

Processes and Technology

Lecture Outline

- Process Planning
- Process Analysis
- Process Innovation
- Amortization
- Technology Decisions

Learning Objectives

- Evaluate strategic options in process planning, including whether or not to outsource
- Differentiate among different types of production processes
- Understand the effect of volume and standardization on process selection
- Appreciate the difficulties in translating a design to a process
- Use simple flowcharting tools to improve everyday processes
- Investigate the use of technology in manufacturing and service processes

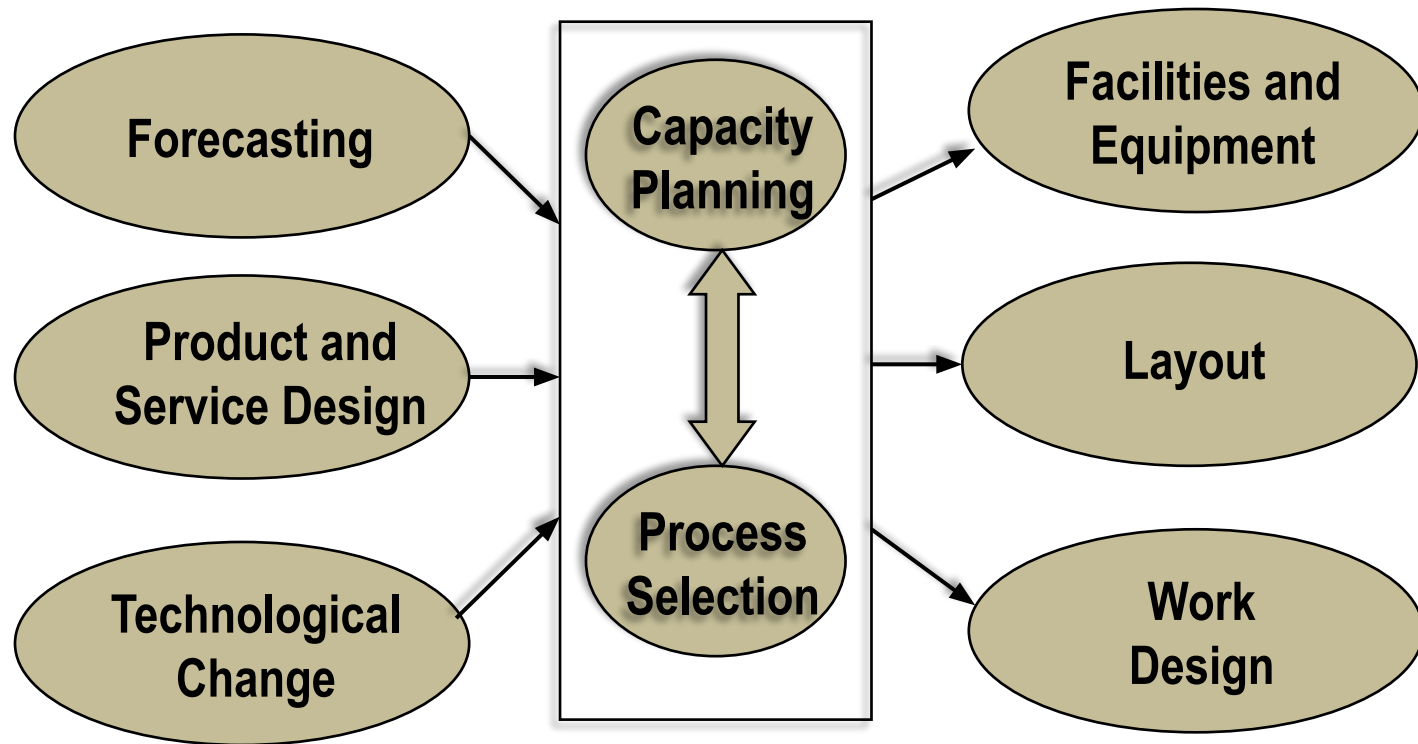
Process Planning

- Process
 - Group of related tasks with specific inputs & outputs
- Process design
 - tasks to be done & how they are coordinated among functions, people, & organizations
- Process strategy
 - an organization's overall approach for physically producing goods and services
- Process planning
 - converts designs into workable instructions for manufacture or delivery

Process Selection

- Process selection
 - Refers to deciding on the way production of goods or services will be organized
 - It has major implications for
 - Capacity planning
 - Layout of facilities
 - Equipment
 - Design of work systems

Process Selection and System Design



Process Strategy

- Vertical integration
 - extent to which firm will produce inputs and control outputs of each stage of production process
- Capital intensity
 - mix of capital (i.e., equipment, automation) and labor resources used in production process
- Process flexibility
 - ease with which resources can be adjusted in response to changes in demand, technology, products or services, and resource availability
- Customer involvement
 - role of customer in production process

Outsourcing

- Cost
 - Is it cheaper to make or buy the item
- Capacity
 - Does the company have the capacity
- Quality
 - Easier to control quality in your own factory
- Speed
 - Shipping time can reduce savings
- Reliability
 - Quality and timing are reliability measures
- Expertise
 - Protect proprietary information

