

Operations Management

CHAPTER

Design for Goods and Services



โดย

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Outline

- ☑ ***Global Company Profile: Regal Marine***
- ☑ ***Goods and Services Selection***
 - ☑ ***Product Strategy Options Support Competitive Advantage***
 - ☑ ***Product Life Cycles***
 - ☑ ***Life Cycle and Strategy***
 - ☑ ***Product-by-Value Analysis***

Outline - Continued

- ☑ ***Generating New Products***
 - ☑ ***New Product Opportunities***
 - ☑ ***Importance of New Products***
- ☑ ***Product Development***
 - ☑ ***Product Development System***
 - ☑ ***Quality Function Deployment (QFD)***
 - ☑ ***Organizing for Product Development***
 - ☑ ***Manufacturability and Value Engineering***

Outline - Continued

- ☑ ***Issues for Product Design***
 - ☑ ***Robust Design***
 - ☑ ***Modular Design***
 - ☑ ***Computer-Aided Design (CAD)***
 - ☑ ***Computer-Aided Manufacturing (CAM)***
 - ☑ ***Virtual Reality Technology***
 - ☑ ***Value Analysis***
 - ☑ ***Ethics and Environmentally Friendly Design***

Outline - Continued

Time-Based Competition

- Purchasing Technology by Acquiring a Firm***

- Joint Ventures***

- Alliances***

Defining a Product

- Make-or-Buy Decisions***

- Group Technology***

Outline - Continued

- ☑ ***Documents For Production***
 - ☑ ***Product Life-Cycle Management (PLM)***
- ☑ ***Service Design***
 - ☑ ***Documents for Services***
- ☑ ***Application of Decision Trees to Product Design***
- ☑ ***Transition to Production***

Learning Objectives

When you complete this chapter you should be able to :

- 1. Define product life cycle***
- 2. Describe a product development system***
- 3. Build a house of quality***
- 4. Describe how time-based competition is implemented***

Learning Objectives

When you complete this chapter you should be able to :

- 5. Describe how products and services are defined***
- 6. Prepare the documents needed for production***
- 7. Describe customer participation in the design and production of services***
- 8. Apply decision trees to product issues***

Product Decision

- The good or service the organization provides society***
- Top organizations typically focus on core products***
- Customers buy satisfaction, not just a physical good or particular service***
- Fundamental to an organization's strategy with implications throughout the operations function***

Product Strategy Options

Differentiation

Shouldice Hospital

Low cost

Taco Bell

Rapid response

Toyota

Product Life Cycles

- May be any length from a few hours to decades***
- The operations function must be able to introduce new products successfully***

Product Life Cycles

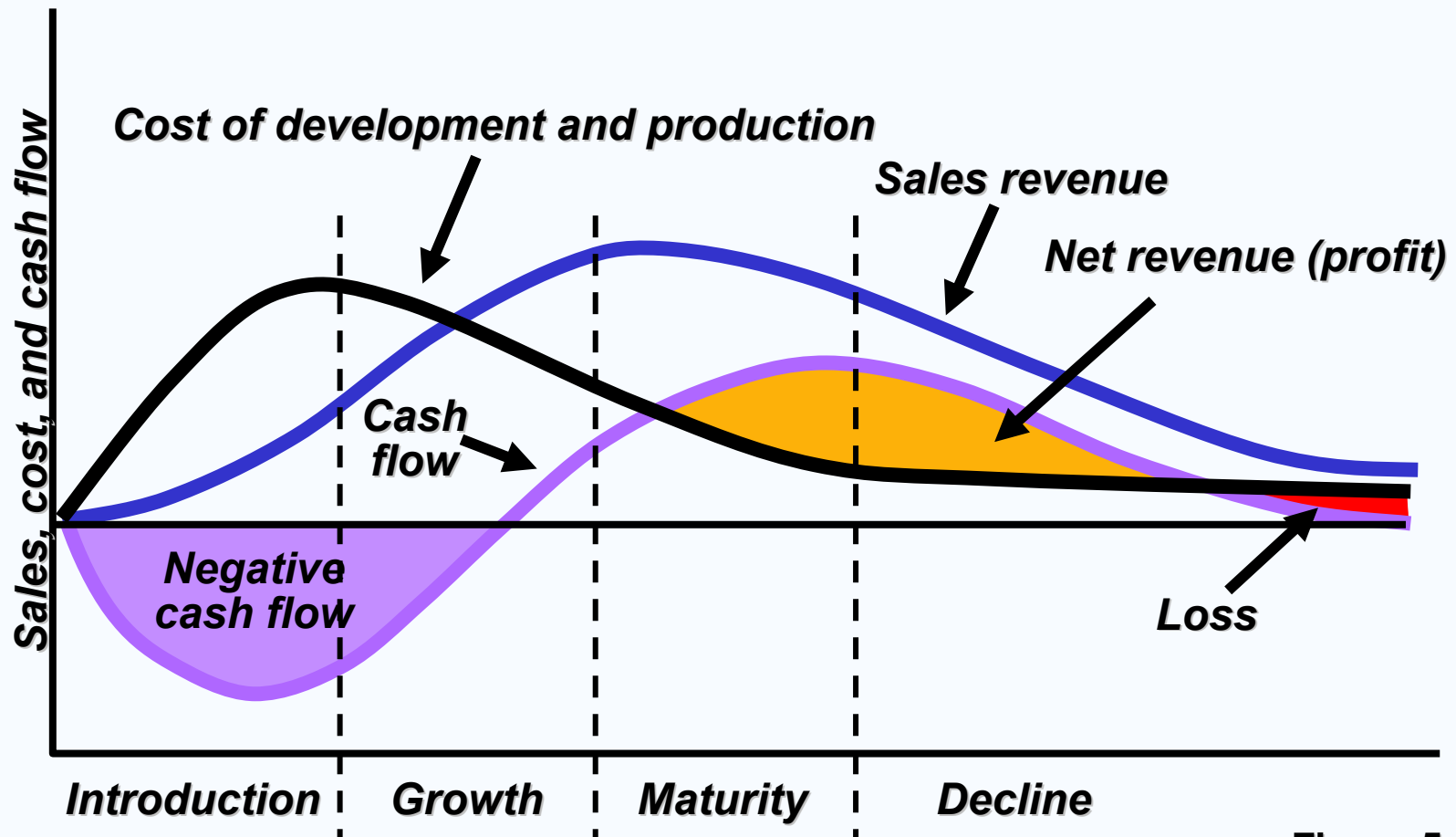


Figure 5.1

Product Life Cycle

Introduction

- Fine tuning may warrant unusual expenses for***
 - Research***
 - Product development***
 - Process modification and enhancement***
 - Supplier development***

Product Life Cycle

Growth

- Product design begins to stabilize***
- Effective forecasting of capacity becomes necessary***
- Adding or enhancing capacity may be necessary***

Product Life Cycle

Maturity

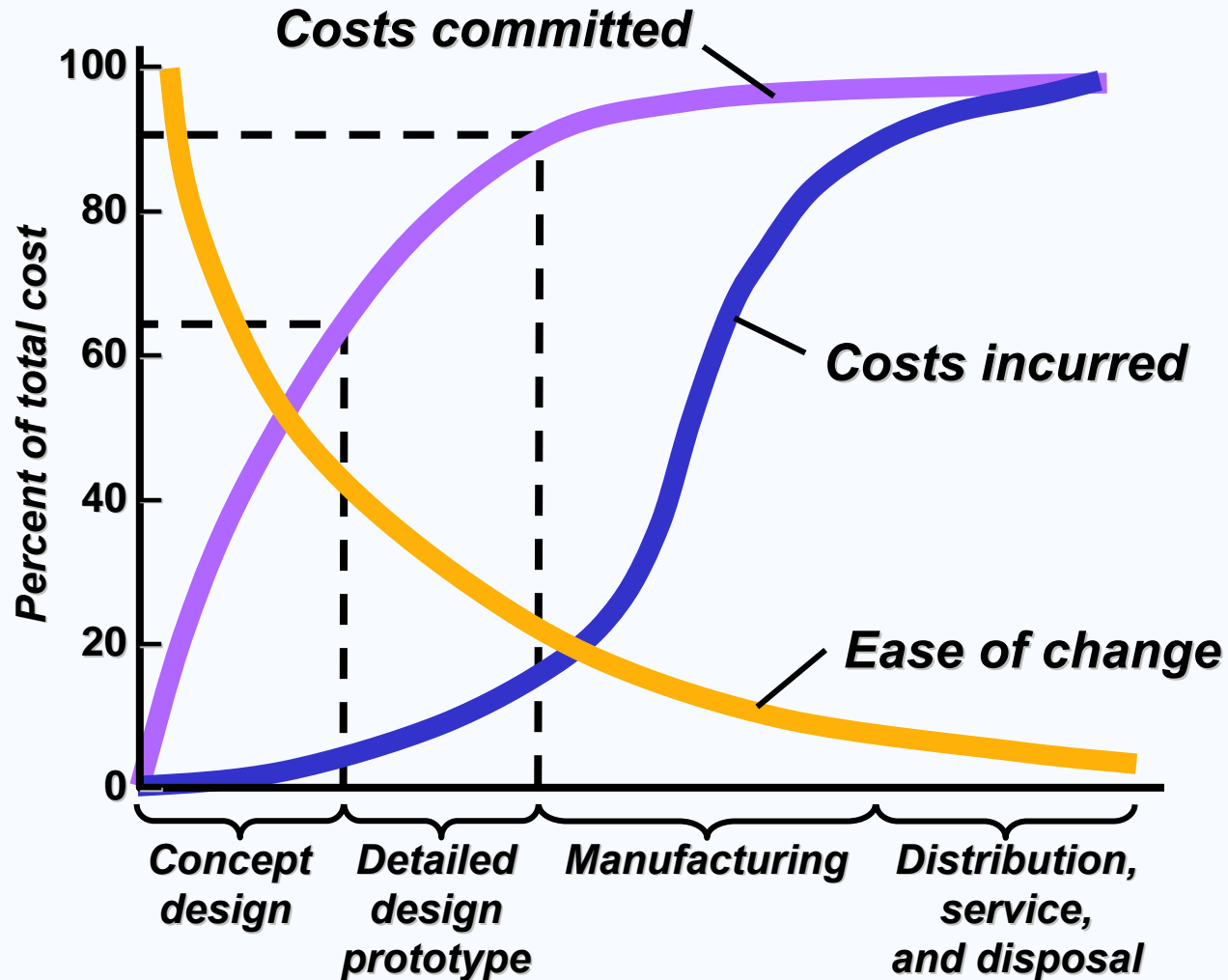
- Competitors now established***
- High volume, innovative production may be needed***
- Improved cost control, reduction in options, paring down of product line***

Product Life Cycle

Decline

- ☑ Unless product makes a special contribution to the organization, must plan to terminate offering***

Product Life Cycle Costs



Product-by-Value Analysis

- Lists products in descending order of their individual dollar contribution to the firm***
- Lists the total annual dollar contribution of the product***
- Helps management evaluate alternative strategies***

Product-by-Value Analysis

Sam's Furniture Factory

	<i>Individual Contribution (\$)</i>	<i>Total Annual Contribution (\$)</i>
<i>Love Seat</i>	\$102	\$36,720
<i>Arm Chair</i>	\$87	\$51,765
<i>Foot Stool</i>	\$12	\$6,240
<i>Recliner</i>	\$136	\$51,000

New Product Opportunities

- 1. Understanding the customer***
- 2. Economic change***
- 3. Sociological and demographic change***
- 4. Technological change***
- 5. Political/legal change***
- 6. Market practice, professional standards, suppliers, distributors***



