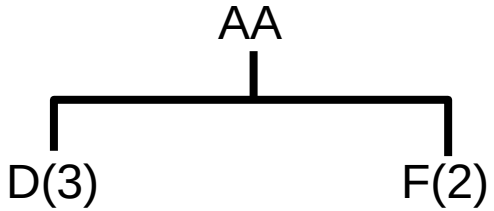
Item			Week 1	2	3	4	5	6	Lead Time
C	Gross						120[A]		1
	On-Hand	20					10		
	Net						100		
	Order Receipt						100		
	Order Release					100			
D	Gross				130[B]				1
	On-Hand	10			10				
	Net				120				
	Order Receipt				120				
	Order Release			120					

Net Material Requirements Plan (con't)

Item			Week 1	2	3	4	5	6	Lead Time
E	Gross				195[B]	100[C]			2
	On-Hand	10			10	0			
	Net				185	100			
	Order Receipt				185	100			
	Order Release		185	100					
F	Gross					200[C]			3
	On-Hand	5				5			
	Net					195			
	Order Receipt					195			
	Order Release		195						

Two or More End Products

- Most manufacturing companies have more than one end item, which may have common components
- In this example, the second product is AA and it has the following material structure tree



- If we require 10 units of AA, the gross requirements for parts D and F can be computed

$$\text{Part D: } 3 \times \text{number of AA's} = 3 \times 10 = 30$$

$$\text{Part F: } 2 \times \text{number of AA's} = 2 \times 10 = 20$$

Two or More End Products (con't)

- The lead time for AA is one week
- The gross requirement for AA is 10 units in week 6 and there are no units on hand
- This new product can be added to the MRP process
- The addition of AA will only change the MRP schedules for the parts contained in AA

- MRP can also schedule spare parts and components
- These have to be included as gross requirements

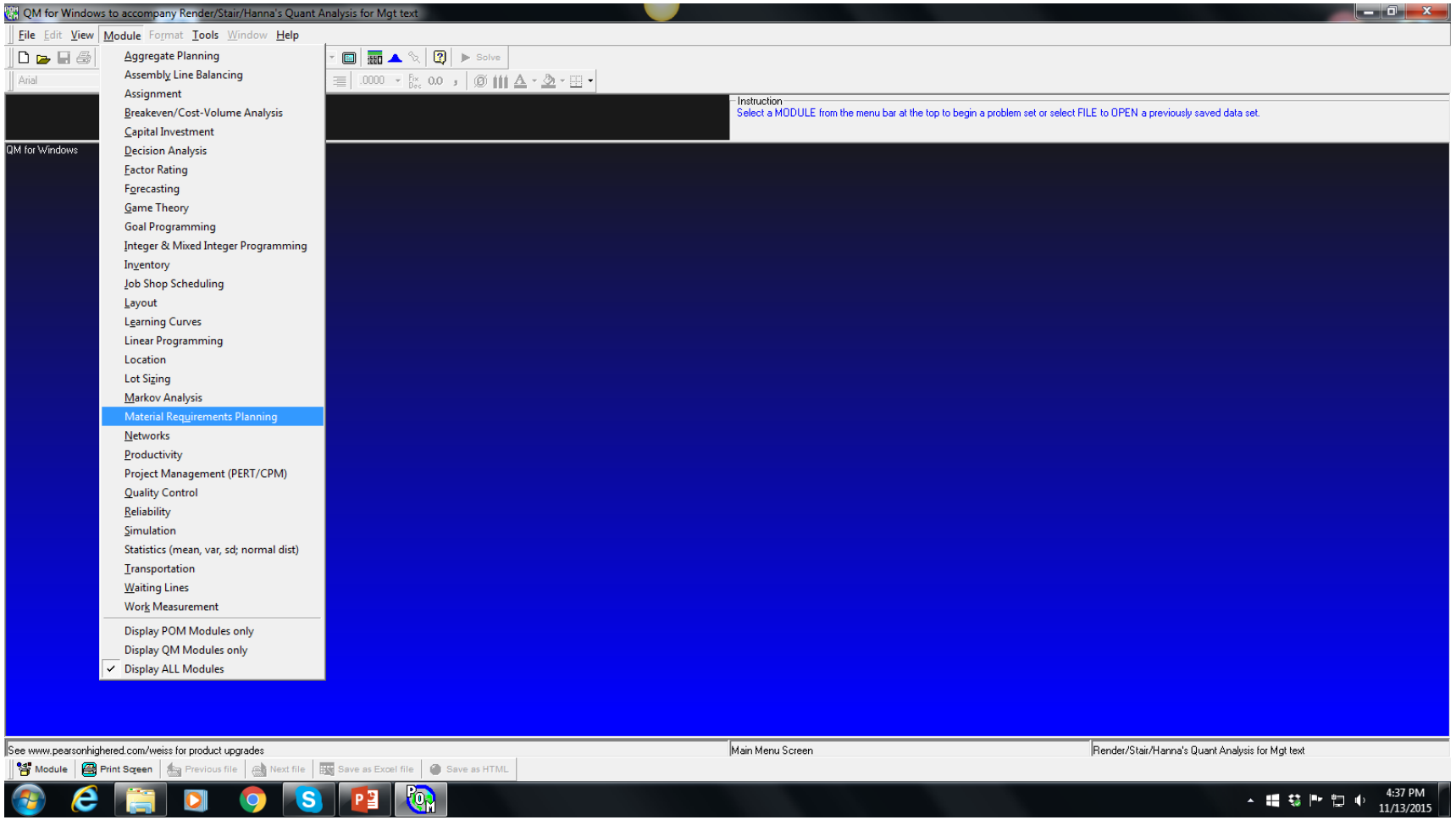
Two or More End Products (con't)

	Week						Lead Time
Item	1	2	3	4	5	6	
AA Gross						10	1
On-Hand 0						0	
Net						10	
Order Receipt						10	
Order Release					10		

