

11

Material Requirements Planning (MRP) and ERP

PowerPoint presentation to accompany
Heizer and Render
Operations Management, Eleventh Edition
Principles of Operations Management, Ninth Edition

Learning Objectives

When you complete this chapter you should be able to:

- 1. Develop** a product structure
- 2. Build** a gross requirements plan
- 3. Build** a net requirements plan
- 4. Determine** lot sizes for lot-for-lot, EOQ, and POQ
- 5. Describe** MRP II
- 6. Describe** closed-loop MRP
- 7. Describe** ERP

MRP for Wheeled Coach

- Largest manufacturer of ambulances in the world
- International competitor
- 12 major ambulance designs
 - 18,000 different inventory items
 - 6,000 manufactured parts
 - 12,000 purchased parts



MRP for Wheeled Coach

- Four Key Tasks
 - Material plan must meet both the requirements of the master schedule and the capabilities of the production facility
 - Plan must be executed as designed
 - Minimize inventory investment
 - Maintain excellent record integrity

Dependent Demand

For any product for which a schedule can be established, dependent demand techniques should be used

Dependent Demand

Benefits of MRP

1. Better response to customer orders
2. Faster response to market changes
3. Improved utilization of facilities and labor
4. Reduced inventory levels

Dependent Demand

- The demand for one item is related to the demand for another item
- Given a quantity for the end item, the demand for all parts and components can be calculated
- In general, used whenever a schedule can be established for an item
- MRP is the common technique

Dependent Inventory Model Requirements

Effective use of dependent demand inventory models requires the following

1. Master production schedule
2. Specifications or bill of material
3. Inventory availability
4. Purchase orders outstanding
5. Lead times

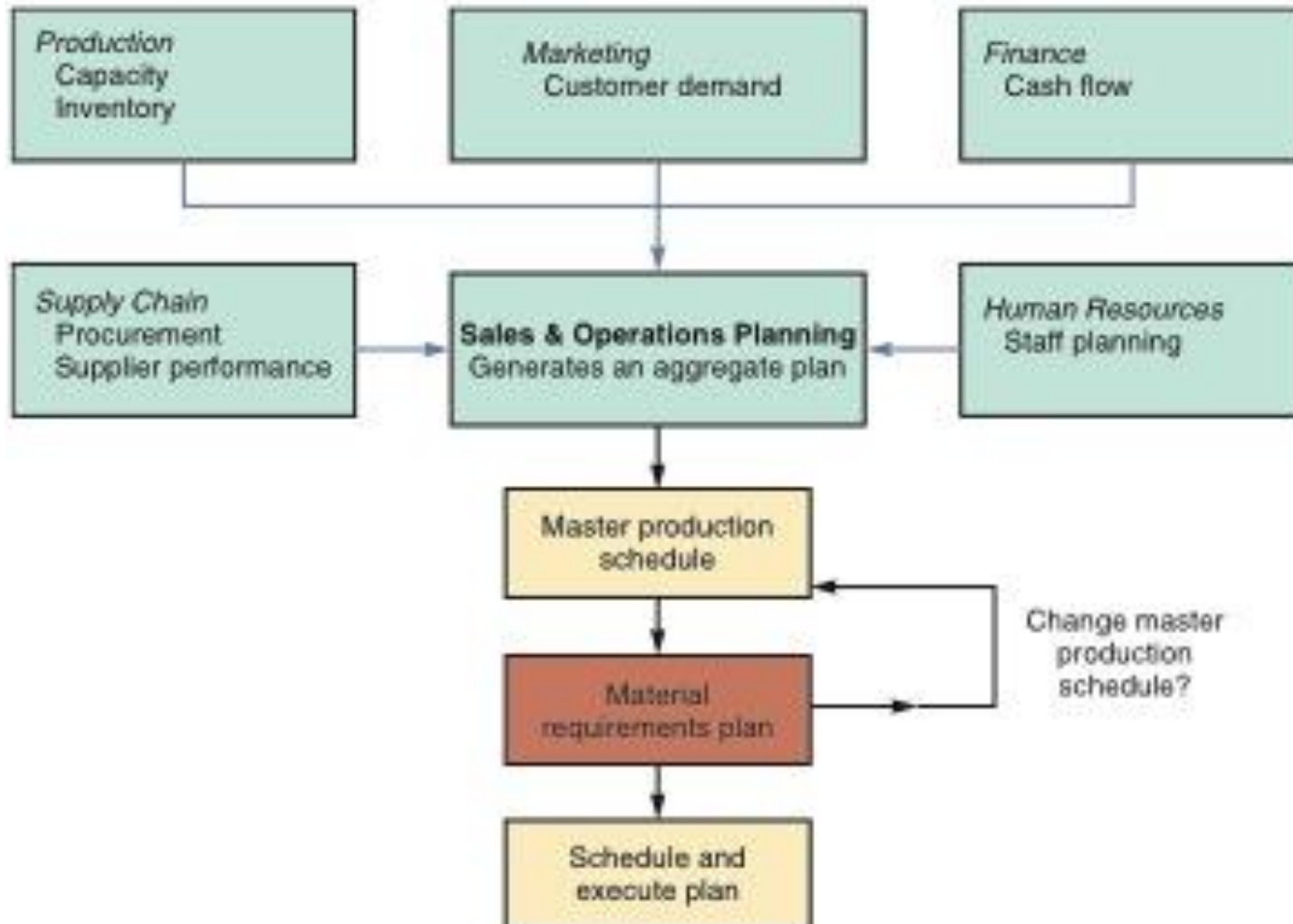
Master Production Schedule (MPS)

- Specifies what is to be made and when
- Must be in accordance with the aggregate production plan
- Inputs from financial plans, customer demand, engineering, supplier performance
- As the process moves from planning to execution, each step must be tested for feasibility
- The MPS is the result of the production planning process

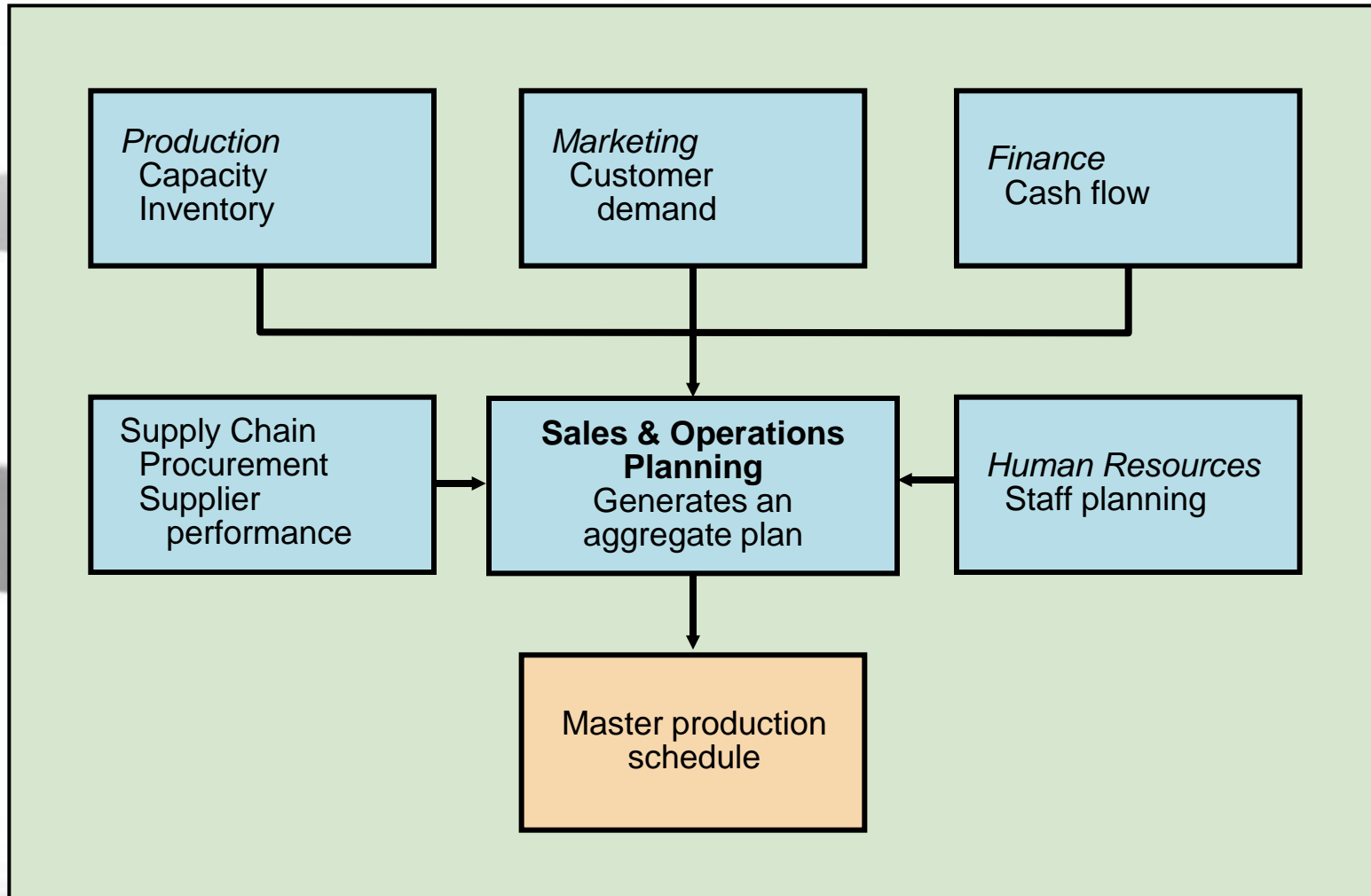
Master Production Schedule (MPS)

