DESIGN OF PRODUCTS AND SERVICES

Chapter Three

McGraw-Hill/Irwin

The Product Design Process

- Companies continuously bring new products to market
- Product design is integral to success
- Product design differs significantly depending on the industry
- Companies often outsource major functions
  - **Contract manufacturer:** an organization capable of manufacturing and/or purchasing all the components needed to produce a finished product

Core Competency

- **Core competency:** the one thing a company can do better than its competitors
- A core competency has three characteristics:
  1. It provides potential access to a wide variety of markets
  2. It increases perceived customer benefits
  3. It is hard for competitors to imitate

Brainstorming: A General Method for Problem Solving

- Defer judgment
- Build on the ideas of others
- Stay focused on the topic
- One person at a time
- Go for quantity
- Encourage wild ideas
- Be visual

Six Phases of the Generic Development Process (Formal Process)

- Phase 0: Planning
- Phase 1: Concept development
- Phase 2: System-level design
- Phase 3: Design detail
- Phase 4: Testing and refinement
- Phase 5: Production ramp-up

Phase 0: Planning

- Precedes project approval
- Begins with corporate strategy
- Includes assessment of technology developments and market objectives
- Output is the project mission statement

Phase 1: Concept Development

- Needs of the target market are identified
- Alternative product concepts are generated and evaluated
- One or more concepts are selected for further development and testing
  - **Concept:** a description of the form, function, and features of a product

Phase 2: System-Level Design

- Definition of the product architecture
- Decomposition of the product into subsystems and components
- Final assembly scheme for the production system is usually defined
- Output:
  - Geometric layout of the product
  - Functional specifications for each subsystem
  - Preliminary process flow diagram

Phase 3: Design Detail

- Complete specification of the geometry, materials, and tolerances for all parts
- Identification of all the standard parts to be purchased from suppliers
- Process plan is established
- Tooling is designed
- Output:
  - Drawings describing the geometry of each part and its tooling
  - Specifications of purchased parts
  - Process plan

Phase 4: Testing and Refinement

- Construction and evaluation of multiple preproduction versions of product
  - Same geometry and material as production version
  - Not necessarily fabricated with the actual production processes
- Prototypes tested to determine if the product will work as designed

Phase 5: Production Ramp-Up

- Product is made using the intended production system
- Need to train workers and resolve any remaining problems
- Products may be supplied to preferred customers for evaluation
- Transition to ongoing production is gradual

The Generic Product Development Process

Phase 0: Planning	Phase 1: Concept Development	Phase 2: System-Level Design	Phase 3: Detail Design	Phase 4: Testing and Refinement	Phase 5: Production Ramp-Up
Marketing					
• Articulate market opportunity. • Define market segments.	• Collect customer needs. • Identify lead users. • Identify competitive products.	• Develop plan for product options and extended product family. • Set target sales price point(s).	• Develop marketing plan.	• Develop promotion and launch materials. • Facilitate field testing.	• Place early production with key customers.
Design					
• Consider product platform and architecture. • Assess new technologies.	• Investigate feasibility of product concepts. • Develop industrial design concepts. • Build and test experimental prototypes.	• Generate alternative product architectures. • Define major subsystems and interfaces. • Refine industrial design.	• Define part geometry. • Choose materials. • Assign tolerances. • Complete industrial design control documentation.	• Reliability testing. • Life testing. • Performance testing. • Obtain regulatory approvals. • Implement design changes.	• Evaluate early production output.
Manufacturing					
• Identify production constraints. • Set supply chain strategy.	• Estimate manufacturing cost. • Assess production feasibility.	• Identify suppliers for key components. • Perform make-buy analysis. • Define final assembly scheme. • Set target costs.	• Define piece-part production processes. • Design tooling. • Define quality assurance processes. • Begin procurement of long-lead tooling.	• Facilitate supplier ramp-up. • Refine fabrication and assembly processes. • Train workforce. • Refine quality assurance processes.	• Begin operation of entire production system.
Other Functions					
• Research: Demonstrate available technologies. • Finance: Provide planning goals. • General Management: Allocate project resources.	• Finance: Facilitate economic analysis. • Legal: Investigate patent issues.	• Finance: Facilitate make-buy analysis. • Service: Identify service issues.		• Sales: Develop sales plan.	