**Brainstorming
is a useful tool**

Importance of New Products

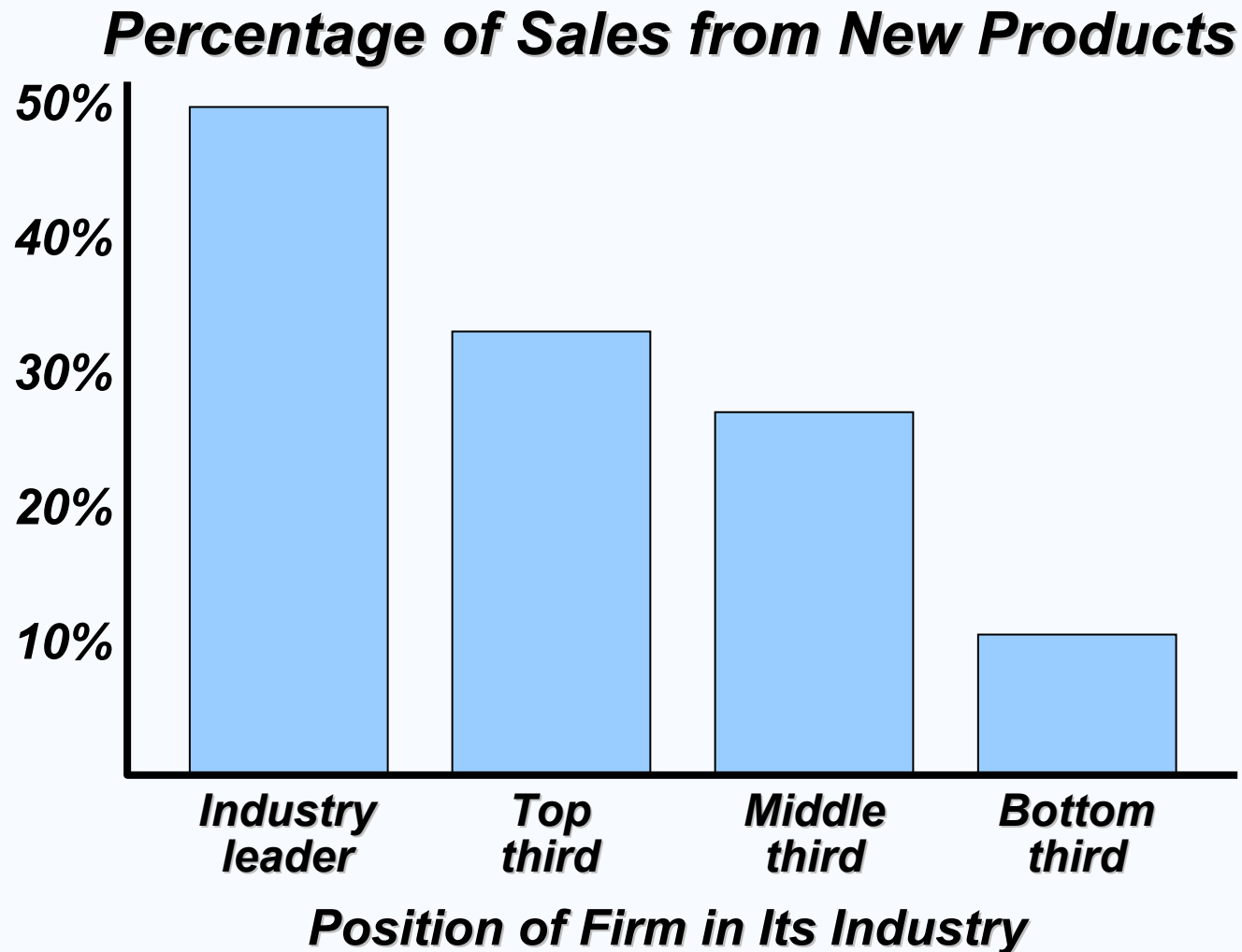
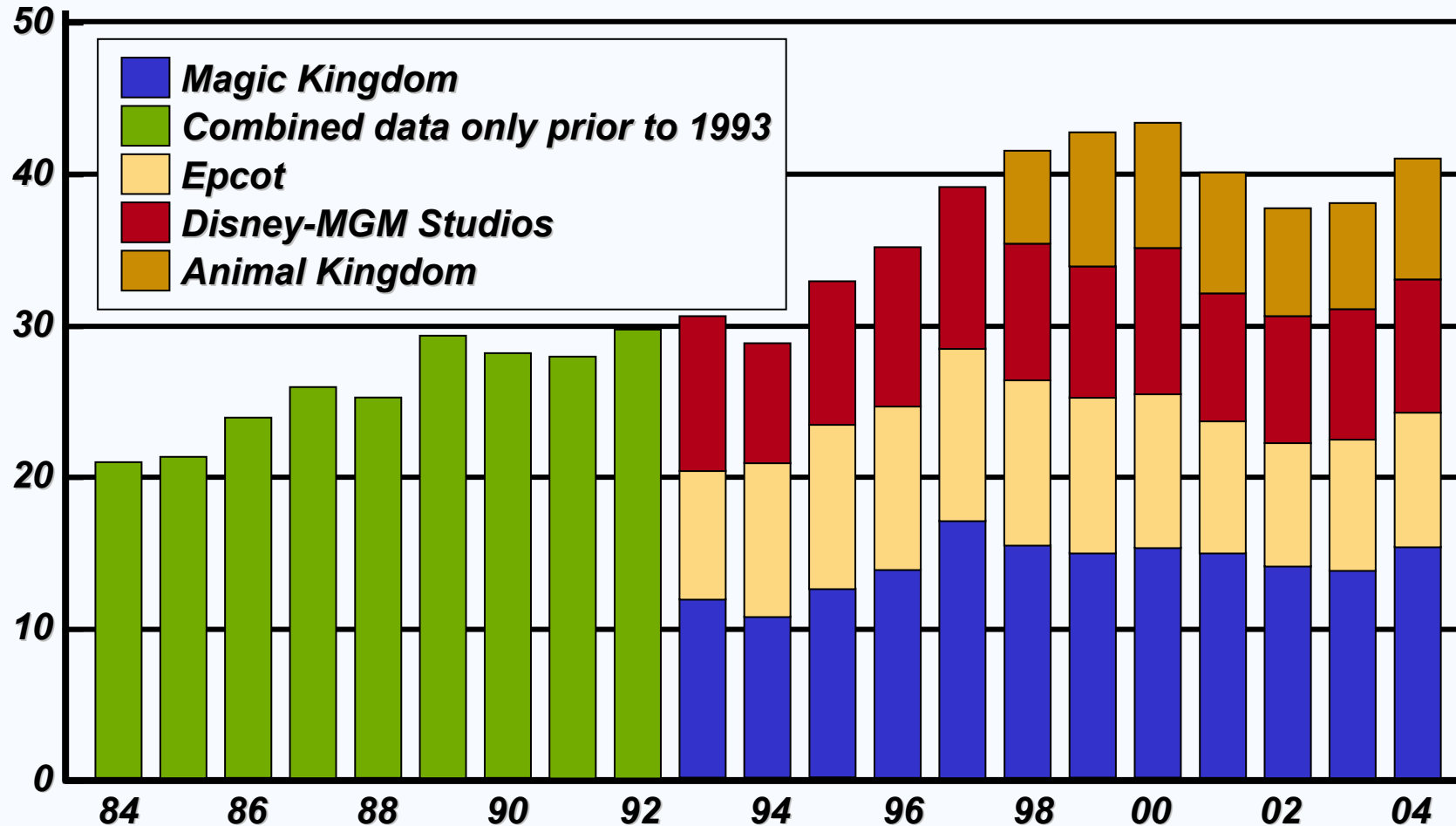


Figure 5.2

New Products at Disney

Millions of visitors

Figure 5.2



Product Development System

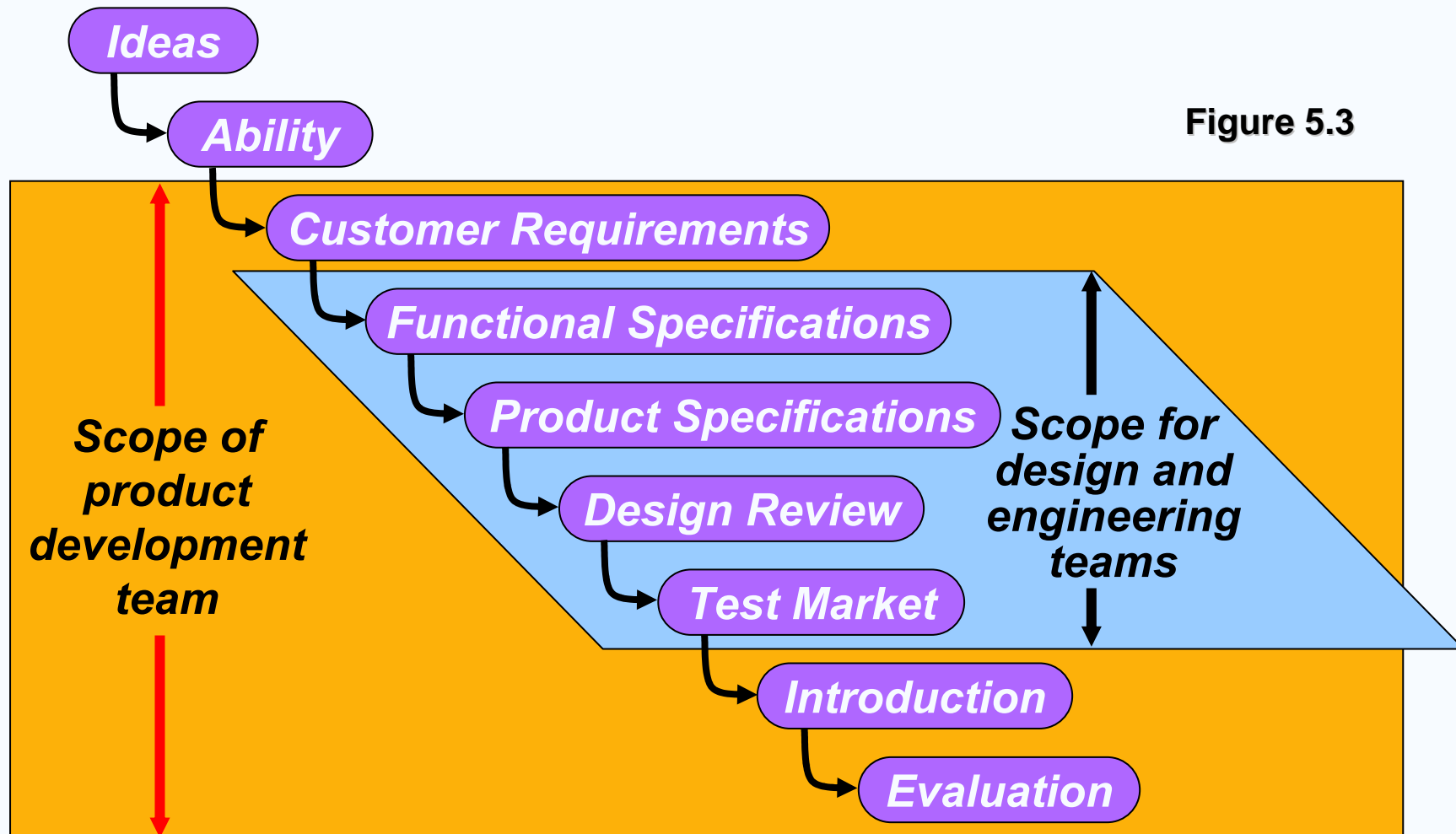
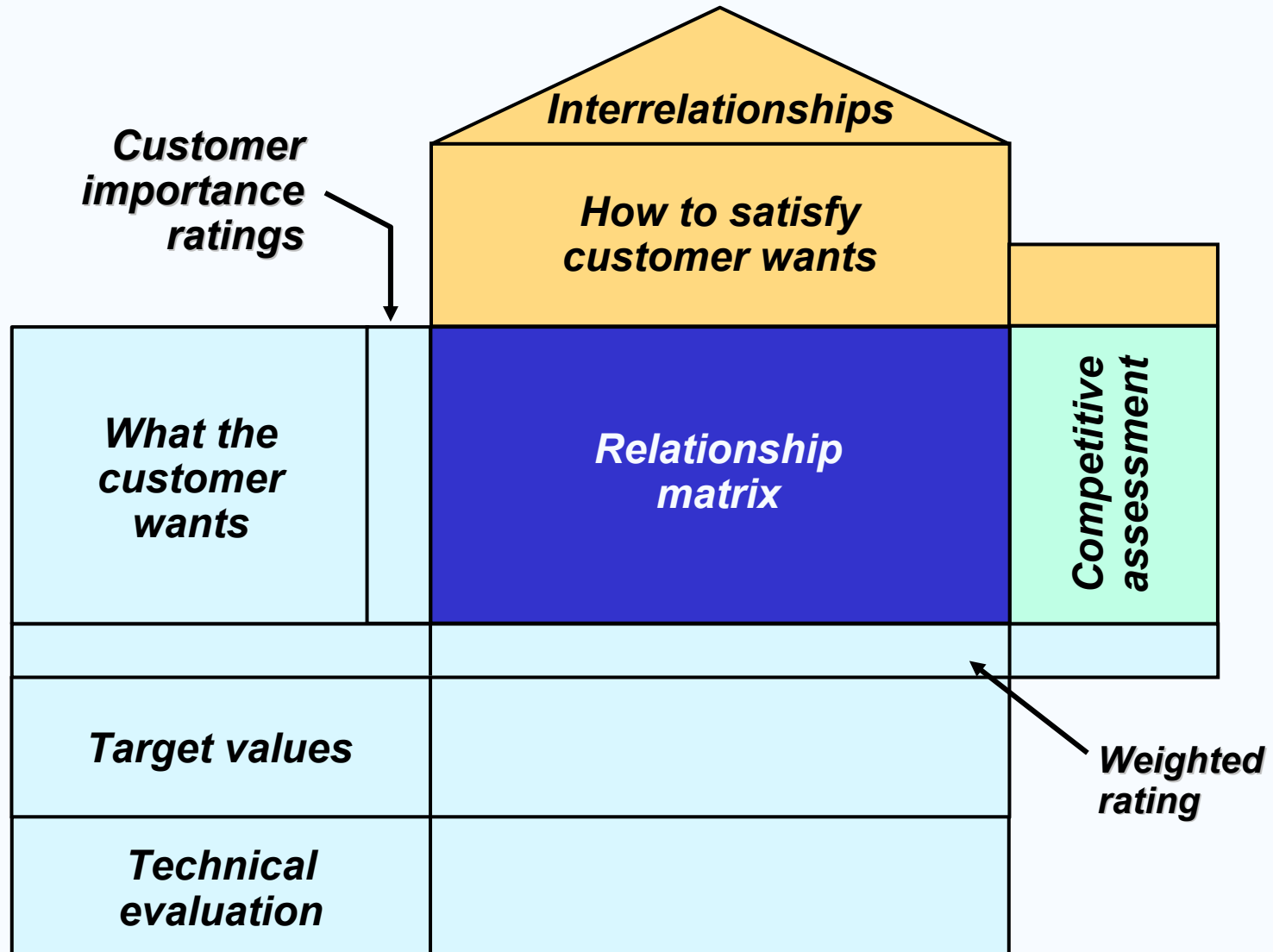


