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Chapter 7
Process Strategy

Chapter 7 Learning Outcomes:

- Describe four production processes
- Compute crossover points for different processes
- Use the tools of process analysis
- Describe customer interaction in process design
- Identify recent advances in production technology
- Understand Capacity & Bottleneck analysis (from Supplement 7)

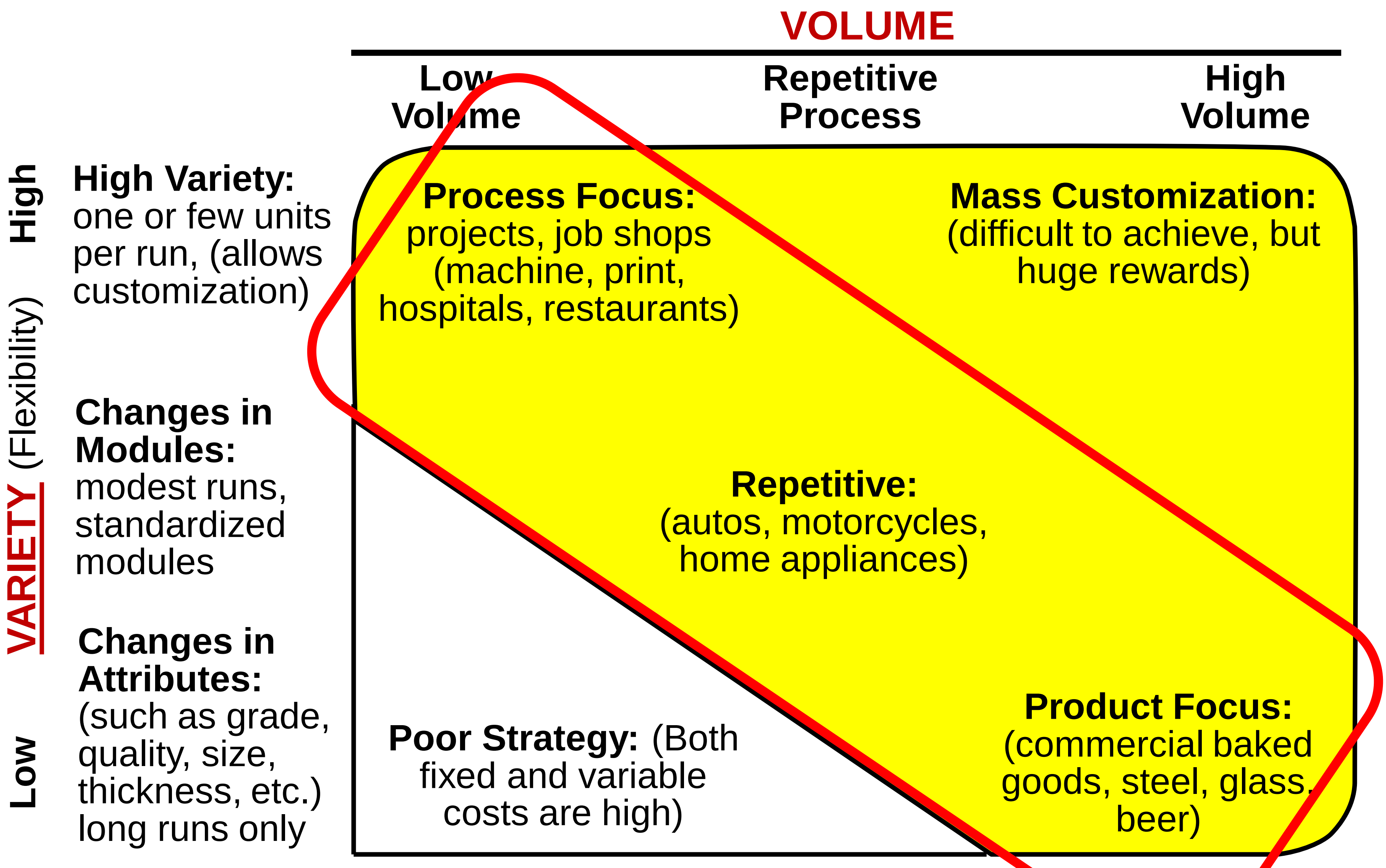
Process Strategies

- Process strategies: an organization's approach to transforming resources into goods and services

  - Four process strategies:
    1. Process focus
    2. Repetitive focus
    3. Product focus
    4. Mass customization

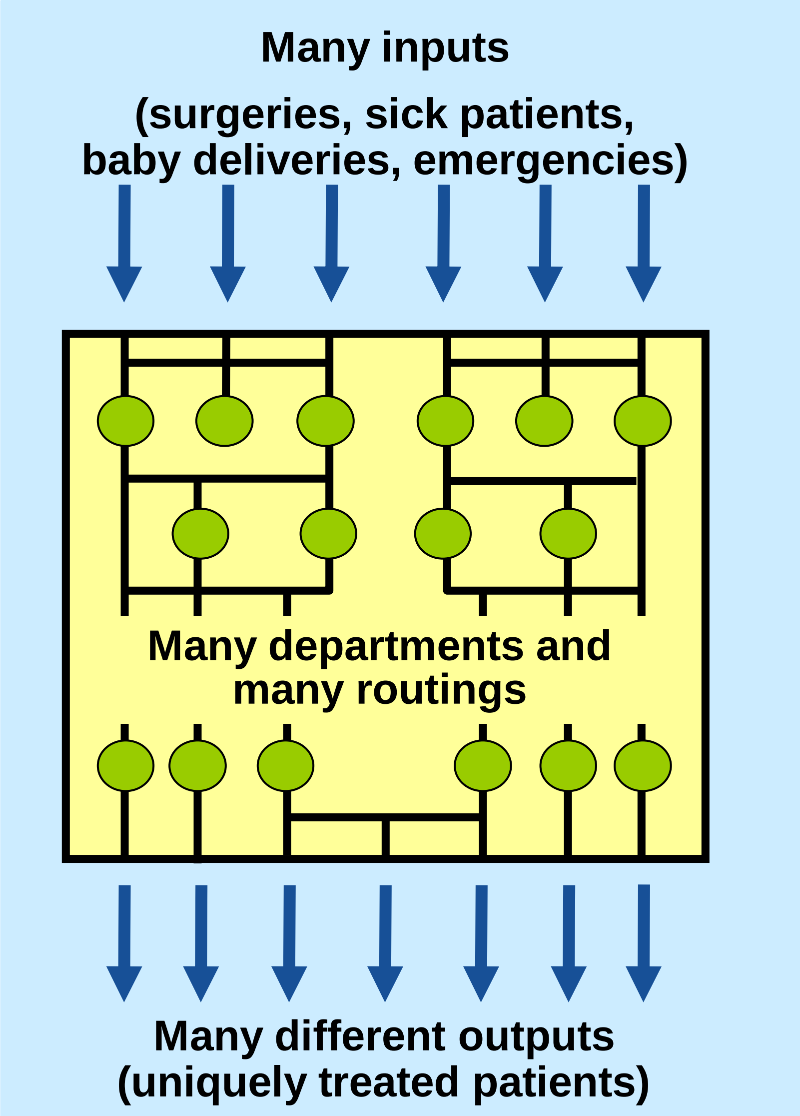
  - Within these basic strategies there are many ways they may be implemented

Product-Process Matrix



1. Process Focus

- <u>Process focus</u>: a production facility organized around processes to facilitate low-volume, high variety production
- Features:
  - Facilities are organized around specific activities or processes
  - General purpose equipment and skilled personnel
  - High degree of product flexibility
  - Typically high costs and low equipment utilization
  - Product flows may vary considerably making planning and scheduling a challenge
- Example: Arnold Palmer Hospital