Generic Product Development Process

- **Technology-push products:** firm begins with new technology and looks for a market
- **Platform products:** built around a preexisting technological subsystem
- **Process-intensive products:** production process has an impact on the properties of the product
  - Product design cannot be separated from process design

Generic Product Development Process

Continued

- **Customized products:** new products are slight variations of existing configurations
- **High-risk products:** technical or market uncertainties create high risks of failure
- **Quick-build products:** rapid modeling and prototyping enables many design-build-test cycles

Generic Product Development Process

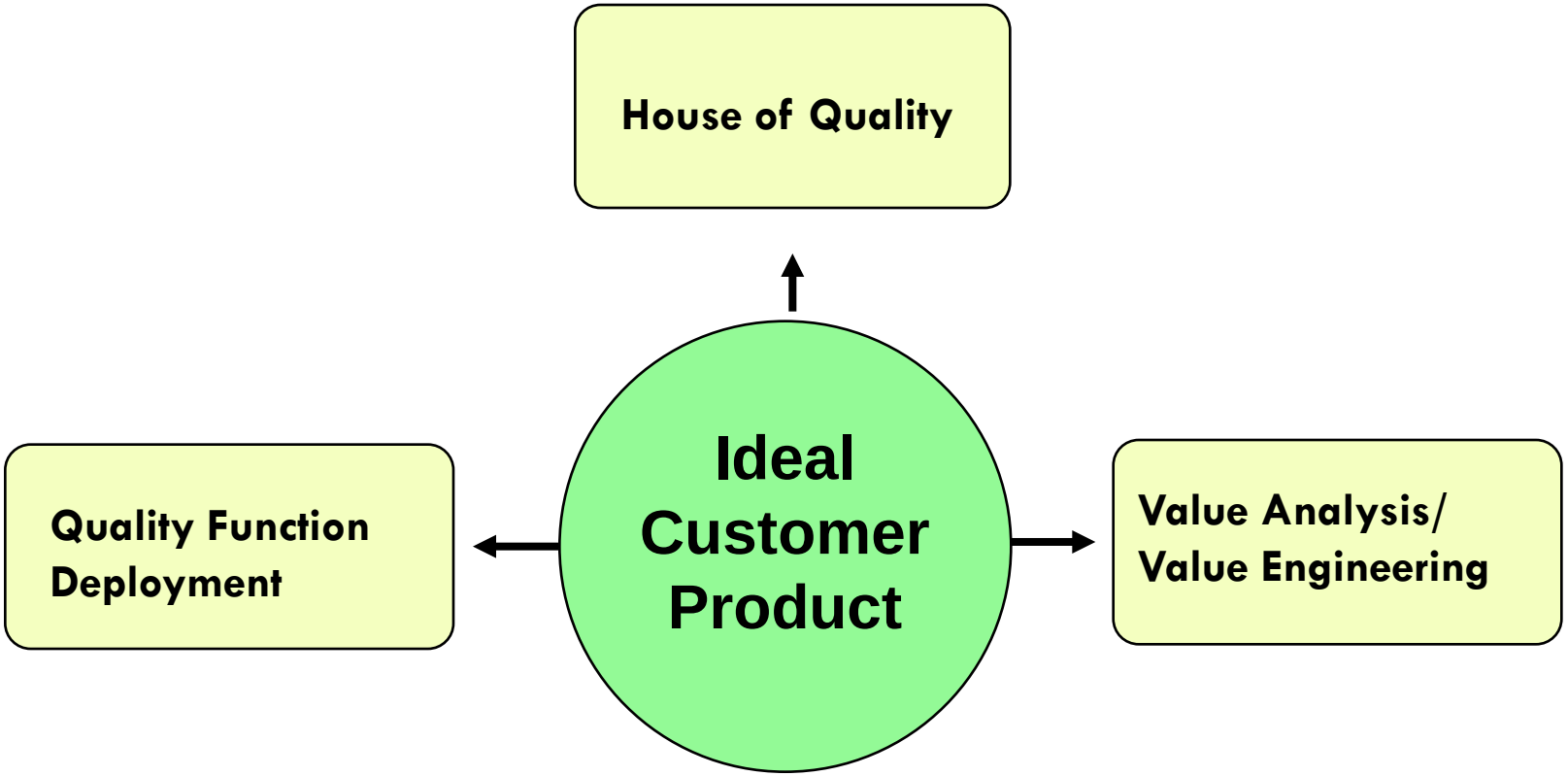
Continued

- **Complex systems:** systems must be decomposed into several subsystems and many components
- **Generic:** begins with a market opportunity and team selects appropriate technologies to meet customer needs