- MPS is established in terms of specific products
- Schedule must be followed for a reasonable length of time
- The MPS is quite often fixed or frozen in the near term part of the plan
- The MPS is a rolling schedule
- The MPS is a statement of what is to be produced, not a forecast of demand

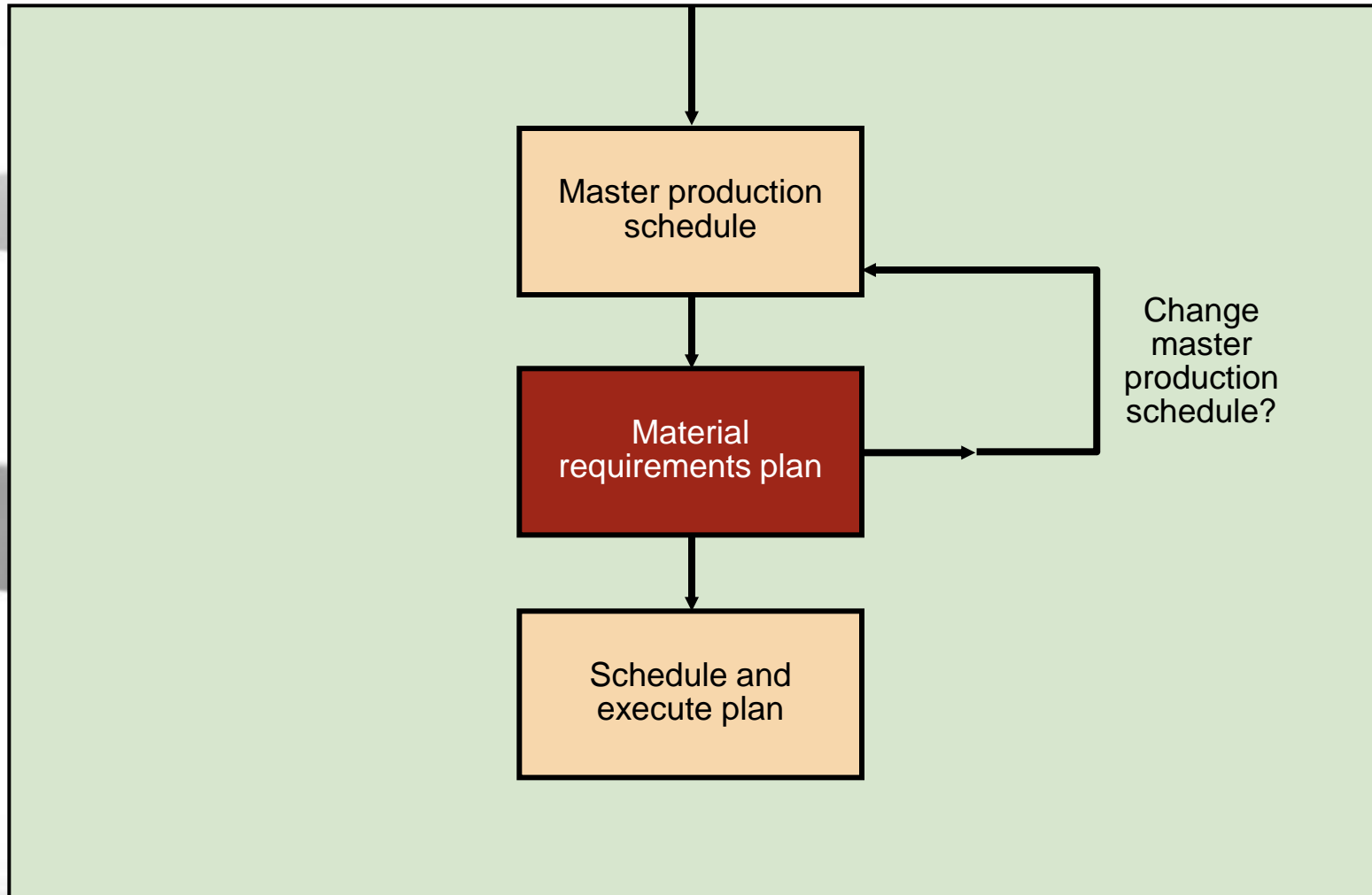
The Planning Process



The Planning Process



The Planning Process



Aggregate Production Plan

Months	January				February			
Aggregate Plan (Shows the total quantity of amplifiers)	1,500				1,200			
Weeks	1	2	3	4	5	6	7	8
Master Production Schedule (Shows the specific type and quantity of amplifier to be produced)								
240-watt amplifier	100		100		100		100	
150-watt amplifier		500		500		450		450
75-watt amplifier			300				100	

Master Production Schedule (MPS)

Can be expressed in any of the following terms:

1. *A customer order* in a job shop (make-to-order) company
2. *Modules* in a repetitive (assemble-to-order or forecast) company
3. *An end item* in a continuous (stock-to-forecast) company