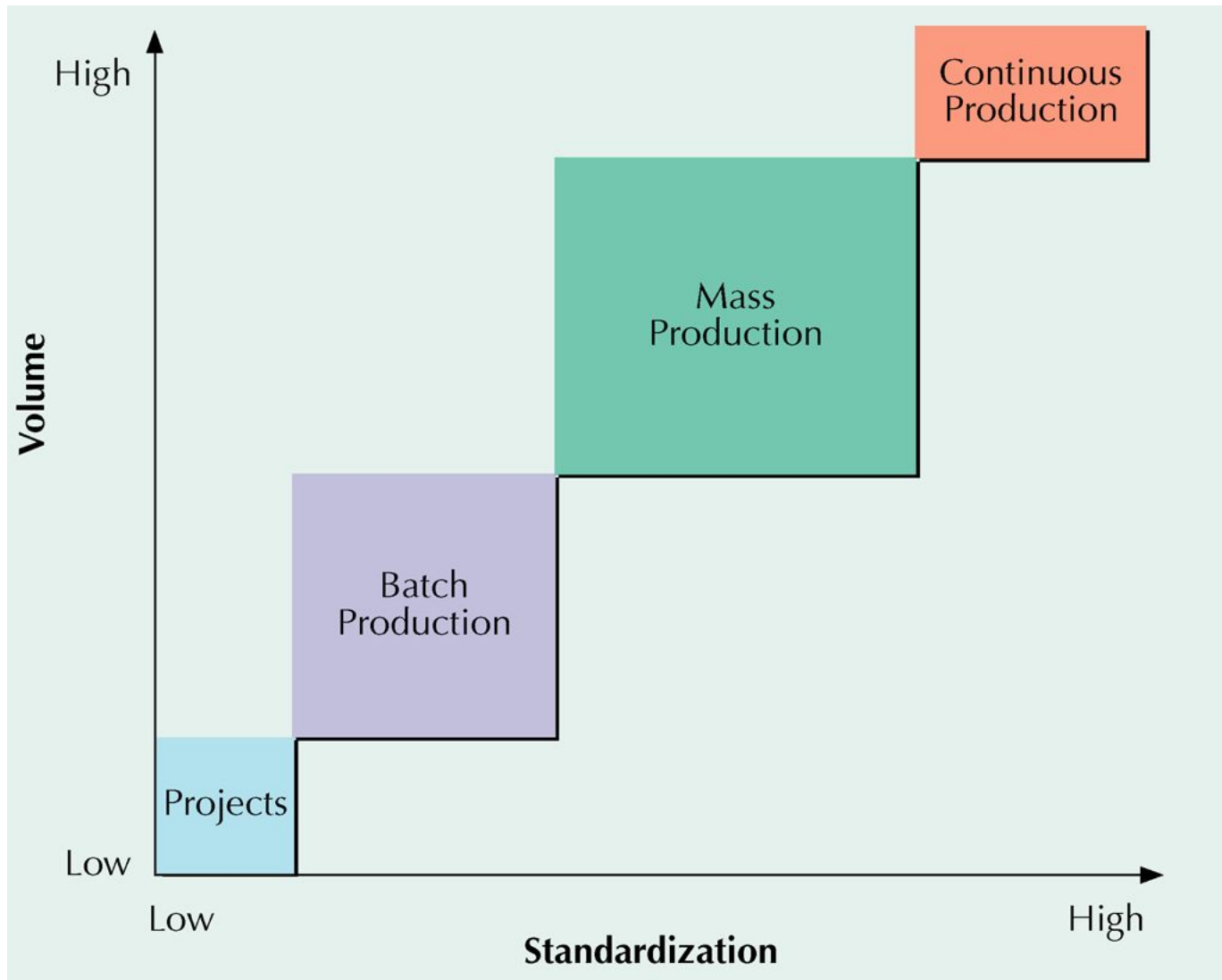
Sourcing Continuum



Process Selection

- Projects
 - one-of-a-kind production of a product to customer order
- Batch production
 - process many different jobs at the same time in groups or batches
- Mass production
 - produce large volumes of a standard product for a mass market
- Continuous production
 - used for very-high volume commodity products

Product-Process Matrix



Types of Processes

	PROJECT	BATCH	MASS	CONT.
Type of product	Unique	Made-to-order (customized)	Made-to-stock (standardized)	Commodity
Type of customer	One-at-a-time	Few individual customers	Mass market	Mass market
Product demand	Infrequent	Fluctuates	Stable	Very stable

Types of Processes

	PROJECT	BATCH	MASS	CONT.
Demand volume	Very low	Low to medium	High	Very high
No. of different products	Infinite variety	Many, varied	Few	Very few
Production system	Long-term project	Discrete, job shops	Repetitive, assembly lines	Continuous, process industries

Types of Processes

	PROJECT	BATCH	MASS	CONT.
Equipment	Varied	General-purpose	Special-purpose	Highly automated
Primary type of work	Specialized contracts	Fabrication	Assembly	Mixing, treating, refining
Worker skills	Experts, crafts-persons	Wide range of skills	Limited range of skills	Equipment monitors

Types of Processes

	PROJECT	BATCH	MASS	CONT.
Advantages	Custom work, latest technology	Flexibility, quality	Efficiency, speed, low cost	Highly efficient, large capacity, ease of control
Dis-advantages	Non-repetitive, small customer base, expensive	Costly, slow, difficult to manage	Capital investment; lack of responsiveness	Difficult to change, far-reaching errors, limited variety
Examples	Construction, shipbuilding, spacecraft	Machine shops, print shops, bakeries, education	Automobiles, televisions, computers, fast food	Paint, chemicals, foodstuffs

Process Selection With Break-Even Analysis

- Study cost trade-offs based on demand volume
- Cost
 - Fixed costs
 - constant regardless of the number of units produced
 - Variable costs
 - vary with the volume of units produced
- Revenue
 - price at which an item is sold

Process Selection With Break-Even Analysis

- Total revenue
 - price times volume sold
- Profit
 - difference between total revenue and total cost

Process Selection With Break-Even Analysis

Total cost = fixed cost + total variable cost

$$TC = c_f + vc_v$$

Total revenue = volume x price

$$TR = vp$$

Profit = total revenue - total cost

$$Z = TR - TC = vp - (c_f + vc_v)$$

c_f = fixed cost

V = volume (i.e., number of units produced and sold)

c_v = variable cost per unit

p = price per unit

Process Selection With Break-Even Analysis

$$TR = TC$$

$$vp = c_f + vc_v$$

$$vp - vc_v = c_f$$

$$v(p - c_v) = c_f$$

$$v = \frac{c_f}{p - c_v}$$

Solving for Break-Even Point (Volume)