Summary of Variants of Generic Product Development Process

Process Type	Description	Distinct Features	Examples
Generic (market-pull products)	The team begins with a market opportunity and selects appropriate technologies to meet customer needs	Process generally includes distinct planning, concept development, system-level design, detail design, testing and refinement, and production ramp-up phases	Sporting goods, furniture, tools
Technology-push products	The team begins with a new technology, then finds an appropriate market	Planning phase involves matching technology and market; concept development assumes a given technology	Gore-Tex rainwear, Tyvek envelopes
Platform products	The team assumes that the new product will be built around an established technological subsystem	Concept development assumes a proven technology platform	Consumer electronics, computers, printers
Process-intensive products	Characteristics of the product are highly constrained by the production process	Either an existing production process must be specified from the start or both product and process must be developed together from the start	Snack foods, breakfast cereals, chemicals, semiconductors
Customized products	New products are slight variations of existing configurations	Similarity of projects allows for a streamlined and highly structured development process	Motors, switches, batteries, containers
High-risk products	Technical or market uncertainties create high risks of failure	Risks are identified early and tracked throughout the process Analysis and testing activities take place as early as possible	Pharmaceuticals, space systems
Quick-build products	Rapid modeling and prototyping enables many design–build–test cycles	Detail design and testing phases are repeated a number of times until the product is completed or time/budget runs out	Software, cellular phones
Complex systems	System must be decomposed into several subsystems and many components	Subsystems and components are developed by many teams working in parallel, followed by system integration and validation	Airplanes, jet engines, automobiles

Designing for the Customer

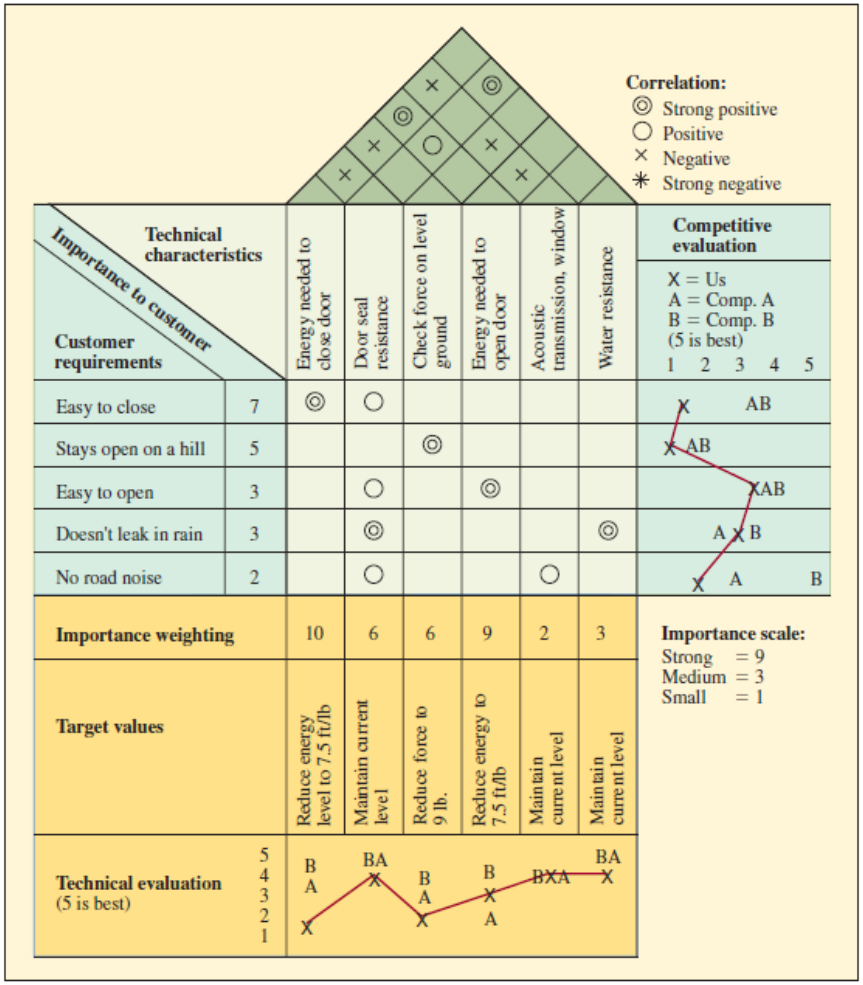


Quality Function Deployment

- Interfunctional teams from marketing, design engineering, and manufacturing
- Begins with listening to the customer
  - Uses market research
  - Customer preferences are defined and broken down into customer requirements
- House of quality

Completed House of Quality Matrix for a Car Door

Customer requirements information forms the basis for this matrix, used to translate them into operating or engineering goals



Value Analysis/Value Engineering (VA/VE)

- Purpose is to simplify products and processes
- Objective is to achieve better performance at a lower cost while maintaining all functional requirements defined by the customer
  - Does the item have any design features that are not necessary?
  - Can two or more parts be combined into one?
  - How can we cut down the weight?
  - Are there nonstandard parts that can be eliminated?