2. Repetitive Focus

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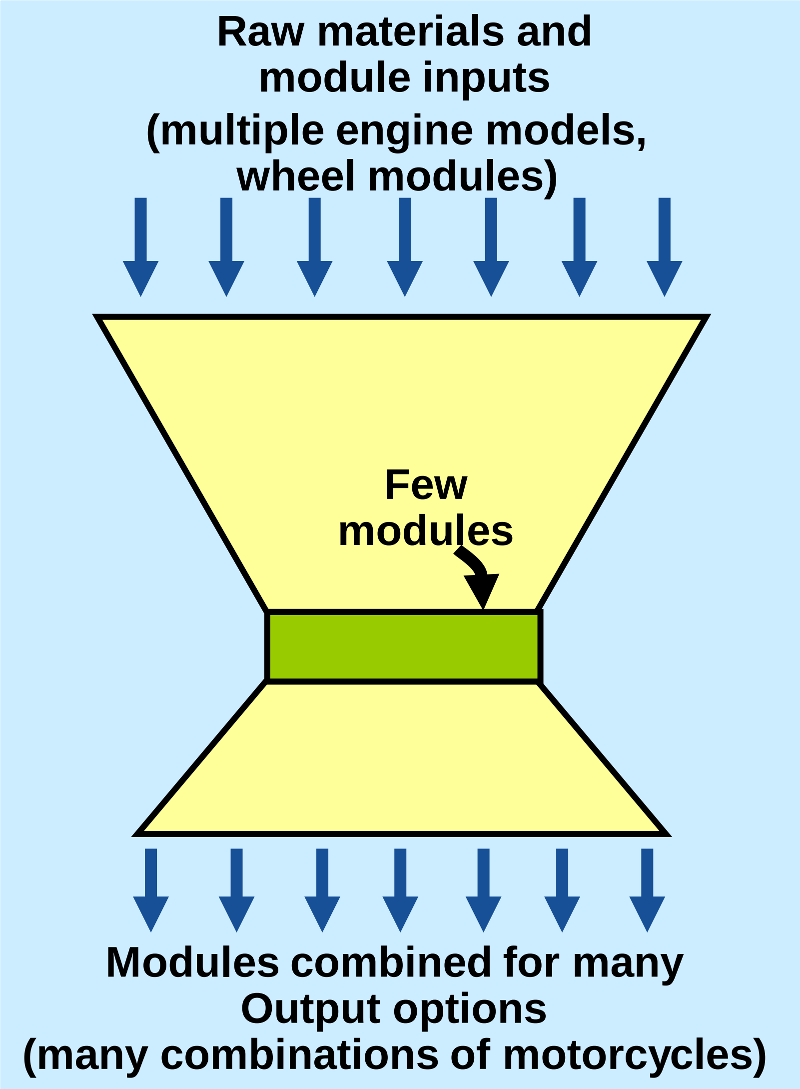
- Repetitive focus: a product-oriented production process that uses modules
  - Modules: parts or components of a product previously prepared, often in a continuous process
- Features:
  - Facilities often organized as assembly lines
  - Characterized by modules with parts and assemblies made previously
  - Modules may be combined for many output options
  - Less flexibility than process-focused facilities but more efficient
- Example: Harley-Davidson



3. Product Focus

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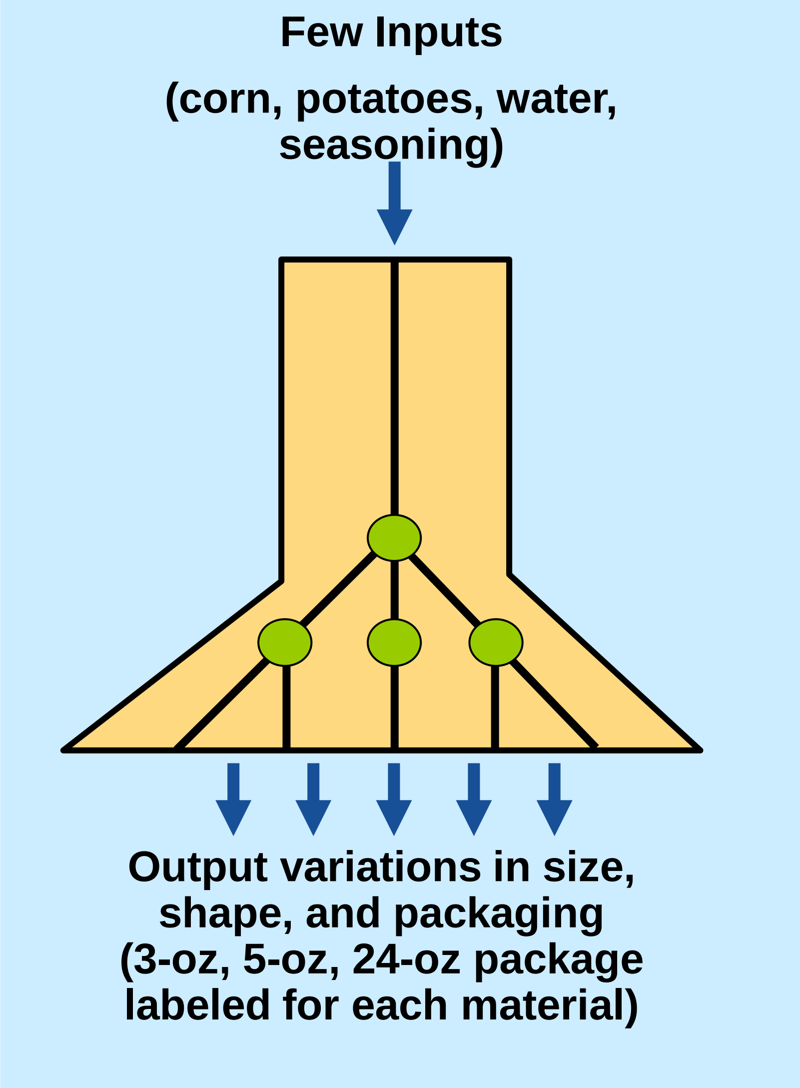
- Product focus: a facility organized around products; a product-oriented, high-volume, low variety process
- Features:
  - Facilities are organized by product
  - High volume but low variety of products
  - Long, continuous production runs enable efficient processes
  - Typically high fixed cost but low variable cost
  - Generally less skilled labor
- Example: Frito-Lay



4. Mass Customization

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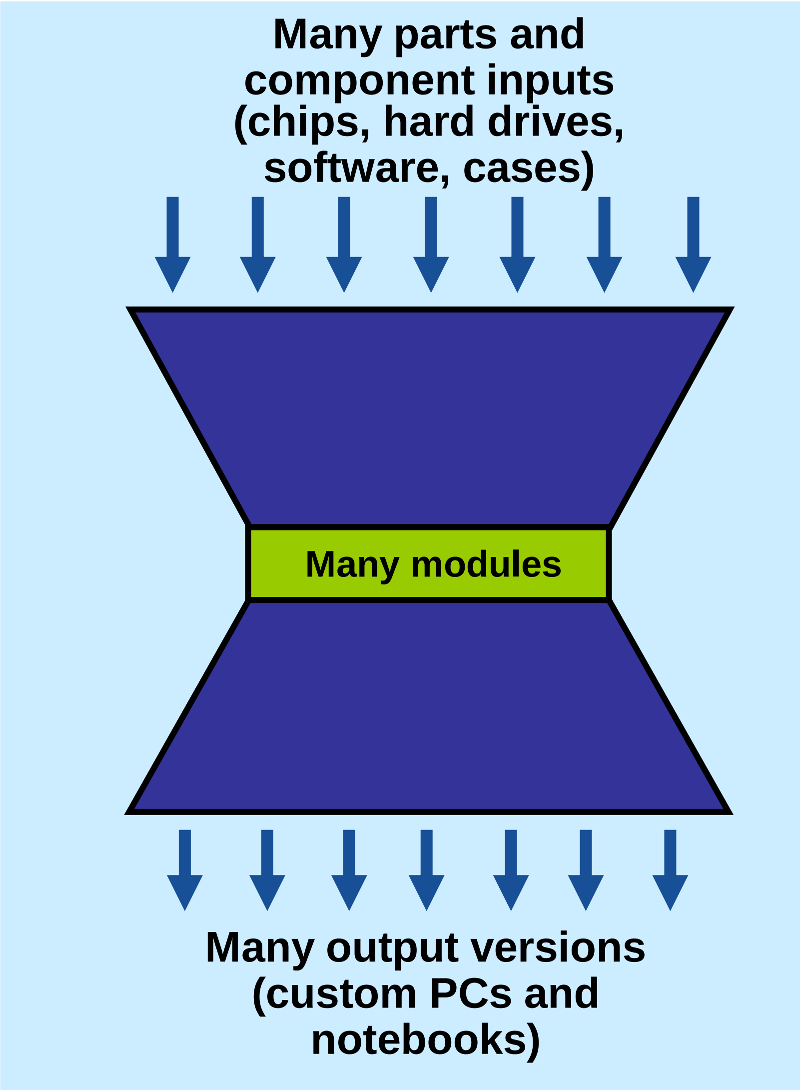
- Mass customization: rapid, low-cost production that caters to constantly changing unique customer desires
- Features:
  - Imaginative and fast product design
  - Rapid process design
  - Tightly controlled inventory management
  - Tight schedules
  - Responsive supply chain partners
- Example: Dell Computer



Comparison of Processes

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1. PROCESS FOCUS (LOW-VOLUME, HIGH-VARIETY)	2. REPETITIVE FOCUS (MODULAR)	3. PRODUCT FOCUS (HIGH-VOLUME, LOW-VARIETY)	4. MASS CUSTOMIZATION (HIGH-VOLUME, HIGH-VARIETY)
• Small quantity and large variety of **products**	• Long runs, usually a standardized product from modules	• Large quantity and small variety of products	• Large quantity and large variety of products
• Broadly **skilled operators**	• Moderately trained employees	• Less broadly skilled operators	• Flexible operators
• **Instructions** for each job	• Few changes in the instructions	• Standardized job instructions	• Custom orders requiring many job instructions
• High **inventory**	• Low inventory	• Low inventory	• Low inventory relative to value the product

