

# Service Operations

## Planning and Scheduling



# Overview

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- Introduction
- Scheduling Quasi-Manufacturing Service Operations
- Scheduling Customer-as-Participant Service Operations
- Scheduling Customer-as-Product Service Operations
- Wrap-Up: What World-Class Companies Do

# Introduction

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- Services are operations with:
  - Intangible outputs that ordinarily cannot be inventoried
  - Close customer contact
  - Short lead times
  - High labor costs relative to capital costs
  - Subjectively determined quality

# Introduction

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- Facts about service businesses:
  - Enormous diversity
  - Service businesses can be any size
  - Twice as many non-retail service businesses as retail
  - Technical training important due to significant dependence on computers, automation and technology



# Introduction

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- Other Facts about service businesses:
  - Service workers well paid relative to manufacturing
  - Need better planning, controlling, and management to stay competitive

# Spectrum of Service Industries

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- Transportation
- Banking
- Retailing
- Health Care
- Entertainment
- Insurance
- Real Estate
- Communications
- Utilities
- ... and more

# No Clear Line Between Manufacturing and Service Firms

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- Every business, whether manufacturing or service, has a mix of customer service aspects and production aspects in its operations
- Manufacturing has much to learn from services that excel
- Services have much to learn from manufacturers that excel

# Operations Strategies

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- Positioning strategies contain two elements:
  - Type of service design
    - Standard or custom
    - Amount of customer contact
    - Mix of physical goods and intangible services
  - Type of production process
    - Quasi-manufacturing
    - Customer-as-participant
    - Customer-as-product

# Types of Service Operations

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- Quasi-manufacturing
  - Production occurs much as manufacturing
  - Physical goods dominant over intangible services
- Customer-as-participant
  - High degree of customer involvement
  - Physical goods may or may not be significant
  - Service either standard or custom
- Customer-as-product
  - Service performed on customer... usually custom

# Scheduling Challenges in Services

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- Planning and controlling day-to-day activities difficult due to:
  - Services produced and delivered by people
  - Pattern of demand for services is non-uniform

# Non-Uniform Demand

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- Cannot inventory services in advance of high-demand periods, so businesses use following tactics:
  - Preemptive actions to make demand more uniform
    - Off-peak incentives/discounts (telephone)
    - Appointment schedules (dentist)
    - Fixed schedules (airline)
  - Make operations more flexible so it is easier to vary capacity
    - Part-time personnel (supermarket)
    - Subcontractors (postal service)
    - In-house standby resources (fire department)

# Non-Uniform Demand

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- Additional tactics used by businesses:
  - Anticipate demand and schedule employees during each time period to meet demand
  - Allow waiting lines to form
- These two tactics will be covered in greater detail



# Scheduling Quasi-Manufacturing Services

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- Product-Focused Operations
  - Resemble product-focused production lines
  - Customer demand is forecast and capacity decisions made just as in manufacturing
  - High volumes of standardized products
  - Management focused on controlling production costs, product quality, and delivery of physical goods
  - Example... McDonald's back-room operation

# Scheduling Quasi-Manufacturing Services

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- Process-Focused Operations
  - Managed like job shops in manufacturing
  - Input-output control important to balance capacity between operations
  - Gantt charts used to coordinate flows between departments
  - Sequence of jobs consider sequencing rules, changeover costs, and flow times

# Work Shift Scheduling

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- Three difficulties in scheduling services:
  - Demand variability
  - Service time variability
  - Availability of personnel when needed
- Managers use two tactics:
  - Use full-time employees exclusively
  - Use some full-time employees as base and fill in peak demand with part-time employees

## Example: Scheduling Employees

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The owner of a haircutting shop wants to convert from a drop-in system of customer arrivals to an appointment system.

Each customer requires an average of 30 minutes of a stylist's time. The stylists are all full-time employees and can work any 4 consecutive days per week from 10 a.m. to 7 p.m. (with an hour off for lunch), Monday through Saturday.

On the next slide are: 1) average number of drop-in customers each day, and 2) estimated number of customer appointments each day.

## Example: Scheduling Employees

	<u>Mon.</u>	<u>Tue.</u>	<u>Wed.</u>	<u>Thu.</u>	<u>Fri.</u>	<u>Sat.</u>	<u>Total</u>
Drop-ins	40	30	10	20	30	60	190
Appointments	32	32	32	32	32	32	192

- a) How many stylists are required to service 32 appointments in a day?
- b) What is the minimum number of stylists required per week?
- c) Use the work shift heuristic procedure to develop the stylists' weekly work shift schedules.