Designing Products for Manufacture and Assembly

- Traditional approach
  - "We design it, you build it" or "over the wall"
- Concurrent engineering
  - "Let's work together simultaneously"

Design for Manufacturing and Assembly

- Greatest improvements related to DFMA arise from simplification of the product by reducing the number of separate parts:
  1. During the operation of the product, does the part move relative to all other parts already assembled?
  2. Must the part be of a different material or be isolated from other parts already assembled?
  3. Must the part be separate from all other parts to allow the disassembly of the product for adjustment or maintenance?

Ecodesign

- **Ecodesign:** the incorporation of environmental considerations in the design and development of products or services
  - The whole life cycle is considered
  - The product is considered as a system
  - A multi-criteria approach is used
- Application of ecodesign can benefit business

Designing Service Products

- Service products are very different
- Direct customer involvement introduces significant variability in the process
- Questions to address:
  - How will this variability be addressed?
  - What are the implications for operational cost and the customer service experience?

Three General Factors for Determining Fit

1. Service experience fit
   - The new service should fit into the current service experience for the customer
2. Operational fit
   - Existing processes should be able to support the operation of the new service
3. Financial impact
   - Introducing a new service should be financially justified

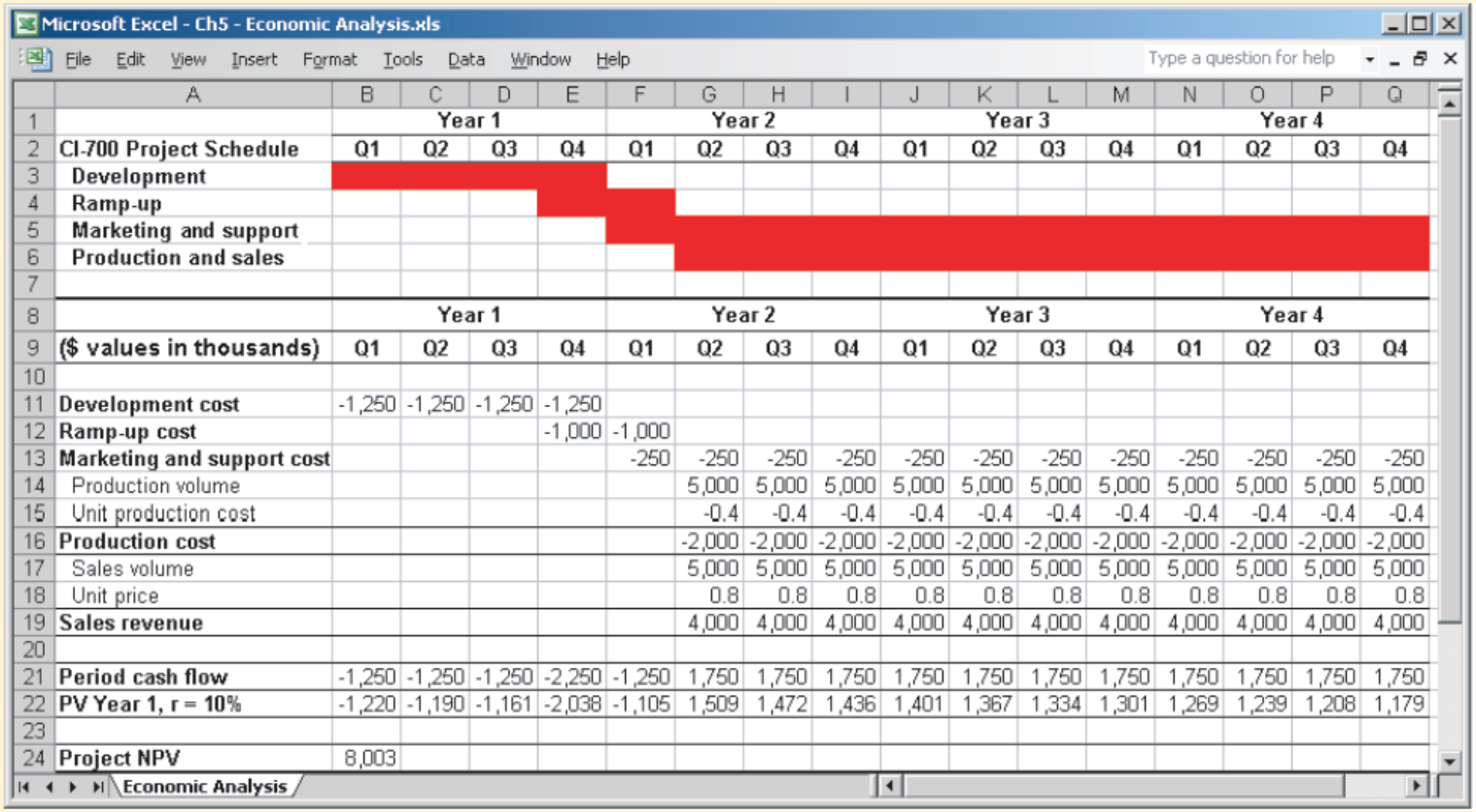
Structural Alternatives for a Family Restaurant