MPS Example

TABLE 14.1

Master Production Schedule for Chef John's Buffalo Chicken Mac & Cheese

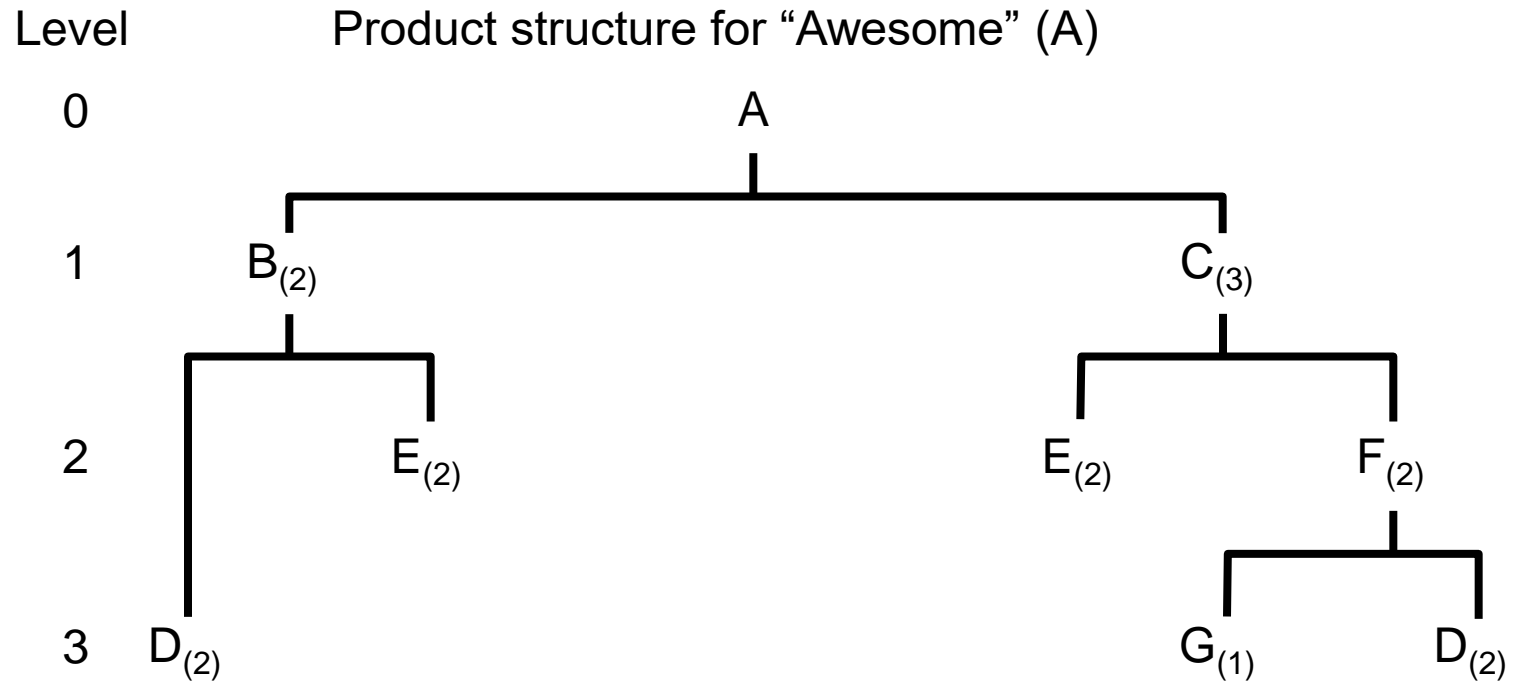
GROSS REQUIREMENTS FOR CHEF JOHN'S BUFFALO MAC & CHEESE

Day	6	7	8	9	10	11	12	13	14	And so on
Quantity	450		200	350	525		235	375		

Bills of Material

- List of components, ingredients, and materials needed to make product
- Provides product structure
 - Items above given level are called parents
 - Items below given level are called components or children

BOM Example



BOM Example

For an order of 50 Awesome speaker kits

Part B:	2 x number of As =	(2)(50) =	100
Part C:	3 x number of As =	(3)(50) =	150
Part D:	2 x number of Bs		
	+ 2 x number of Fs =	(2)(100) + (2)(300) =	800
Part E:	2 x number of Bs		
	+ 2 x number of Cs =	(2)(100) + (2)(150) =	500
Part F:	2 x number of Cs =	(2)(150) =	300
Part G:	1 x number of Fs =	(1)(300) =	300

3 D₍₂₎

G₍₁₎

D₍₂₎

Bills of Material

- Modular Bills
 - Modules are not final products but components that can be assembled into multiple end items
 - Can significantly simplify planning and scheduling

Bills of Material

- Planning Bills
 - Also called “pseudo” or super bills
 - Created to assign an artificial parent to the BOM
 - Used to group subassemblies to reduce the number of items planned and scheduled
 - Used to create standard “kits” for production

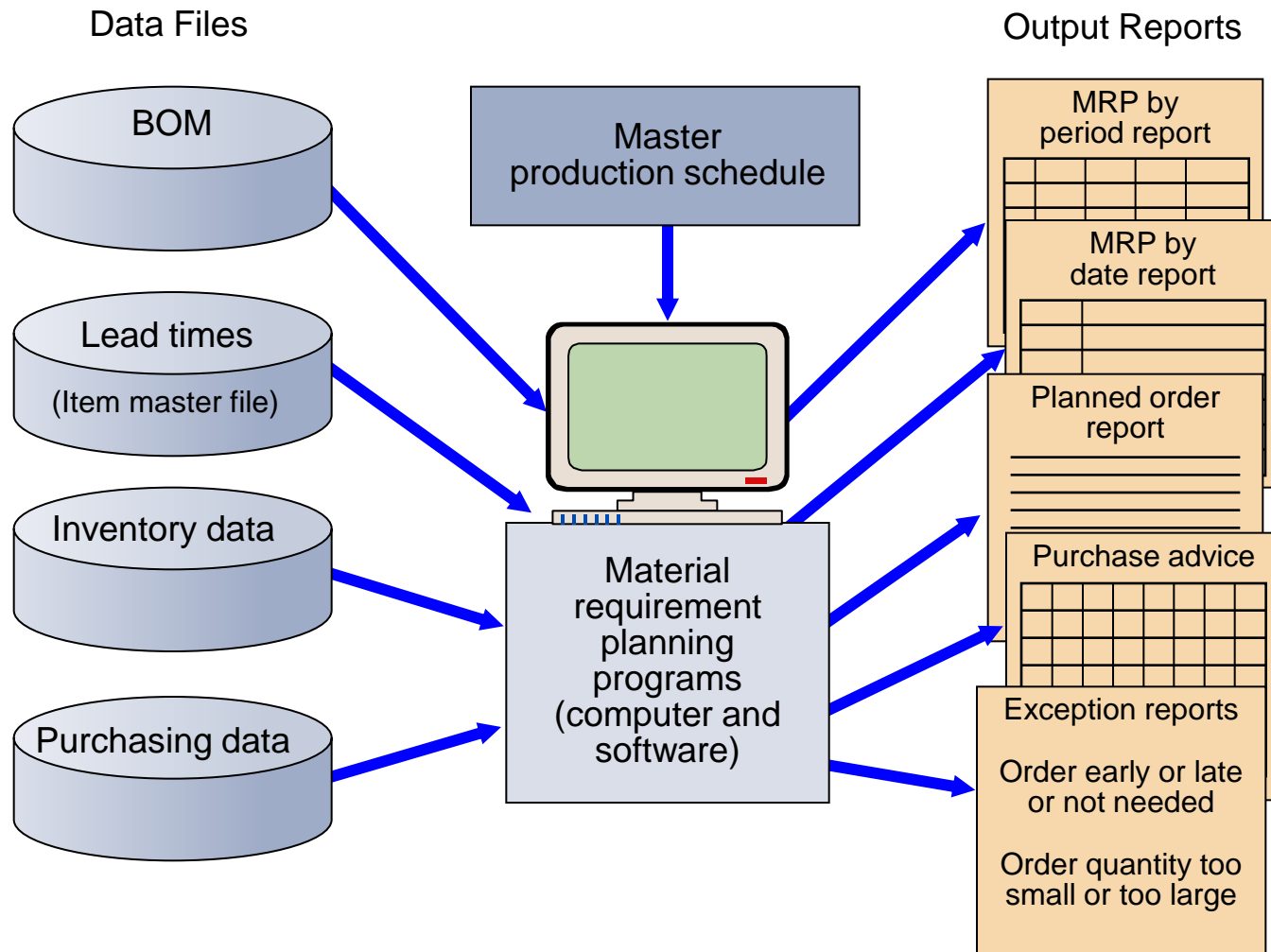
Bills of Material

- Phantom Bills
 - Describe subassemblies that exist only temporarily
 - Are part of another assembly and never go into inventory
- Low-Level Coding
 - Item is coded at the lowest level at which it occurs
 - BOMs are processed one level at a time

Accurate Inventory Records

- Accurate inventory records are absolutely required for MRP (or any dependent demand system) to operate correctly
- Generally MRP systems require more than 99% accuracy

MRP Structure



Safety Stock

- BOMs, inventory records, purchase and production quantities may not be perfect
- Consideration of safety stock may be prudent
- Should be minimized and ultimately eliminated
- Typically built into projected on-hand inventory

MRP Management

- MRP dynamics
 - Facilitates replanning when changes occur
 - **System nervousness** can result from too many changes
 - **Time fences** put limits on replanning
 - **Pegging** links each item to its parent allowing effective analysis of changes

MRP Management

- MRP limitations
 - MRP does not do detailed scheduling—it plans
 - Works best in product-focused, repetitive environments
 - Requires fixed lead time and infinite size time **buckets**