Break-Even Analysis

Fixed cost = c_f = \$2,000

Variable cost = c_v = \$50 per unit

Price = p = \$100 per unit

Break-even point is

$$v = \frac{c_f}{p - c_v} =$$

Break-Even Analysis

Fixed cost = c_f = \$2,000

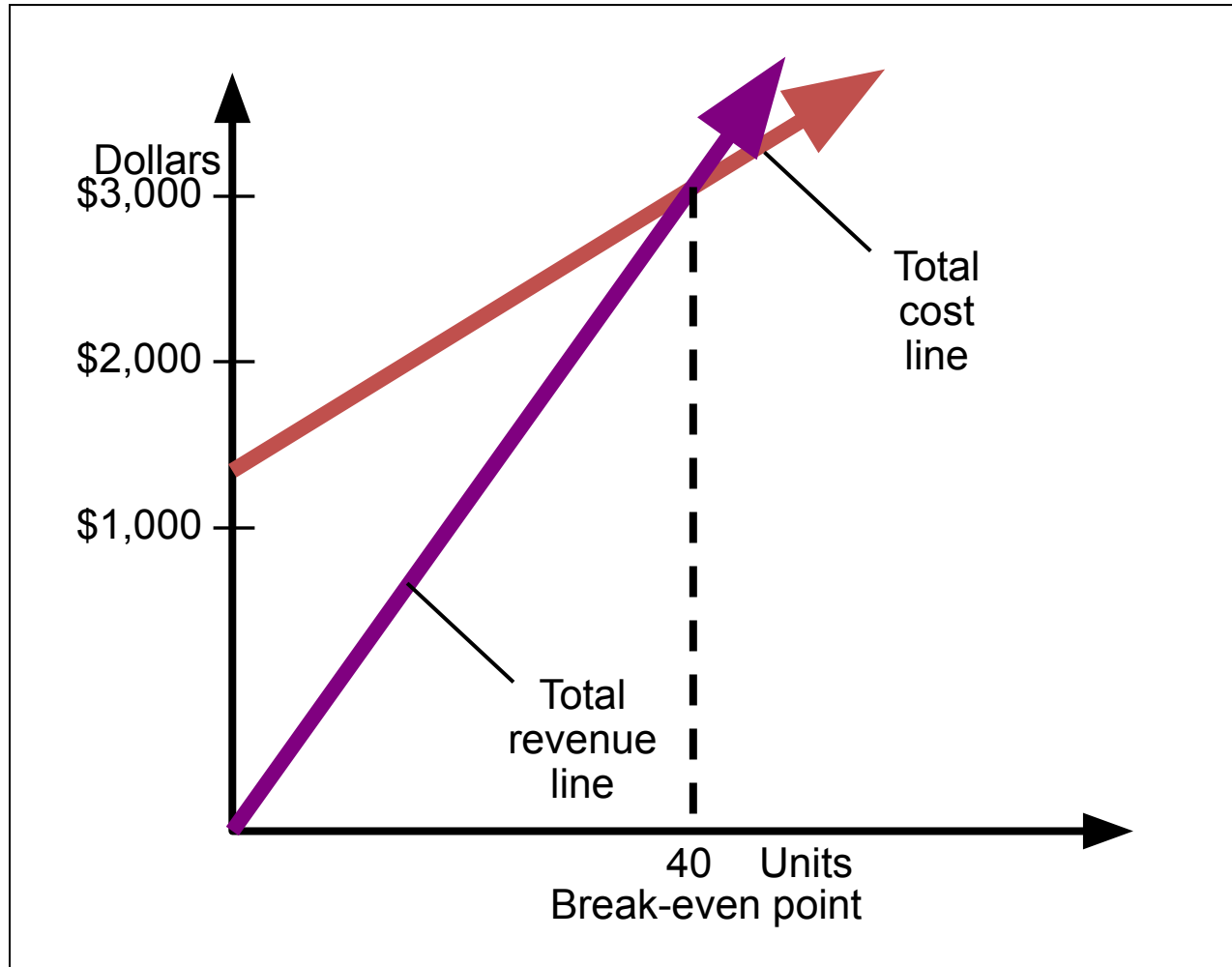
Variable cost = c_v = \$50 per unit

Price = p = \$100 per unit

Break-even point is

$$v = \frac{c_f}{p - c_v} = \frac{2000}{100 - 50} = 40 \text{ units}$$

Break-Even Analysis: Graph



Process Selection – Multiple Processes

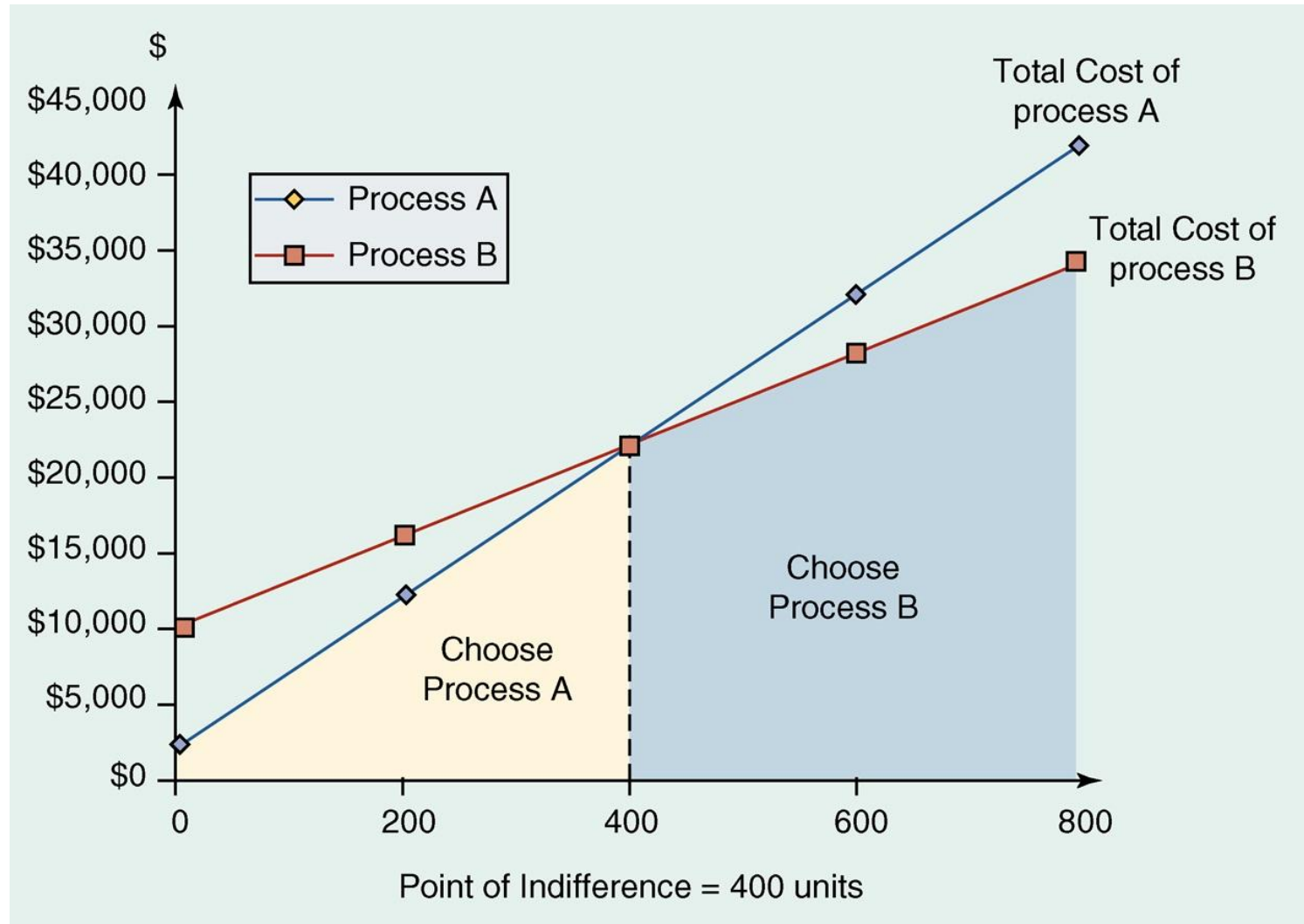
<i>Process A</i>	<i>Process B</i>
$\$2,000 + \$50v$	$\$10,000 + \$30v$

Process Selection – Multiple Processes

<i>Process A</i>	<i>Process B</i>
$\$2,000 + \$50v$	$\$10,000 + \$30v$
$\$20v = \$8,000$	
$v = 400 \text{ units}$	

Below or equal to 400, choose A
Above or equal to 400, choose B

Multiple Processes – Indifference Point



Capital equipment (Furnace A)

Cost = 100,000

$R = 12\%$

Lifetime = 20 years

Annualized amount = ?

Capital equipment (Furnace B)

Cost = 120,000

$R = 12\%$

Lifetime = 30 years

Annualized amount = ?

Ammortization/Annualization

$$S_n = a + ar + ar^2 + ar^3 + \dots ar^{n-1}$$

$$S_n = a(1 - r^n)/(1 - r)$$

P = *Principal*

R = Annual interest rate

N = Time duration/number of intervals

SI = Simple interest

$$SI = P * R * N$$

$$A_1 = P(1 + R)$$

$$A_n = P(1 + R)^N$$

Amortization/Annualization

Y = Amount loaned

X = Annual Instalment

N = Time duration/lifetime

R = Rate of interest

$$X(1 + R)^N + X(1 + R)^{N-1} + \dots + X(1 + R) = Y(1 + R)^N$$

$$X\{(1 + R)^N + (1 + R)^{N-1} + \dots + (1 + R)\} = Y(1 + R)^N$$

$$X\{1 - (1 + R)^N / (1 - (1 + R))\} = Y(1 + R)^N$$

$$X = Y * R * (1 + R)^N / ((1 + R)^N - 1)$$

Capital equipment (Furnace A)

Cost = 100,000

$R = 12\%$

Lifetime = 20 years

Annualized amount = ?

Capital equipment (Furnace B)

Cost = 120,000

$R = 12\%$

Lifetime = 30 years

Annualized amount = ?