Comparison of Processes

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1. PROCESS FOCUS (LOW-VOLUME, HIGH-VARIETY)	2. REPETITIVE FOCUS (MODULAR)	3. PRODUCT FOCUS (HIGH-VOLUME, LOW-VARIETY)	4. MASS CUSTOMIZATION (HIGH-VOLUME, HIGH-VARIETY)
• **Finished goods** are made to order and not stored	• Finished goods are made to frequent forecasts	• Finished goods are made to a forecast and stored	• Finished goods are Build to Order (BTO)
• **Scheduling** is complex	• Scheduling is routine	• Scheduling is routine	• Sophisticated scheduling accommodates custom orders
• **Fixed costs** are low and variable costs high	• Fixed costs are dependent on flexibility of the facility	• Fixed costs are high and variable costs low	• Fixed costs tend to be high and variable costs low

Crossover Analysis

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- Crossover analysis: an approach to choosing among alternative processes or equipment
  - At any given volume, only one process will have the lowest cost

VC_A = Variable cost/unit (Option A), FC_A = fixed costs (Option A)
VC_B = Variable cost/unit (Option B), FC_B = fixed costs (Option B)
VC_C = Variable cost/unit (Option C), FC_C = fixed costs (Option C)

Total cost of Option A: $(VC_A)Q + FC_A$
Total cost of Option B: $(VC_B)Q + FC_B$
Total cost of Option C: $(VC_C)Q + FC_C$
Q = quantity produced, Crossover quantity, Q*:

$$Q^*_{A-B} = \frac{FC_B - FC_A}{VC_A - VC_B} \qquad Q^*_{B-C} = \frac{FC_C - FC_B}{VC_B - VC_C}$$

Crossover Example

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- Evaluate three different accounting software products
- Calculate crossover points between software A and B and between software B and C

PRODUCT	TOTAL FIXED COST	VARIABLE COST PER UNIT
Software A	$200,000	$60
Software B	$300,000	$25
Software C	$400,000	$10

$$Q^*_{A-B} = \frac{FC_B - FC_A}{VC_A - VC_B}$$

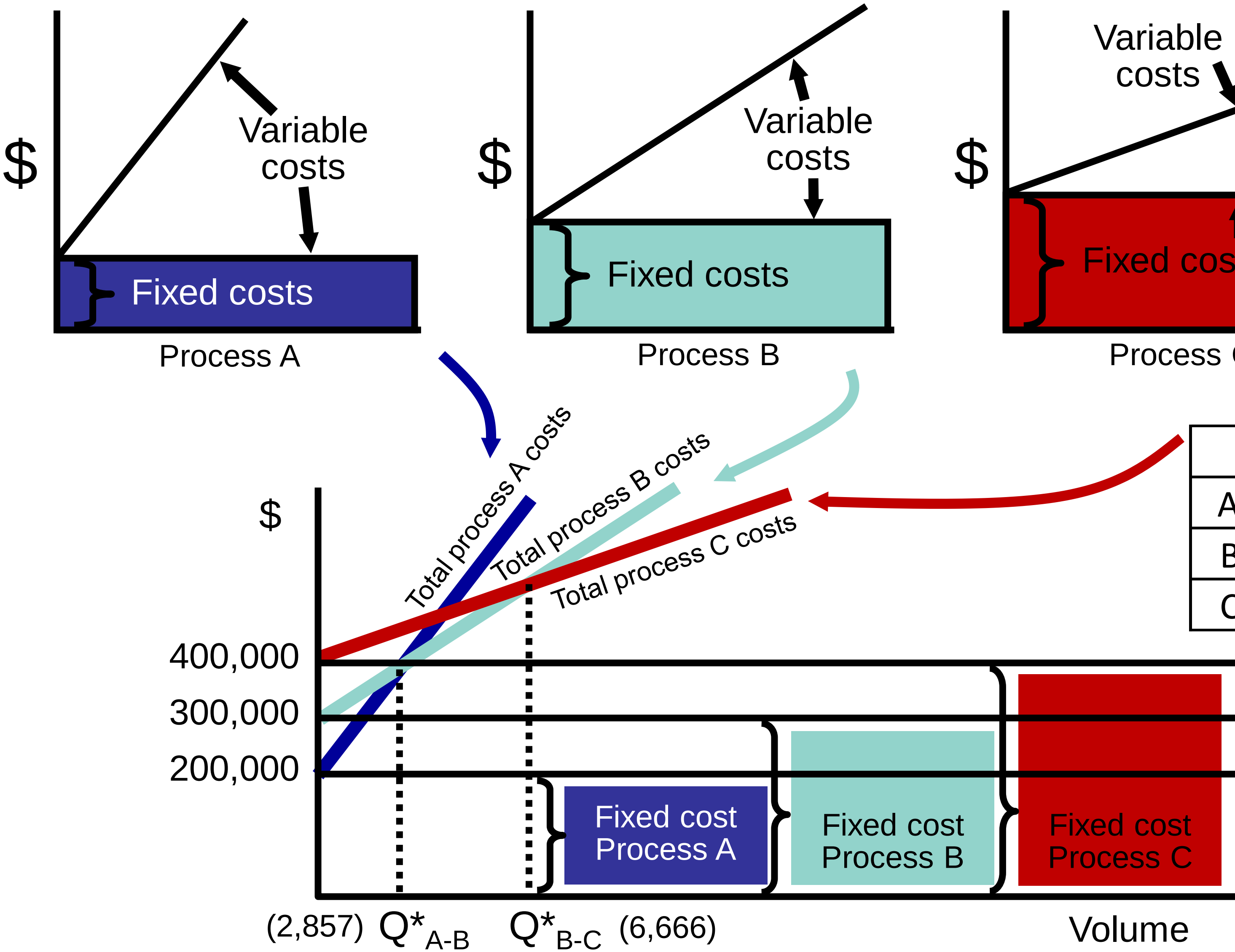
$$Q^*_{B-C} = \frac{FC_C - FC_B}{VC_B - VC_C}$$

$$Q^*_{A-B} = \frac{300{,}000 - 200{,}000}{60 - 25} = \frac{100{,}000}{35} = 2857$$

$$Q^*_{B-C} = \frac{400{,}000 - 300{,}000}{25 - 10} = \frac{100{,}000}{15} = 6666$$

Crossover points: $Q^*_{A\text{-}B}$ = 2857 units, $Q^*_{B\text{-}C}$ = 6666 units

Crossover Example



	Fixed	Variable
A	200,000	$60
B	300,000	$25
C	400,000	$10

Q: If we need to purchase 5000 units, which is the best choice?

Ans: Process B

Process Analysis and Design

- When analyzing and designing processes, ask
  - Is the process designed to achieve competitive advantage?
  - Does the process eliminate steps that do not add value?
  - Does the process maximize customer value as perceived by the customer?
  - Will the process win orders?

- Process analysis and design tools
  - Flow charts
  - Time-function mapping
  - Value-stream mapping
  - Process charts
  - Service blueprinting

Flow Charts

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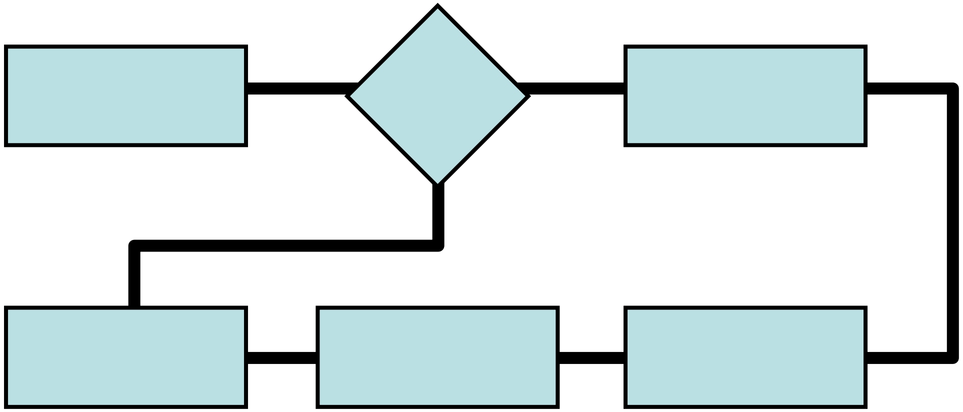
- Flow charts: shows the movement of materials



Time-Function Map
(or Process Map)

