Business Fundamentals for Analytics

Supply Chain Management

Bob Myers

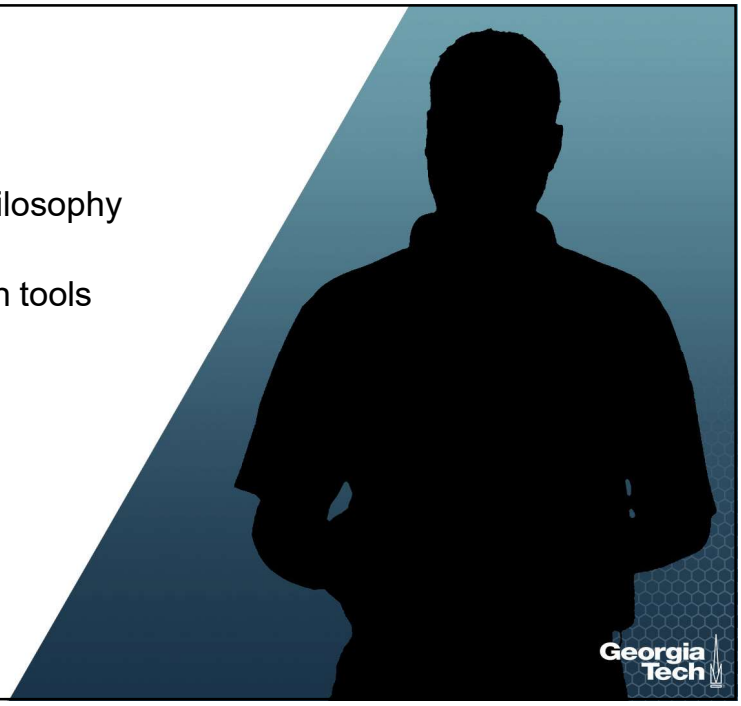
Lecturer
Scheller College of Business

Lean Operations

1

Learning Objectives

- Discuss the origins and philosophy of Lean
- Describe the most common tools and techniques in Lean



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What is the Philosophy of Lean?

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Success Story

	1991 (old way)	1995 (LEAN)
Development Time	3-4 years	1 year
Employee Hours per machine	160	80
Manufacturing space per machine	100 sq ft	55 sq ft
Defects per machine	8	.8
$$ of WIP and FG	$2.6 Million	$1.9 Million
Throughput time	16 weeks	14 hours – 5 days
Lead Time	4-20 weeks	1-4 weeks

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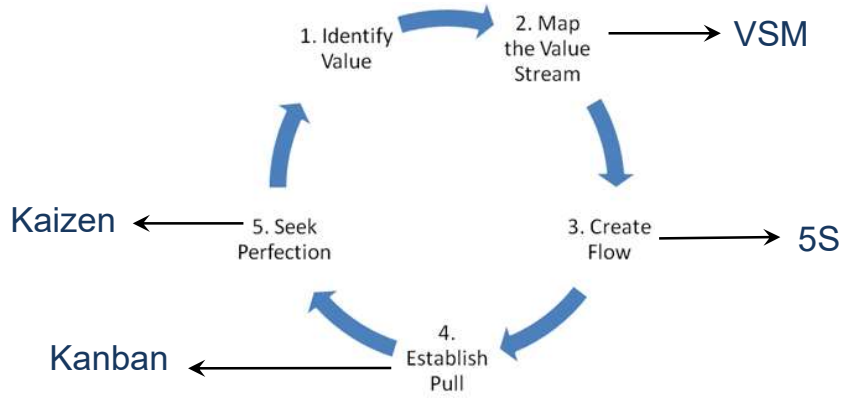
5 Principles of Lean



The five-step thought process for guiding the implementation of lean techniques. Image copyright 2016, Lean Enterprise Institute, Inc.