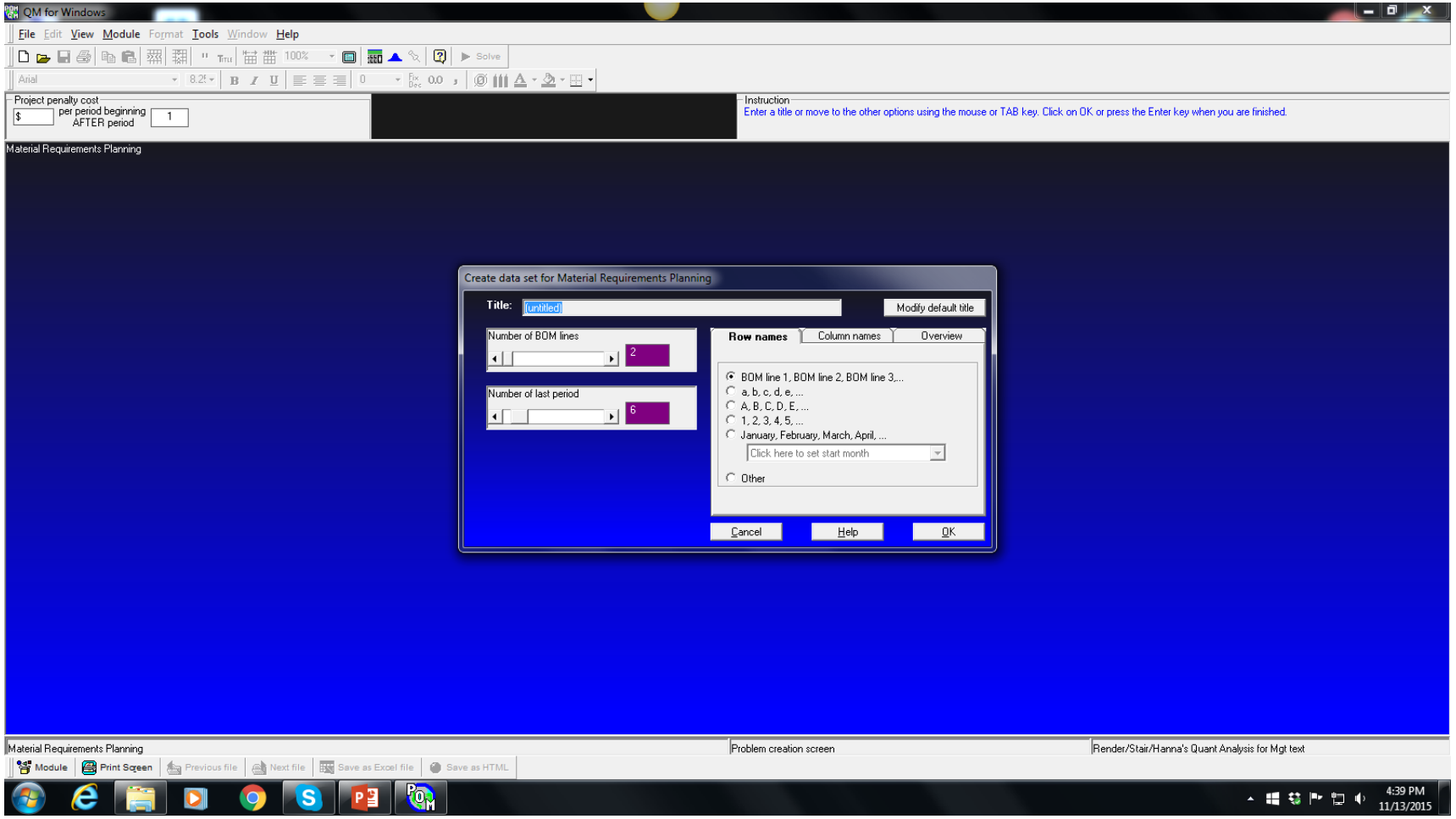
Two or More End Products (con't)

Item		1	2	3	4	5	6	Lead Time
		Week						
D	Gross			130[B]		30[AA]		1
	On-Hand 10			10		0		
	Net			120		30		
	Order Receipt			120		30		
	Order Release		120		30			
F	Gross				200[C]	20[AA]		3
	On-Hand 5				5	0		
	Net				195	20		
	Order Receipt				195	20		
	Order Release	195	20					

MRP in QM

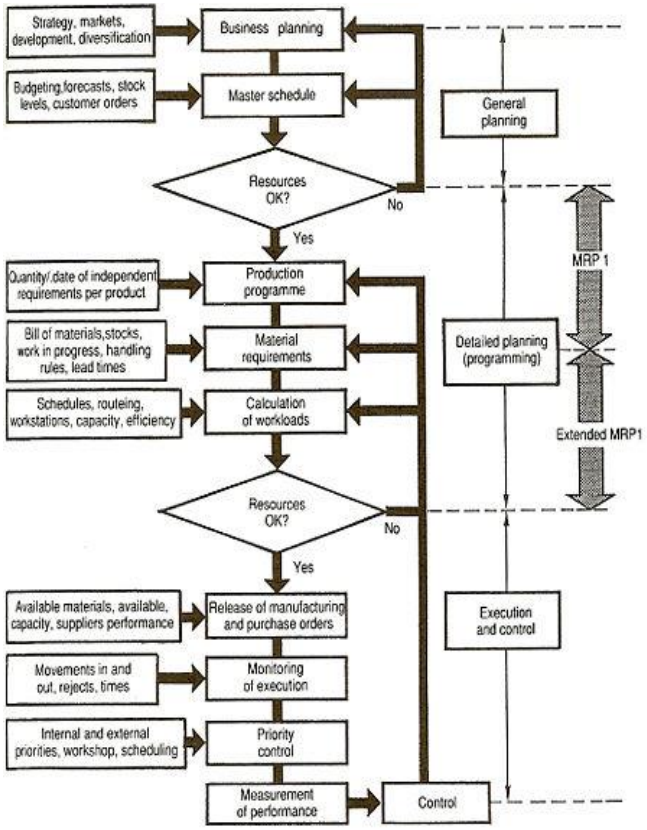


MRP in QM (con't)



MRP II
[Material Resource Planning]

- MRP has evolved to include not only the components required in production, but also the labor hours, material/supply cost, and other resources related to production
- In this approach the term MRP II is often used and the word *resource* replaces the word *requirements*