Figure 5.3

Quality Function Deployment

- ☑ ***Identify customer wants***
- ☑ ***Identify how the good/service will satisfy customer wants***
- ☑ ***Relate customer wants to product hows***
- ☑ ***Identify relationships between the firm's hows***
- ☑ ***Develop importance ratings***
- ☑ ***Evaluate competing products***
- ☑ ***Compare performance to desirable technical attributes***

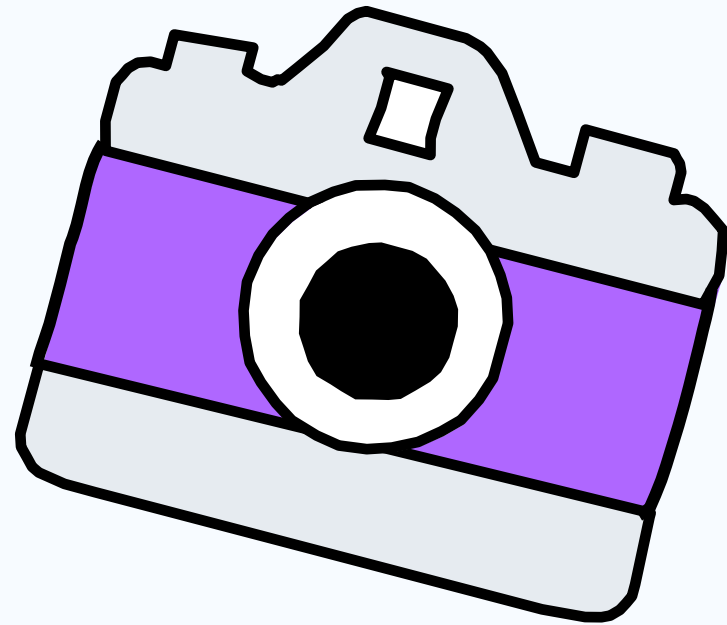
QFD House of Quality



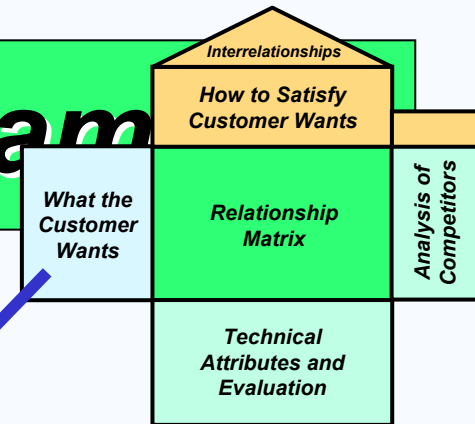
House of Quality Example

Your team has been charged with designing a new camera for Great Cameras, Inc.

The first action is to construct a House of Quality



House of Quality Exam

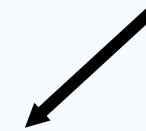


What the customer wants

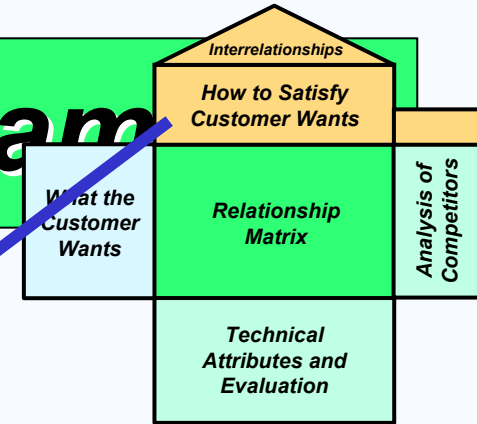


Lightweight	3
Easy to use	4
Reliable	5
Easy to hold steady	2
Color correction	1

**Customer importance rating
(5 = highest)**



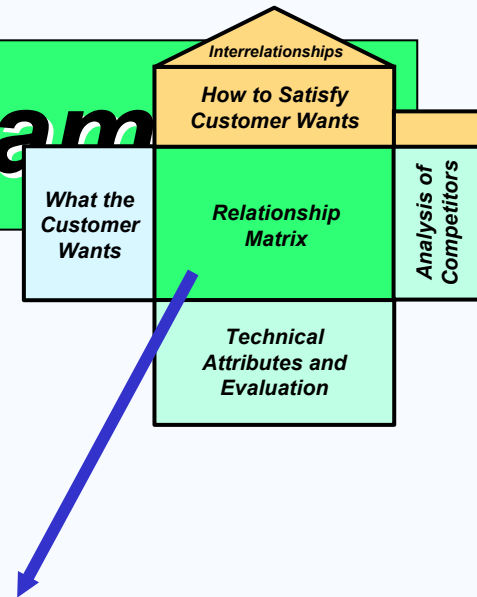
House of Quality Exam



<i>Low electricity requirements</i>
<i>Aluminum components</i>
<i>Auto focus</i>
<i>Auto exposure</i>
<i>Paint pallet</i>
<i>Ergonomic design</i>

How to Satisfy Customer Wants

House of Quality Exam



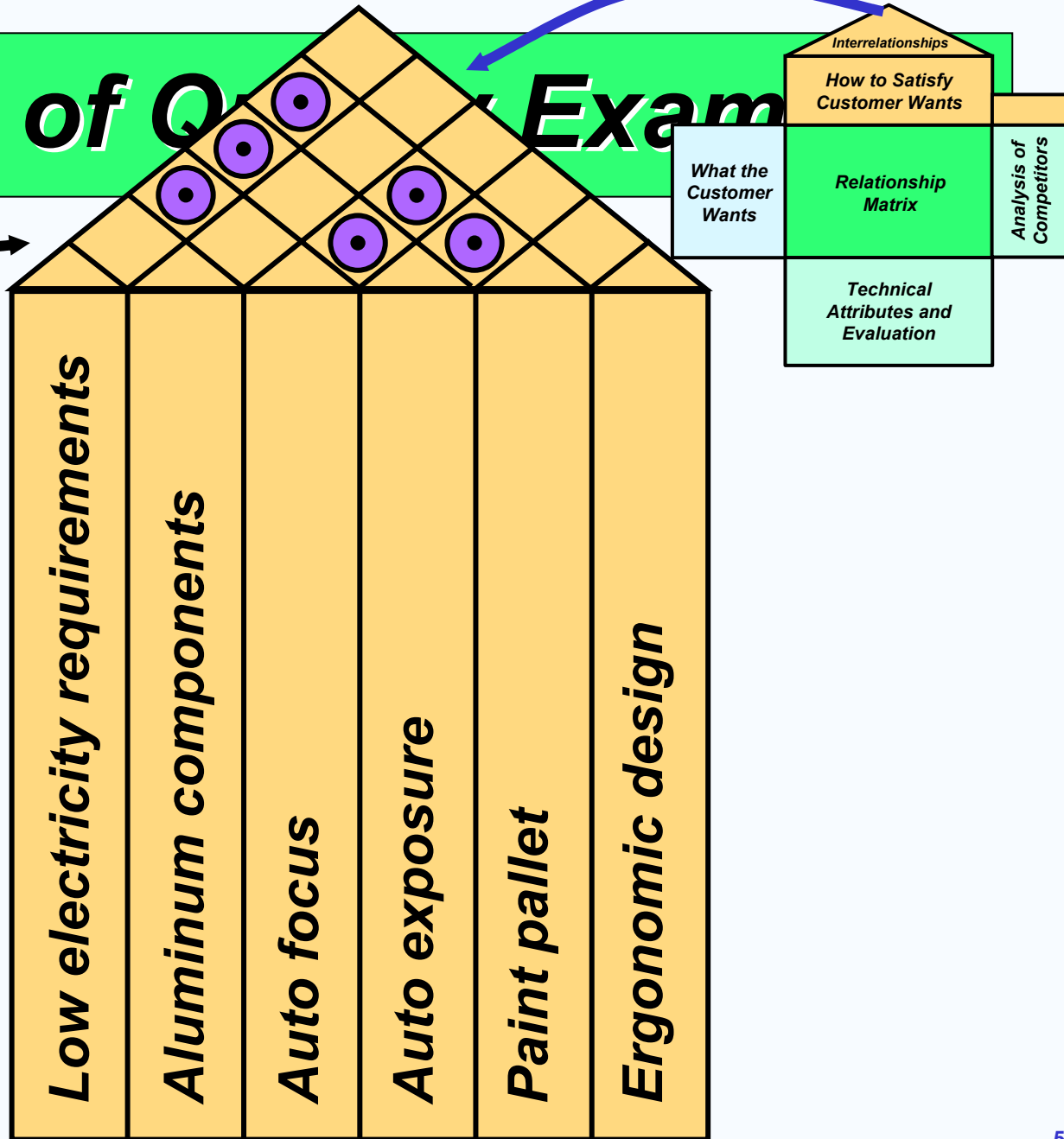
- High relationship
- Medium relationship
- Low relationship

Lightweight	3	●	●				●
Easy to use	4	●		●	●	●	●
Reliable	5	●		●	●	●	
Easy to hold steady	2						●
Color corrections	1					●	