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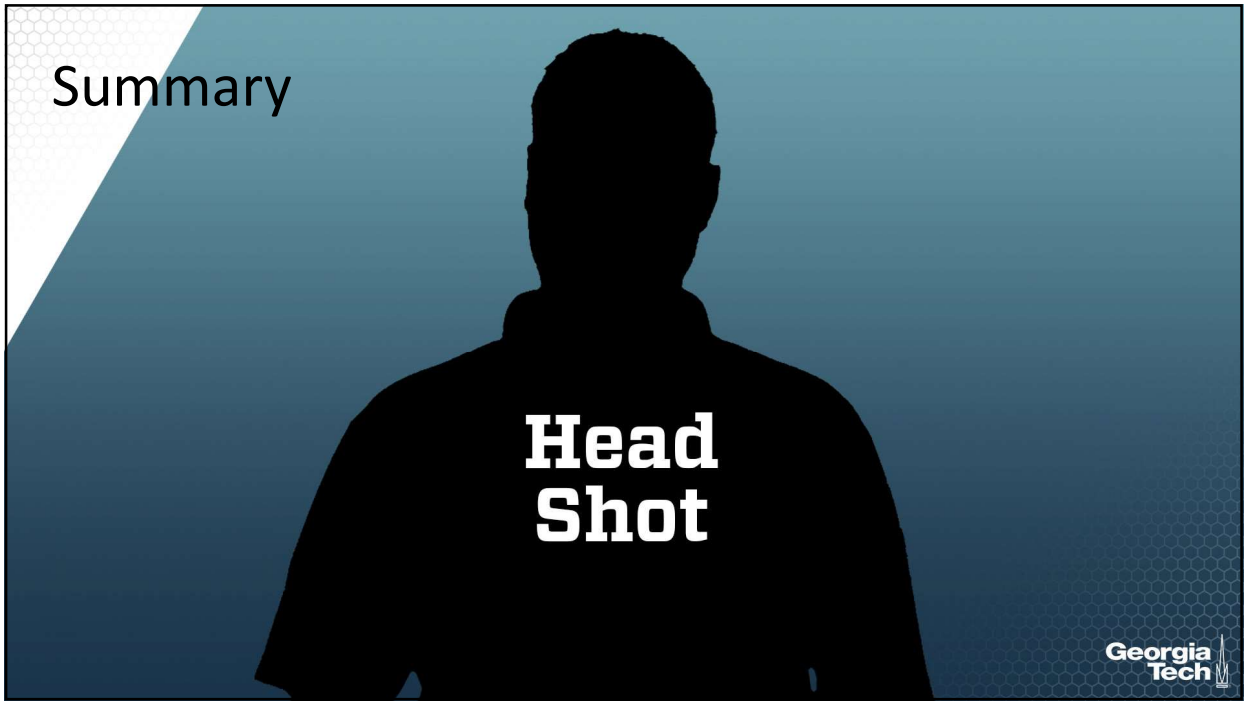
Summary



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Lecturer
Scheller College of Business

Push vs Pull

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Lesson Objectives

- Explain the use of Kanban in Lean
- Discuss "**Push**" vs "**Pull**"

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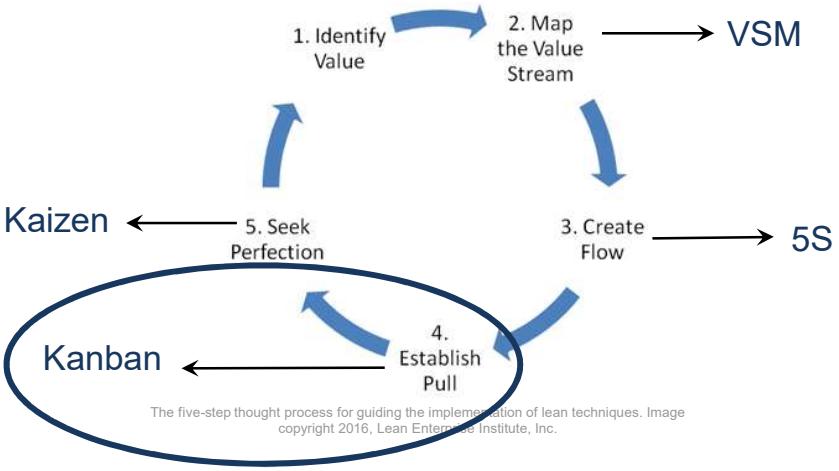
5 Principles of Lean



The five-step thought process for guiding the implementation of lean techniques. Image copyright 2016, Lean Enterprise Institute, Inc.