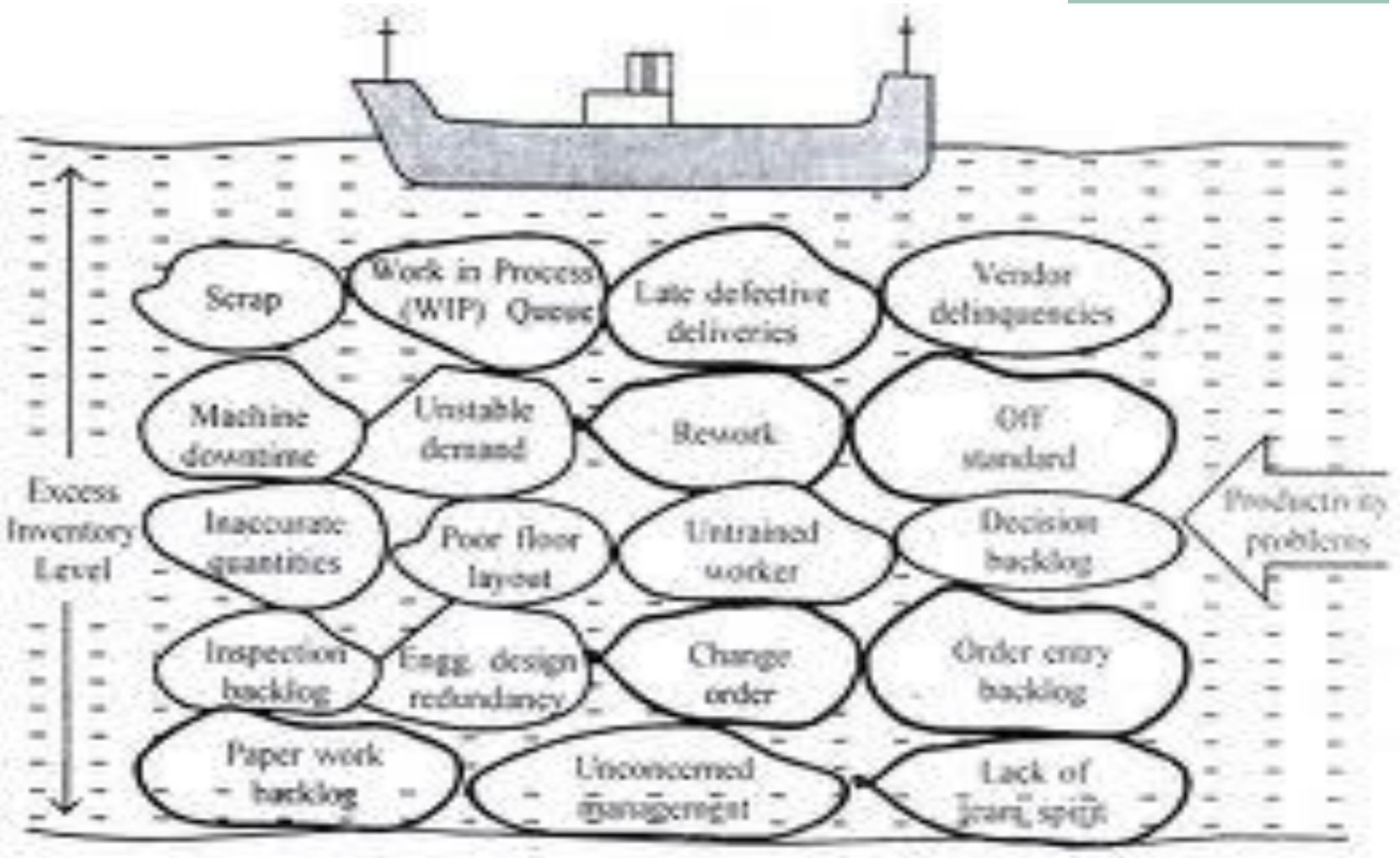
Around 1980, over-frequent changes in sales forecasts, entailing continual reajustments in production, as well as the unsuitability of the parameters fixed buy the system, led MRP (Material Requirement Planning) to evolve into a new concept : Manufacturating Resource Planning or MRP2

Source : "CIM: Principles of Computer Integrated Manufacturing", Jean-Baptiste Waldner, John Wiley & Sons, 1992. Reproduced with author's authorization

Just-in-Time Inventory Control

- To achieve greater efficiency in the production process, organizations have tried to have less in-process inventory on hand
- This is known as *JIT inventory*
- The inventory arrives just in time to be used during the manufacturing process
- JIT requires the correction of many problems (see next slide) as well as tight integration of the manufacturing company and the supplier's physical and IT systems

Setting High Inventory Levels [hides many problems]