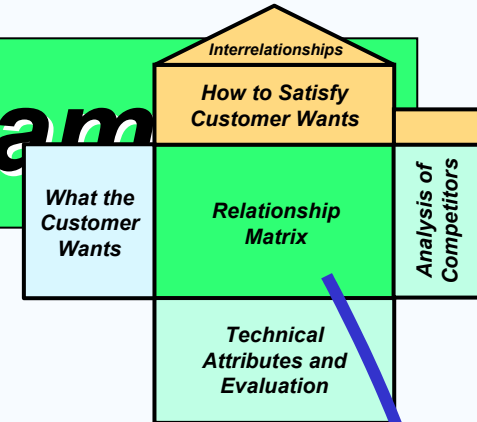
Relationship matrix

House of Quality Exam

Relationships between the things we can do



House of Quality Exam



<i>Lightweight</i>	3	●	●				●
<i>Easy to use</i>	4	●		●	●	●	●
<i>Reliable</i>	5	●		●	●	●	
<i>Easy to hold steady</i>	2						●
<i>Color corrections</i>	1					●	
<i>Our importance ratings</i>		22	9	27	27	32	25

**Weighted
rating**



How well do competing products meet customer wants

				Company A	Company B
<i>Lightweight</i>	3	•	•	G	P
<i>Easy to use</i>	4	•	●	G	P
<i>Reliable</i>	5	●		F	G
<i>Easy to hold steady</i>	2			G	P
<i>Color corrections</i>	1			P	P
<i>Our importance ratings</i>	22		5		



<i>Target values (Technical attributes)</i>		<i>0.5 A</i>	<i>75%</i>	<i>2' to ∞</i>	<i>2 circuits</i>	<i>Failure 1 per 10,000</i>	<i>Panel ranking</i>
<i>Technical evaluation</i>	<i>Company A</i>	<i>0.7</i>	<i>60%</i>	<i>yes</i>	<i>1</i>	<i>ok</i>	<i>G</i>
	<i>Company B</i>	<i>0.6</i>	<i>50%</i>	<i>yes</i>	<i>2</i>	<i>ok</i>	<i>F</i>
	<i>Us</i>	<i>0.5</i>	<i>75%</i>	<i>yes</i>	<i>2</i>	<i>ok</i>	<i>G</i>

House of Quality Example

Completed House of Quality

		Low electricity requirements	Aluminum components	Auto focus	Auto exposure	Paint pallet	Ergonomic design	Company A	Company B
<i>Lightweight</i>	3	•	●				•	G	P
<i>Easy to use</i>	4	•		●	●	●	●	G	P
<i>Reliable</i>	5	●		●	●	●		F	G
<i>Easy to hold steady</i>	2						●	G	P
<i>Color correction</i>	1					●		P	P
Our importance ratings		22	9	27	27	32	25		
Target values (Technical attributes)		0.5 A	75%	2' to ∞	2 circuits	Failure 1 per 10,000	Panel ranking		
Technical evaluation	Company A	0.7	60%	yes	1	ok	G		
	Company B	0.6	50%	yes	2	ok	F		
	Us	0.5	75%	yes	2	ok	G		

House of Quality Sequence

Deploying resources through the organization in response to customer requirements

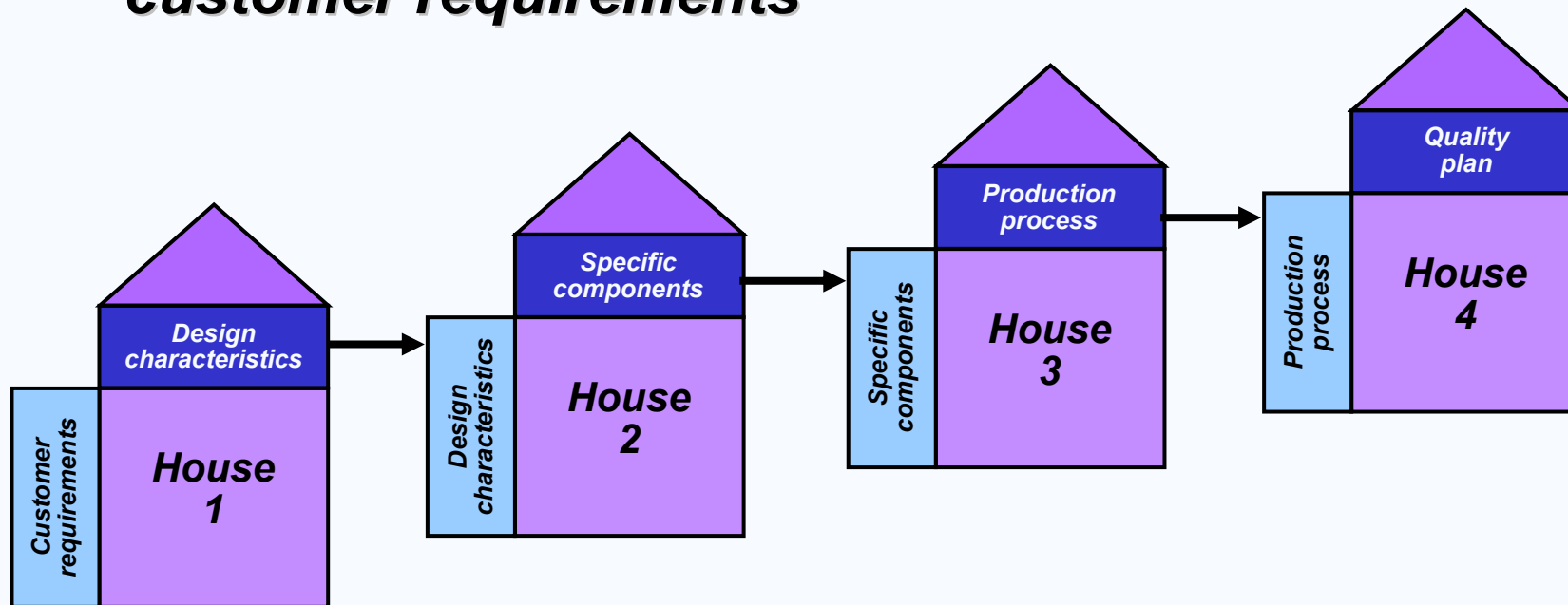


Figure 5.4

Organizing for Product Development

- ☑ ***Historically – distinct departments***
 - ☑ ***Duties and responsibilities are defined***
 - ☑ ***Difficult to foster forward thinking***
- ☑ ***A Champion***
 - ☑ ***Product manager drives the product through the product development system and related organizations***

Organizing for Product Development

- Team approach***
 - Cross functional – representatives from all disciplines or functions***
 - Product development teams, design for manufacturability teams, value engineering teams***
- Japanese “whole organization” approach***
 - No organizational divisions***

Manufacturability and Value Engineering

Benefits:

- 1. Reduced complexity of products***
- 2. Additional standardization of products***
- 3. Improved functional aspects of product***
- 4. Improved job design and job safety***
- 5. Improved maintainability (serviceability) of the product***
- 6. Robust design***

Cost Reduction of a Bracket via Value Engineering

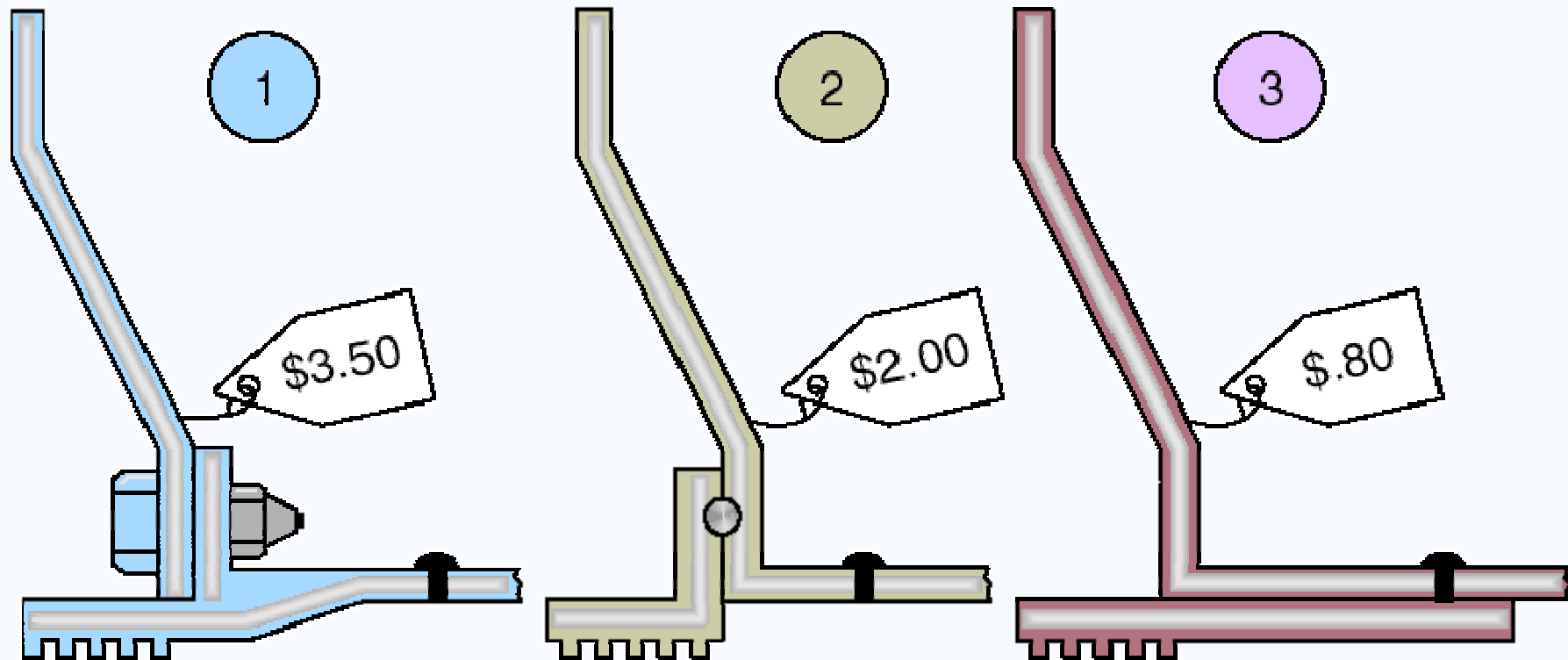


Figure 5.5

Issues for Product Development

- Robust design***
- Modular design***
- Computer-aided design (CAD)***
- Computer-aided manufacturing (CAM)***
- Virtual reality technology***
- Value analysis***
- Environmentally friendly design***

Robust Design

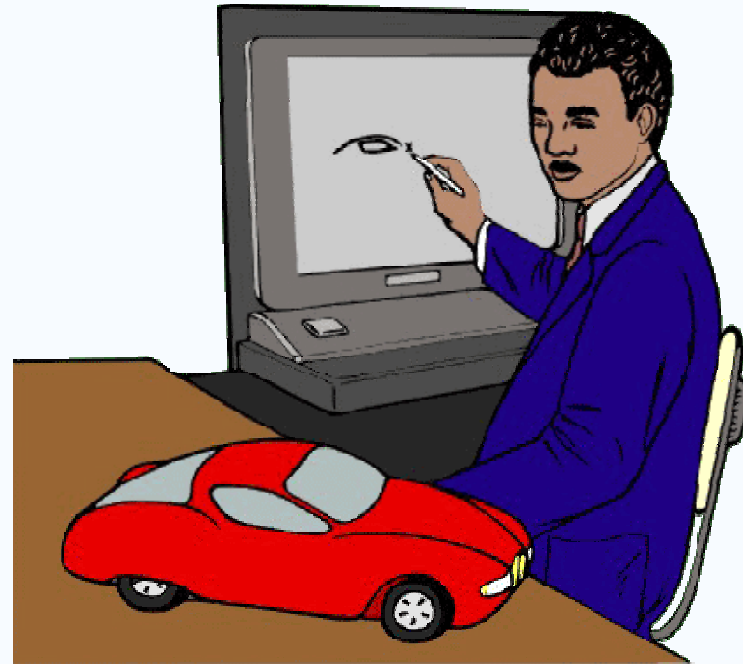
- Product is designed so that small variations in production or assembly do not adversely affect the product***
- Typically results in lower cost and higher quality***