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Where did Toyota get the idea for Kanban?

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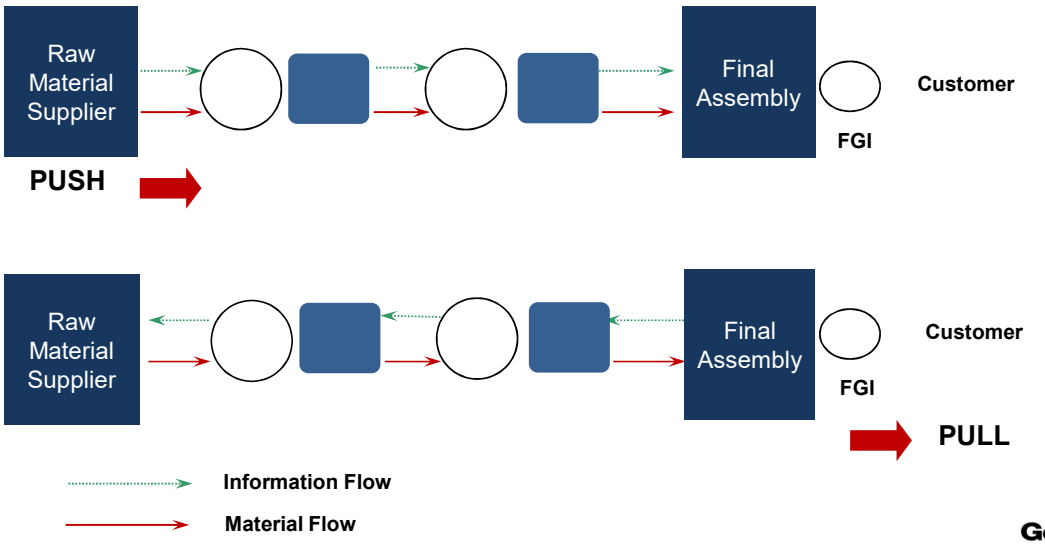
Push vs. Pull



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Push System

- Every worker maximizes own output, making as many products as possible
- Pros and cons:
  - Focuses on keeping individual operators and workstations busy rather than effective use of materials.
  - Volumes of defective work may be produced
  - Throughput time will increase as work-in-process increases
  - Line bottlenecks and inventories of unfinished products will occur
  - Hard to respond to special orders and order changes due to long throughput time

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Pull System

- Production line is controlled by the last operation, Kanban cards control WIP
- Pros and cons
  - Controls maximum WIP and eliminates WIP accumulating at bottlenecks
  - Keeps materials busy, not operators. Operators work only when there is a signal to produce.
  - If a problem arises, there is no slack in the system
  - Throughput time and WIP are decreased, faster reaction to defects and less opportunity to create defects

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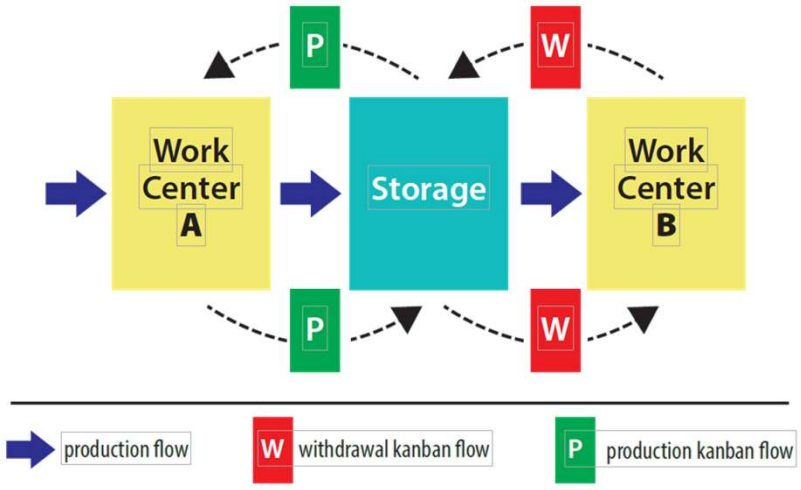
Kanban Example