Extensions of MRP

- MRP II
- Closed-Loop MRP
- Capacity Planning

Material Requirements Planning II

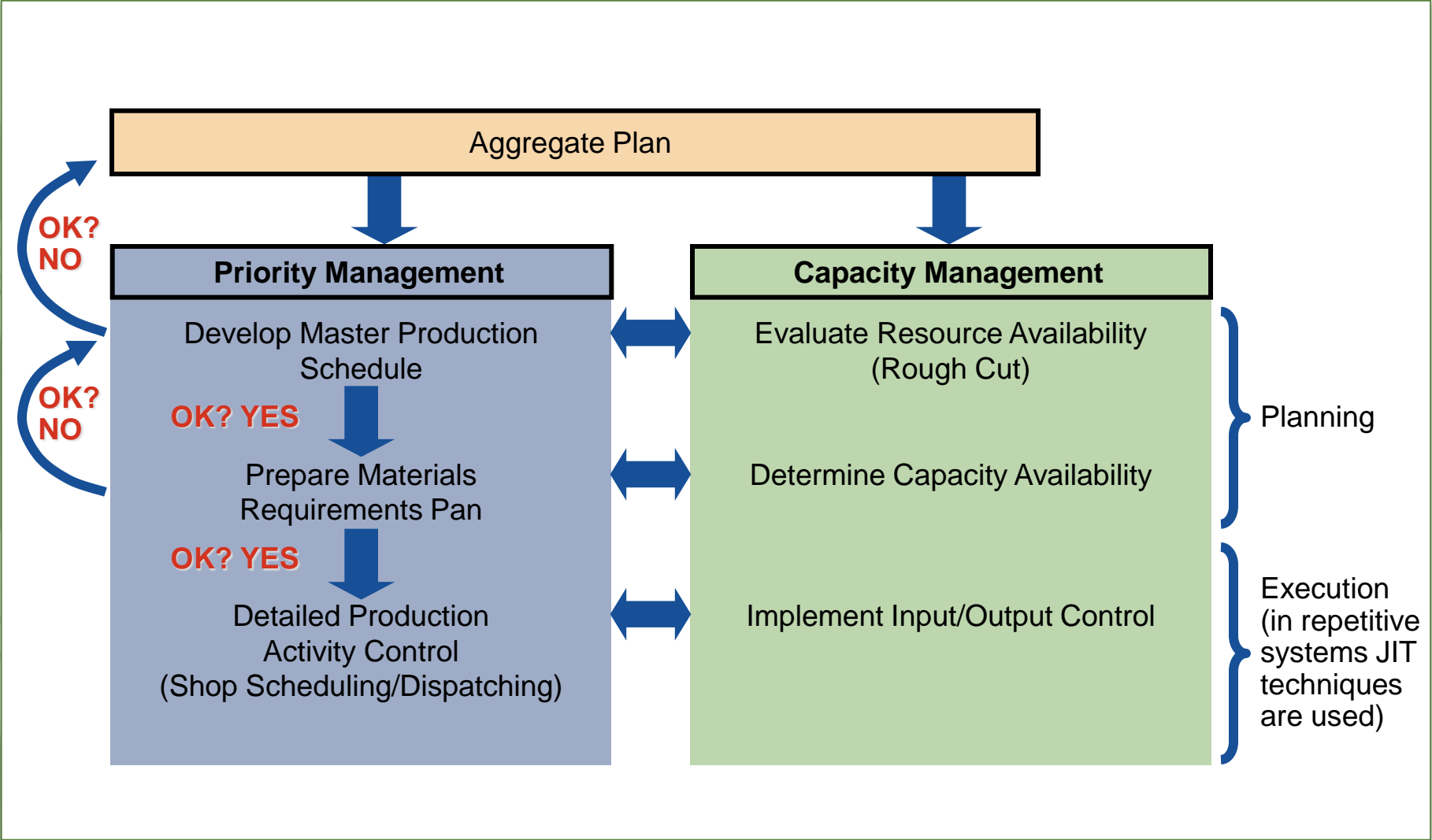
- Requirement data can be enriched by other resources
- Generally called **MRP II** or Material Resource Planning
- Outputs can include scrap, packaging waste, effluent, carbon emissions
- Data used by purchasing, production scheduling, capacity planning, inventory, warehouse management



Material Resource Planning

TABLE		Material Resource Planning (MRP II)				
	LT	Weeks				
		5	6	7	8	
Computer <i>Labor Hrs:</i> .2 each <i>Machine Hrs:</i> .2 each <i>Scrap:</i> 1 ounce fiberglass each <i>Payables:</i> \$0 each	1				100 20 20 6.25 lb \$0	
PC Board (1 each) <i>Labor Hrs:</i> .15 each <i>Machine Hrs:</i> .1 each <i>Scrap:</i> .5 ounces copper each <i>Payables:</i> raw material at \$5 each	2			100 15 10 3.125 lb \$500		
Processors (5 each) <i>Labor Hrs:</i> .2 each <i>Machine Hrs:</i> .2 each <i>Scrap:</i> .01 ounces of acid waste each <i>Payables:</i> processors at \$10 each	4	500 100 100 0.3125 lb \$5,000				

Closed-Loop MRP System



Capacity Planning

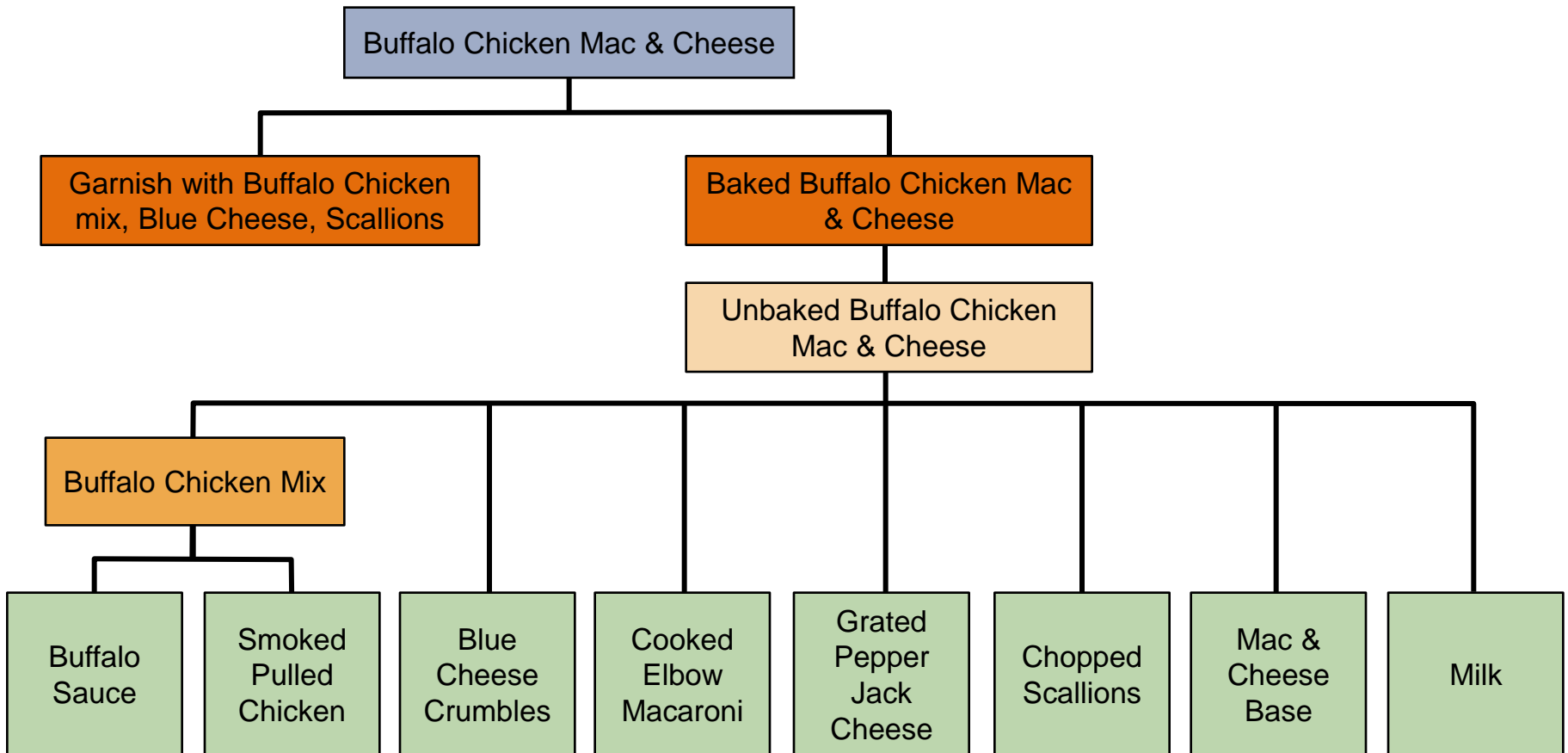
- Feedback from the MRP system
- **Load reports** show resource requirements for work centers
- Work can be moved between work centers to smooth the load or bring it within capacity

MRP in Services

- Some services or service items are directly linked to demand for other services
- These can be treated as dependent demand services or items
 - Restaurants
 - Hospitals
 - Hotels