JIT Tactics

Use a pull system to move inventory

Reduce lot size

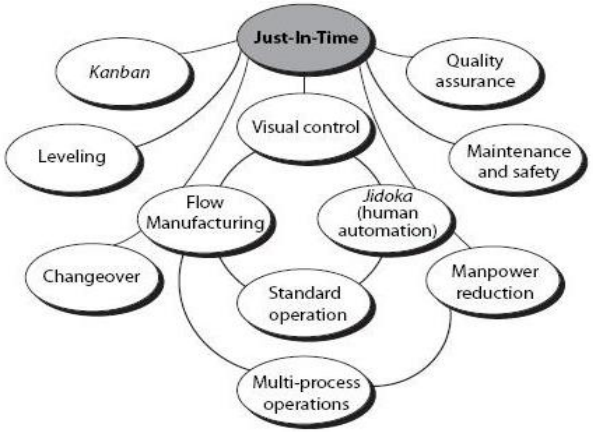
Reduce setup time

Develop *Just-in-Time* delivery systems with suppliers

Deliver directly to point of use

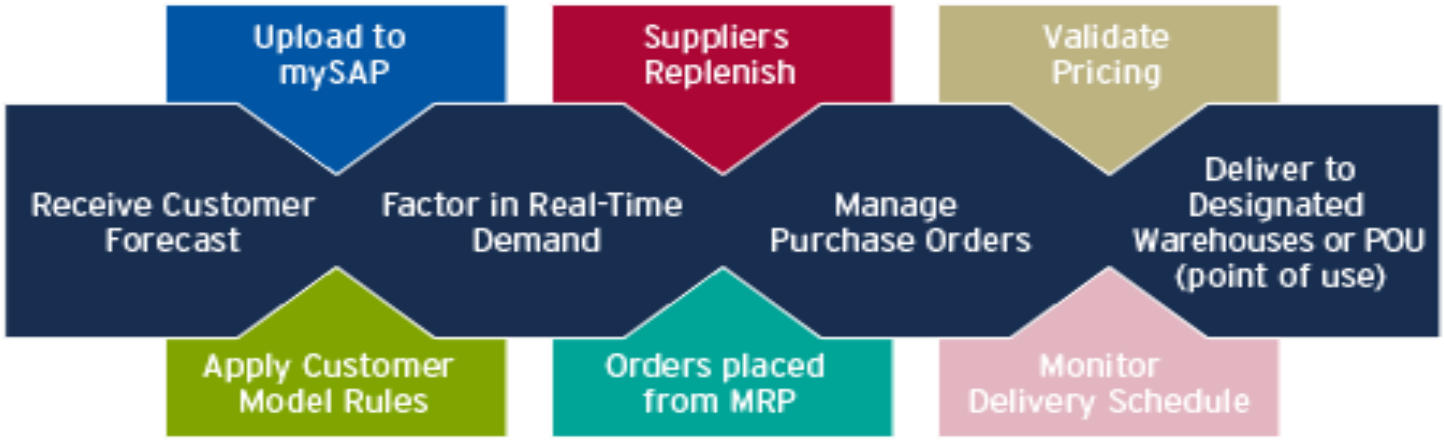
Perform-to-schedule

Use group technology



Enterprise Resource Planning

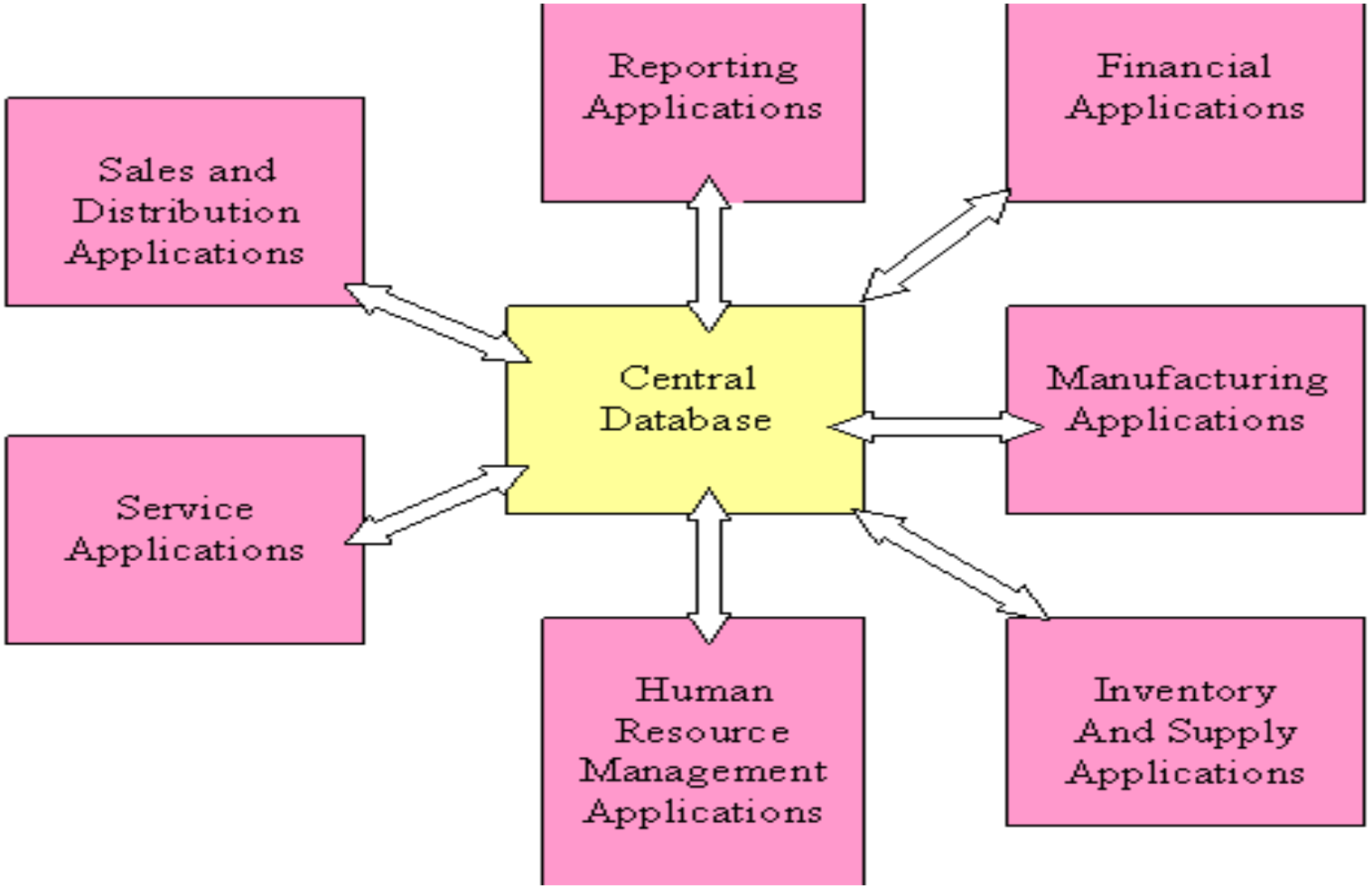
As the MRP II concept evolved and involved many organizational units, sophisticated software was developed; these systems were extended and became known as *enterprise resource planning* (*ERP*) systems