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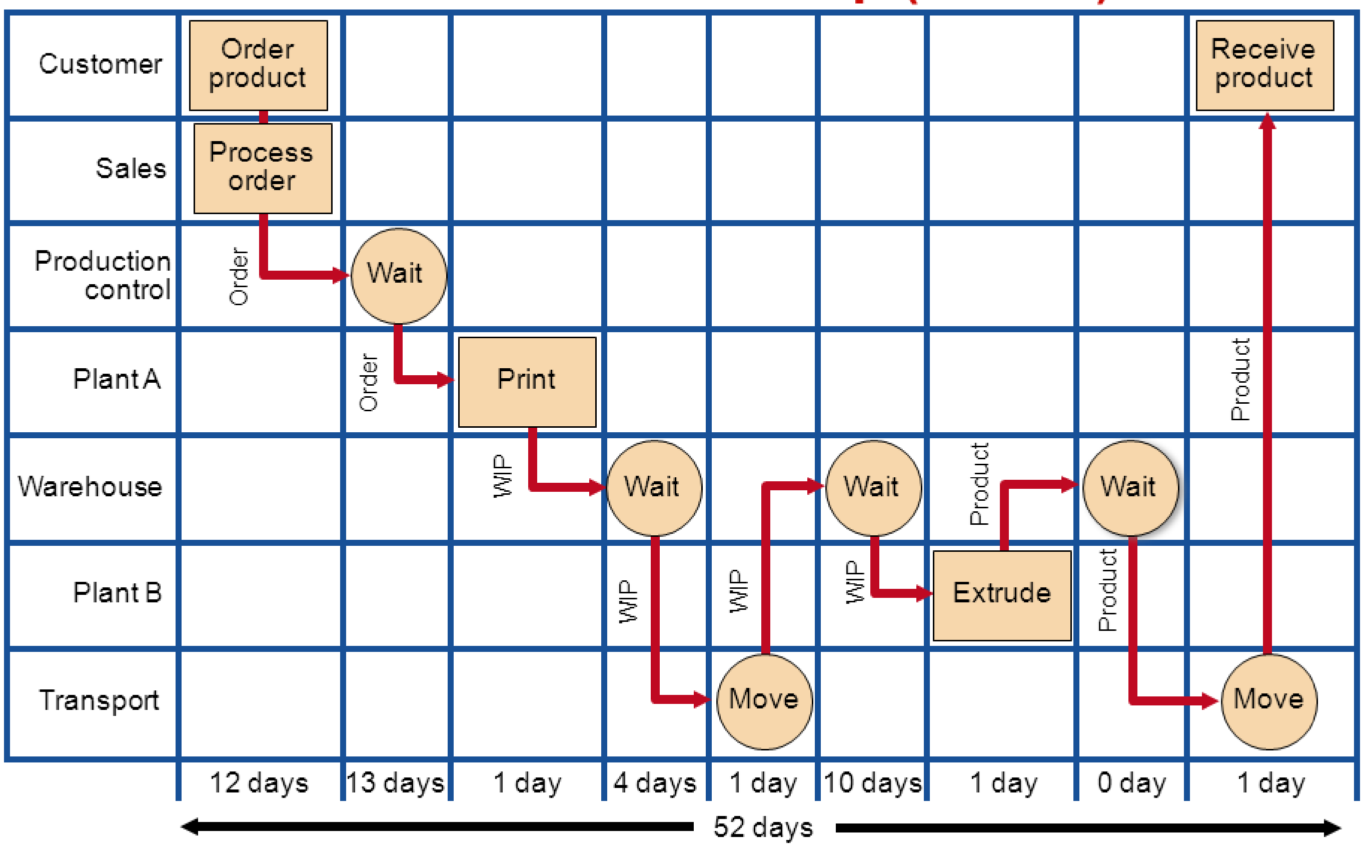
- Time-function mapping: shows flows and time frame

"Baseline" Time-Function Map (Before)



Time-Function Map (or Process Map)

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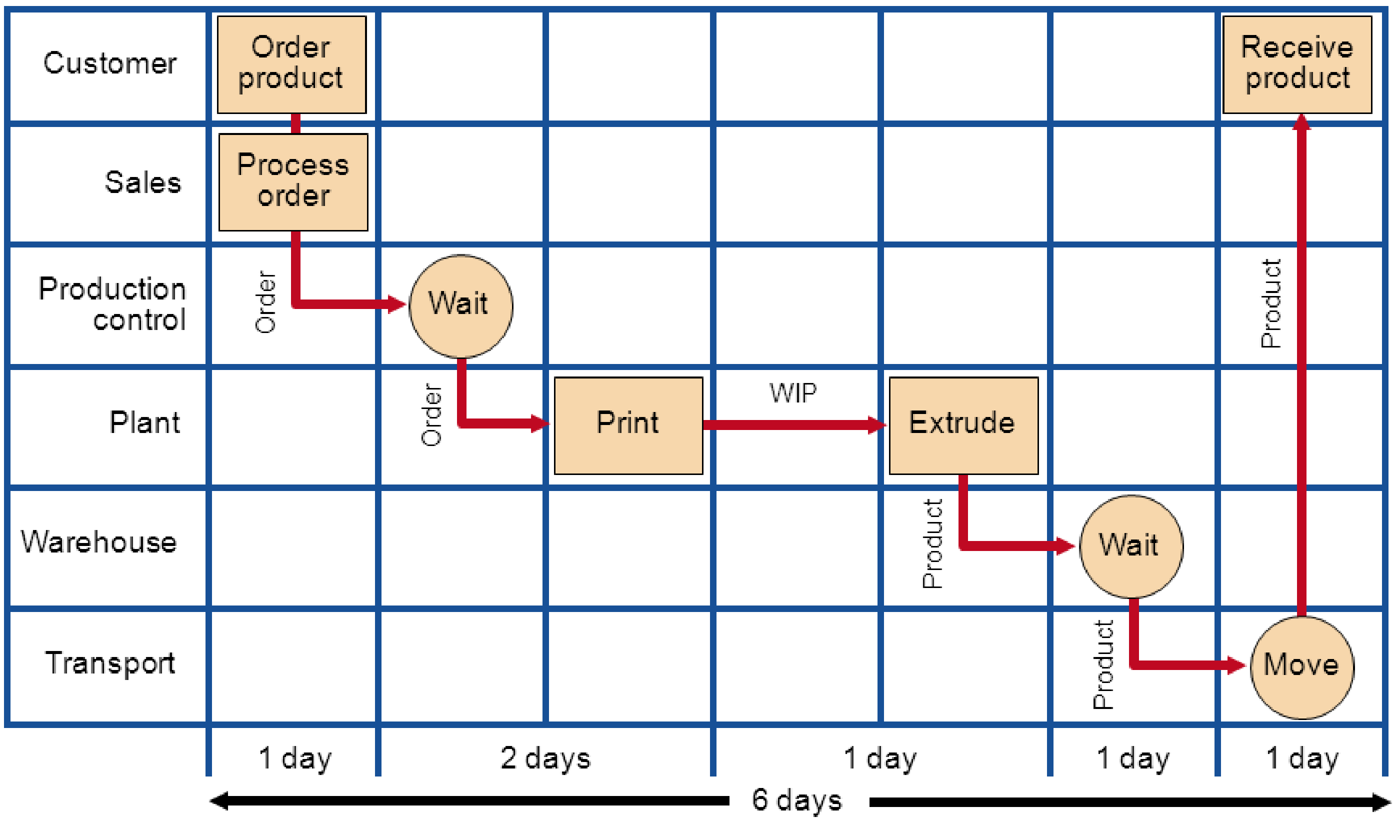
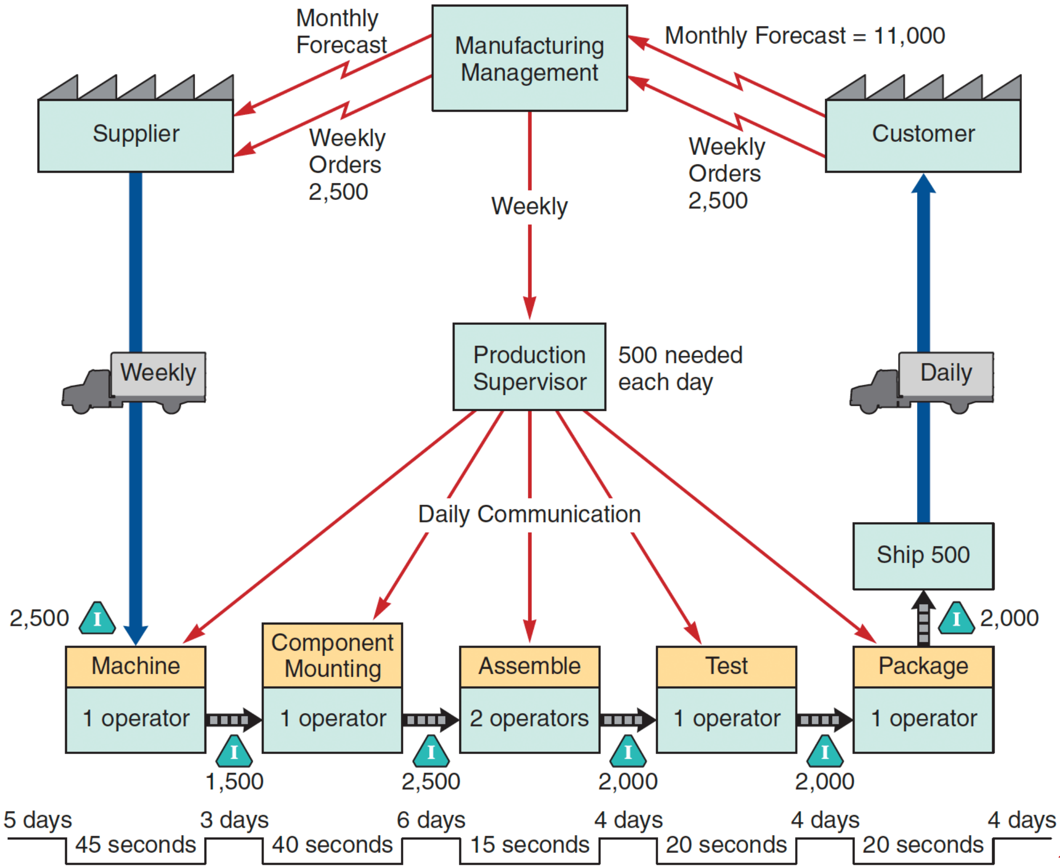
“Target” Time-Function Map (After)