MRP in Services

(a) PRODUCT STRUCTURE TREE



MRP in Services

(b) BILL OF MATERIALS

Production Specifications	Buffalo Chicken Mac & Cheese (6 portions)				
<i>Ingredients</i>	<i>Quantity</i>	<i>Measure</i>	<i>Unit Cost</i>	<i>Total Cost</i>	<i>Labor Hrs.</i>
Elbow Macaroni (large, uncooked)	20.00	oz.	\$ 0.09	\$ 1.80	
Cheese-Pepper Jack (grated)	10.00	oz.	0.17	1.70	
Mac and Cheese Base (from refrigerator)	32.00	oz.	0.80	25.60	
Milk	4.00	oz.	0.03	0.12	
Smoked Pulled Chicken	2.00	lb.	2.90	5.80	
Buffalo Sauce	8.00	oz.	0.09	0.72	
Blue Cheese Crumbles	4.00	oz.	0.19	0.76	
Scallions	2.00	oz.	0.18	0.36	
					0.2 hrs

Distribution Resource Planning (DRP)

Using dependent demand techniques through the supply chain

- Expected demand or sales forecasts become gross requirements
- All other levels are computed
- DRP pulls inventory through the system
- Small and frequent replenishments

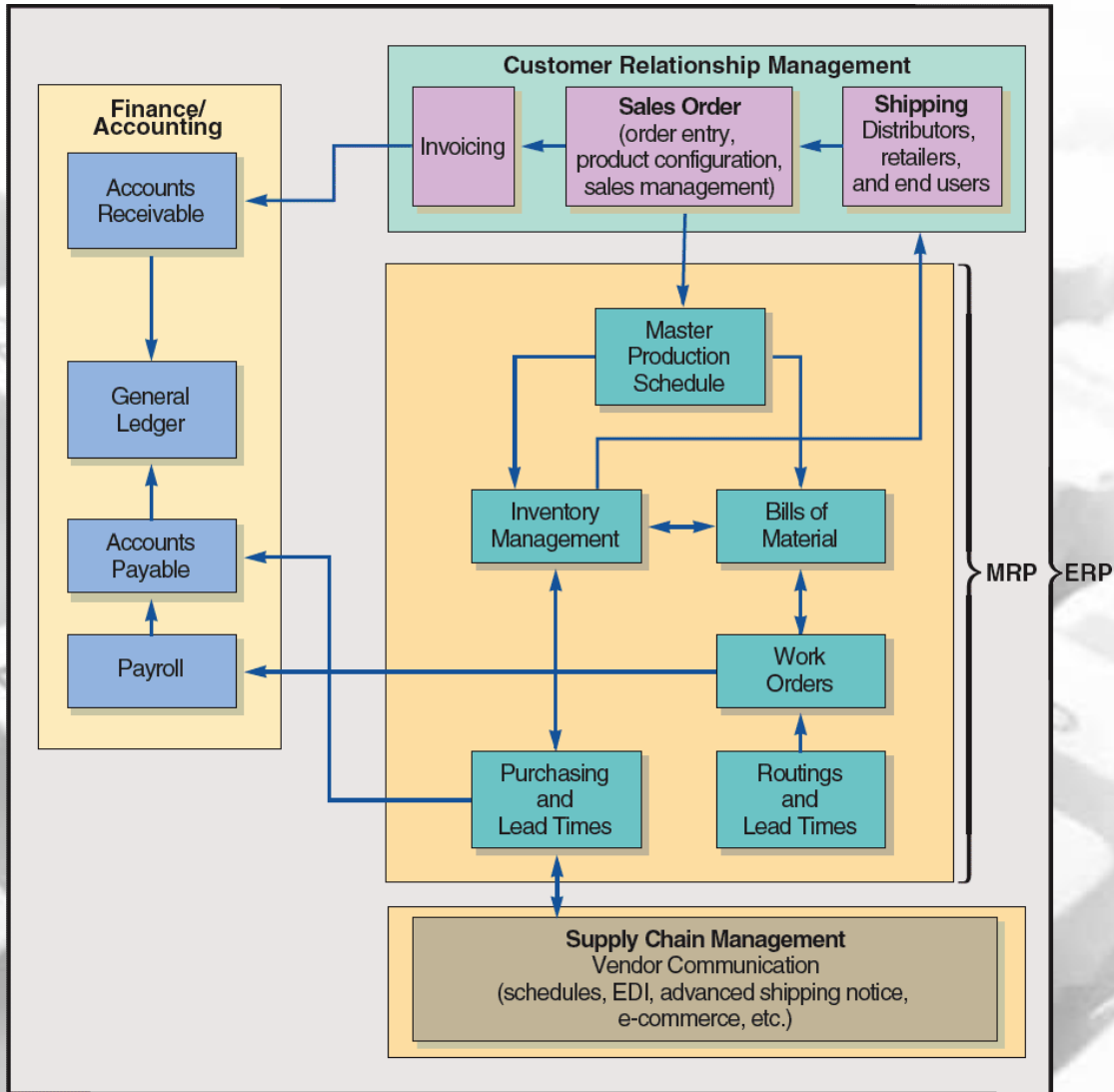
Enterprise Resource Planning (ERP)

- An extension of the MRP system to tie in customers and suppliers
 1. Allows automation and integration of many business processes
 2. Shares common data bases and business practices
 3. Produces information in real time
- Coordinates business from supplier evaluation to customer invoicing

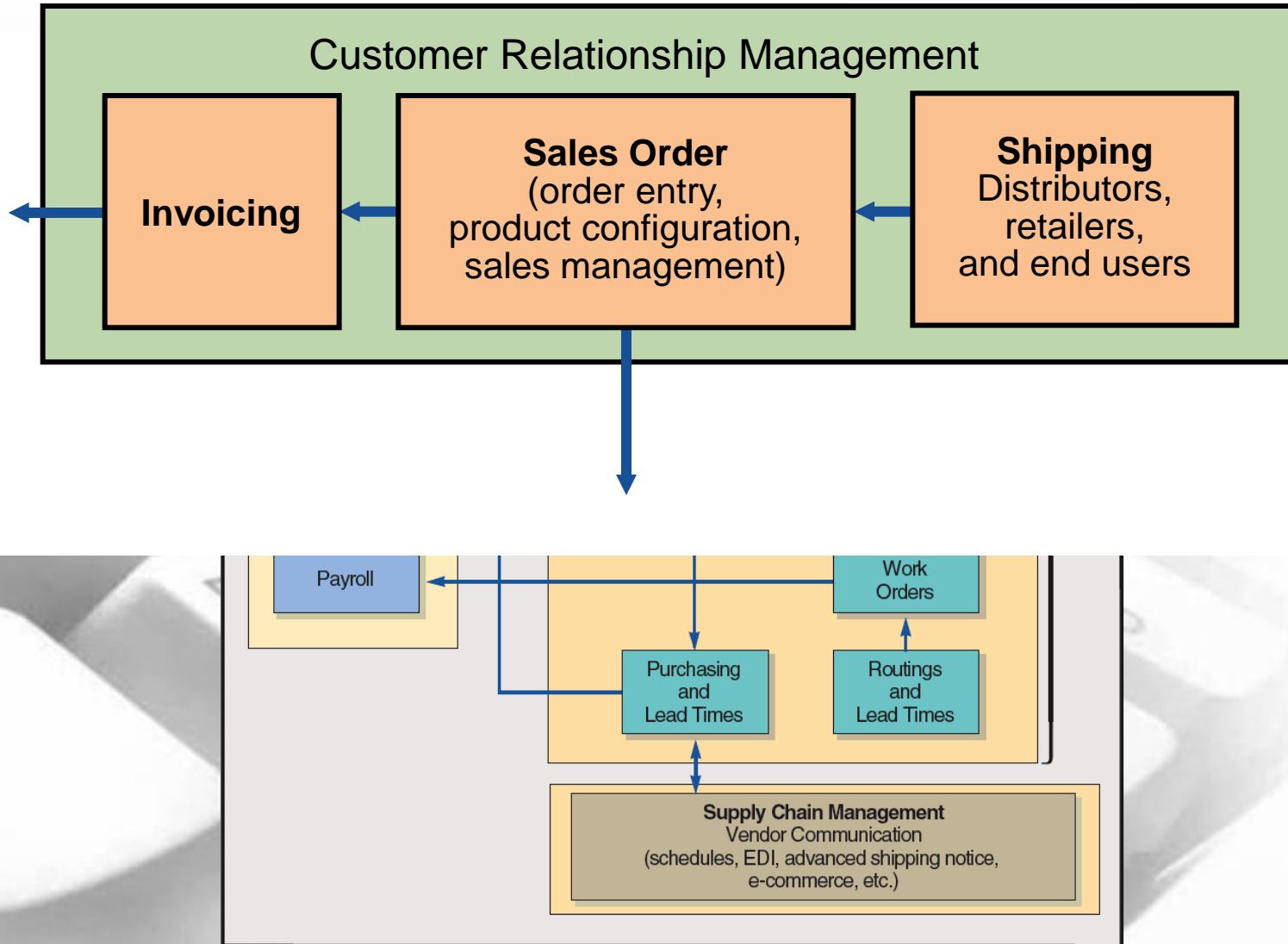
Enterprise Resource Planning (ERP)

