

Chapter 4

Product, Process, and Service Design



Overview

- Designing and Developing Products and Services
- Process Planning and Design
- Major Factors Affecting Process Design Decisions
- Types of Process Designs
- Interrelationships Among Product Design, Process Design, and Inventory Policy
- Process Design in Services
- Deciding Among Processing Alternatives
- Wrap-Up: What World-Class Companies Do

Product/Service Design

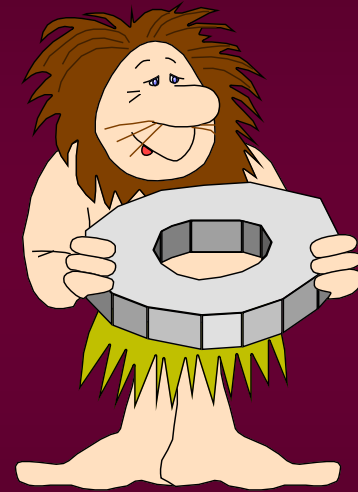
When a product/service is designed:

- The detailed characteristics of the product/service are established.
- The characteristics of the product/service directly affects how the product/service can be produced/delivered.
- How the product/service is produced/delivered determines the design of the production/delivery system.

Product/Service Design

Product/service design directly affects:

- Product/service quality
- Production/delivery cost
- Customer satisfaction



Product/Service Design and Development

- Sources of Product Innovation
- Developing New Products/Services
- Getting Them to Market Faster
- Improving Current Products/Services
- Designing for Ease of Production
- Designing for Quality
- Designing and Developing New Services

Sources of Product/Service Innovation

- Customers
- Managers
- Marketing
- Operations
- Engineering
- Research and Development (R&D)
 - Basic research
 - Applied research

Steps in Developing New Products

1. Technical and economic feasibility studies
2. Prototype design
3. Performance testing of prototype
4. Market sensing/evaluation and economic evaluation of the prototype
5. Design of production model
6. Market/performance/process testing and economic evaluation of production model
7. Continuous modification of production model

Steps in Developing New Products

1. Technical and Economic Feasibility Studies
 - Determine the advisability of establishing a project for developing the product
 - If initial feasibility studies are favorable, engineers prepare an initial prototype design

Steps in Developing New Products

2. Prototype Design

- This design should exhibit the basic form, fit, and function of the final product
- It will not necessarily be identical to the production model

Steps in Developing New Products

3. Performance Testing of Prototype

- Performance testing and redesign of the prototype continues until this design-test-redesign process produces a satisfactorily performing prototype

Steps in Developing New Products

4. Market Sensing/Evaluation and Economic Evaluation of the Prototype

- Accomplished by demonstrations to potential customers, market test, or market surveys
- If the response to the prototype is favorable, economic evaluation of the prototype is performed to estimate production volume, costs, and profits
- If the economic evaluation is favorable, the project enters the production design phase.

Steps in Developing New Products

5. Design of Production Model

- The initial design of the production model will not be the final design; the model will evolve

Steps in Developing New Products

6. Market/Performance/Process Testing and Economic Evaluation of Production Model

- The production model should exhibit:
 - low cost
 - reliable quality
 - superior performance
 - the ability to be produced in the desired quantities on the intended equipment

Steps in Developing New Products

7. Continuous Modification of Production Model

- Production designs are continuously modified to:
 - Adapt to changing market conditions
 - Adapt to changing production technology
 - Allow for manufacturing improvements

Managing Product Development Projects

- About 5% of all new-product ideas survive to production, and only about 10% of these are successful.
- It is best to cancel unpromising new-product/service development projects early!
- Employees often become emotionally caught up in these projects and are overly optimistic
- An impartial management review board is needed for periodic reviews of the progress of these projects.