Value-Stream Mapping



- <u>Value-stream mapping</u>: shows flows and time and value added beyond the immediate organization

Non-value added = 26 days

Value added = 140 seconds

Process Chart

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- <u>Process charts</u>: uses symbols to show key activities

Present Method ☒ PROCESS CHART Proposed Method ☐

SUBJECT CHARTED *Hamburger Assembly Process* DATE *8 / 1 / 10*

DEPARTMENT ______ CHART BY *KH* SHEET NO. *1* OF *1*

DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
	—	○ ⇨ □ D ▽	*Meat Patty in Storage*
1.5	*.05*	○ ⇨ □ D ▽	*Transfer to Broiler*
	2.50	○ ⇨ □ D ▽	*Broiler*
	.05	○ ⇨ □ D ▽	*Visual Inspection*
1.0	*.05*	○ ⇨ □ D ▽	*Transfer to Rack*
	.15	○ ⇨ □ D ▽	*Temporary Storage*
.5	*.10*	○ ⇨ □ D ▽	*Obtain Buns, Lettuce, etc.*
	.20	○ ⇨ □ D ▽	*Assemble Order*
.5	*.05*	○ ⇨ □ D ▽	*Place in Finish Rack*
		○ ⇨ □ D ▽	
3.5	*3.15*	*2 4 1 – 2*	TOTALS

Value-added time = Operation time/Total time = (2.50+.20)/3.15 = 85.7%

○ = operation; ⇨ = transportation; □ = inspection; D = delay; ▽ = storage.

Service Blueprinting

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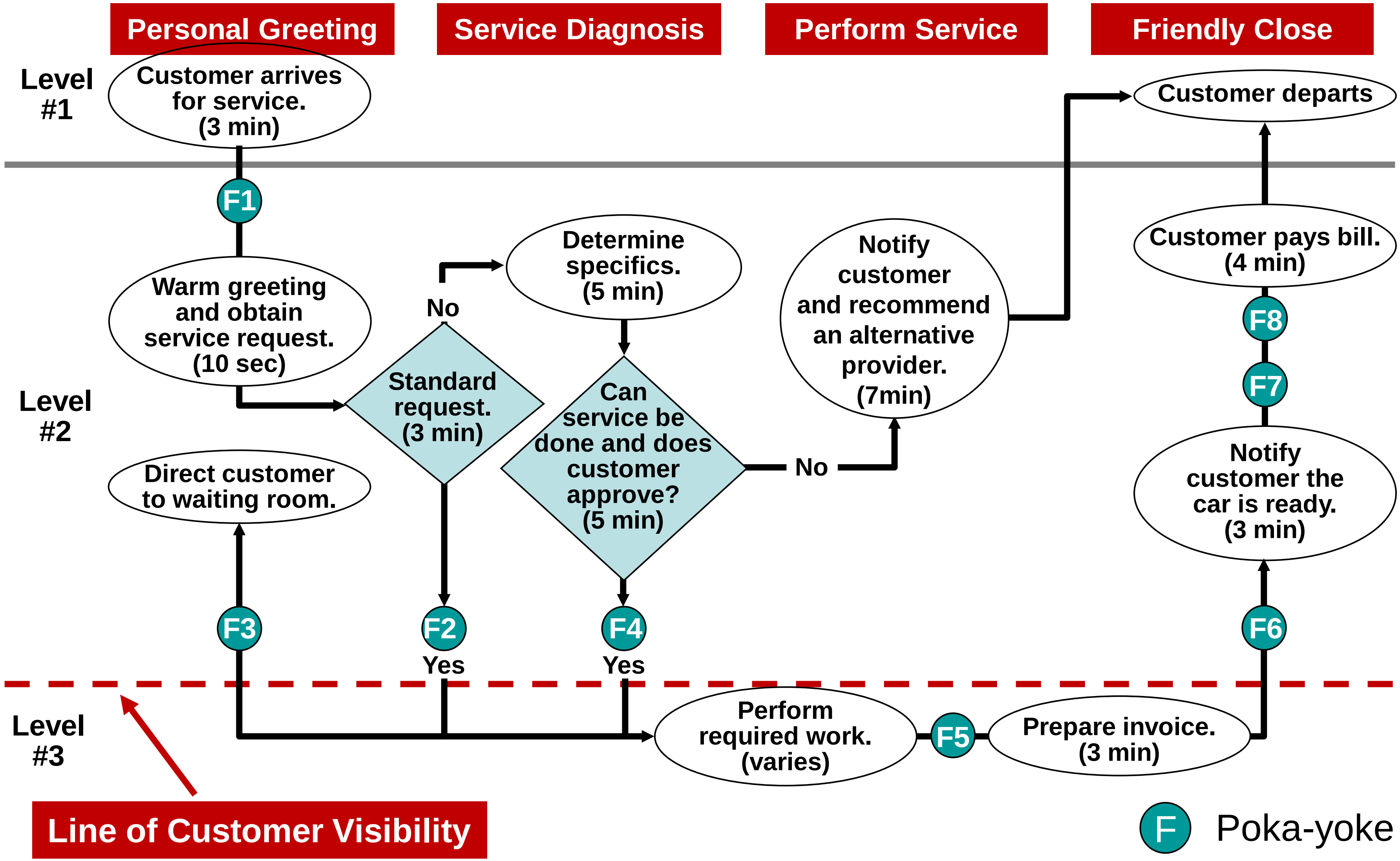
- Service blueprinting: a process analysis technique that lends itself to a focus on the customer and the provider's interaction with the customer
  - Focuses on the customer and provider interaction
  - Defines three levels of interaction
    - Level 1: customer is in control
    - Level 2: customer may interact with service provider
    - Level 3: service is removed from customer's control and interaction
  - Each level has different management issues
  - Identifies potential failure points
    - Poka-yokes: literally translated "foolproof"; a procedure that blocks the inevitable mistake from becoming a defect

Service Blueprint



Special Considerations for Service Process Design

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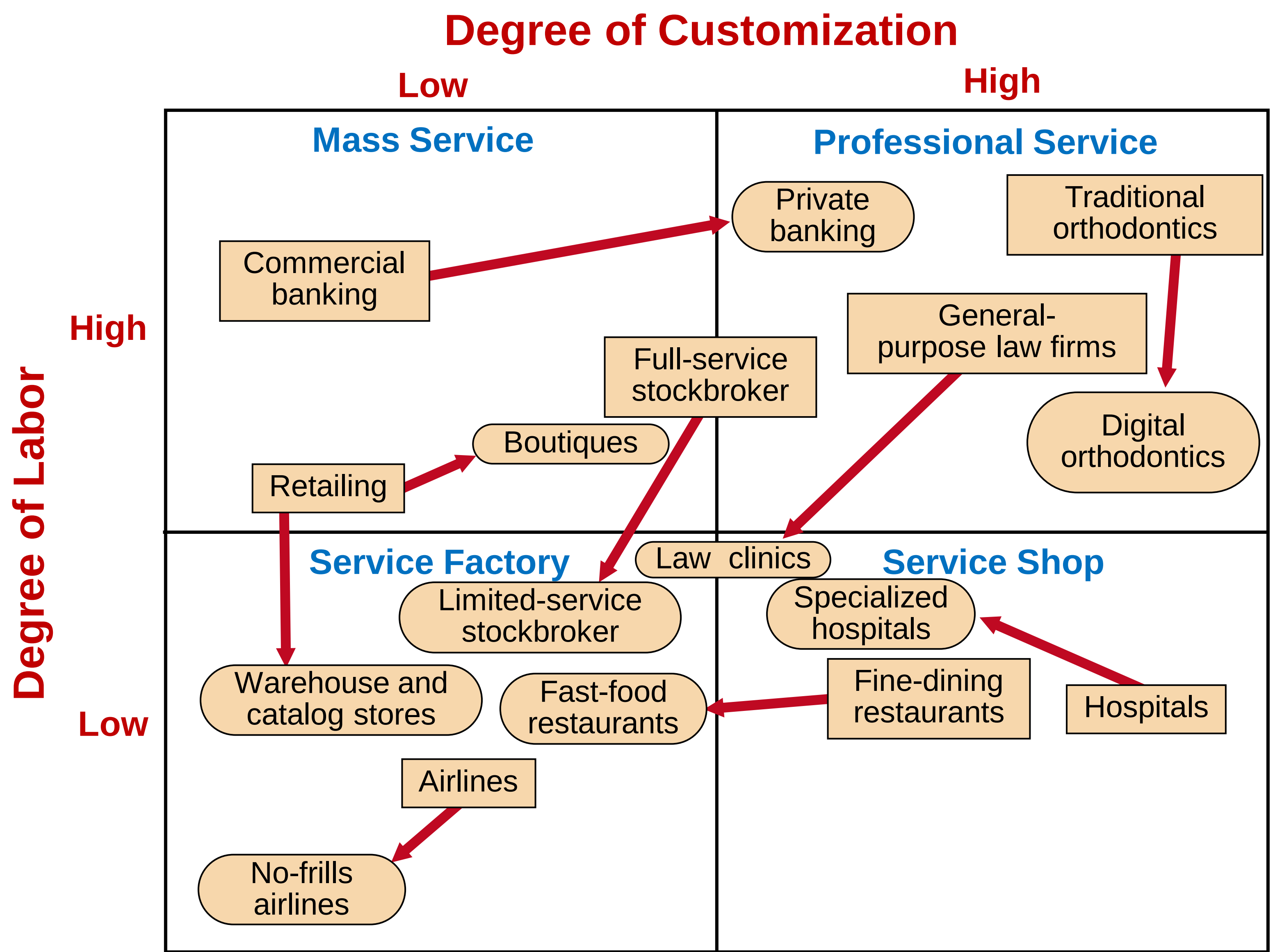
- Service process design
  - Some interaction with customer is necessary, but this often affects performance adversely
  - The better these interactions are accommodated in the process design, the more efficient and effective the process
  - Find the right combination of cost and customer interaction using Service Process Matrix
    - Mass Service and Professional Service
    - Service Factory and Service Shop