Modular Design

- Products designed in easily segmented components***
- Adds flexibility to both production and marketing***
- Improved ability to satisfy customer requirements***

Computer Aided Design (CAD)

- ☑ ***Using computers to design products and prepare engineering documentation***
- ☑ ***Shorter development cycles, improved accuracy, lower cost***
- ☑ ***Information and designs can be deployed worldwide***



Extensions of CAD

- ☑ ***Design for Manufacturing and Assembly (DFMA)***
 - ☑ ***Solve manufacturing problems during the design stage***
- ☑ ***3-D Object Modeling***
 - ☑ ***Small prototype development***
- ☑ ***CAD through the internet***
- ☑ ***International data exchange through STEP***



Computer-Aided Manufacturing (CAM)

- Utilizing specialized computers and program to control manufacturing equipment***
- Often driven by the CAD system (CAD/CAM)***

Benefits of CAD/CAM

- 1. Product quality***
- 2. Shorter design time***
- 3. Production cost reductions***
- 4. Database availability***
- 5. New range of capabilities***

Virtual Reality Technology

- Computer technology used to develop an interactive, 3-D model of a product from the basic CAD data***
- Allows people to 'see' the finished design before a physical model is built***
- Very effective in large-scale designs such as plant layout***

Value Analysis

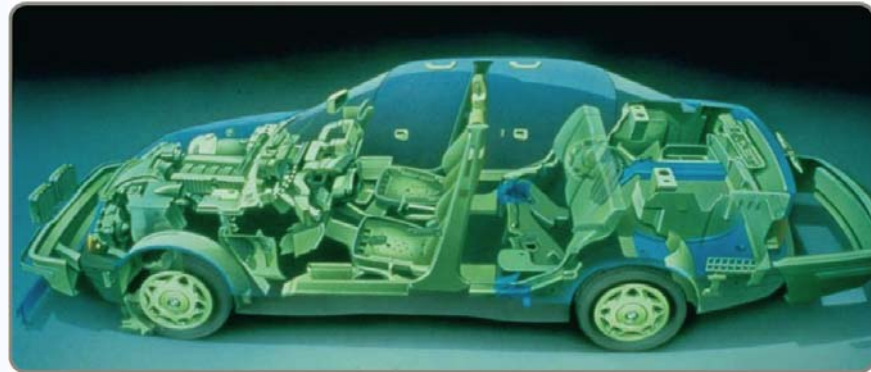
- Focuses on design improvement during production***
- Seeks improvements leading either to a better product or a product which can be produced more economically***

Ethics and Environmentally Friendly Designs

It is possible to enhance productivity, drive down costs, and preserve resources

Effective at any stage of the product life cycle

- Design***
- Production***
- Destruction***



The Ethical Approach

- View product design from a systems perspective***
 - Inputs, processes, outputs***
 - Costs to the firm/costs to society***
- Consider the entire life cycle of the product***

Goals for Ethical and Environmentally Friendly Designs

- 1. Develop safe and more environmentally sound products***
- 2. Minimize waste of raw materials and energy***
- 3. Reduce environmental liabilities***
- 4. Increase cost-effectiveness of complying with environmental regulations***
- 5. Be recognized as a good corporate citizen***

Guidelines for Environmentally Friendly Designs

- 1. Make products recyclable***
- 2. Use recycled materials***
- 3. Use less harmful ingredients***
- 4. Use lighter components***
- 5. Use less energy***
- 6. Use less material***



Legal and Industry Standards

For Design ...

- Federal Drug Administration***
- Consumer Products Safety Commission***
- National Highway Safety Administration***
- Children's Product Safety Act***

Legal and Industry Standards

For Manufacture/Assembly ...

- Occupational Safety and Health Administration***
- Environmental Protection Agency***
- Professional ergonomic standards***
- State and local laws dealing with employment standards, discrimination, etc.***

Legal and Industry Standards

For Disassembly/Disposal ...

- Vehicle Recycling Partnership***
- Increasingly rigid laws worldwide***

Time-Based Competition

- Product life cycles are becoming shorter and the rate of technological change is increasing***
- Developing new products faster can result in a competitive advantage***

Product Development Continuum

Figure 5.6

External Development Strategies

Alliances

Joint ventures

***Purchase technology or expertise
by acquiring the developer***

Internal Development Strategies

Migrations of existing products

Enhancements to existing products

New internally developed products

Internal ← ***Cost of product development*** → ***Shared***
Lengthy ← ***Speed of product development*** → ***Rapid and/
or Existing***
High ← ***Risk of product development*** → ***Shared***

Acquiring Technology

- ☑ ***By Purchasing a Firm***
 - ☑ ***Speeds development***
 - ☑ ***Issues concern the fit between the acquired organization and product and the host***
- ☑ ***Through Joint Ventures***
 - ☑ ***Both organizations learn***
 - ☑ ***Risks are shared***
- ☑ ***Through Alliances***
 - ☑ ***Cooperative agreements between independent organizations***

Defining The Product

- ☑ ***First definition is in terms of functions***
- ☑ ***Rigorous specifications are developed during the design phase***
- ☑ ***Manufactured products will have an engineering drawing***
- ☑ ***Bill of material (BOM) lists the components of a product***

Product Documents

- ☑ ***Engineering drawing***
 - ☑ ***Shows dimensions, tolerances, and materials***
 - ☑ ***Shows codes for Group Technology***
- ☑ ***Bill of Material***
 - ☑ ***Lists components, quantities and where used***
 - ☑ ***Shows product structure***

Monterey Jack Cheese

(a) U.S. grade AA. Monterey cheese shall conform to the following requirements:

(1) *Flavor.* Is fine and highly pleasing, free from undesirable flavors and odors. May possess a very slight acid or feed flavor.

(2) *Body and texture.* A plug drawn from the cheese shall be reasonably firm. It shall have numerous small mechanical openings evenly distributed throughout the plug. It shall not possess sweet holes, yeast holes, or other gas holes.

(3) *Color.* Shall have a natural, uniform, bright and attractive appearance.

(4) *Finish and appearance - bandaged and paraffin-dipped.* The rind shall be sound, firm, and smooth providing a good protection to the cheese.

Code of Federal Regulation, Parts 53 to 109,
General Service Administration

Engineering Drawings

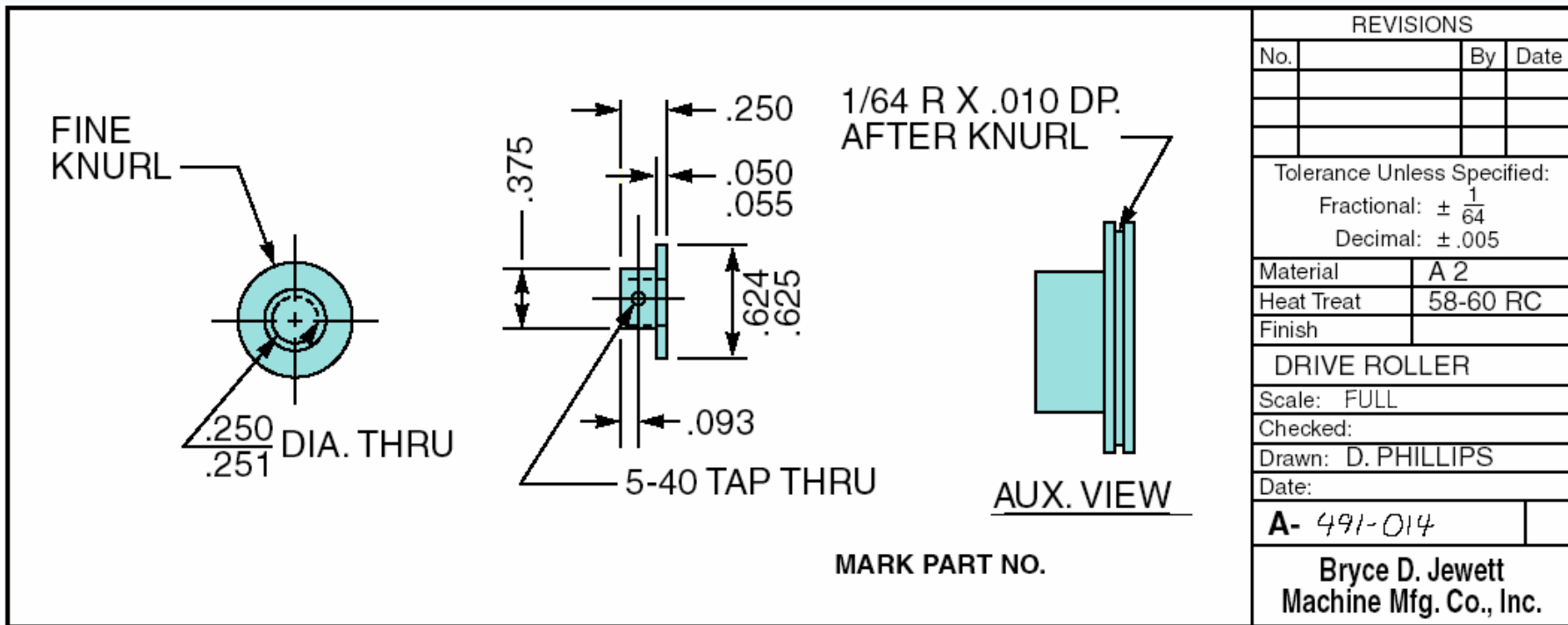


Figure 5.8

Bills of Material

BOM for Panel Weldment

<i>NUMBER</i>	<i>DESCRIPTION</i>	<i>QTY</i>
<i>A 60-71</i>	<i>PANEL WELDM'T</i>	<i>1</i>
<i>A 60-7</i>	<i>LOWER ROLLER ASSM.</i>	<i>1</i>
<i>R 60-17</i>	<i>ROLLER</i>	<i>1</i>
<i>R 60-428</i>	<i>PIN</i>	<i>1</i>
<i>P 60-2</i>	<i>LOCKNUT</i>	<i>1</i>
<i>A 60-72</i>	<i>GUIDE ASSM. REAR</i>	<i>1</i>
<i>R 60-57-1</i>	<i>SUPPORT ANGLE</i>	<i>1</i>
<i>A 60-4</i>	<i>ROLLER ASSM.</i>	<i>1</i>
<i>02-50-1150</i>	<i>BOLT</i>	<i>1</i>
<i>A 60-73</i>	<i>GUIDE ASSM. FRONT</i>	<i>1</i>
<i>A 60-74</i>	<i>SUPPORT WELDM'T</i>	<i>1</i>
<i>R 60-99</i>	<i>WEAR PLATE</i>	<i>1</i>
<i>02-50-1150</i>	<i>BOLT</i>	<i>1</i>

Figure 5.9 (a)

Bills of Material

**Hard Rock
Cafe's Hickory
BBQ Bacon
Cheeseburger**

<i>DESCRIPTION</i>	<i>QTY</i>
<i>Bun</i>	<i>1</i>
<i>Hamburger patty</i>	<i>8 oz.</i>
<i>Cheddar cheese</i>	<i>2 slices</i>
<i>Bacon</i>	<i>2 strips</i>
<i>BBQ onions</i>	<i>1/2 cup</i>
<i>Hickory BBQ sauce</i>	<i>1 oz.</i>
<i>Burger set</i>	
<i>Lettuce</i>	<i>1 leaf</i>
<i>Tomato</i>	<i>1 slice</i>
<i>Red onion</i>	<i>4 rings</i>
<i>Pickle</i>	<i>1 slice</i>
<i>French fries</i>	<i>5 oz.</i>
<i>Seasoned salt</i>	<i>1 tsp.</i>
<i>11-inch plate</i>	<i>1</i>
<i>HRC flag</i>	<i>1</i>