Getting New Products to Market Faster

- Speed creates competitive advantages
- Speed saves money
- Tools to improve speed:
 - Autonomous design and development teams
 - Computer-aided design/computer-aided manufacturing (CAD/CAM)
 - Simultaneous (concurrent) engineering

Tools to Improve Speed to Market

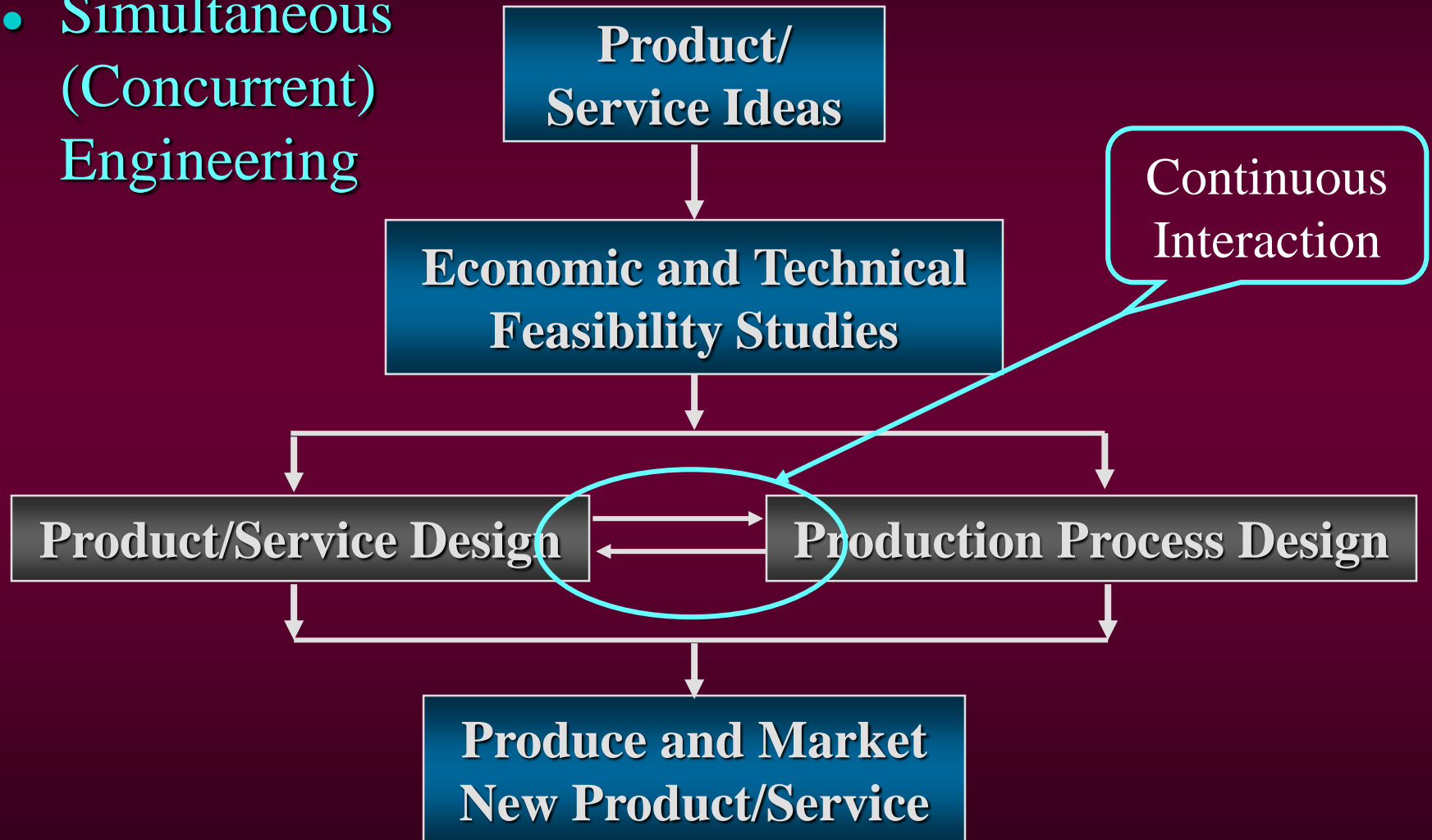
- Autonomous Design and Development Teams
 - Teams are given decision-making responsibility and more freedom to design and introduce new products/services
 - Time-to-market has been slashed dramatically
 - Enormous sums of money have been saved
 - Teams do not have to deal with the bureaucratic red tape ordinarily required to obtain approvals

Tools to Improve Speed to Market

- Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM)
 - Engineers, using CAD/CAM, can generate many views of parts, rotate images, magnify views, and check for interference between parts
 - Part designs can be stored in a data base for use on other products
 - When it is time for manufacturing, the product design is retrieved, translated into a language that production machinery understands, and then the production system can be automatically set up.