Service Process Matrix



Techniques for Improving Service Productivity

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STRATEGY	TECHNIQUE	EXAMPLE
Separation	*Structuring service* so customers must go where the service is offered	Bank customers go to a manager to open a new account, to loan officers for loans, and to tellers for deposits
Self-service	*Self-service* so customers examine, compare, and evaluate at their own pace	Supermarkets and department stores
Postponement	*Customizing* at delivery	Customizing vans at delivery rather than at production
Focus	*Restricting* the offerings	Limited-menu restaurant
Modules	*Modular* selection of service *Modular* production	Investment and insurance selection Prepackaged food modules in restaurants
Automation	*Separating* services that may lend themselves to some type of automation	Automatic teller machines
Scheduling	Precise personnel *scheduling*	Scheduling ticket counter personnel at 15-minute intervals at airlines
Training	*Clarifying* the service options *Explaining how to avoid problems*	Investment counselor, funeral directors. After-sale maintenance personnel

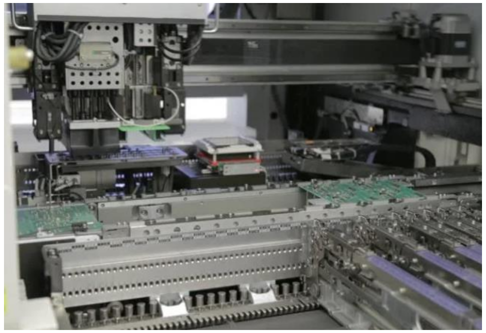
Production Technology

- Decisions about equipment and technology are often complex
- Possible competitive advantage
  - Stable processes
  - Flexibility: ability to respond with little penalty in time, cost or customer value

- Production Technology
  - Machine technology
  - Automatic Identification Systems
  - Process control
  - Vision system
  - Robots
  - Automated Storage and Retrieval Systems
  - Automated Guided Vehicles
  - Flexible Manufacturing Systems
  - Computer-Integrated Manufacturing

Machine Technology

- Machine technology
  - Increased precision
  - Increased productivity
  - Increased flexibility
  - Improved environmental impact
  - Reduced changeover time
  - Decreased size
  - Reduced power requirements



Automatic Identification Systems

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- Automatic Identification System (AIS): a system for transforming data into electronic form, for example, bar codes
  - Improved data acquisition
  - Reduced data entry errors
  - Increased speed
  - Increased scope of process automation

- Radio Frequency Identification (RFID): a wireless system in which integrated circuits with antennas send radio waves

QR Code

5901234123457

Bar Code

Process Control

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- Process control: the use of information technology to control a physical process
  - Sensors collect data
  - Devices read data on periodic basis
  - Measurements translated into digital signals then sent to a computer
  - Computer programs analyze the data
  - Resulting output may take numerous forms

Vision Systems

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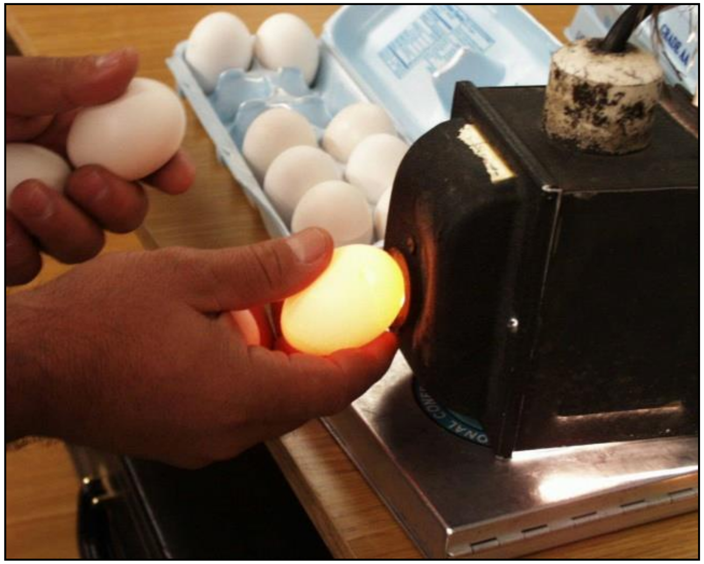

- Vision systems: systems that use video cameras and computer technology in inspection roles
  - Particular aid to inspection
  - Consistently accurate
  - Never bored
  - Modest cost
  - Superior to individuals performing the same tasks

Robots

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- Robot: a flexible machine with the ability to hold, move or grab items. It functions through electronic impulses that activate motors and switches
  - Perform monotonous or dangerous tasks
  - Perform tasks requiring significant strength or endurance
  - Generally enhanced consistency and accuracy

Automated Systems

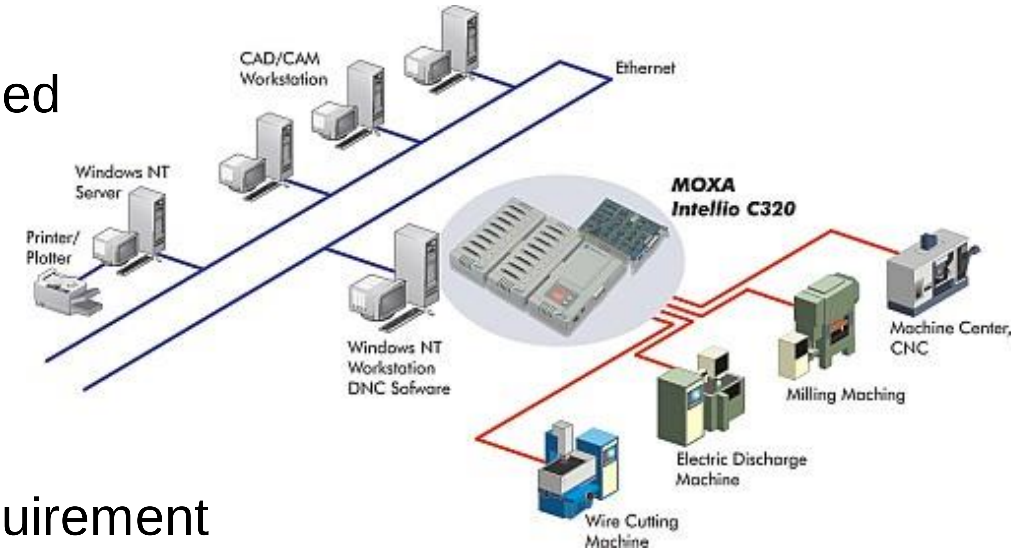
- Automated Storage and Retrieval System (ASRS): computer-controlled warehouse that provide for the automatic placement of parts into and form designated places within a warehouse
  - Reduced errors and labor
  - Particularly useful in inventory and test areas of manufacturing firms

Automated Guided Vehicle (AGV): electronically guided and controlled cart used to move materials