Source: The art of Kanban – Creative Safety Supply

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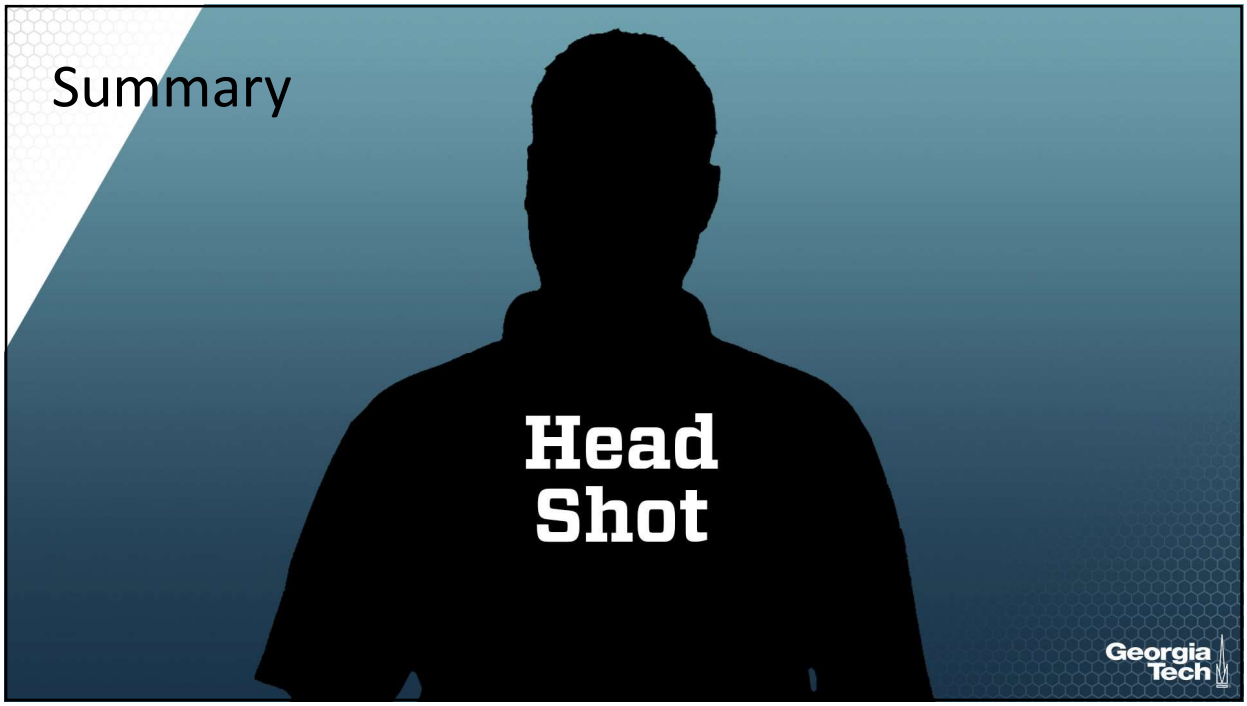
Summary
Head Shot
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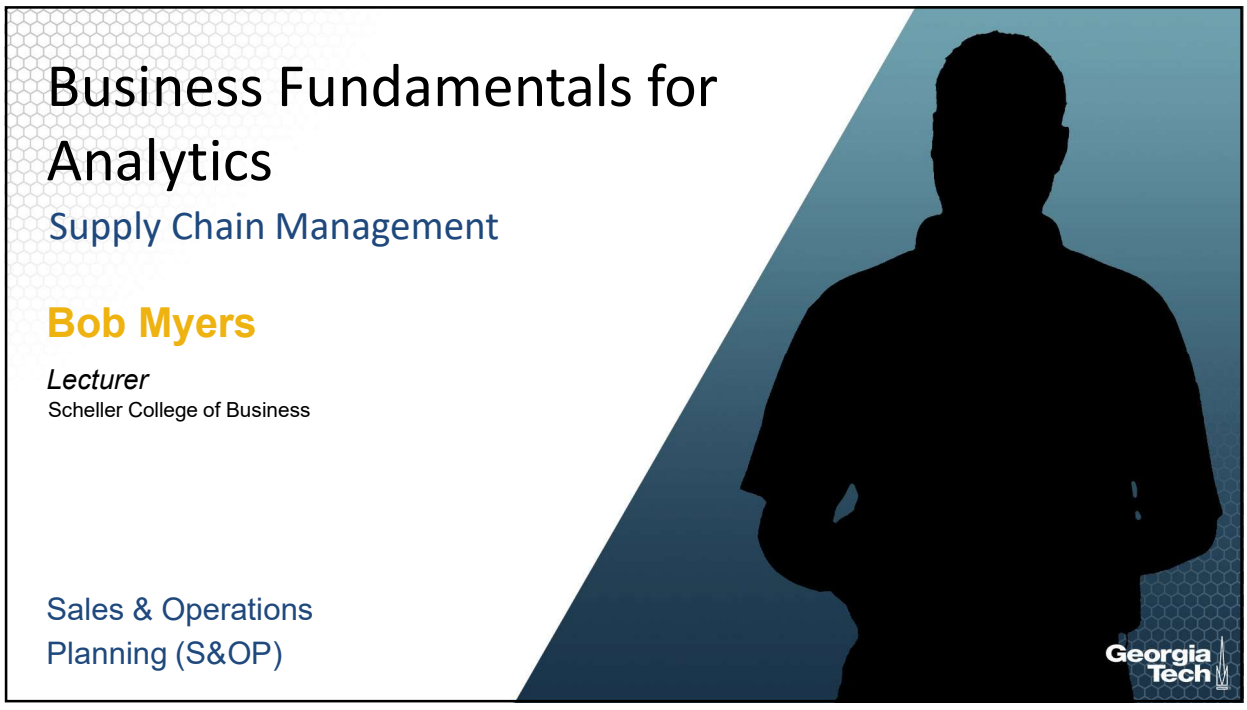
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Bob Myers
Lecturer
Scheller College of Business
Sales & Operations Planning (S&OP)
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Learning Objectives