- ERP modules include
 - Basic MRP
 - Finance
 - Human resources
 - Supply chain management (SCM)
 - Customer relationship management (CRM)
 - Sustainability

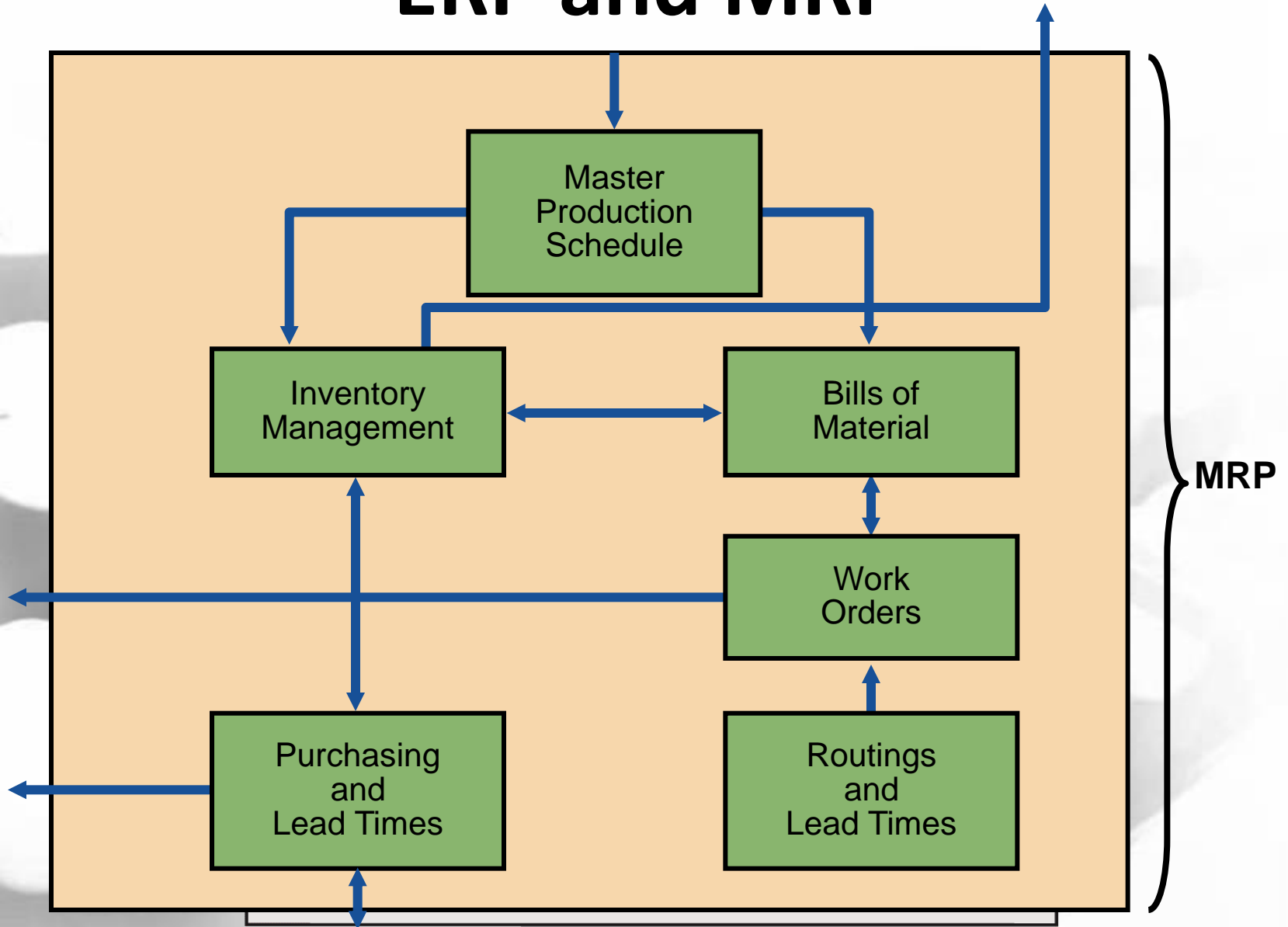
ERP and MRP



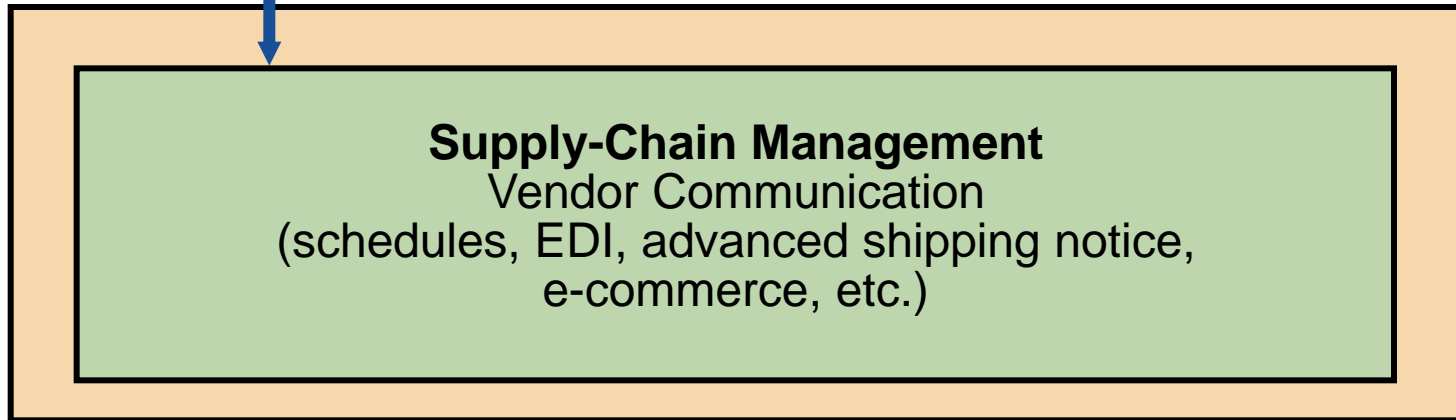
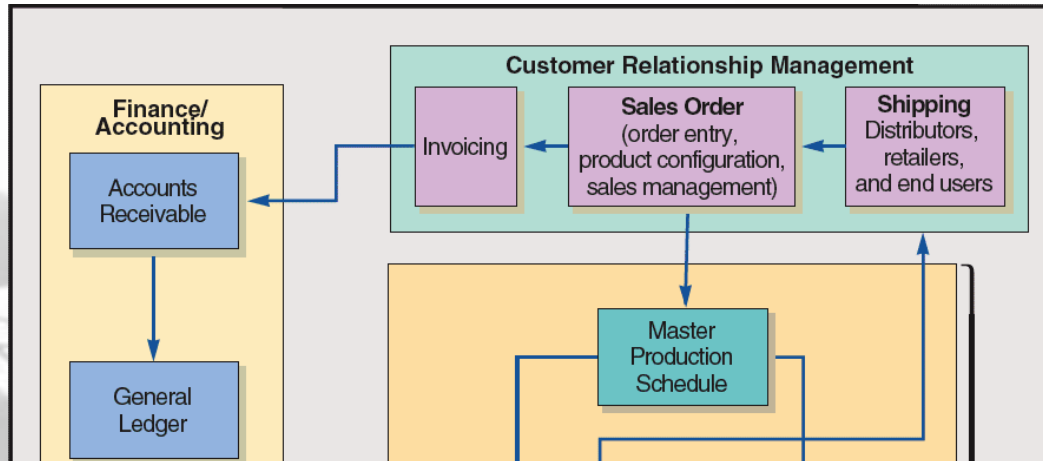
ERP and MRP