Process Plans

- Set of documents that detail manufacturing and service delivery specifications
 - assembly charts
 - operations sheets
 - quality-control check-sheets

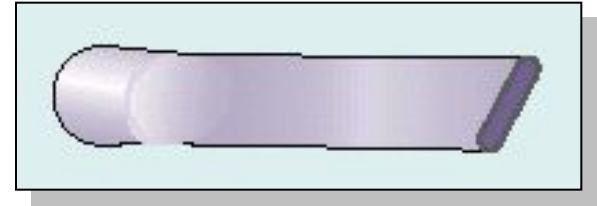
Operations Sheet for Plastic Part

Part name Crevice Tool

Part No. 52074

Usage Hand-Vac

Assembly No. 520



<i>Oper. No.</i>	<i>Description</i>	<i>Dept.</i>	<i>Machine/Tools</i>	<i>Time</i>	
10	Pour in plastic bits	041	Injection molding	2 min	
20	Insert mold	041 #076		2 min	
30	Check settings & start machine	041 113, 67, 650		20 min	
40	Collect parts & lay flat	051	Plastics finishing	10 min	
50	Remove & clean mold	042	Parts washer	15 min	
60	Break off rough edges	051	Plastics finishing	10 min	

Process Analysis

- Systematic study of all aspects of a process
 - make it faster
 - more efficient
 - less costly
 - more responsive
- Basic tools
 - process flowcharts
 - diagrams
 - maps

Building a Flowchart

- Determine objectives
- Define process boundaries
- Define units of flow
- Choose type of chart
- Observe process and collect data
- Map out process
- Validate chart

Flow Charts in Microsoft Visio

Microsoft Visio

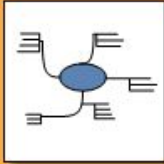
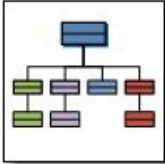

File Edit View Insert Format Tools Data Shape Window Help

Template Categories

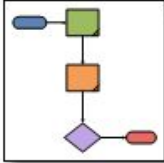
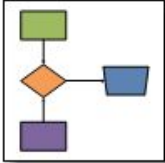


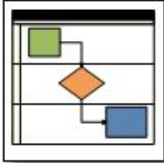

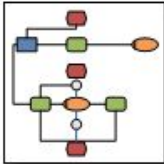
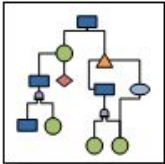
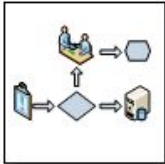

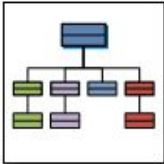
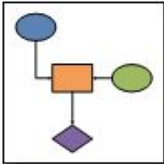
- Getting Started
- Samples
- Business**
- Engineering
- Flowchart
- General
- Maps and Floor Plans
- Network
- Schedule
- Software and Database

Business

Featured Templates

-  Brainstorming Diagram
-  Organization Chart
-  PivotDiagram

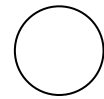
Other Templates

-  Audit Diagram
-  Basic Flowchart
-  Cause and Effect Diagram
-  Charts and Graphs
-  Cross Functional Flowchart
-  Data Flow Diagram
-  EPC Diagram
-  Fault Tree Analysis Diagram
-  ITIL Diagram
-  Marketing Charts and Diagrams
-  Organization Chart Wizard
-  TQM Diagram

Process Flowcharts

- Look at manufacture of product or delivery of service from broad perspective
- Incorporate
 - nonproductive activities (inspection, transportation, delay, storage)
 - productive activities (operations)