Tools to Improve Speed to Market

- Simultaneous (Concurrent) Engineering



Improving the Design of Existing Products/Services

- Focus is improving performance, quality, and cost
- Objective is maintaining or improving market share of maturing products/services
- Little changes can be significant
- Small, steady (continuous) improvements can add up to huge long-term improvements
- Value analysis is practiced, meaning design features are examined in terms of their cost/benefit (value).

Designing for Ease of Production

- Ease of Production (Manufacturability)
 - Specifications - Precise information about the characteristics of the product
 - Tolerances - Minimum & maximum limits on a dimension that allows the item to function as designed
 - Standardization - Reduce variety among a group of products or parts
 - Simplification - Reduce or eliminate the complexity of a part or product

Designing for Quality

- Crucial element of product design is its impact on quality
- Quality is determined by the customer's perception of the degree of excellence of the product/service's characteristics
- Chapter 7 covers the principles of designing products/services for quality

Designing and Developing New Services

Three general dimensions of service design are:

- Degree of Standardization of the Service
 - Custom-fashioned for particular customers or basically the same for all customers?
- Degree of Customer Contact in Delivering the Service
 - High level of contact (dress boutique) or low level (fast-food restaurant)?
- Mix of Physical Goods and Intangible Services
 - Mix dominated by physical goods (tailor's shop) or by intangible services (university)?

Designing and Developing New Services

- Differences Between New Service and New Product Development
 - Unless services are dominated by physical goods, their development usually does not require engineering, testing, and prototype building.
 - Because many service businesses involve intangible services, market sensing tends to be more by surveys rather than by market tests and demonstrations.

Process Planning and Design



Process Planning and Design System

Inputs:

- Product/Service Information
- Production System Information
- Operations Strategy



Process Planning & Design:

- Process-Type Selection
- Vertical Integration Studies
- Process/Product Studies
- Equipment Studies
- Production Procedures Studies
- Facilities Studies

Outputs:

- Process Technology
- Facilities
- Personnel Estimates

Major Factors Affecting Process Designs

- Nature of product/service demand
- Degree of vertical integration
- Production flexibility
- Degree of automation
- Product/Service quality

Nature of Product/Service Demand

- Production processes must have adequate capacity to produce the volume of the products/services that customers need.
- Provisions must be made for expanding or contracting capacity to keep pace with demand patterns.
- Some types of processes are more easily expanded and contracted than others.
- Product/service price affects demand, so pricing decisions and the choice of processes must be synchronized.

Degree of Vertical Integration

- Vertical integration is the amount of the production and distribution chain that is brought under the ownership of a company.
- This determines how many production processes need to be planned and designed.
- Decision of integration is based on cost, availability of capital, quality, technological capability, and more.
- Strategic outsourcing (lower degree of integration) is the outsourcing of processes in order to react quicker to changes in customer needs, competitor actions, and technology.

Production Flexibility

- Product flexibility -- ability of the production (or delivery) system to quickly change from producing (delivering) one product (or service) to another.
- Volume flexibility -- ability to quickly increase or reduce the volume of product(or service) produced (or delivered).

Degree of Automation

- Advantages of automation
 - Improves product quality
 - Improves product flexibility
 - Reduces labor and related costs
- Disadvantages of automation
 - Equipment can be very expensive
 - Integration into existing operations can be difficult

Product/Service Quality

- Old viewpoint – high-quality products must be made in small quantities by expert craftsmen
- New viewpoint – high-quality products can be mass-produced using automated machinery
- Automated machinery can produce products of incredible uniformity
- The choice of design of production processes is affected by the need for superior quality.