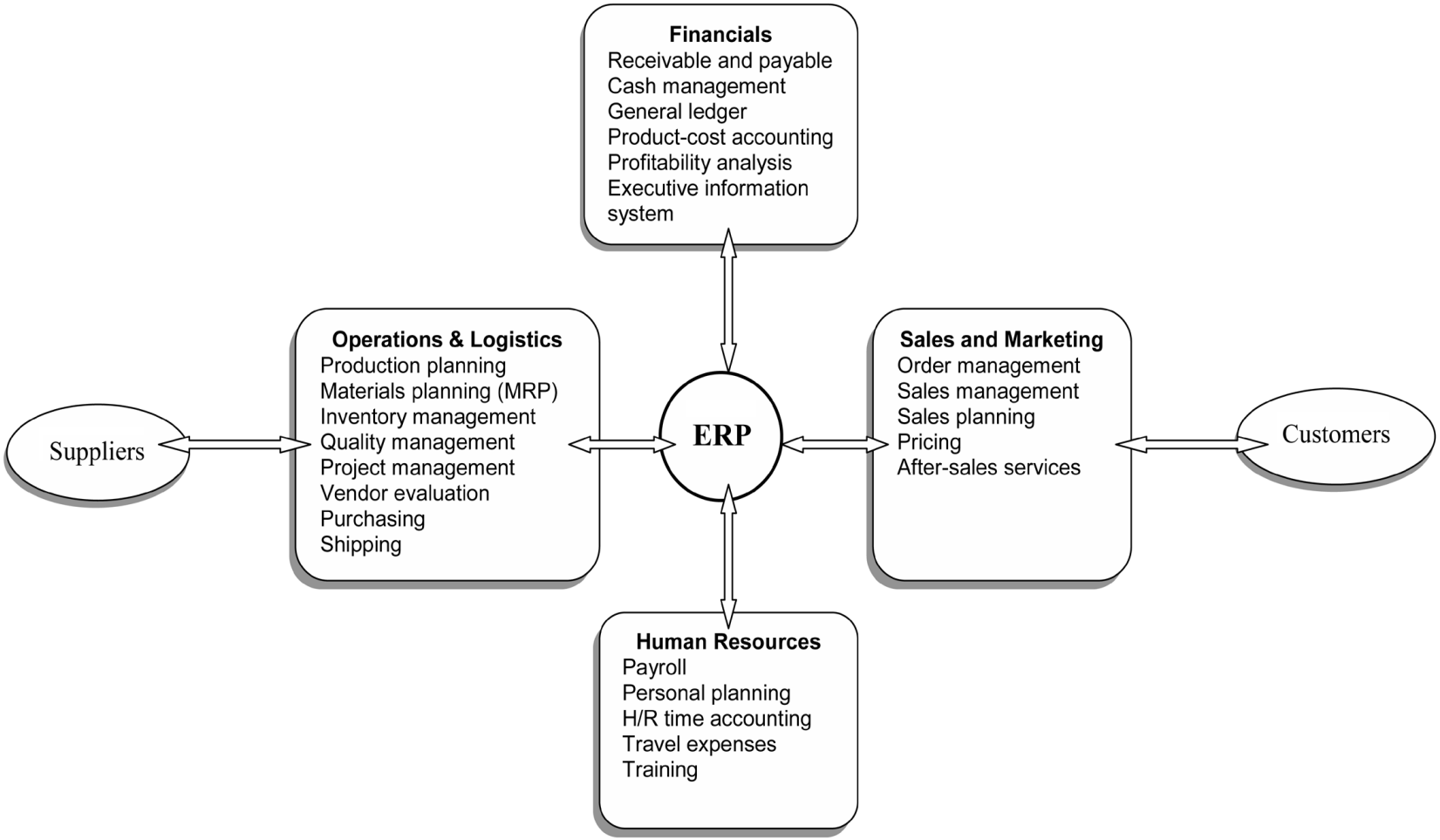
Enterprise Resource Planning (con't)

- The objective of an ERP System is to reduce costs by integrating most of the operations of a firm using "best practices"
- Departmental systems (Manufacturing, Warehouse, Marketing, Accounting, Purchasing, Human Resources, etc.) are all integrated using one database
- Data are entered only once into a database where it can be quickly and easily accessed by anyone
- Benefits include
  - Reduced transaction costs
  - Increased speed and accuracy of information
- Almost all areas of the firm benefit

ERP Central Database



Typical ERP Functions

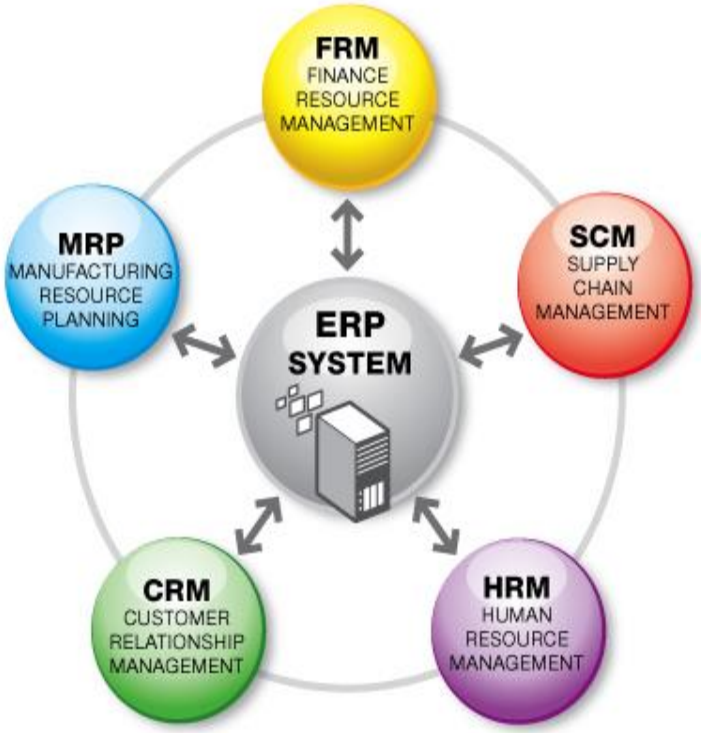


ERP Systems (Con't)

- **Best practices** are the most successful solutions or problem-solving methods for achieving a business objective
- Drawbacks to ERP systems
  - They can be extremely complex, expensive, and time-consuming to implement
  - May not fit your current business processes
    - Somewhat "tunable" without major customization
- Leading ERP software vendors include SAP, Oracle and PeopleSoft
- **Loss of competitive advantage ?**

When an ERP is appropriate ?