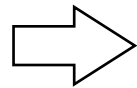
Process Flowchart Symbols



Operation



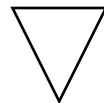
Inspection



Transportation



Delay

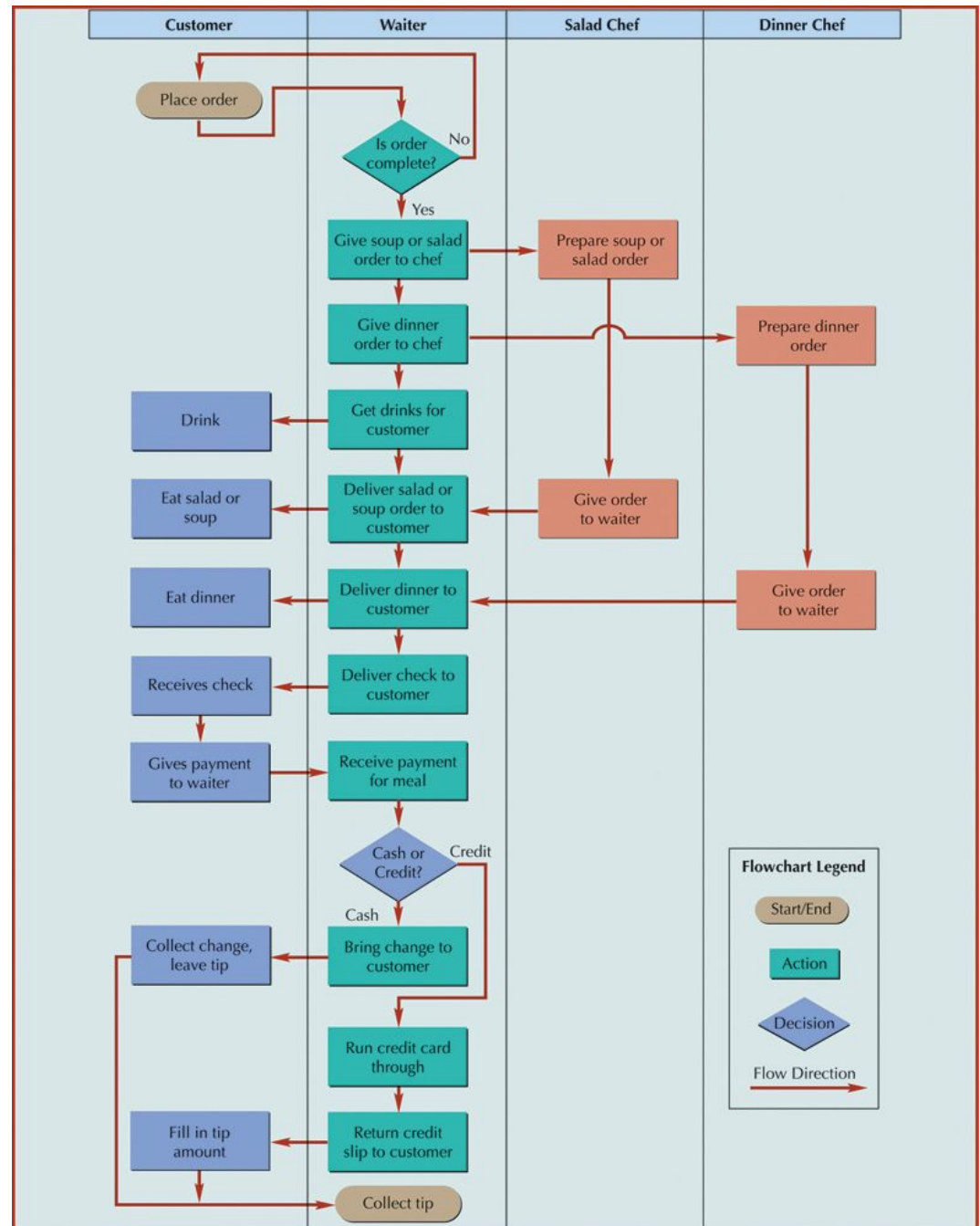


Storage

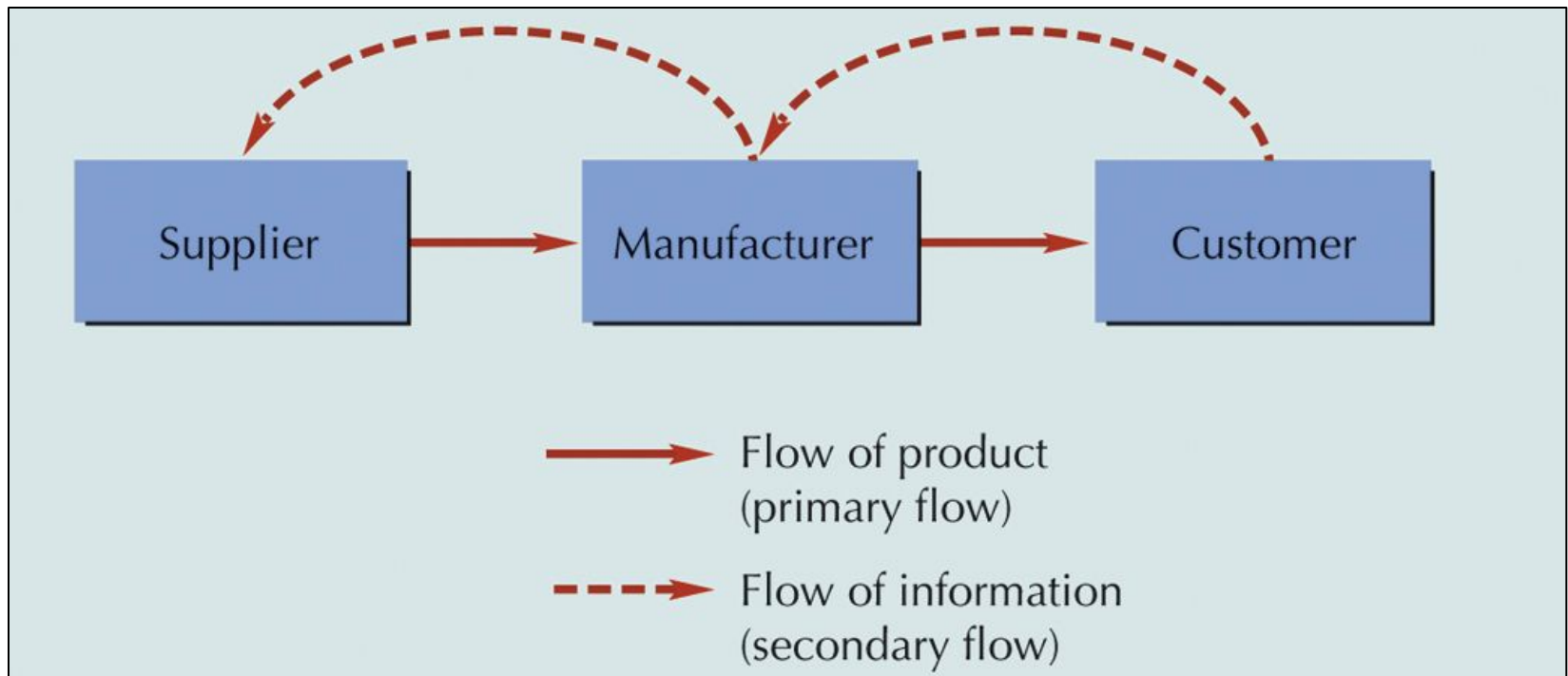
Process Flowchart of Apple Processing

Date: 9-30-12						Location: Graves Mountain		
Analyst: TLR						Process: Applesauce		
Step	Operation	Transport	Inspect	Delay	Storage	Description of process	Time (min)	Distance (feet)
1	●	⇒	□	D	▽	Unload apples from truck	20	
2	○	⇒	□	D	▽	Move to inspection station		100 ft
3	○	⇒	■	D	▽	Weigh, inspect, sort	30	
4	○	⇒	□	D	▽	Move to storage		50 ft
5	○	⇒	□	D	▼	Wait until needed	360	
6	○	⇒	□	D	▽	Move to peeler		20 ft
7	●	⇒	□	D	▽	Peel and core apples	15	
8	○	⇒	□	D	▼	Soak in water until needed	20	
9	●	⇒	□	D	▽	Place on conveyor	5	
10	○	⇒	□	D	▽	Move to mixing area		20 ft
Page 1 of 3						Total	450	190 ft