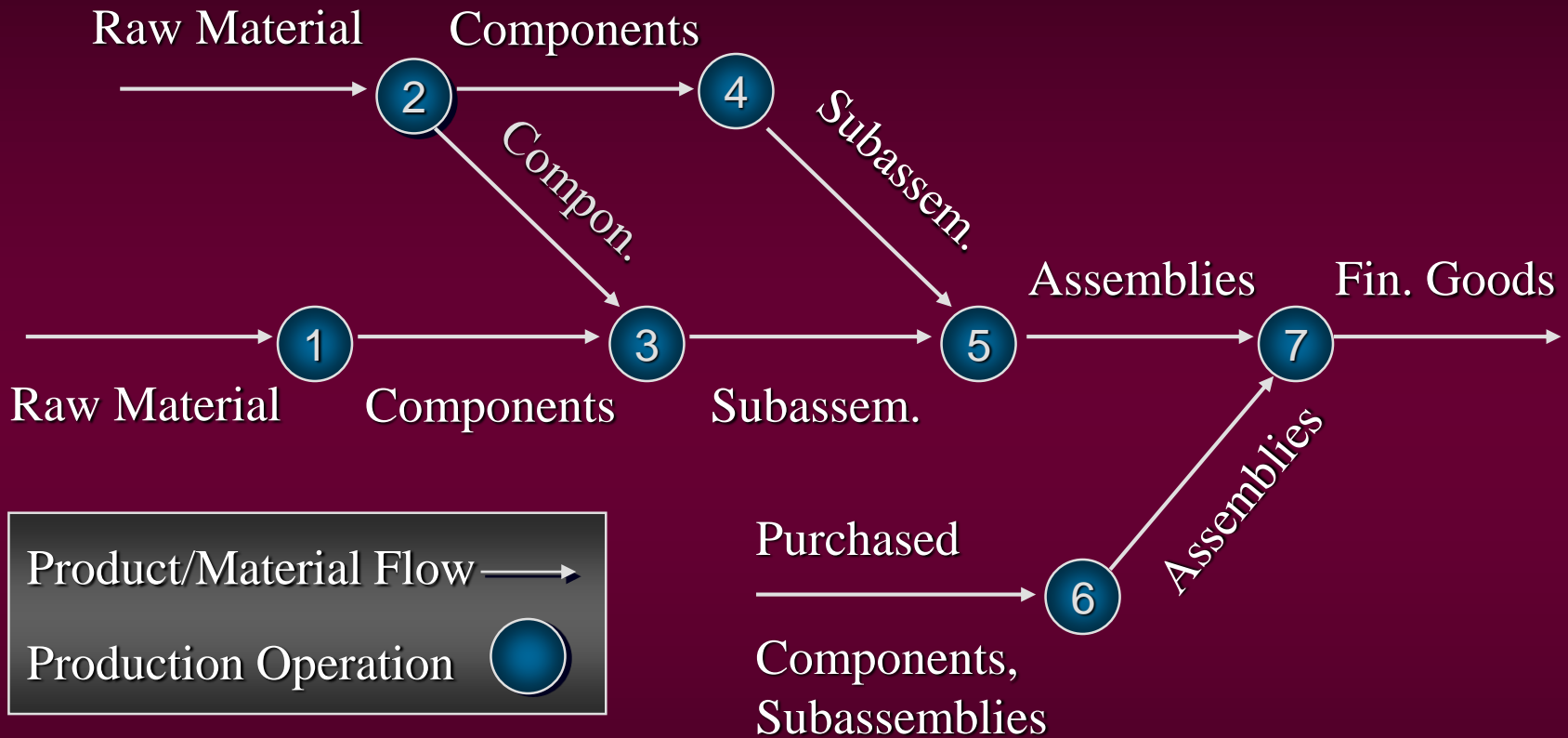
Types of Process Designs

- Product-Focused
- Process-Focused
- Group Technology/Cellular Manufacturing

Product-Focused

- Processes (conversions) are arranged based on the sequence of operations required to produce a product or provide a service
- Also called “Production Line” or “Assembly Line”
- Two general forms
 - Discrete unit – automobiles, dishwashers
 - Process (Continuous) – petrochemicals, paper