## Example: Scheduling Employees

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- Number of Stylists Required per Day

$$\frac{\text{Number of customers per day}}{\left[ \begin{array}{l} \text{Number of work hours} \\ \text{per day per stylist} \end{array} \times \begin{array}{l} \text{Number of customers} \\ \text{served per hour per stylist} \end{array} \right]}$$

= 32/((8)(2)) = 2 stylists

## Example: Scheduling Employees

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- Minimum Number of Stylists Required per Week?

Number of Customers per Week

Number of Customers per Stylist per Week

$$= 192 / ((8 \text{ hr/day})(4 \text{ days/week})(2 \text{ cust./hr/stylist}))$$

$$= 192 / 64 = 3 \text{ stylists}$$

## Example: Scheduling Employees

- Stylists' Weekly Work Shift Schedules

<u>Stylist</u>	<u>Mon.</u>	<u>Tue.</u>	<u>Wed.</u>	<u>Thu.</u>	<u>Fri.</u>	<u>Sat.</u>
1	0	0	2	2	2	2
2	2	2	0	0	1	1
3	1	1	1	1	0	0

Note: Pair of days boxed represent days off.



# Scheduling Customer-as-Participant Services

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- Must provide customer ease of use/access features.... lighting, walkways, etc.
- Layouts must focus on merchandising and attractive display of products
- Employee performance crucial to customer satisfaction
- Waiting lines used extensively to level demand

# Waiting Lines in Service Operations

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- **Waiting lines form because:**
  - Demand patterns are irregular or random.
  - Service times vary among “customers”.
  - Managers try to strike a balance between efficiently utilizing resources and keeping customer satisfaction high.

# Waiting Line Examples

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- Computer printing jobs waiting for printing
- Workers waiting to punch a time clock
- Customers in line at a drive-up window
- Drivers waiting to pay a highway toll
- Skiers waiting for a chair lift
- Airplanes waiting to take off

# Waiting Line Analysis

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- Assists managers in determining:
  - How many servers to use
  - Likelihood a customer will have to wait
  - Average time a customer will wait
  - Average number of customers waiting
  - Waiting line space needed
  - Percentage of time all servers are idle

# Waiting Line Terminology

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- Queue - a waiting line
- Channels - number of waiting lines in a queuing system
- Service phases – number of steps in service process
- Arrival rate ( $\lambda$ ) - rate at which persons or things arrive (in arrivals per unit of time)
- Service rate ( $\mu$ ) - rate that arrivals are serviced (in arrivals per unit of time)

# Waiting Line Terminology

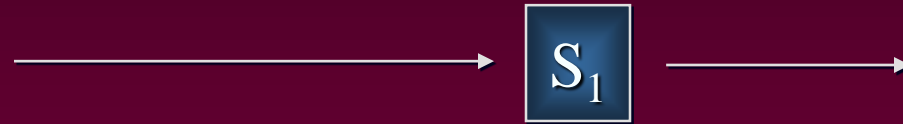
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- Queue discipline - rule that determines the order in which arrivals are serviced
- Queue length – number of arrivals waiting for service
- Time in system – an arrival's waiting time and service time
- Utilization – degree to which any part of the service system is occupied by an arrival

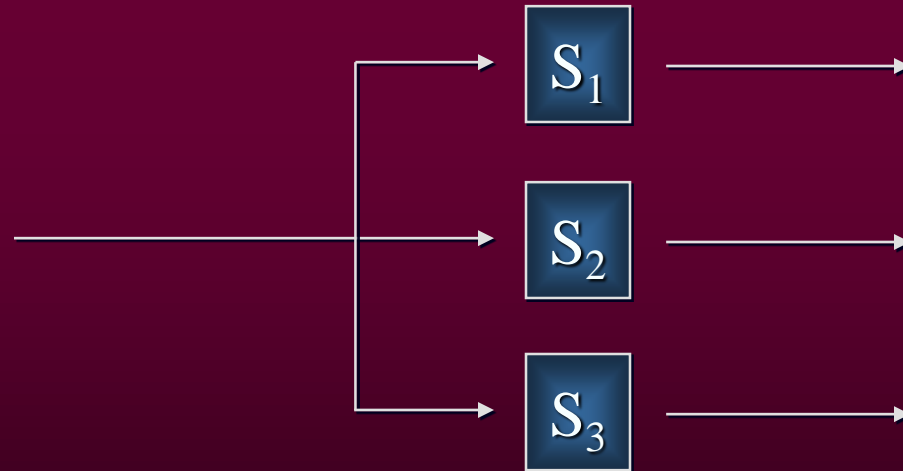
# Queuing System Structures

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- Single Phase - Single Channel