Figure 5.9 (b)

Group Technology

- ☑ ***Parts grouped into families with similar characteristics***
- ☑ ***Coding system describes processing and physical characteristics***
- ☑ ***Part families can be produced in dedicated manufacturing cells***

Group Technology Scheme

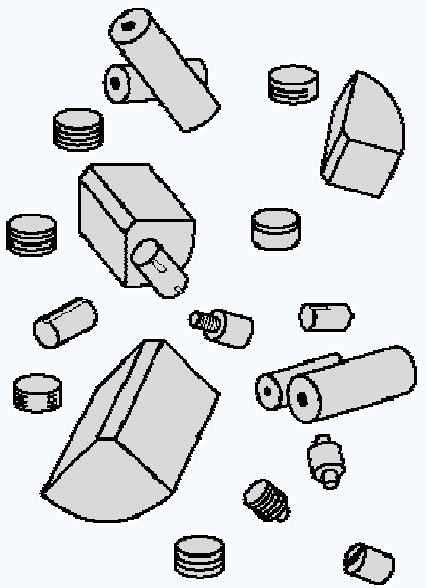



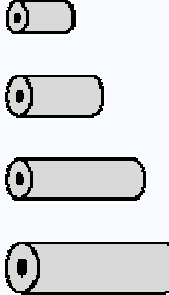
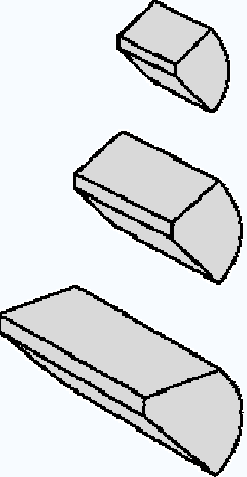
(a) Ungrouped Parts	(b) Grouped Cylindrical Parts (families of parts)				
	Grooved	Slotted	Threaded	Drilled	Machined
					

Figure 5.10

Group Technology Benefits

- 1. Improved design***
- 2. Reduced raw material and purchases***
- 3. Simplified production planning and control***
- 4. Improved layout, routing, and machine loading***
- 5. Reduced tooling setup time, work-in-process, and production time***

Documents for Production

- Assembly drawing***
- Assembly chart***
- Route sheet***
- Work order***
- Engineering change notices (ECNs)***

Assembly Drawing

- ☑ ***Shows exploded view of product***
- ☑ ***Details relative locations to show how to assemble the product***

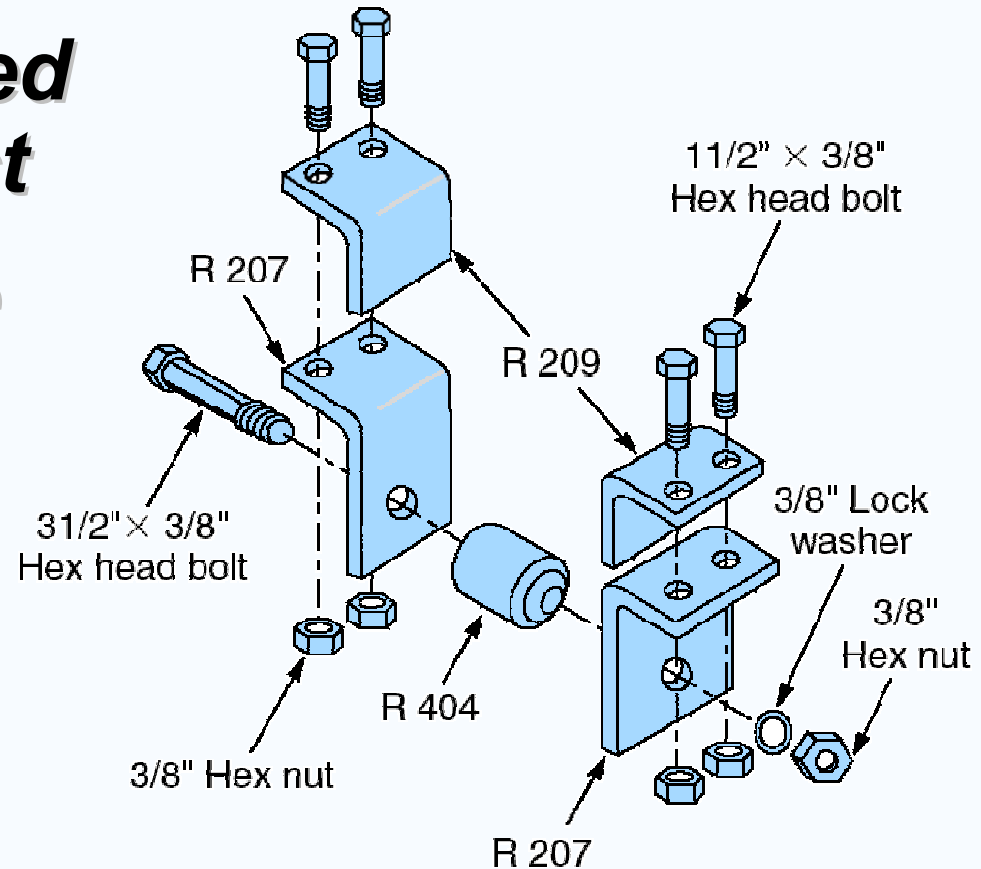
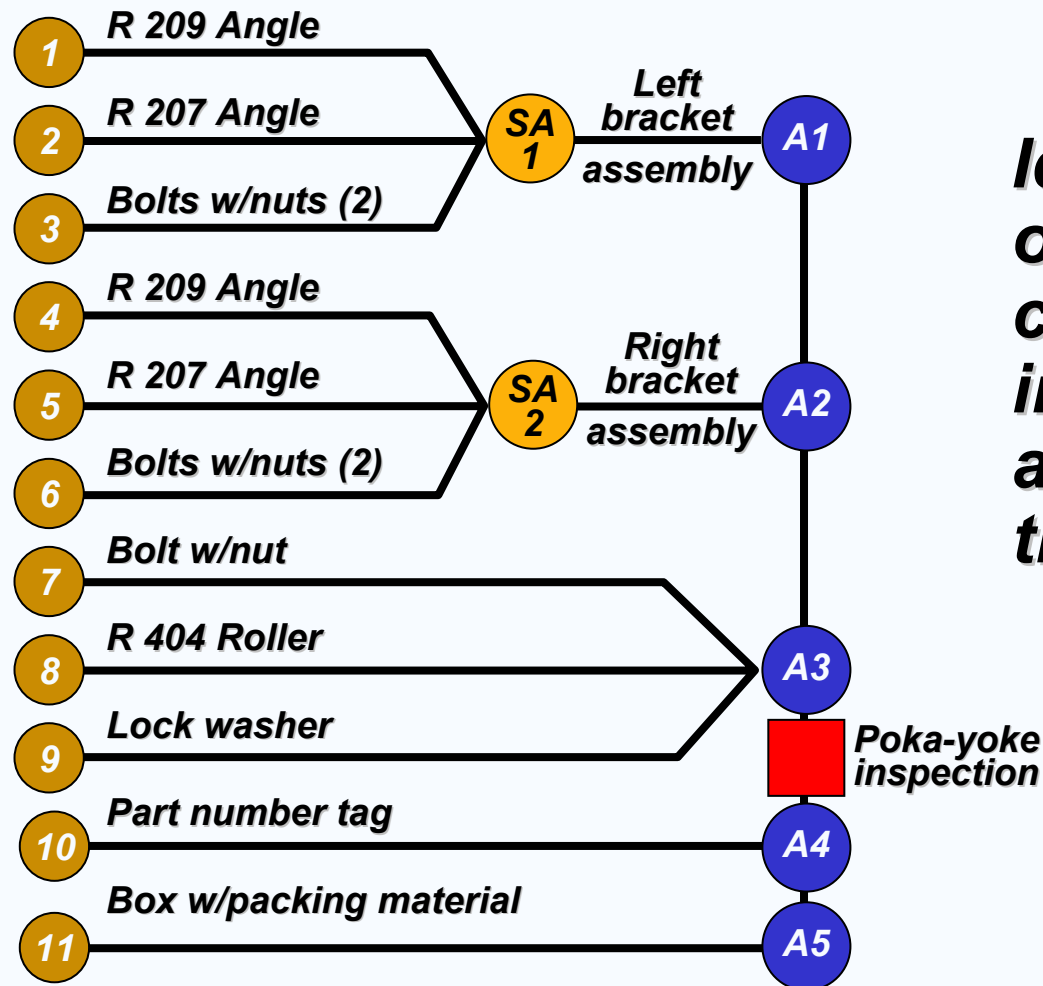


Figure 5.11 (a)

Assembly Chart



Identifies the point of production where components flow into subassemblies and ultimately into the final product

Figure 5.11 (b)

Route Sheet

Lists the operations and times required to produce a component

<i>Process</i>	<i>Machine</i>	<i>Operations</i>	<i>Setup Time</i>	<i>Operation Time/Unit</i>
<i>1</i>	<i>Auto Insert 2</i>	<i>Insert Component Set 56</i>	<i>1.5</i>	<i>.4</i>
<i>2</i>	<i>Manual Insert 1</i>	<i>Insert Component Set 12C</i>	<i>.5</i>	<i>2.3</i>
<i>3</i>	<i>Wave Solder</i>	<i>Solder all components to board</i>	<i>1.5</i>	<i>4.1</i>
<i>4</i>	<i>Test 4</i>	<i>Circuit integrity test 4GY</i>	<i>.25</i>	<i>.5</i>

Work Order

Instructions to produce a given quantity of a particular item, usually to a schedule

<i>Work Order</i>			
<i>Item</i>	<i>Quantity</i>	<i>Start Date</i>	<i>Due Date</i>
157C	125	5/2/08	5/4/08
<i>Production Dept</i>		<i>Delivery Location</i>	
F32		Dept K11	

Engineering Change Notice (ECN)

- A correction or modification to a product's definition or documentation***
 - Engineering drawings***
 - Bill of material***

Quite common with long product life cycles, long manufacturing lead times, or rapidly changing technologies

Configuration Management

- ☑ ***The need to manage ECNs has led to the development of configuration management systems***
- ☑ ***A product's planned and changing components are accurately identified and control and accountability for change are identified and maintained***

Product Life-Cycle Management (PLM)

- ☑ ***Integrated software that brings together most, if not all, elements of product design and manufacture***
 - ☑ ***Product design***
 - ☑ ***CAD/CAM, DFMA***
 - ☑ ***Product routing***
 - ☑ ***Materials***
 - ☑ ***Assembly***
 - ☑ ***Environmental***

Service Design

- ☑ ***Service typically includes direct interaction with the customer***
 - ☑ ***Increased opportunity for customization***
 - ☑ ***Reduced productivity***
- ☑ ***Cost and quality are still determined at the design stage***
 - ☑ ***Delay customization***
 - ☑ ***Modularization***
 - ☑ ***Reduce customer interaction, often through automation***