Product-Focused



Product-Focused

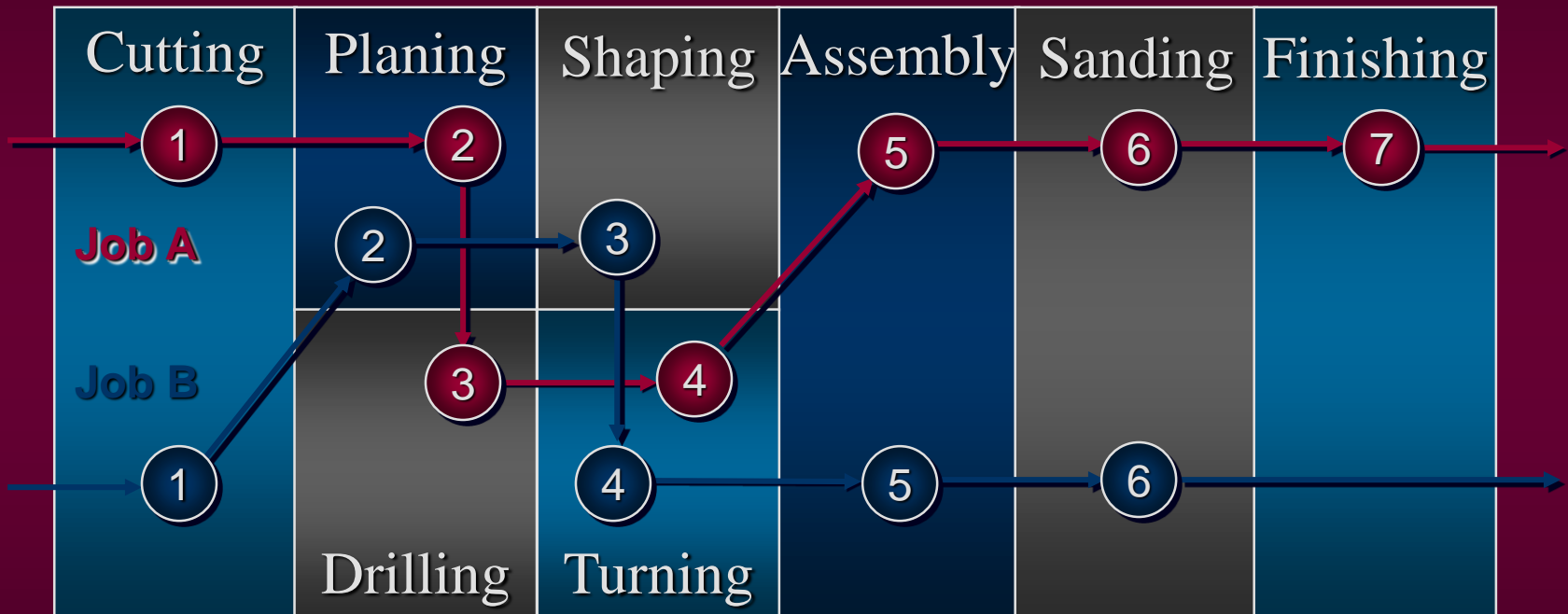
- Advantages
 - Lower labor-skill requirements
 - Reduced worker training
 - Reduced supervision
 - Ease of planning and controlling production
- Disadvantages
 - Higher initial investment level
 - Relatively low product flexibility

Process-Focused

- Processes (conversions) are arranged based on the type of process, i.e., similar processes are grouped together
- Products/services (jobs) move from department (process group) to department based on that particular job's processing requirements
- Also called “Job Shop” or “Intermittent Production”
- Examples
 - Auto body repair
 - Custom woodworking shop

Process-Focused

Custom Woodworking Shop



Process-Focused

- Advantages
 - High product flexibility
 - Lower initial investment level
- Disadvantages
 - Higher labor-skill requirements
 - More worker training
 - More supervision
 - More complex production planning and controlling

Group Technology/Cellular Manufacturing

- Group Technology
 - Each part produced receives a multi-digit code that describes the physical characteristics of the part.
 - Parts with similar characteristics are grouped into part families
 - Parts in a part family are typically made on the same machines with similar tooling

Group Technology/Cellular Manufacturing

- Cellular Manufacturing
 - Some part families (those requiring significant batch sizes) can be assigned to manufacturing cells.
 - The organization of the shop floor into cells is referred to as cellular manufacturing.
 - Flow of parts within cells tend to be more like product-focused systems

Group Technology/Cellular Manufacturing

- Advantages (relative to a job shop)
 - Process changeovers simplified
 - Variability of tasks reduced (less training needed)
 - More direct routes through the system
 - Quality control is improved
 - Production planning and control simpler
 - Automation simpler

Group Technology/Cellular Manufacturing

- Disadvantages
 - Duplication of equipment
 - Under-utilization of facilities
 - Processing of items that do not fit into a family may be inefficient