Process Map or Swimlane Chart of Restaurant Service

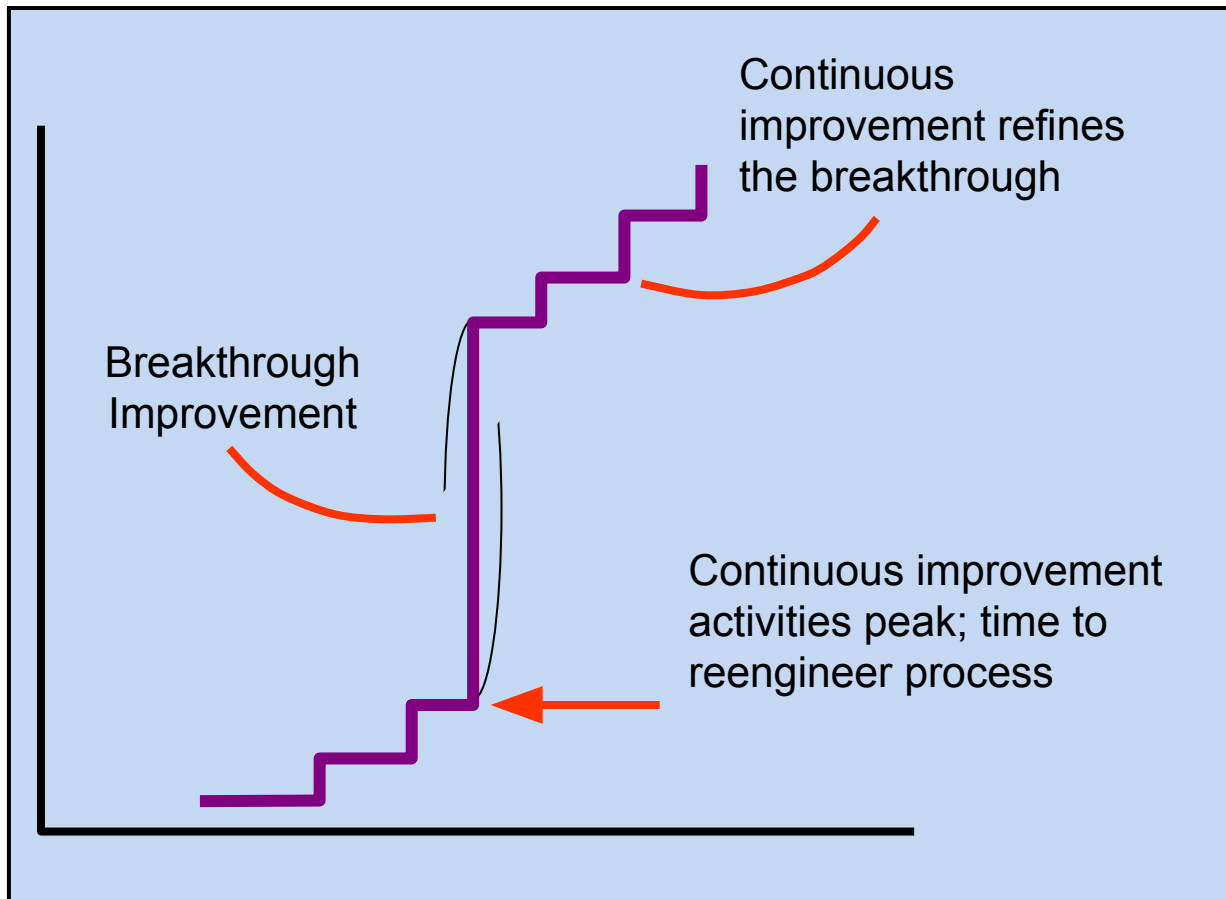


Simple Value Chain Flowchart

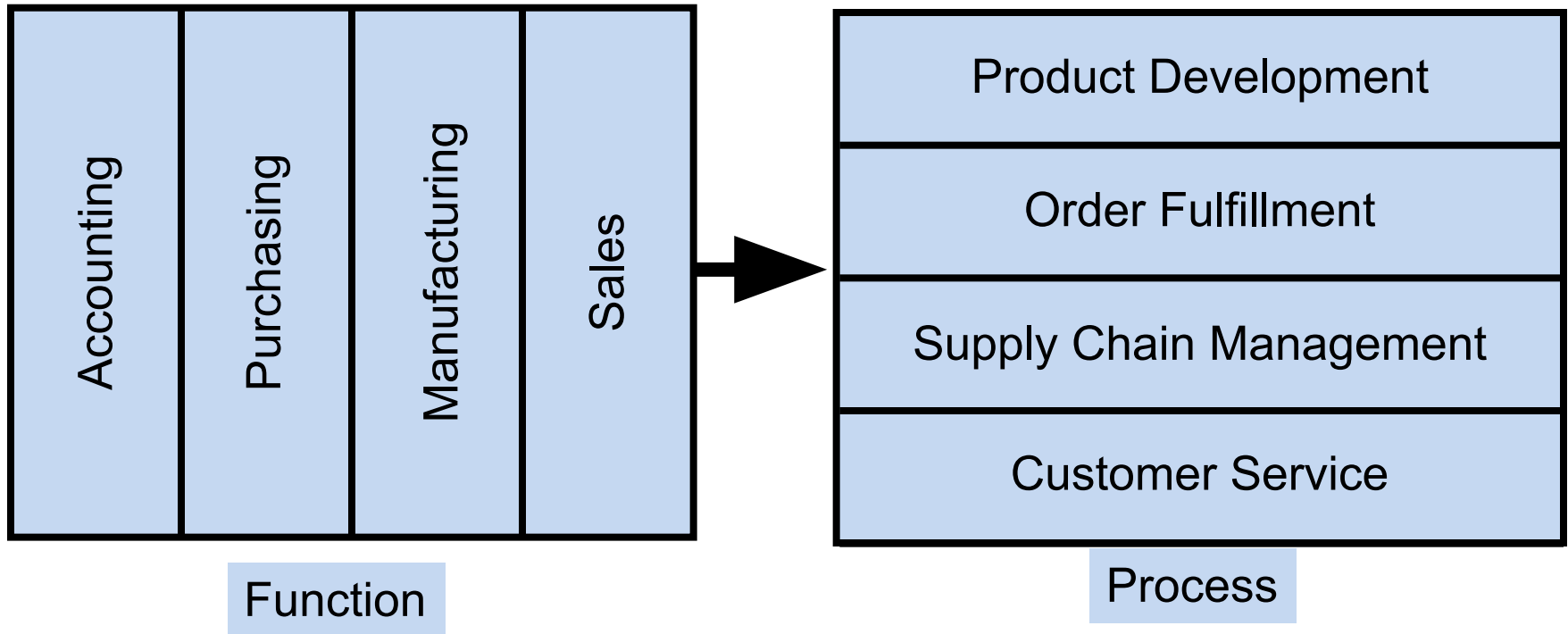


Process Innovation

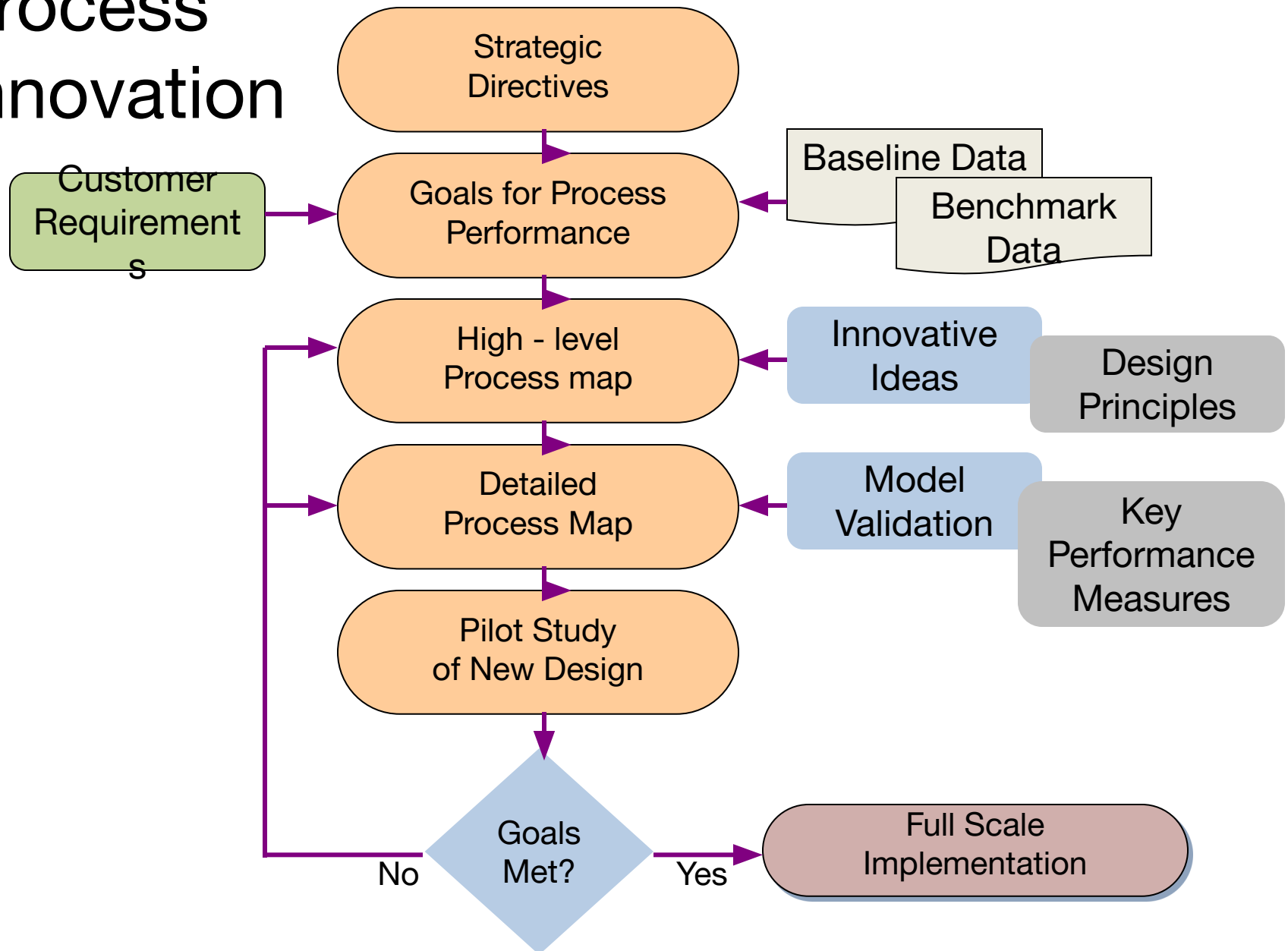
Total redesign of a process for breakthrough improvements