Service Design

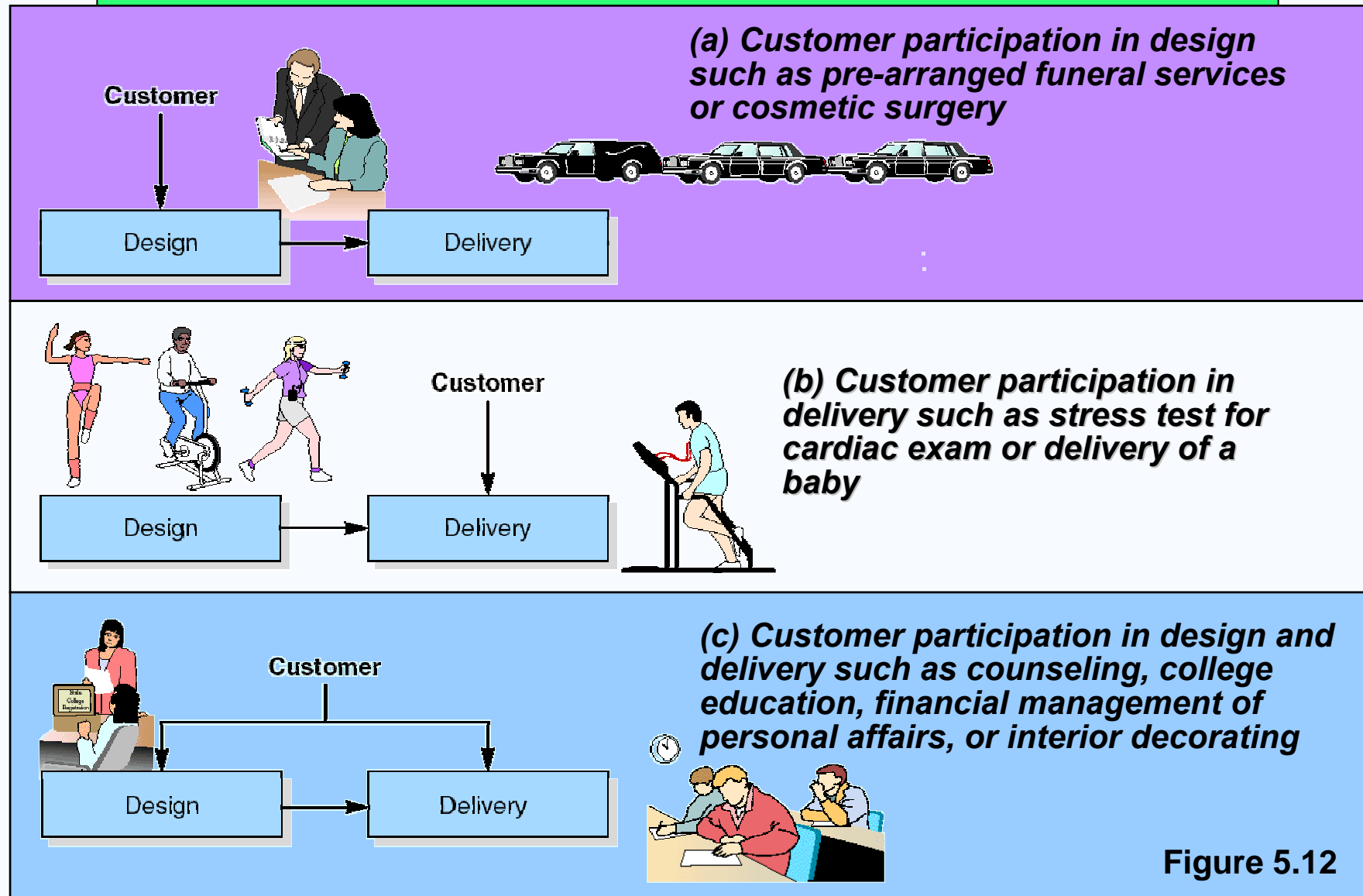


Figure 5.12

Moments of Truth

- Concept created by Jan Carlzon of Scandinavian Airways***
- Critical moments between the customer and the organization that determine customer satisfaction***
- There may be many of these moments***
- These are opportunities to gain or lose business***

Moments-of-Truth Computer Company Hotline

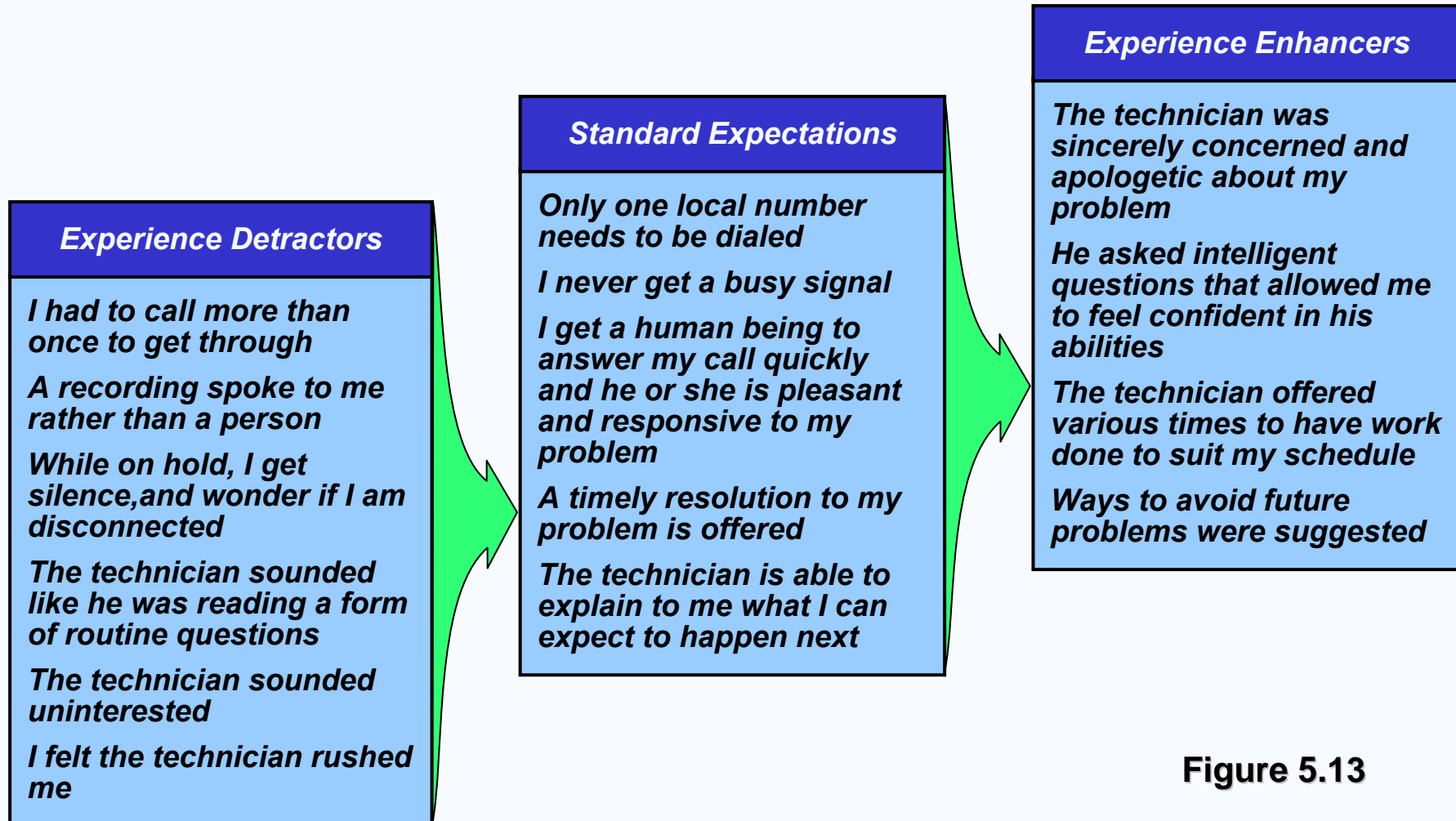


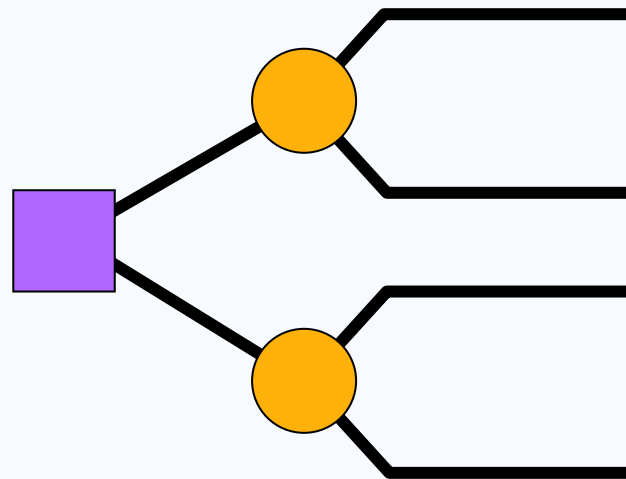
Figure 5.13

Documents for Services

- High levels of customer interaction necessitates different documentation***
- Often explicit job instructions for moments-of-truth***
- Scripts and storyboards are other techniques***

Application of Decision Trees to Product Design

- ☑ Particularly useful when there are a series of decisions and outcomes which lead to other decisions and outcomes***



Application of Decision Trees to Product Design

Procedures

- ☑ Include all possible alternatives and states of nature - including “doing nothing”***
- ☑ Enter payoffs at end of branch***
- ☑ Determine the expected value of each branch and “prune” the tree to find the alternative with the best expected value***