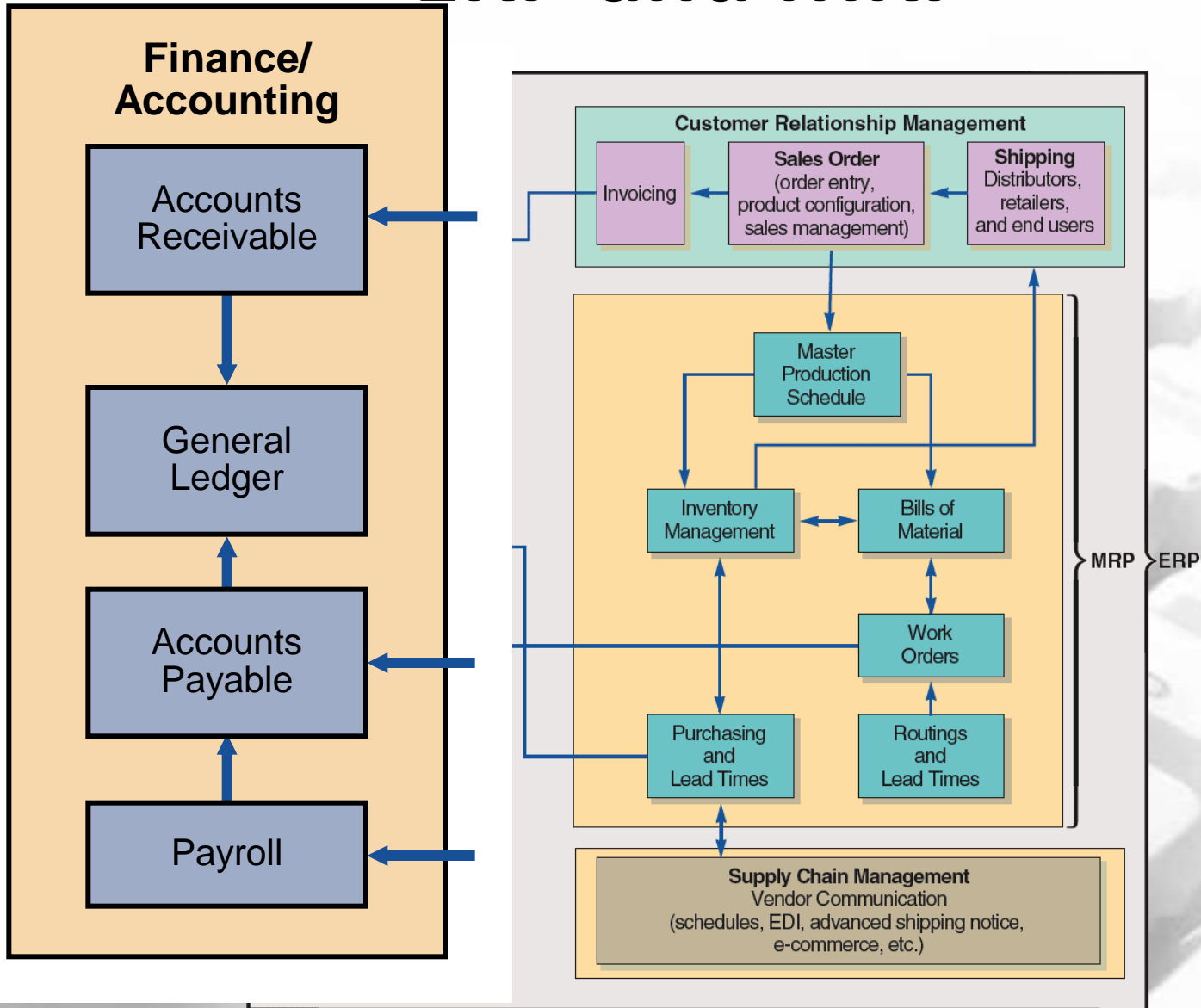
ERP and MRP



ERP and MRP



ERP and MRP



Enterprise Resource Planning (ERP)

- ERP systems have the potential to
 - Reduce transaction costs
 - Increase the speed and accuracy of information
- Facilitates a strategic emphasis on JIT systems and supply chain integration
- Can be expensive and time-consuming to install

SAP's ERP Modules

CASH TO CASH

Covers all financial related activity:

Accounts receivable

Accounts payable

General ledger

Treasury

Cash management

Asset management

PROMOTE TO DELIVER

Covers front-end customer-oriented activities:

Marketing

Quote and order processing

Transportation

Documentation and labeling

After sales service

Warranty and guarantees

DESIGN TO MANUFACTURE

Covers internal production activities:

Design engineering

Production engineering

Plant maintenance

Shop floor reporting

Contract/project management

Subcontractor management

PROCURE TO PAY

Covers sourcing activities:

Vendor sourcing

Purchase requisitioning

Purchase ordering

Purchase contracts

Inbound logistics

Supplier invoicing/matching

Supplier payment/settlement

Supplier performance

RECRUIT TO RETIRE

Covers all HR- and payroll-oriented activity:

Time and attendance

Travel and expenses

Payroll

DOCK TO DISPATCH

Covers internal inventory management:

Warehousing

Distribution planning

Forecasting

Replenishment planning

Physical inventory

Material handling

ERP in the Service Sector

- ERP systems have been developed for health care, government, retail stores, hotels, and financial services
- Also called **efficient consumer response** (ECR) systems
- Objective is to tie sales to buying, inventory, logistics, and production

Short-Term Scheduling

The objective of scheduling is to allocate and prioritize demand (generated by either forecasts or customer orders) to available facilities

Importance of Short-Term Scheduling

- Effective and efficient scheduling can be a competitive advantage
 - Faster movement of goods through a facility means better use of assets and lower costs
 - Additional capacity resulting from faster throughput improves customer service through faster delivery
 - Good schedules result in more dependable deliveries

Scheduling Issues

- ▶ Scheduling deals with the timing of operations
- ▶ The task is the allocation and prioritization of demand
- ▶ Significant factors are
 1. Forward or backward scheduling
 2. Finite or infinite loading
 3. The criteria for sequencing jobs

Scheduling Decisions

TABLE Scheduling Decisions	
ORGANIZATION	MANAGERS SCHEDULE THE FOLLOWING
Delta Air Lines	Maintenance of aircraft Departure timetables Flight crews, catering, gate, ticketing personnel
Arnold Palmer Hospital	Operating room use Patient admissions Nursing, security, maintenance staffs Outpatient treatments
University of Alabama	Classrooms and audiovisual equipment Student and instructor schedules Graduate and undergraduate courses
Amway Center	Ushers, ticket takers, food servers, security personnel Delivery of fresh foods and meal preparation Orlando Magic games, concerts, arena football
Lockheed Martin Factory	Production of goods Purchases of materials Workers

Scheduling Flow

Capacity Planning
 (Long term; years)
 Changes in Facilities
 Changes in Equipment
 See Chapter 7 and Supplement 7



Aggregate Planning
 (Intermediate term; quarterly or monthly)
 Facility utilization
 Personnel changes
 Subcontracting
 See Chapter 13



Master Schedule
 (Intermediate term; weekly)
 Material requirements planning
 Disaggregate the aggregate plan
 See Chapters 13 and 14



Short Term Scheduling
 (Short term; days, hours, minutes)
 Work center loading
 Job sequencing/dispatching
 See this chapter

Capacity Plan for New Facilities

Adjust capacity to the demand suggested by strategic plan



Aggregate Production Plan for All Bikes

(Determine personnel or subcontracting necessary to match aggregate demand to existing facilities/capacity)

Month	1	2
Bike Production	800	850

Master Production Schedule for Bike Models

(Determine weekly capacity schedule)

Week	Month 1				Month 2			
	1	2	3	4	5	6	7	8
Model 22		200		200		200		200
Model 24	100		100		150		100	
Model 26	100		100		100		100	

Work Assigned to Specific Personnel and Work Centers

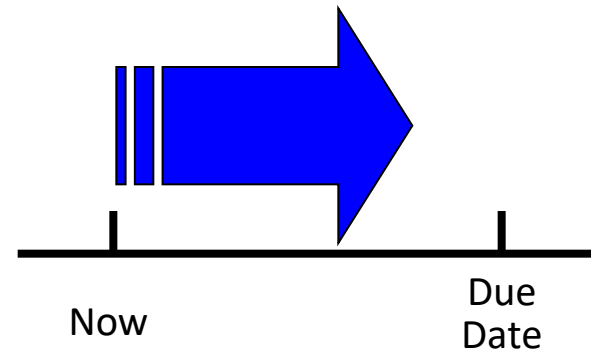
Make finite capacity schedule by matching specific tasks to specific people and machines