From Function to Process

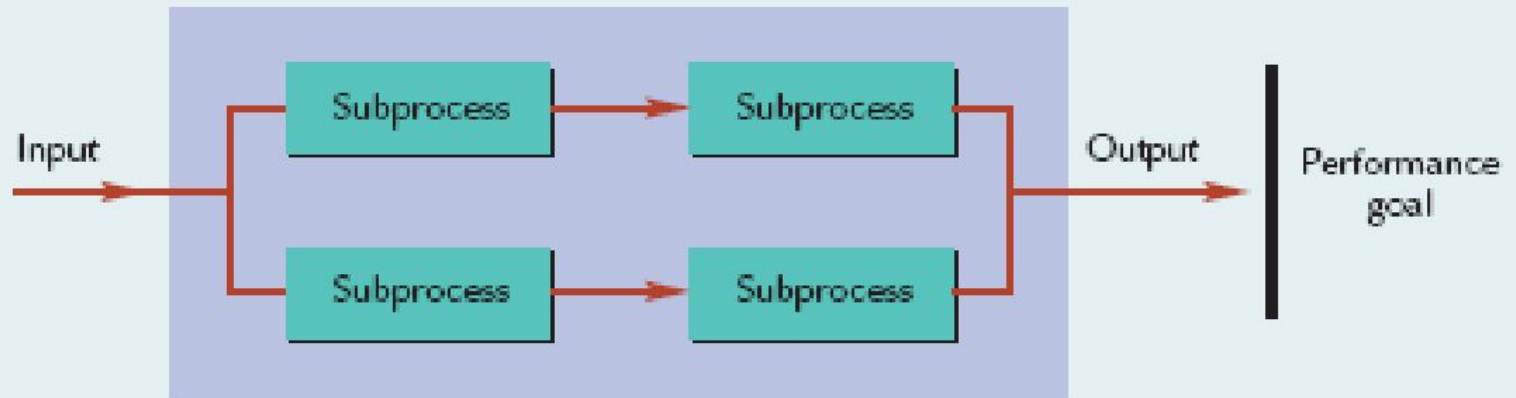


Process Innovation

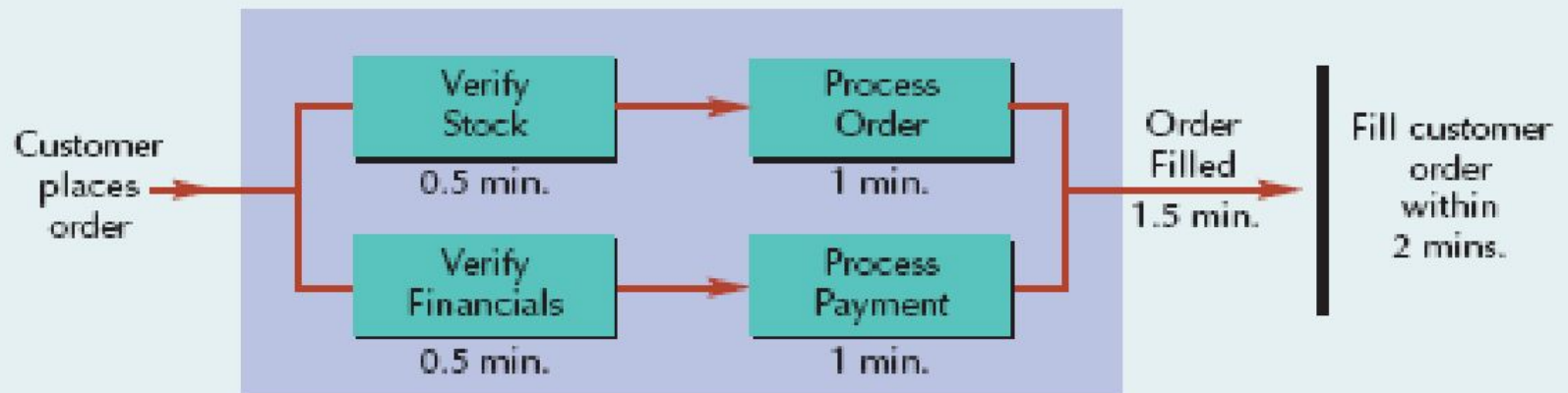


High-Level Process Map

(a) Generic



(b) Online Order Processing



Principles for Redesigning Processes

- Remove waste, simplify, and consolidate similar activities
- Link processes to create value
- Let the swiftest and most capable enterprise execute the process
- Flex process for any time, any place, any way
- Capture information digitally at the source and propagate it through process

Principles for Redesigning Processes

- Provide visibility through fresher and richer information about process status
- Fit process with sensors and feedback loops that can prompt action
- Add analytic capabilities to the process
- Connect, collect, and create knowledge around process through all who touch it
- Personalize process with preferences and habits of participants

Techniques for Generating Innovative Ideas

- Vary the entry point to a problem
 - in trying to untangle fishing lines, it's best to start from the fish, not the poles
- Draw analogies
 - a previous solution to an old problem might work
- Change your perspective
 - think like a customer
 - bring in persons who have no knowledge of process

Techniques for Generating Innovative Ideas

- Try inverse brainstorming
 - what would *increase* cost
 - what would *displease* the customer
- Chain forward as far as possible
 - if I solve this problem, what is the next problem
- Use attribute brainstorming
 - how would this process operate if. . .
 - our workers were mobile and flexible
 - there were no monetary constraints
 - we had perfect knowledge