Group Technology/Cellular Manufacturing

- Candidates for GT/CM are job shops having:
 - A degree of parts standardization
 - Moderate batch sizes

Product/Process Design & Inventory Policy

- Standard Products and Produce to Stock
 - Sales forecasts drive production schedule
 - Maintain pre-determined finished-goods levels
 - MRP forecast drives material ordering
- Custom Products and Produce to Order
 - Orders set production schedule and drive material deliveries
 - Design time (preproduction planning) may be required before production can be scheduled

Process Design in Services

- Some of the factors important in process design for products are also important in services:
 - Nature (level and pattern) of customer demand
 - Degree of vertical integration
 - Production flexibility
 - Degree of automation
 - Service quality

Process Design in Services

- Three schemes for producing and delivering services
 - Quasi-Manufacturing
 - Customer-as-Participant
 - Customer-as-Product

Process Design in Services

- Quasi-Manufacturing
 - Physical goods are dominant over intangible service
 - Production of goods takes place along a production line
 - Operations can be highly automated
 - Almost no customer interaction
 - Little regard for customer relations
 - Example – bank's checking encoding operation

Process Design in Services

- Customer-as-Participant
 - Physical goods may be a significant part of the service
 - Services may be either standardized or custom
 - High degree of customer involvement in the process
 - Examples: ATM, self-service gas station

Process Design in Services

- Customer-as-Product
 - Service is provided through personal attention to the customer
 - Customized service on the customer
 - High degree of customer contact
 - There is a perception of high quality
 - Customer becomes the central focus of the process design
 - Examples: medical clinic, hair salon