- Situations in which it is appropriate for an ERP to drive business process design include:
  - When an organization is just starting out and processes do not yet exist
  - When an organization doesn't rely on its operational business processes as a source of competitive advantage
  - When current systems are in crisis and there is not enough time, resources or knowledge in the firm to fix them (such was true for many companies trying to get ready for Y2K)



Information Integration through EC*ERP System

When an ERP is inappropriate ?

- Situations in which it is inappropriate for an ERP to drive business process design include:
  - When an organization derives strategic advantage from its operational business processes
  - Insufficient corporate size for software and platform costs of ERP (one size does not fit all)
    - Some vendors have begun to offer small (less than 500 employees) company versions including Oracle, Microsoft, and Baan

Supply Chain Management

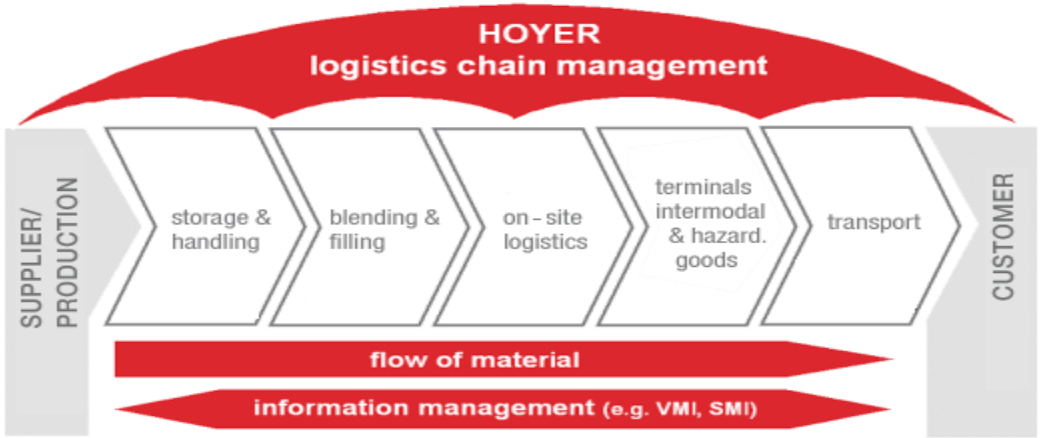
- The management of the future requirements, supply planning, goods flow, and utilization of product, perhaps throughout a Global Network
- Supply Chain management is concerned with:
  - Right item
  - Right quantity
  - Right time
  - Right place

The Flows in the Supply Chain

- ***Material flows*** are the physical products, raw materials, supplies and so forth that flow along the chain
  - *Reverse* flows – returned products, recycled products and disposal of materials or products
- ***Information flows*** are all data related to demand, shipments, orders, returns, and schedules as well as changes in any of these data
- ***Financial flows*** are all transfers of money, payments, and credit-related data

The Flows in the Supply Chain (con't)

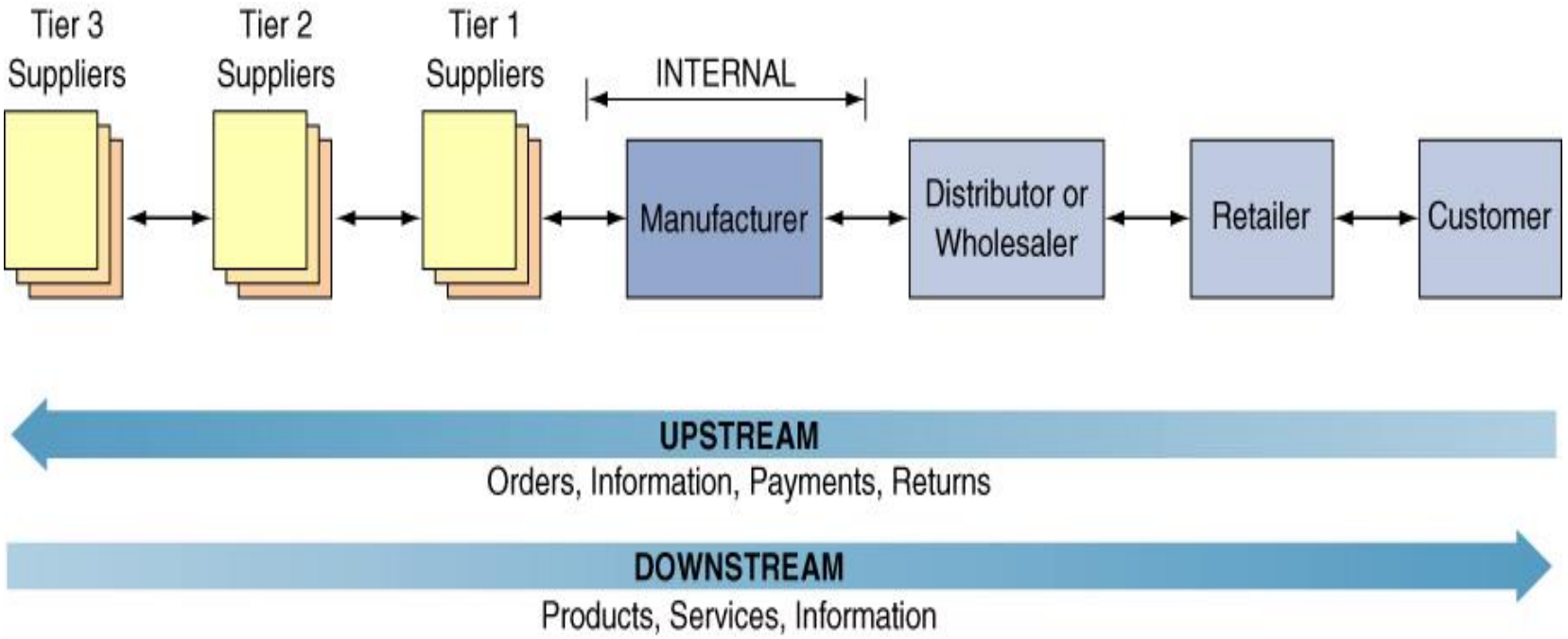
- All three flows (material, information, currency) involve:
  - Time
  - Cost
  - Risk (Possibility of errors, damage, etc.)
- The goal of all business is to minimize time, cost, and risk in each flow through whatever means possible, particularly technology !!!