Process Name	Lower Complexity/ Divergence	Current Process	Higher Complexity/ Divergence
Reservations	No reservations	Take reservation	Specific table selection
Seating	Guests seat themselves	Host shows guests the table	Maitre d' escorts guests to seats, pulls out chairs, and places napkins in their laps
Menus	No menu	Menus on the table	Recite menu; describe entrees and specials
Bread	No bread offered at the table	Serve bread and butter	Assortment of hot breads and hors d'oeuvres
Ordering	Guests pick their food from buffet line	Take orders	At table; taken personally by maitre d'
Salads	Salad bar	Prepare orders	Individually prepared at table
Entrees	Entrees offered on the buffet	Entree (15 choices)	Expand to 20 choices; add flaming or sizzling dishes, deboning fish at the table
Desserts	Dessert bar	Dessert (6 choices)	Expand to 12 choices
Beverages	Guests get their drinks from the drink station	Beverage (6 choices)	Add exotic coffees, wine list, liqueurs
Service during the meal	No service	Serve orders	Separate-course service; hand-grind pepper
Payment	Paid at entry to buffet	Collect payment	Choice of payment, including house accounts
Table clearing	Guests are asked to bus the table themselves	Bus boy clears table at the end	Bus boy clears table throughout the meal

Economic Analysis of Project Development Costs

- Using measurable factors to help determine:
  - Go/no-go milestones
  - Operational design and development decisions
- Building a base-case financial model
- A financial model consisting of major cash flows
  - Sensitivity analysis for “what if” questions

Merging the Project Financials and Schedule into a Cash Flow Report


Microsoft Excel - Ch5 - Economic Analysis.xls

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		Year 1				Year 2				Year 3				Year 4			
2	CI-700 Project Schedule	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3	Development																
4	Ramp-up																
5	Marketing and support																
6	Production and sales																
7																	
8		Year 1				Year 2				Year 3				Year 4			
9	($ values in thousands)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
10																	
11	Development cost	-1,250	-1,250	-1,250	-1,250												
12	Ramp-up cost				-1,000	-1,000											
13	Marketing and support cost					-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250
14	Production volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
15	Unit production cost						-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
16	Production cost						-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000
17	Sales volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
18	Unit price						0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
19	Sales revenue						4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
20																	
21	Period cash flow	-1,250	-1,250	-1,250	-2,250	-1,250	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750
22	PV Year 1, r = 10%	-1,220	-1,190	-1,161	-2,038	-1,105	1,509	1,472	1,436	1,401	1,367	1,334	1,301	1,269	1,239	1,208	1,179
23																	
24	Project NPV	8,003															

Economic Analysis

Possible Sensitivity Analysis Scenarios

- Longer product development time
- Higher/lower sales volume
- Higher/lower sales price
- Higher/lower development costs

Measuring Product Development Performance

- A steady stream of new products is important to competitiveness
- Firms must respond to changing customer needs and competitor moves
- Ability to identify opportunities and bring new products to market is critical
  - Must also be efficient

Performance Measures for Development Projects

Performance Dimension	Measures	Impact on Competitiveness
Time to market	Frequency of new product introductions Time from initial concept to market introduction Number started and number completed Actual versus plan Percentage of sales coming from new products	Responsiveness to customers/ competitors Quality of design—close to market Frequency of projects—model life
Productivity	Engineering hours per project Cost of materials and tooling per project Actual versus plan	Number of projects—freshness and breadth of line Frequency of projects—economics of development
Quality	Conformance—reliability in use Design—performance and customer satisfaction Yield—factory and field	Reputation—customer loyalty Relative attractiveness to customers—market share Profitability—cost of ongoing service