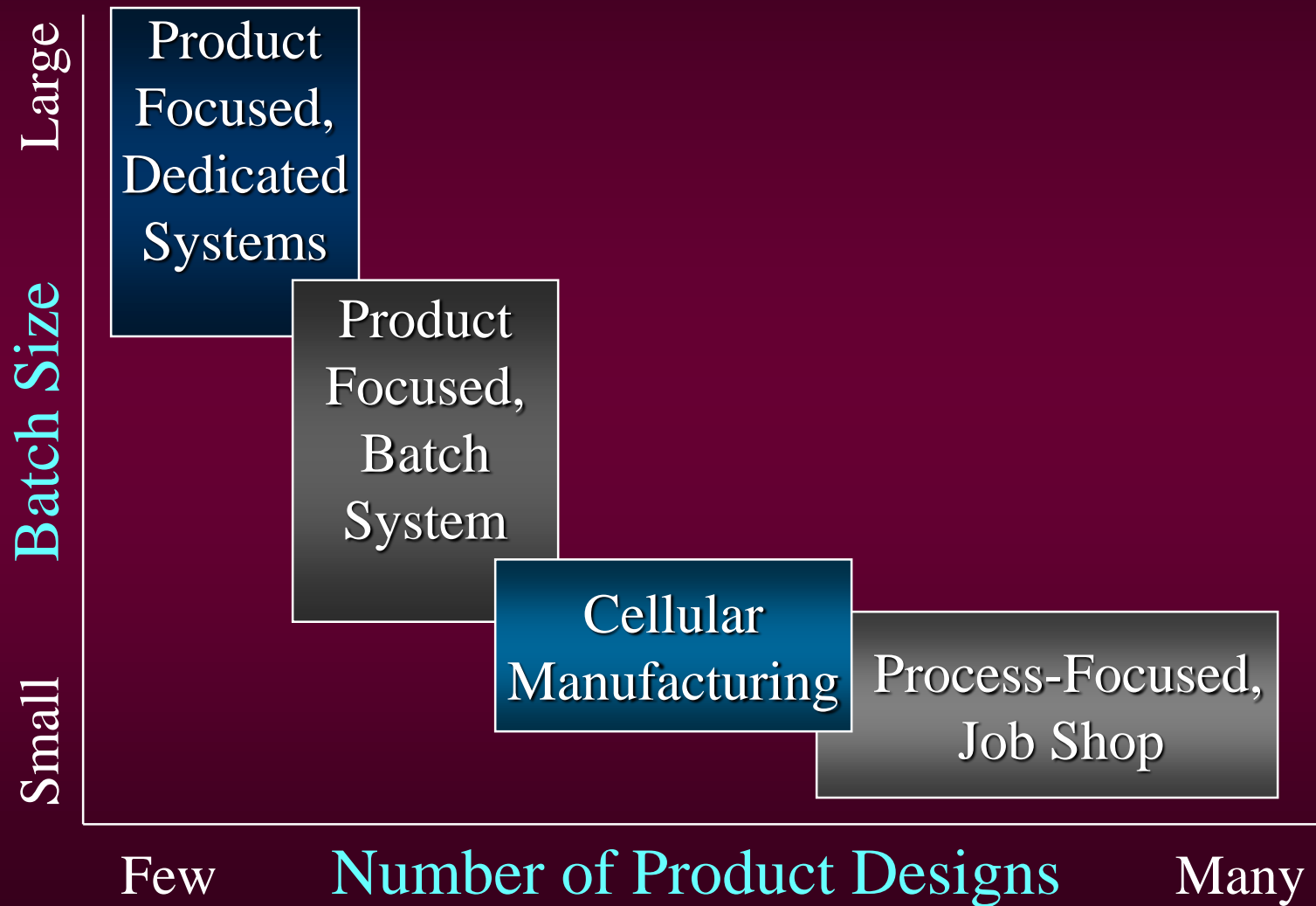
Process Reengineering

- The concept of drastically changing an existing process design
- Not merely making marginal improvements to the process
- A correctly reengineered process should be more efficient
- A smaller labor force is often the result

Deciding Among Processing Alternatives

- Batch Size and Product/Service Variety
- Capital Requirements
- Economic Analysis
 - Cost Functions of Alternative Processes
 - Break-Even Analysis
 - Financial Analysis