- Single Phase - Multichannel

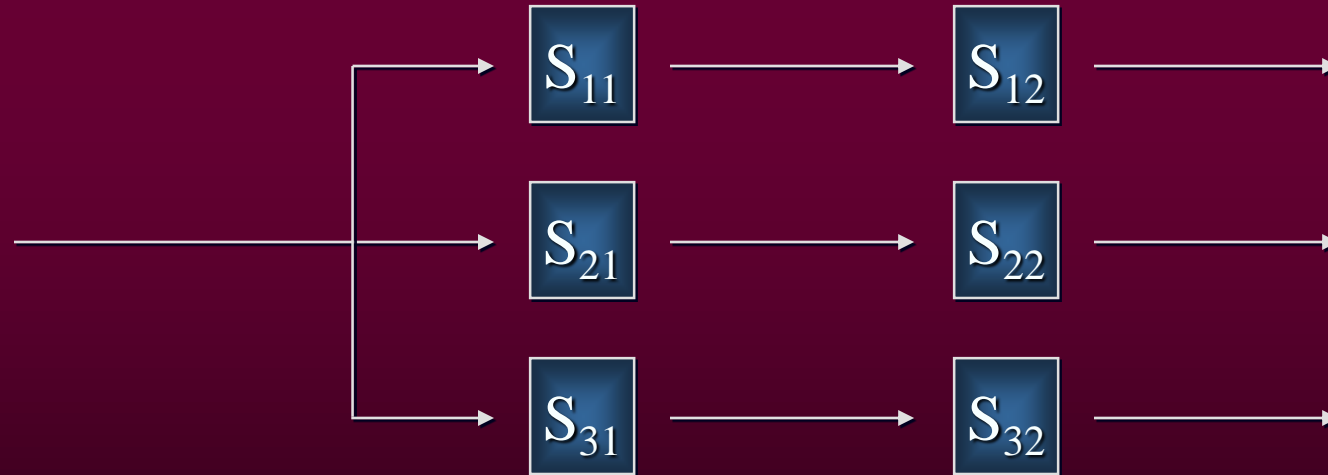


# Queuing System Structures

- Multiphase - Single Channel



- Multiphase - Multichannel





# Definitions of Queuing System Variables

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$\lambda$  = average arrival rate

$1/\lambda$  = average time between arrivals

$\mu$  = average service rate for each server

$1/\mu$  = average service time

$n_1$  = average number of arrivals waiting

$n_s$  = average number of arrivals in the system

$t_1$  = average time arrivals wait

$t_s$  = average time arrivals are in the system

$P_n$  = probability of exactly  $n$  arrivals in the system

# Queuing Models

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- Model 1
  - Single channel
  - Single phase
  - Poisson arrival-rate distribution
  - Poisson service-rate distribution
  - Unlimited maximum queue length
  - Examples:
    - Single-booth theatre ticket sales
    - Single-scanner airport security station

## Example: Queuing Model 1

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Jim Beam pulls stock from his warehouse shelves to fill customer orders. Customer orders arrive at a mean rate of 20 per hour. The arrival rate is Poisson distributed. Each order received by Jim requires an average of two minutes to pull. The service rate is Poisson distributed also.

Questions to follow .....

# Example: Queuing Model 1

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- Service Rate Distribution

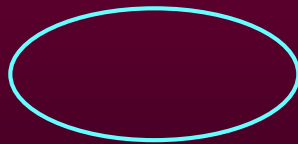
## Question

What is Jim's mean service rate per hour?

## Answer

Since Jim can process an order in an average time of 2 minutes (= 2/60 hr.), then the mean service rate,  $\mu$ , equals  $1/(\text{mean service time})$ , or  $60/2 =$

30/hr.