Decision Tree Example

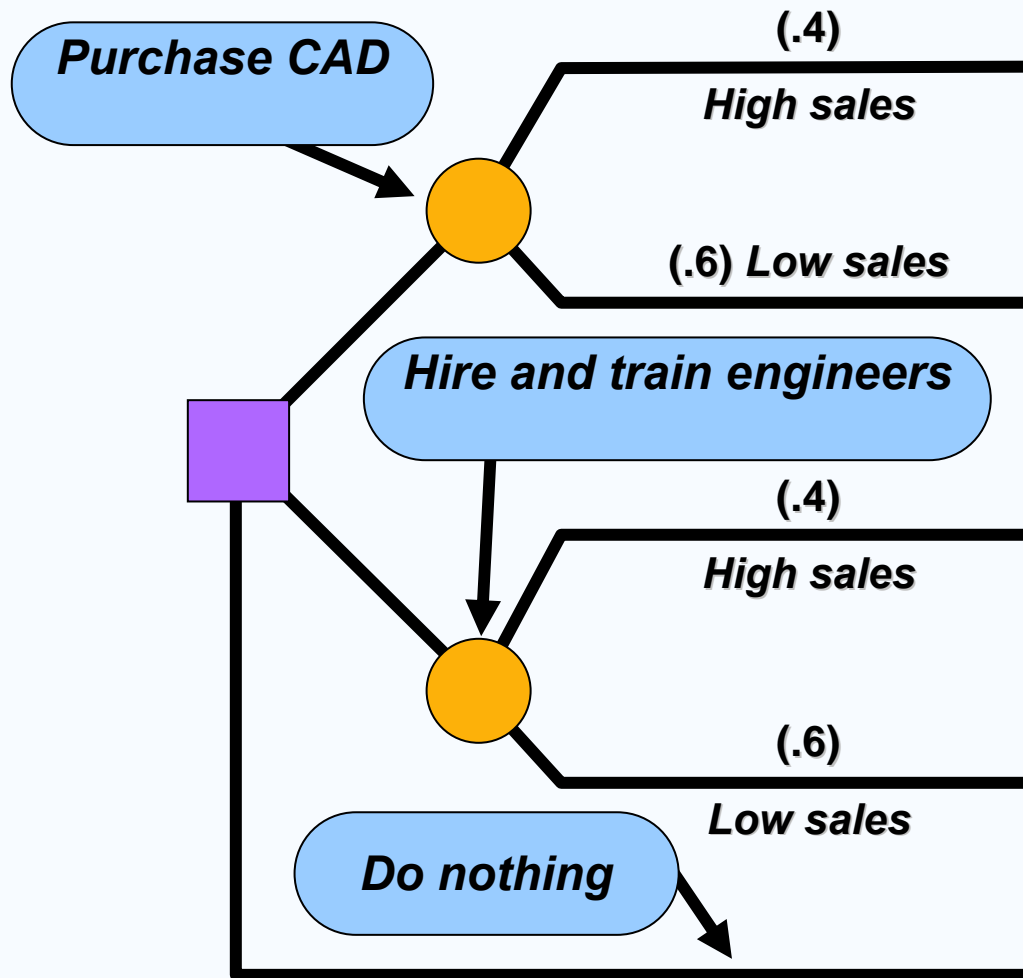


Figure 5.14

Decision Tree Example

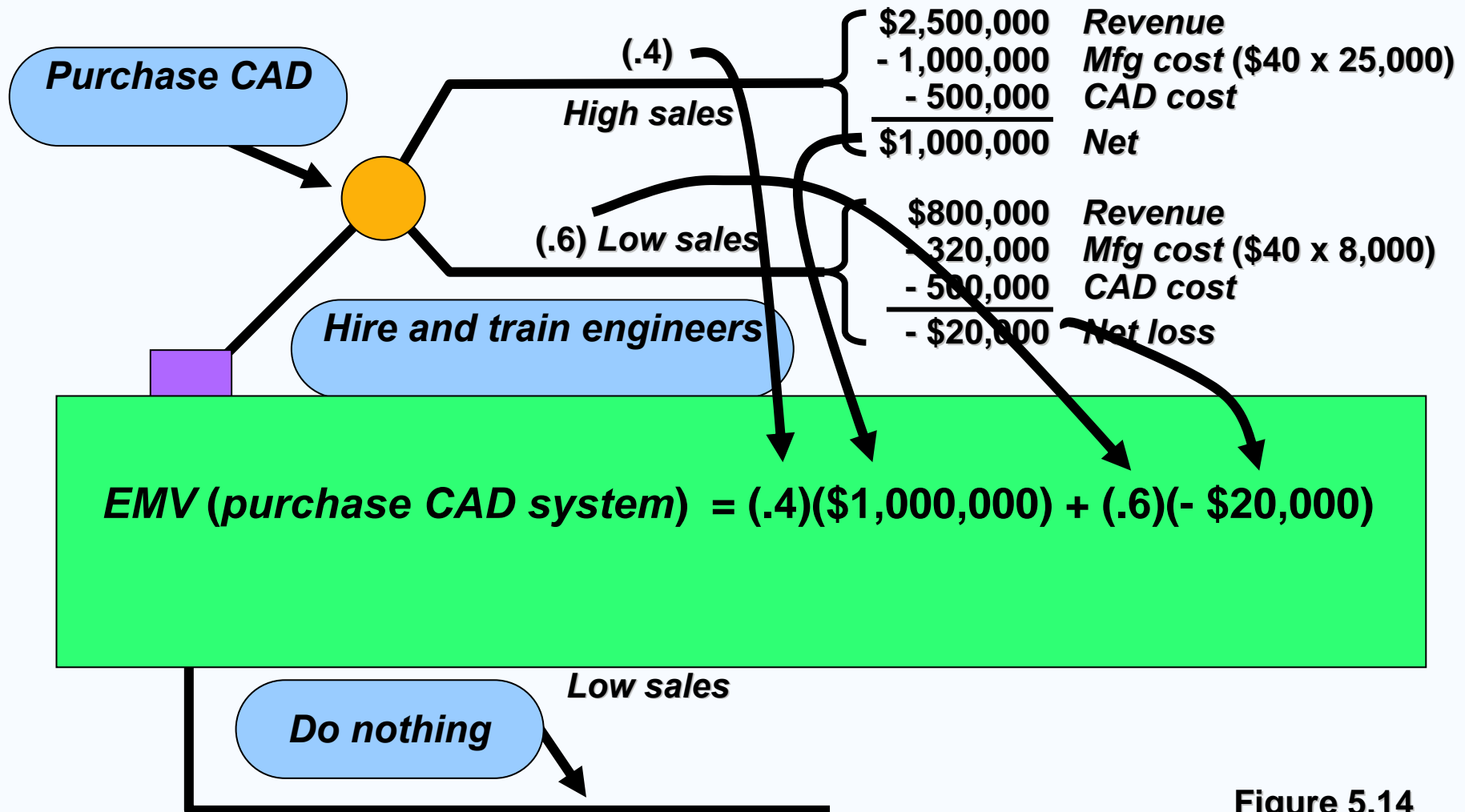


Figure 5.14

Decision Tree Example

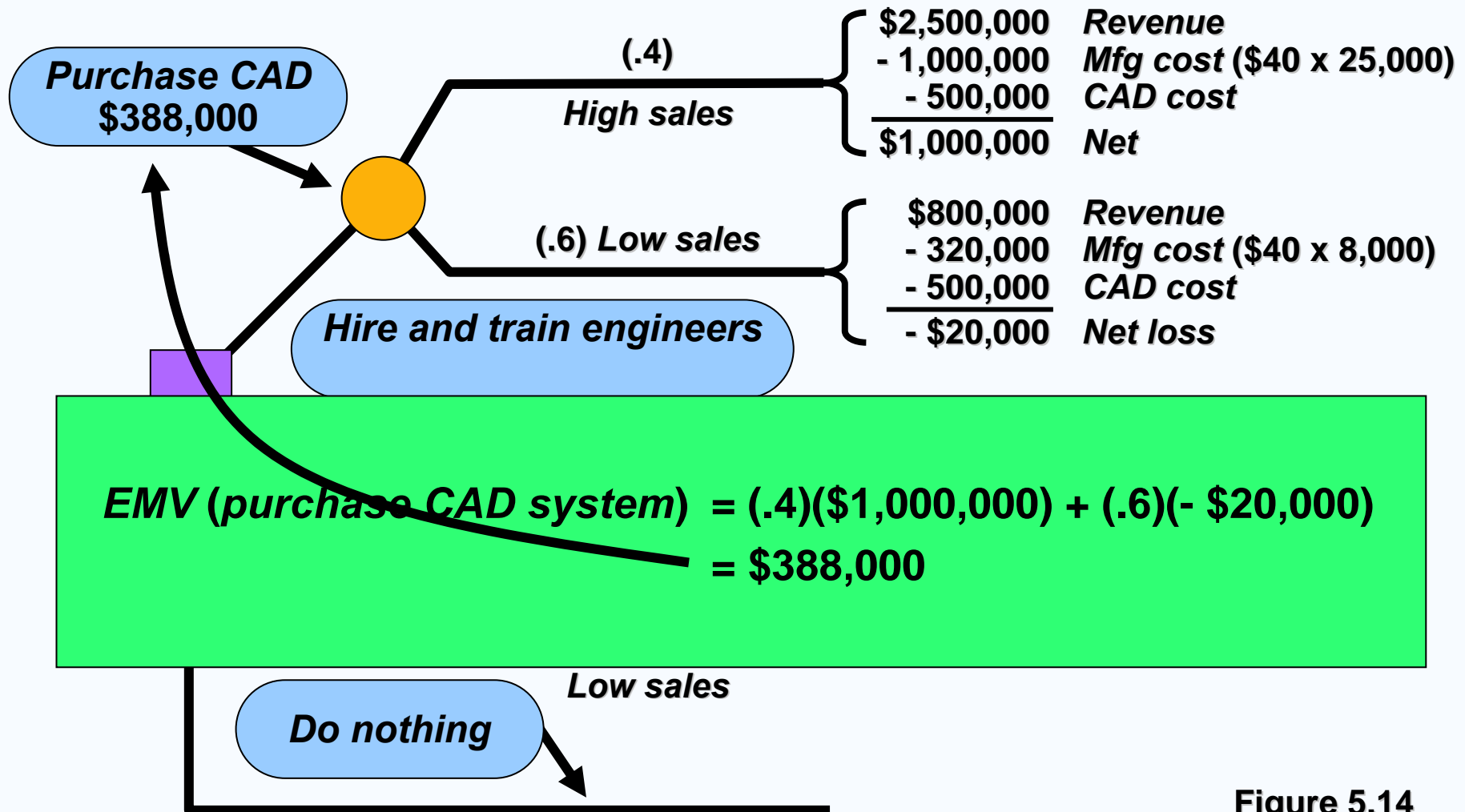


Figure 5.14

Decision Tree Example

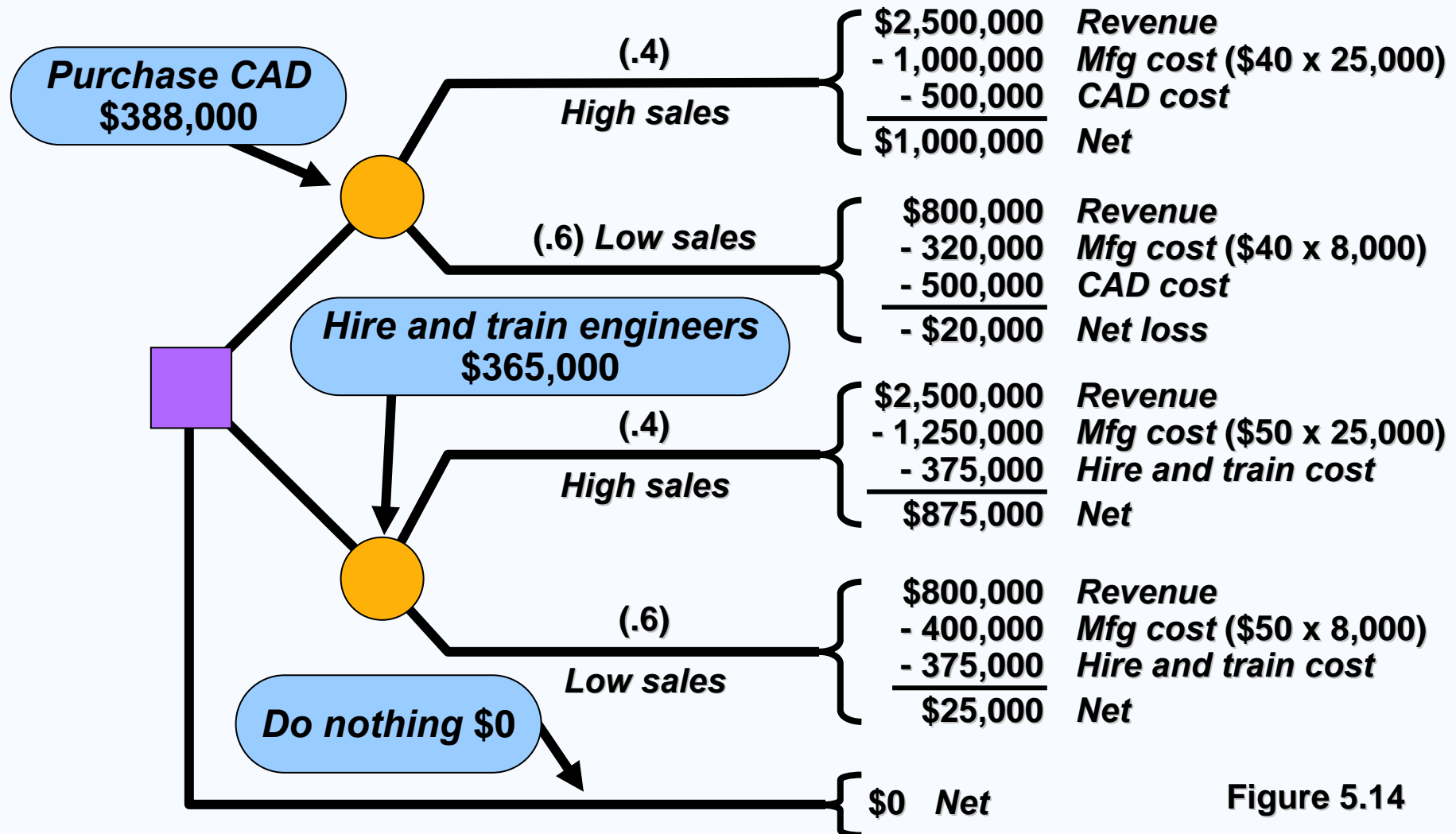


Figure 5.14

Transition to Production

- ☑ ***Know when to move to production***
 - ☑ ***Product development can be viewed as evolutionary and never complete***
 - ☑ ***Product must move from design to production in a timely manner***
- ☑ ***Most products have a trial production period to insure producibility***
 - ☑ ***Develop tooling, quality control, training***
 - ☑ ***Ensures successful production***

Transition to Production

- ☑ ***Responsibility must also transition as the product moves through its life cycle***
 - ☑ ***Line management takes over from design***
- ☑ ***Three common approaches to managing transition***
 - ☑ ***Project managers***
 - ☑ ***Product development teams***
 - ☑ ***Integrate product development and manufacturing organizations***