- Used for movement of products and/or individuals

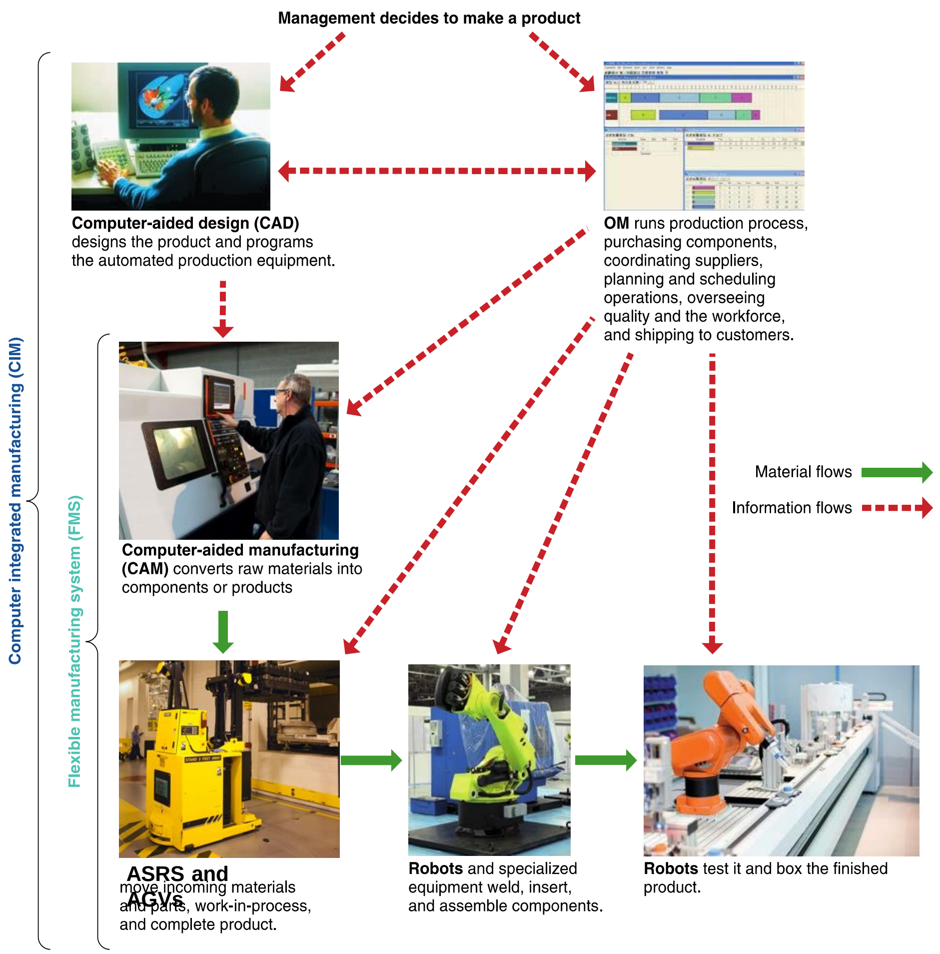
Flexible Manufacturing Systems

- Flexible Manufacturing System (FMS): a system that uses an automated work cell controlled by electronic signal from a common centralized computer facility
  - Computer controls both the workstation and the material handling equipment
  - Enhance flexibility and reduced waste
  - Can economically produce low volume at high quality
  - Reduced changeover time and increased utilization
  - Stringent communication requirement between components



Computer-Integrated Manufacturing (CIM)

- CIM: a manufacturing system in which CAD, FMS, inventory control, warehousing and shipping are integrated
  - Extension of flexible manufacturing systems
    - Backwards to engineering and inventory control
    - Forward into warehousing and shipping
  - Reducing the distinction between low-volume/high-variety, and high-volume/low-variety production



Examples of Technology's Impact on Services

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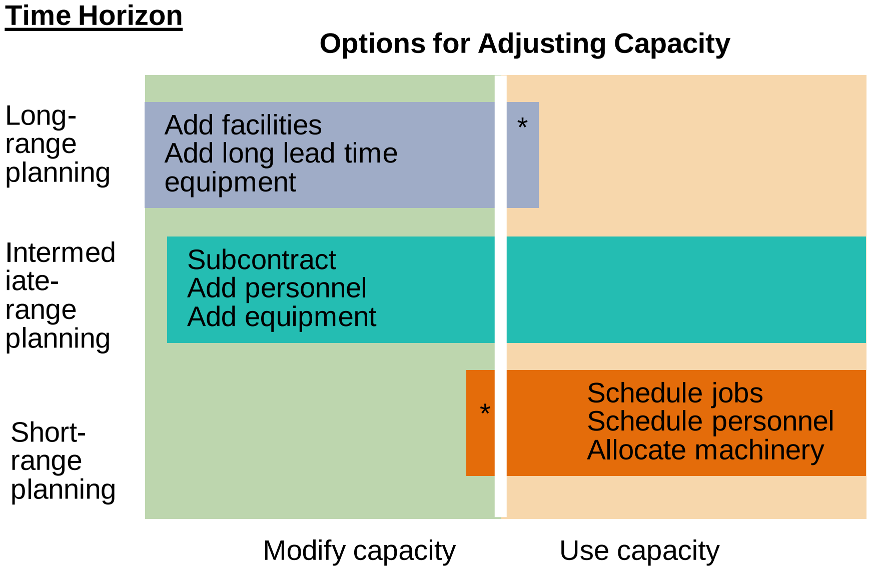
Service Industry	Example
Financial Services	Debit cards, electronic funds transfer, ATMs, Internet stock trading, on-line banking via cell phone
Education	Electronic bulletin boards, on-line journals, WebCT, Canvas and smart phones
Utilities and government	Automated one-man garbage trucks, optical mail and bomb scanners, flood warning systems, meters allowing homeowners to control energy usage and costs
Restaurants and foods	Wireless orders from waiters to kitchen, robot butchering, transponders on cars that track sales at drive-throughs
Communications	Interactive TV, ebooks via Kindle 2
Hotels	Electronic check-in/check-out, electronic key/lock system, mobile web booking
Wholesale/retail trade	ATM-like kiosks, point-of-sale (POS) terminals, e-commerce, electronic communication between store and supplier, bar coded data, RFID
Transportation	Automatic toll booths, satellite-directed navigation systems, WiFi in automobile
Health care	Online patient-monitoring, online medical information systems, robotic surgery
Airlines	Ticketless travel, scheduling, Internet purchases, boarding passes two-dimensional bar codes on smart phones

Process Redesign

- Process redesign: the fundamental rethinking of business processes to bring about dramatic improvements in performance
  - Relies on reevaluating the purpose of the process and questioning both the purpose and the underlying assumptions
  - Requires reexamination of the basic process and its objectives
  - Focuses on activities that cross functional lines
  - Any process is a candidate for redesign

Supplement Ch7: Capacity

- Capacity is the throughput, or the number of units a facility can hold, receive, store, or produce in a period of time.
- Determines if demand can be satisfied
- Three-time horizons

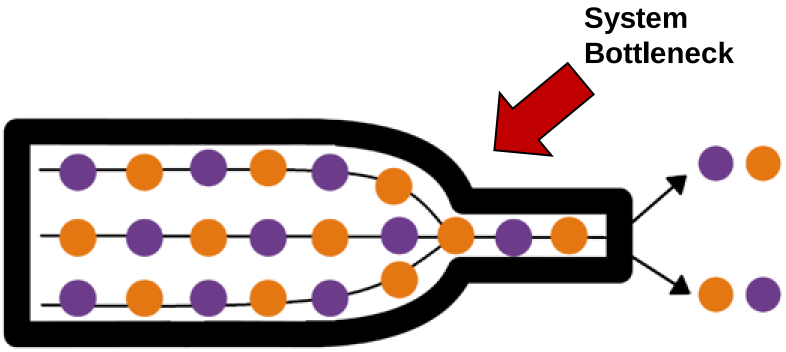


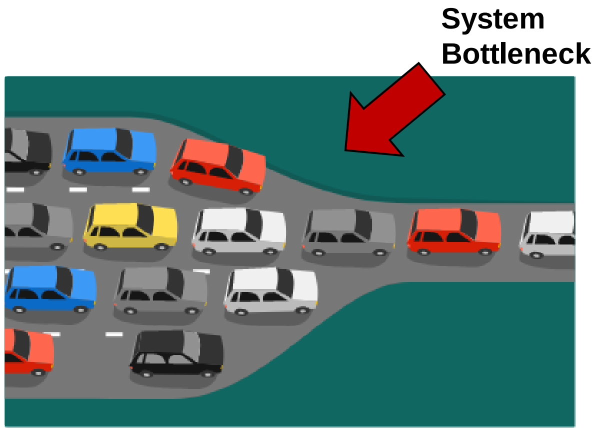
*** Difficult to adjust capacity as limited options exist**

Bottleneck Analysis

- <u>Bottleneck:</u> is the limiting factor or constraint in a system
  - A bottleneck has the lowest effective capacity in a system
  - The bottleneck limits the systems total output

- <u>Capacity analysis:</u> determines the throughput capacity of workstations in a system
  - Each work area can have its own unique capacity