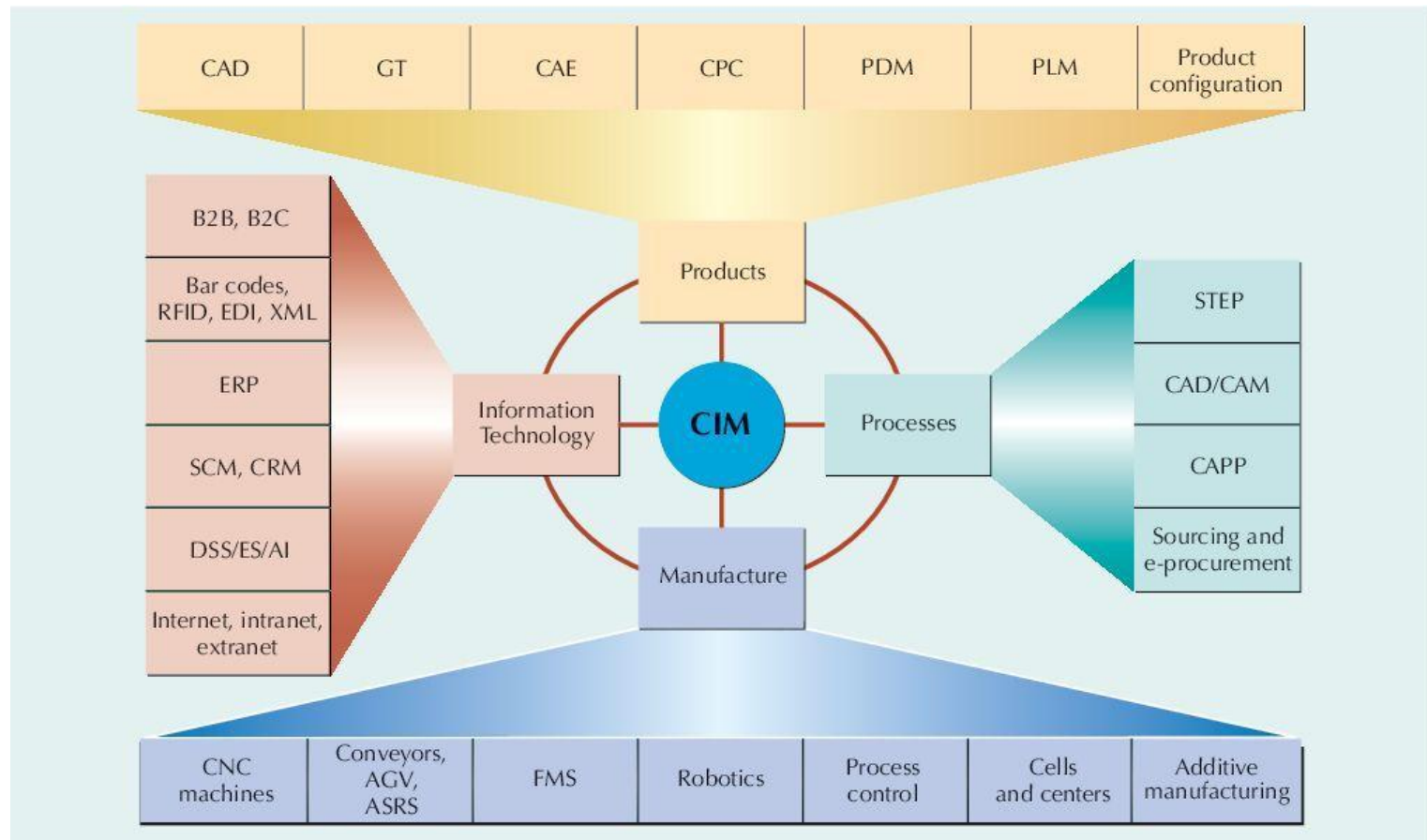
Financial Justification of Technology

- Purchase cost
 - Includes add-ons to make technology work
- Operating Costs
 - Visualize how the technology will be used
- Annual Savings
 - Better quality and efficiency save money
- Revenue Enhancement
 - New technology can enhance revenue

Financial Justification of Technology

- Replacement Analysis
 - When to upgrade to new technology depends on competitive environment
- Risk and Uncertainty
 - It is risky to invest and risky to
- Piecemeal Analysis
 - Make sure new and existing technology are compatible

Advanced Components of Manufacturing



Product Technology

- Computer-aided design (CAD)
 - Creates and communicates designs electronically
- Group technology (GT)
 - Classifies designs into families for easy retrieval and modification
- Computer-aided engineering (CAE)
 - Tests functionality of CAD designs electronically
- Collaborative product commerce (CPC)
 - Facilitates electronic communication and exchange of information among designers and suppliers

Product Technology

- Product data management (PDM)
 - Keeps track of design specs and revisions for the life of the product
- Product life cycle management (PLM)
 - Integrates decisions of those involved in product development, manufacturing, sales, customer service, recycling, and disposal
- Product configuration
 - Defines products “configured” by customers who have selected among various options, usually from a Web site

Process Technology

- Standard for exchange of product model data (STEP)
 - Set standards for communication among different CAD vendors; translates CAD data into requirements for automated inspection and manufacture
- Computer-aided design and manufacture (CAD/CAM)
 - Electronic link between automated design (CAD) and automated manufacture (CAM)
- Computer aided process (CAPP)
 - Generates process plans based on database of similar requirements
- E-procurement
 - Electronic purchasing of items from e-marketplaces, auctions, or company websites

Manufacturing Technology - 1

- Computer numerically control (CNC)
 - Machines controlled by software to perform a range of operations with the help of automated tool changers; collects processing information and quality data
- Flexible manufacturing system (FMS)
 - A collection of CNC machines connected by an automated material handling system to produce a wide variety of parts
- Robots
 - Programmable manipulators that can perform repetitive tasks; more consistent than workers but less flexible

Manufacturing Technology - 2

- **Conveyors**
 - Fixed-path material handling; move items along a belt or chain; “reads” package labels and diverts them to correct destination
- **Automatic guided vehicle (AGV)**
 - Driverless trucks that move material along a specified path; directed by wire or tape embedded in floor or by radio frequencies
- **Automated storage and retrieval system (ASRS)**
 - An automated warehouse; items placed in a storage system and retrieved by fast-moving stacker cranes; controlled by computer

Manufacturing Technology - 3

- Process Control
 - Continuous monitoring of automated equipment; makes real-time decisions on ongoing operation, maintenance, and quality
- Computer-integrated manufacturing (CIM)
 - Automated manufacturing systems integrated through computer technology; also called e-manufacturing
- Additive Manufacturing
 - Building up a product layer-by-layer from digital instructions, 3-D printing

Information Technology

- Business – to –Business (B2B)
 - E-transactions between businesses usually via the Internet
- Business – to –Consumer (B2C)
 - E-transactions between businesses and their customers usually via the Internet
- Internet
 - A global information system of computer networks that facilitates communication and data transfer
- Intranet
 - Communication networks internal to an organization; can also be password (i.e., firewall) protected sites on the Internet

Information Technology

- Extranet
 - Intranets connected to the Internet for shared access with select suppliers, customers, and trading partners
- Bar Codes
 - Series of vertical lines printed on packages that identify item and other information
- Radio Frequency Identification tags (RFID)
 - Integrated circuit embedded in a tag; can send and receive information; a “twenty-first century bar code” with read/write capabilities
- Electronic data interchange (EDI)
 - Computer-to-computer exchange of business documents over a proprietary network; very expensive and inflexible

Information Technology

- Extensible markup language (XML)
 - A markup language that facilitates computer-to-computer communication over the Internet by tagging data before its is sent
- Enterprise resource planning (ERP)
 - Software for managing key functions of an enterprise, including sales, marketing, finance, accounting, production, materials management & human resources
- Supply chain management (SCM)
 - Software to manage flow of goods and information among a network of suppliers, manufacturers and distributors
- Customer relationship management (CRM)
 - Software to manage interactions with customers; compiling and analyzing customer data

Information Technology

- Decision support systems (DSS)
 - Information system to help managers make decisions; includes quantitative modeling components and interactive components for what-if analysis
- Expert systems (ES)
 - A computer system that uses the knowledge of experts to diagnose or solve a problem
- Artificial intelligence (AI)
 - Field of study replicating elements of human thought and natural processes in software; includes expert systems, genetic algorithms, neural networks, and fuzzy logic