- Assess both internal and external mechanisms to match supply with demand

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Main Idea

- Translate business plans into rough labor schedules and production plans
- How do we match up demand (from Sales group) with supply (from Supply Chain group)?
- Given an aggregated demand forecast, how an we minimize the total costs over the planning horizon thru Production, Inventory and Workforce levels?

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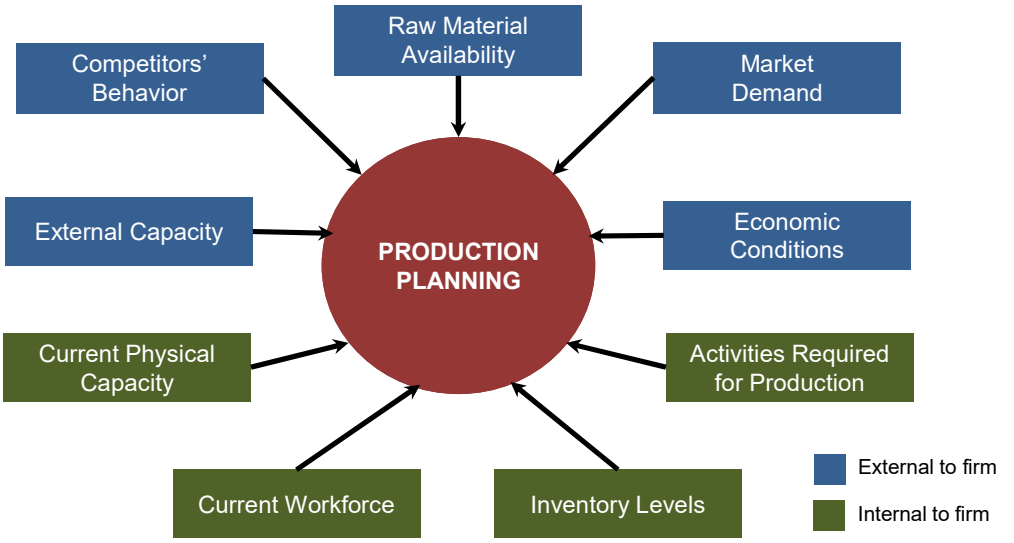
Inputs



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Common Internal Strategies (Supply Chain)

- Hire and fire
- Temporary workers
- Overtime/reduced hours
- Subcontracting
- Excess Inventory
- Large Backlogs
- Change production rates