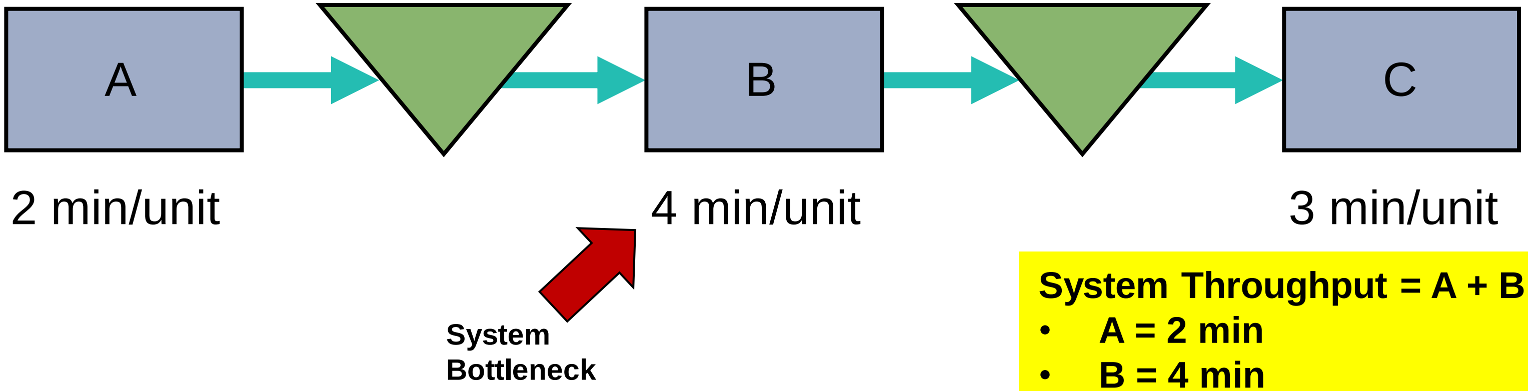




Bottleneck Analysis

- The bottleneck time is the time of the slowest workstation (the one that takes the longest) in a production system

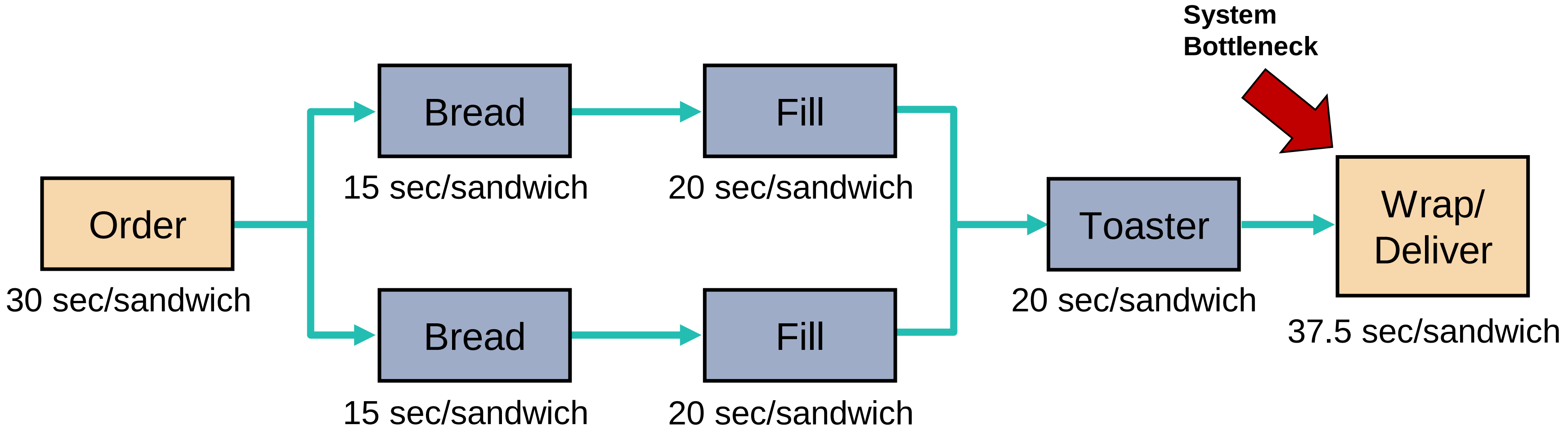
- The throughput time is the time it takes a unit to go through production from start to end



System Throughput = A + B + C
- **A = 2 min**
- **B = 4 min**
- **C = 3 min**
  - **Total = 9 minutes**

Capacity Analysis

- Two identical sandwich lines
- Lines have two workers and three operations (order, build, wrap)
- All completed sandwiches are wrapped



System Throughput = Order + Bread + Fill + Toaster + Wrap

- **Total = 30 seconds + 15 + 20 + 20 + 37.5 = 122.5 seconds**

Capacity Analysis, continued

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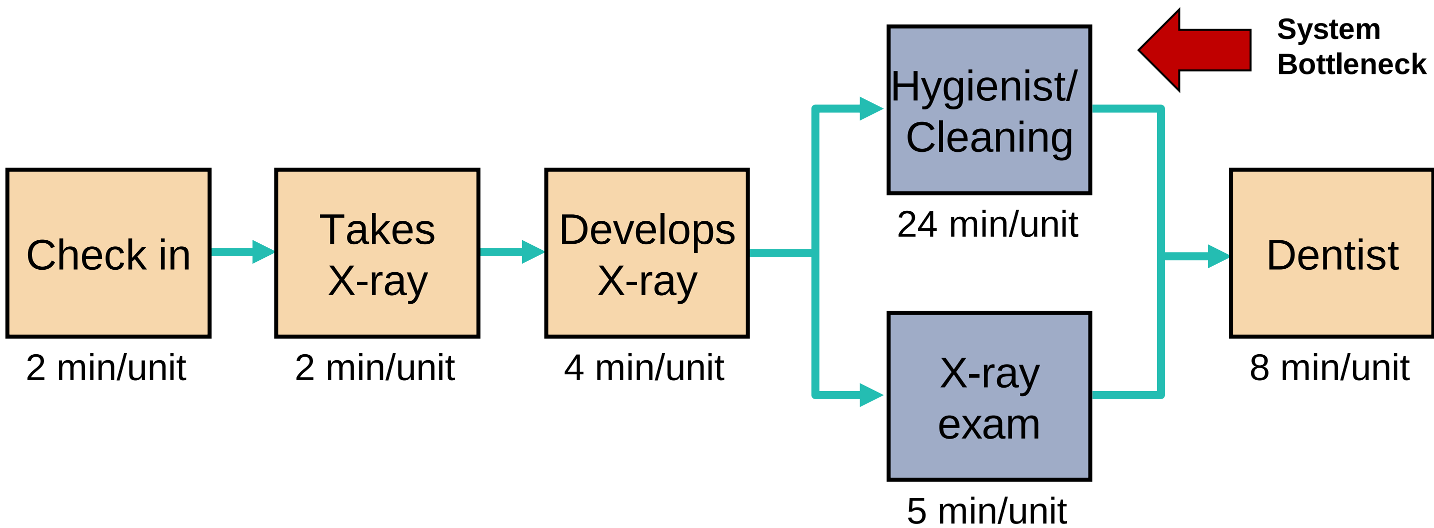
- Standard process for cleaning teeth
- Cleaning and examining X-rays can happen simultaneously



System Throughput = Check in + Take X-Ray + Develop X-ray + Hygienist + Dentist + Check out

- **Total = 2 min + 2 + 4 + 24 + 8 + 6 = 46 minutes**

Process Design and Resource Utilization

- Utilization (U): the fraction of time a workstation or individual is busy over the long run
  - Understanding resource utilization is an important aspect of process design and improvement

$$U = \frac{\text{Resources Demanded}}{\text{Resources Available}}$$

$$U = \frac{\text{Demand Rate}}{\text{Service Rate} * \text{Number of Servers}} \qquad U = \frac{DR}{SR * NS}$$

- If you have any three of the four variables, you can solve for the 4th!

Utilization Example

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An inspection station for assembling printers receives 40 printers/hour and has two inspectors, each of whom can inspect 30 printers per hour.

A. What is the utilization of the inspectors?

B. What demand rate would be required to have a target utilization of 85%?

A. The labor utilization at this inspection station is calculated to be:

$$U = \frac{DR}{SR*NS}$$

$$U = \frac{40}{(2)(30)} = 0.667 \times 100\% = 67\%$$

Utilization Example

An inspection station for assembling printers receives 40 printers/hour and has two inspectors, each of whom can inspect 30 printers per hour.

A. What is the utilization of the inspectors?
B. What demand rate would be required to have a target utilization of 85%?

B. If the utilization rate is 85%, we can calculate the target demand rate by solving the equation:

$U = \frac{DR}{SR*NS}$ → **DR = U(SR)(NS)**, Utilization = U = 85% = 0.85

DR = 0.85(30)(2) = 51 printers per hour