Process Design Depends on Product Diversity and Batch Size



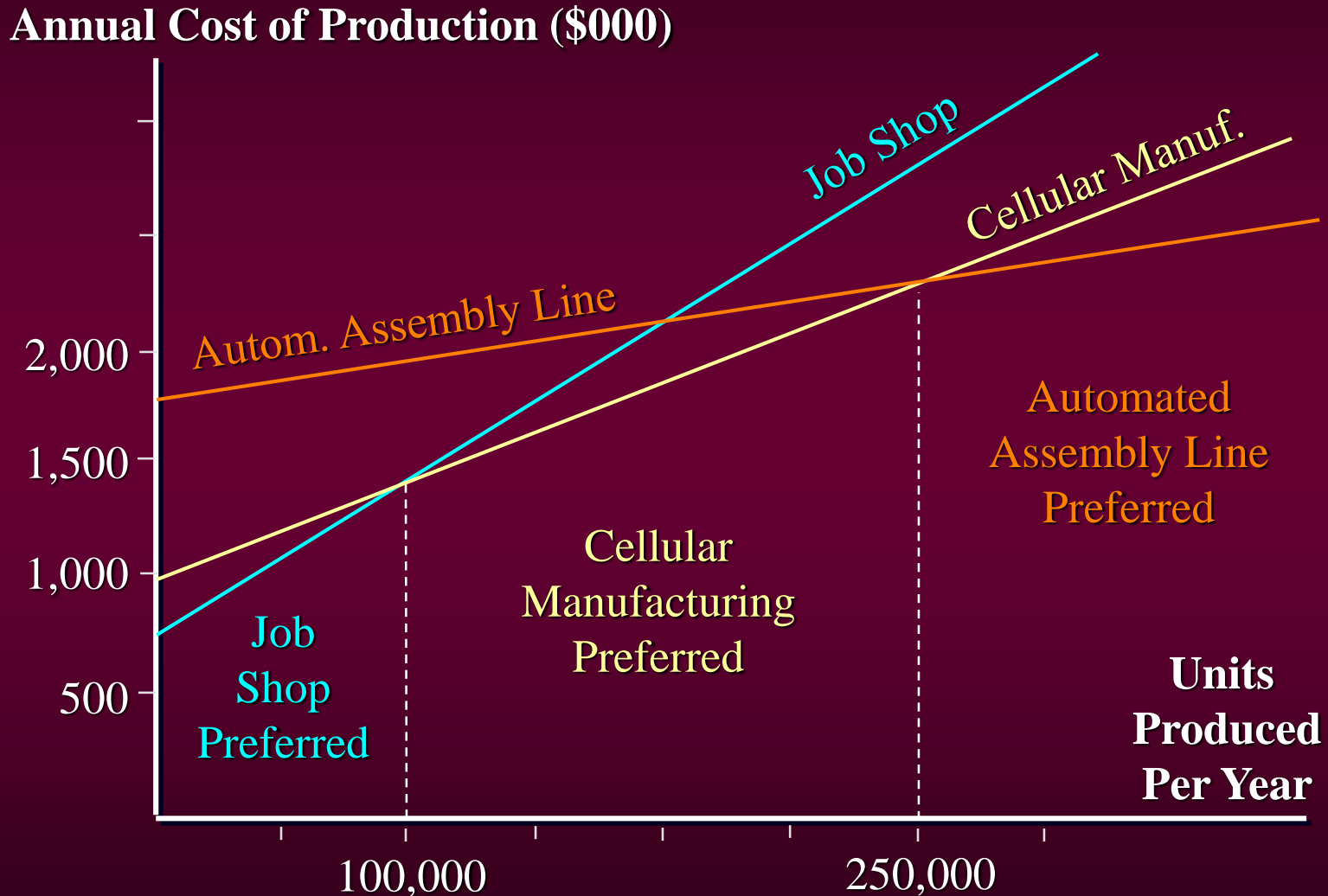
Capital Requirements

- The amount of capital required tends to differ for each type of production process
- Generally, the capital required is greatest for product-focused, dedicated systems
- Generally, the capital required is lowest for process-focused, job shops
- The amount of capital available and the cost of capital are important considerations

Economic Analysis

- Cost Functions of Processing Alternatives
 - Fixed Costs
 - Annual cost when production volume is zero
 - Initial cost of buildings, equipment, and other fixed assets
 - Variable Costs
 - Costs that vary with production volumes
 - Labor, material, and variable overhead

Cost Functions of Processing Alternatives



Cost Functions of Processing Alternatives

- Example

Three production processes (A, B, and C) have the following cost structure:

	Fixed Cost	Variable Cost
<u>Process</u>	<u>Per Year</u>	<u>Per Year</u>
A	\$120,000	\$3.00
B	90,000	4.00
C	80,000	4.50

What is the most economical process for a volume of 8,000 units per year?

Cost Functions of Processing Alternatives

- Example

$$TC = FC + v(Q)$$

A: $TC = 120,000 + 3.00(8,000) = \$144,000$ per year

B: $TC = 90,000 + 4.00(8,000) = \$122,000$ per year

C: $TC = 80,000 + 4.50(8,000) = \$116,000$ per year

The most economical process at 8,000 units is Process C, with the lowest annual cost.

Economic Analysis

- Break-Even Analysis
 - Widely used to analyze and compare decision alternatives
 - Can be displayed either algebraically or graphically
 - Disadvantages:
 - Cannot incorporate uncertainty
 - Costs assumed over entire range of values
 - Does not take into account time value of money

Break-Even Analysis

- Example

Break-Even Points of Processes A, B, and C,
assuming a \$6.95 selling price per unit

$$Q = FC / (p - v)$$

$$A: Q = 120,000 / (6.95 - 3.00) = 30,380 \text{ units}$$

$$B: Q = 90,000 / (6.95 - 4.00) = 30,509 \text{ units}$$

$$C: Q = 80,000 / (6.95 - 4.50) = 32,654 \text{ units}$$

Process A has the lowest break-even point.

Economic Analysis

- Financial Analysis
 - A great amount of money is invested in production processes and these assets are expected to last a long time
 - The time value of money is an important consideration
 - Payback period
 - net present value
 - internal rate of return
 - Profitability index

Deciding Among Processing Alternatives

- Assembly Charts (Gozinto Charts)
 - Macro-view of how materials are united
 - Starting point to understand factory layout needs, equipment needs, training needs
- Process Charts
 - Details of how to build product at each process
 - Includes materials needed, types of processes product flows through, time it takes to process product through each step of flow

Wrap-Up: World Class Practice

- Fast new product introduction
- Design products for ease of production
- Refine forecasting
- Focus on core competencies ... less vertical integration
- Lean production
- Flexible automation
- Job shops move toward cellular manufacturing
- Manage information flow automate and simplify!

End of Chapter 4