The Structure & Components of Supply Chains

- A supply chain involves three segments:
  - ***Upstream***, where sourcing or procurement from external suppliers occurs
  - ***Internal***, where receiving, inventory, picking, packaging, assembly or manufacturing takes place
  - ***Downstream***, where distribution takes place, frequently by external distributors
- **Tiers of suppliers**, a supplier may have one or more subsuppliers, and the subsupplier may have its own subsupplier(s) and so on

Supply Chains



← Money, Material, Information →

Problems along the Supply Chain

- Poor customer service – not delivering quality products or services when and where the customers need them
- High raw material costs, raw material shortages and interruptions, raw material quality problems
- High inventory levels
- Picking and packing costs, errors, delays
- Production problems: quality, delays, strikes
- Delivery problems: loss, shortage, damage, theft

Solutions to Supply Chain Problems

- Vertical integration – purchase suppliers, or bring raw material production in-house
- Optimal inventory – problems with inventory being:
  - Too high – high “holding” cost
  - Too low – delay in fulfillment
- Information sharing amongst supply chain players: forecasts, actual sales, supplies, inventories (see next slide)
  - Suppliers can even manage a company’s inventory for raw materials

Push & Pull Supply Chains

- With a push-based supply chain, products are pushed through the channel, from the production side up to the retailer
  - The manufacturer sets production at a level in accord with historical ordering patterns from retailers
  - It takes longer for a push-based supply chain to respond to changes in demand, which can result in overstocking or bottlenecks and delays (the bullwhip effect), unacceptable service levels and product obsolescence
- In a pull-based supply chain, procurement, production and distribution are demand-driven rather than to forecast
  - However, a pull strategy does not always require make-to-order production
  - Toyota Motors Manufacturing is frequently used as an example of pull production, yet do not typically produce to order
  - They follow the "supermarket model" where limited inventory is kept on hand and is replenished as it is consumed

Push & Pull Supply Chains (con't)

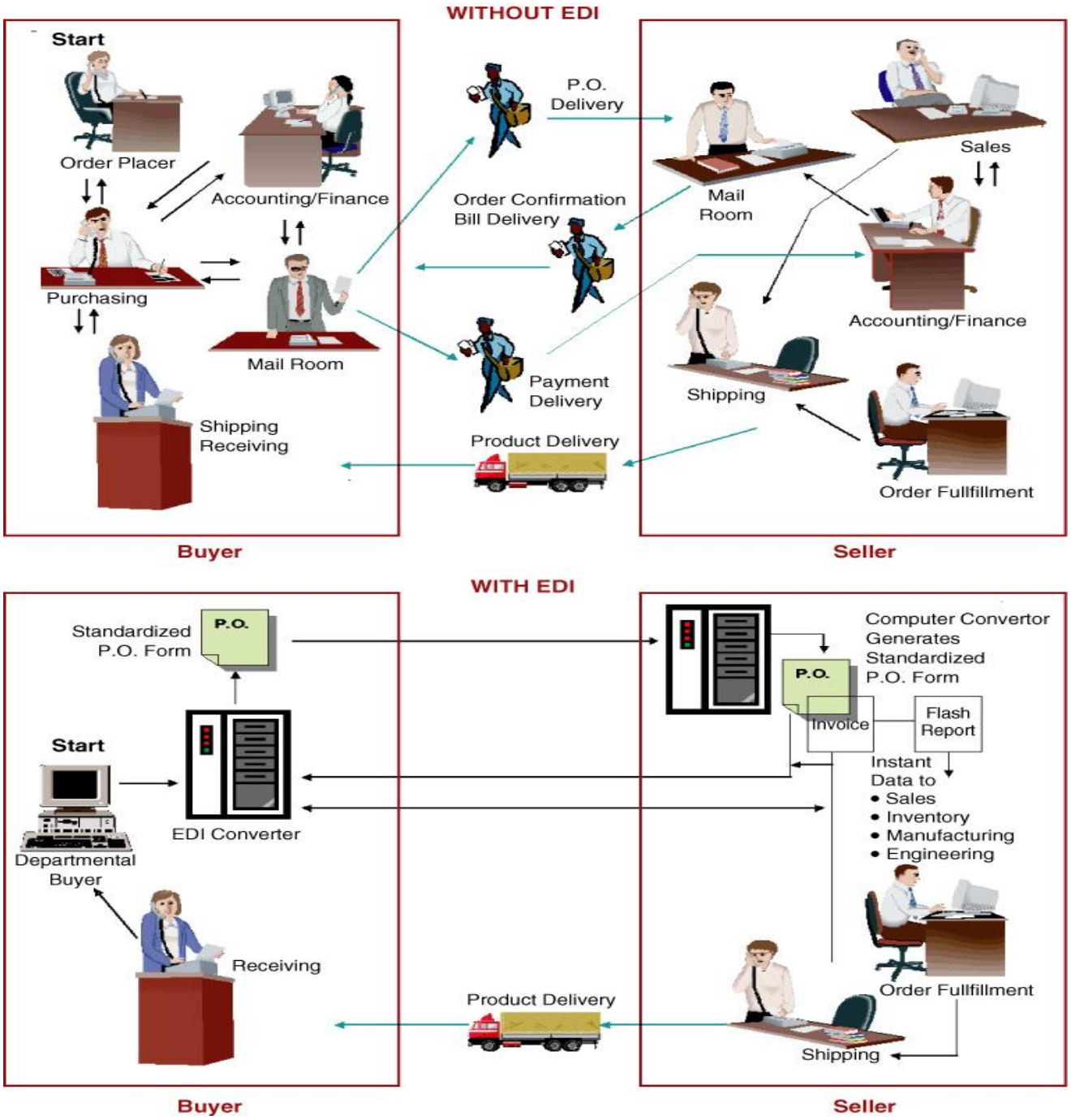
- A supply chain is almost always a combination of both push and pull, where the interface between the push-based stages and the pull-based stages is sometimes known as the push–pull boundary or the decoupling point
  - An example of this would be Dell's build to order supply chain
  - Inventory levels of individual components are determined by forecasting general demand, but final assembly is in response to a specific customer request
  - The decoupling point would then be at the beginning of the assembly line