# Example: Queuing Model 1

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- Average Time in the System

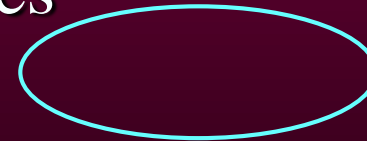
## Question

What is the average time an order must wait from the time Jim receives the order until it is finished being processed (i.e. its turnaround time)?

## Answer

With  $\lambda = 20$  per hour and  $\mu = 30$  per hour, the average time an order waits in the system is:

$$t_s = 1/(\mu - \lambda) = 1/(30 - 20)$$
$$= 1/10 \text{ hour or } 6 \text{ minutes}$$



# Example: Queuing Model 1

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- Average Length of Queue

## Question

What is the average number of orders Jim has waiting to be processed?

## Answer

The average number of orders waiting in the queue is:  $n_1 = \frac{\lambda^2}{\mu(\mu - \lambda)}$

$$= (20)^2 / [(30)(30-20)]$$

$$= 400/300$$

$$= 4/3 \text{ or } 1.33 \text{ orders}$$

# Example: Queuing Model 1

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- Utilization Factor

## Question

What percentage of the time is Jim processing orders?

## Answer

The percentage of time Jim is processing orders is equivalent to the utilization factor,  $\lambda/\mu$ . Thus, the percentage of time he is processing orders is:

$$\begin{aligned}\lambda/\mu &= 20/30 \\ &= 2/3 \text{ or } 66.67\%\end{aligned}$$



# Queuing Models

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- Model 2
  - Single channel
  - Single phase
  - Poisson arrival-rate distribution
  - Constant service rate
  - Unlimited maximum queue length
  - Examples:
    - Single-booth automatic car wash
    - Coffee vending machine



## Example: Queuing Model 2

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The mechanical pony ride machine at the entrance to a very popular J-Mart store provides 2 minutes of riding for \$.50. Children (accompanied of course!) wanting to ride the pony arrive according to a Poisson distribution with a mean rate of 15 per hour.

- a) What fraction of the time is the pony idle?
- b) What is the average number of children waiting to ride the pony?
- c) What is the average time a child waits for a ride?

## Example: Queuing Model 2

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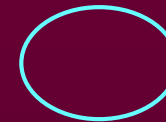
- Fraction of Time Pony is Idle

$$\lambda = 15 \text{ per hour}$$

$$\mu = 60/2 = 30 \text{ per hour}$$

$$\text{Utilization} = \lambda/\mu = 15/30 = .5$$

$$\text{Idle fraction} = 1 - \text{Utilization} = 1 - .5 = .5$$



## Example: Queuing Model 2

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- Average Number of children Waiting for a Ride

$$\bar{n}_1 = \frac{\lambda^2}{2\mu(\mu-\lambda)} = \frac{(15)^2}{2(30)(30-15)} = .25 \text{ children}$$

- Average Time a Child Waits for a Ride

$$\bar{t}_1 = \frac{\lambda}{2\mu(\mu-\lambda)} = \frac{15}{2(30)(30-15)} = .01667 \text{ hours}$$

or 1 minute

# Queuing Models

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- Model 3
  - Single channel
  - Single phase
  - Poisson arrival-rate distribution
  - Poisson service-rate distribution
  - Limited maximum queue length
  - Examples:
    - Auto repair shop with limited parking space
    - Bank drive-thru with limited waiting lane

# Queuing Models

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- Model 4
  - Multiple channel
  - Single phase
  - Poisson arrival-rate distribution
  - Poisson service-rate distribution
  - Unlimited maximum queue length
  - Examples:
    - Expressway exit with multiple toll booths
    - Bank with multiple teller stations

# Wrap-Up: World-Class Practice

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- Successful companies have:
  - Adapted advanced and well-known planning, analyzing, and controlling approaches first developed in manufacturing
  - Recognized the unique properties of service operations and developed novel management approaches for these operations
  - Classify service operations into three types... quasi manufacturing, customer-as-participant, or customer-as-product...provides framework for analysis.

# Wrap-Up: World-Class Practice

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- Factors that create satisfied customers
  - Extrinsic quality of services
  - The facilities...comfort, convenience, and atmosphere
  - The chemistry between customer and people in service system...friendliness and courtesy
  - Skill, competence, and professionalism of the personnel
  - The value of the service; cost relative to the quantity of services received