Assemble Model 22 in work center 6



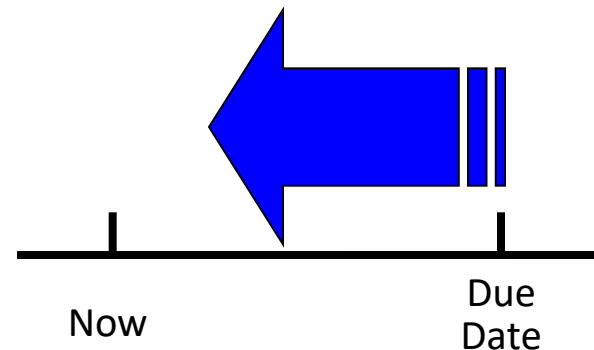
Forward and Backward Scheduling

- *Forward scheduling starts as soon as the requirements are known*
- Produces a feasible schedule though it may not meet due dates
- Frequently results in buildup of work-in-process inventory



Forward and Backward Scheduling

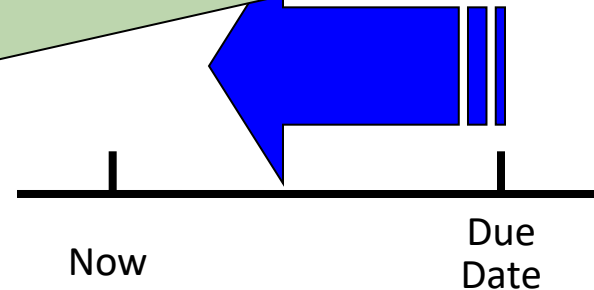
- *Backward scheduling* begins with the due date and schedules the *final* operation first
- Schedule is produced by working backwards through the processes
- Resources may not be available to accomplish the schedule



Forward and Backward Scheduling

- *Backward scheduling* begins with the due date and schedules the first task first
- Scheduling tasks backwards

Often these approaches are combined to develop a trade-off between capacity constraints and customer expectations



Finite and Infinite Loading

- Assigning jobs to work stations
- Finite loading assigns work up to the capacity of the work station
 - All work gets done
 - Due dates may be pushed out
- Infinite loading does not consider capacity
 - All due dates are met
 - Capacities may have to be adjusted

Scheduling Criteria

1. Minimize completion time
2. Maximize utilization of facilities
3. Minimize work-in-process (WIP) inventory
4. Minimize customer waiting time

Different Processes/ Different Approaches

TABLE

Different Processes Suggest Different Approaches to Scheduling

Process-focused facilities (job shops)

- ▶ Scheduling to customer orders where changes in both volume and variety of jobs/clients/patients are frequent
- ▶ Schedules are often due-date focused, with loading refined by finite loading techniques
- ▶ Examples: foundries, machine shops, cabinet shops, print shops, many restaurants, and the fashion industry

Repetitive facilities (assembly lines)

- ▶ Schedule module production and product assembly based on frequent forecasts
- ▶ Finite loading with a focus on generating a forward-looking schedule
- ▶ JIT techniques are used to schedule components that feed the assembly line
- ▶ Examples: assembly lines for washing machines at Whirlpool and automobiles at Ford.

Different Processes/ Different Approaches

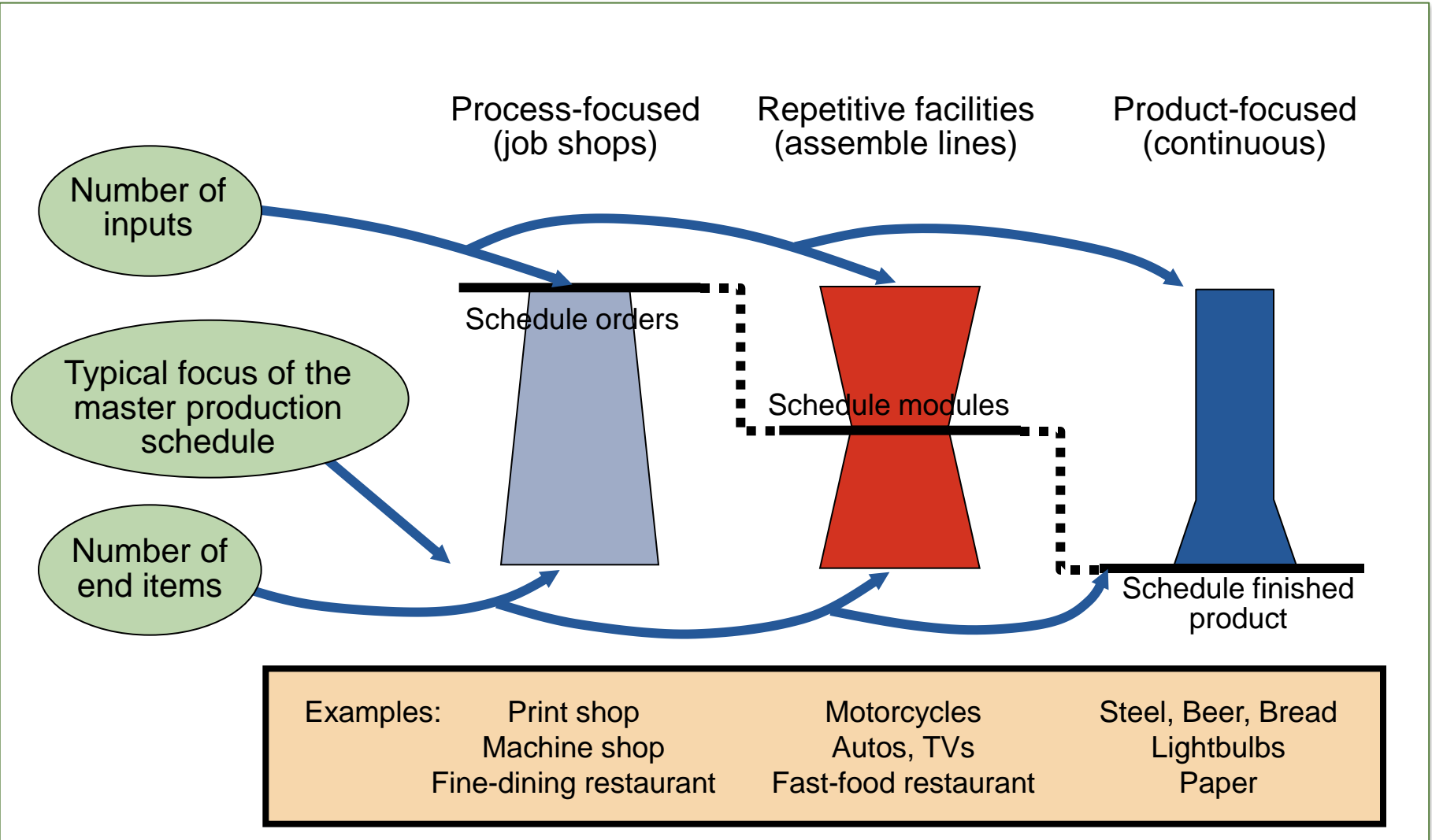
TABLE

Different Processes Suggest Different Approaches to Scheduling

Product-focused facilities (continuous)

- ▶ Schedule high volume finished products of limited variety to meet a reasonably stable demand within existing fixed capacity
- ▶ Finite loading with a focus on generating a forward-looking schedule that can meet known setup and run times for the limited range of products
- ▶ Examples: huge paper machines at International Paper, beer in a brewery at Anheuser-Busch, and potato chips at Frito-Lay

Focus for Different Process Strategies



Scheduling Process-Focused Facilities

- High-variety, low volume
- Production differ considerably
- Schedule incoming orders without violating capacity constraints
- Scheduling can be complex



Terima Kasih
рахмат
danke 謝謝

ngiyabonga

teşekkür ederim

Баярлалаа
спасибо

thank you

gracias

tapadh leat

bedankt
dziękuję

obrigado

sukriya

kop khun krap

taiku

go raibh maith agat

sagolun

terima kasih

arigatō

grazie

takk

dakujem

তোমাকে ধন্যবাদ

감사합니다

xiexie

mercii

merci