Electronic Data Interchange and Extranets

- **Electronic data interchange (EDI)** is a communication standard that enables business partners to exchange routine documents, such as purchase orders, electronically
- ***EDI transactions*** include repetitive business transactions such as purchase orders, invoices, credit approvals, shipping notices, and confirmations
- ***Data formatting standards*** are used and an ***EDI translator*** converts data into a standard format before it is transmitted
- **EDI** serves as a catalyst and a stimulus to improve the standard of information that flows between and among organizations

EDI Benefits

- Reduces cycle time
- Minimize data entry errors
- Length of messages are shorter
- Messages are secured
- Increases productivity and reduces cost
- Enhances customer service
- Minimizes paper costs and delays (usage and storage)


WITHOUT EDI
Start
Order Placer
Accounting/Finance
Purchasing
Mail Room
Shipping
Receiving
P.O.
Delivery
Order Confirmation
Bill Delivery
Payment
Delivery
Product Delivery
Mail
Room
Sales
Accounting/Finance
Shipping
Order Fullfillment
Buyer
Seller
WITH EDI
Standardized
P.O. Form
P.O.
Start
EDI Converter
Departmental
Buyer
Receiving
Computer Convertor
Generates
Standardized
P.O. Form
P.O.
Invoice
Flash
Report
Instant
Data to
• Sales
• Inventory
• Manufacturing
• Engineering
Order Fullfillment
Shipping
Product Delivery
Buyer
Seller

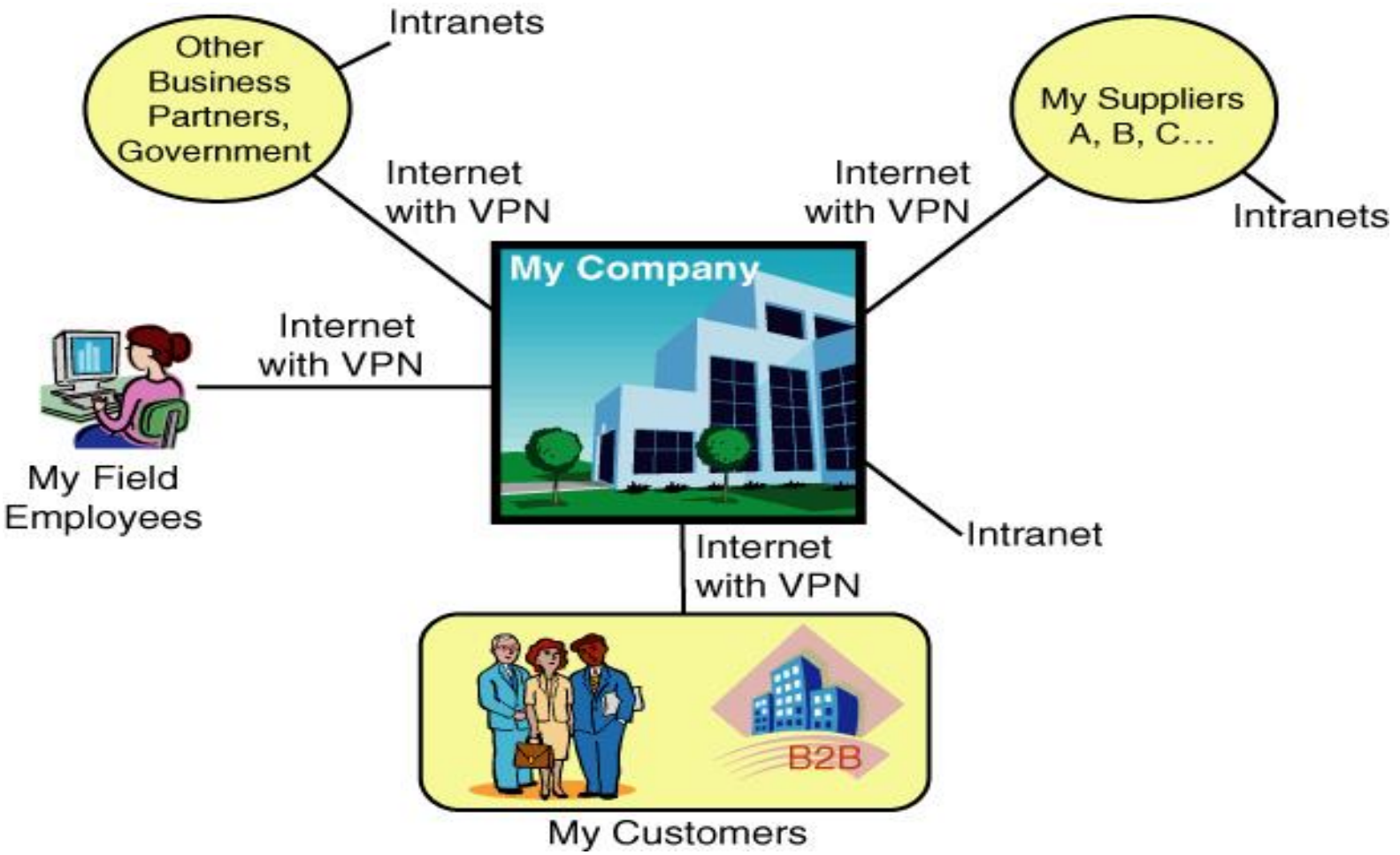
Traditional EDI Limitations

- Significant initial investment to implement
- Ongoing operating costs are high due to the use of expensive, private VANs
- Traditional EDI system is inflexible
- Long startup period
- Multiple EDI standards exist

Extranets
(EDI over the Net)

- **Extranets** link business partners to one another over the Internet by providing access to certain areas of each other's corporate intranets
- The main goal of **extranets** is to foster collaboration between business partners
- An **extranet** is open to selected B2B suppliers, customers and other business partners
- **Common protocols: XML or JSON via VPN**

Internet Business Connections



References

- Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford
- Enterprise Resource Planning by Bret Wagner and Ellen Monk
- mySAP ERP For Dummies by Andreas Vogel and Ian Kimbell
- Open ERP for Retail and Industrial Management by Fabien Pinckaers and Geoff Gardiner

Homework

- Textbook Chapter 6, section 6.10 thru end of chapter
- Questions to be answered: 16, 17, 19