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Common External Strategies (Sales)

- Price change
- Promotions
- Advertising
- “Bundled” or “Packaged” offerings
- Turn down orders
- Pre-Orders/Reservations

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Bob Myers

Lecturer
Scheller College of Business

Inventory Management 1

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Learning Objectives

- Examine the benefits and costs to Inventory
- Outline the key decisions in Inventory Management

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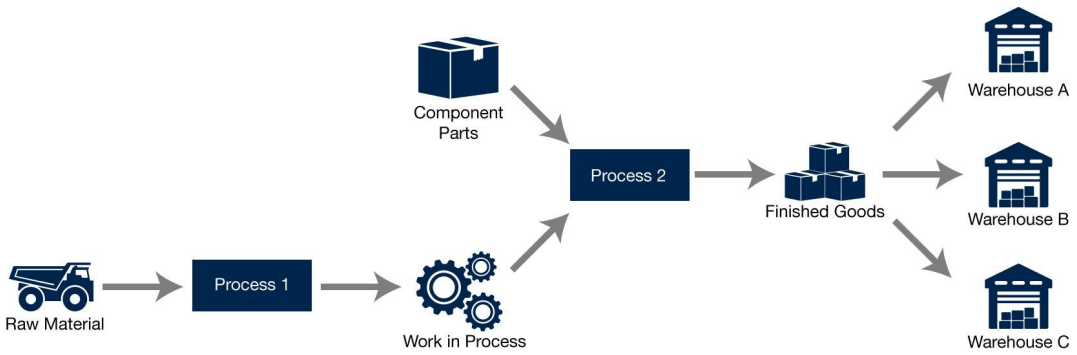
What is Inventory?

- Inventory is the raw material, component parts, work is process, or finished goods that are held at a location in the supply chain.



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Some Things to Consider:

- Inventory is one of a companies biggest assets ($$$)
- US investment in inventory is over $1/.25 Trillion (US Dept of Commerce)
- Inventory accounts for almost 25% of GNP

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Benefits of Inventory

- Hedge against uncertain demand
- Hedge against uncertain supply
- Economize on ordering costs
- Smoothing

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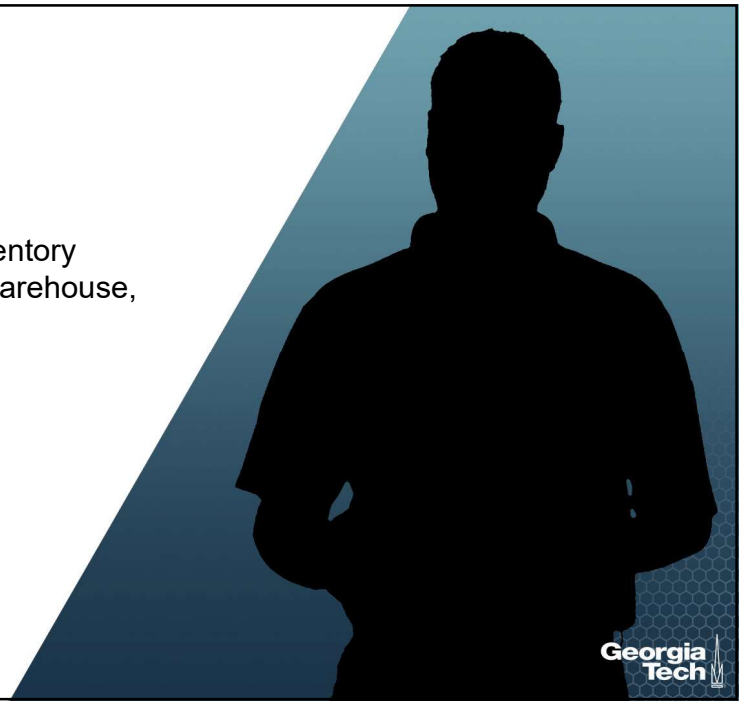
Costs of Inventory

- Holding Costs
  - Expenses to store inventory (insurance, security, warehouse, cooling, etc)
- Obsolescence
- Spoilage
- Rework
- Shrinkage
- Opportunity Costs



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Key Inventory Management Decisions

HOW MUCH should we order?

WHEN should we order more?

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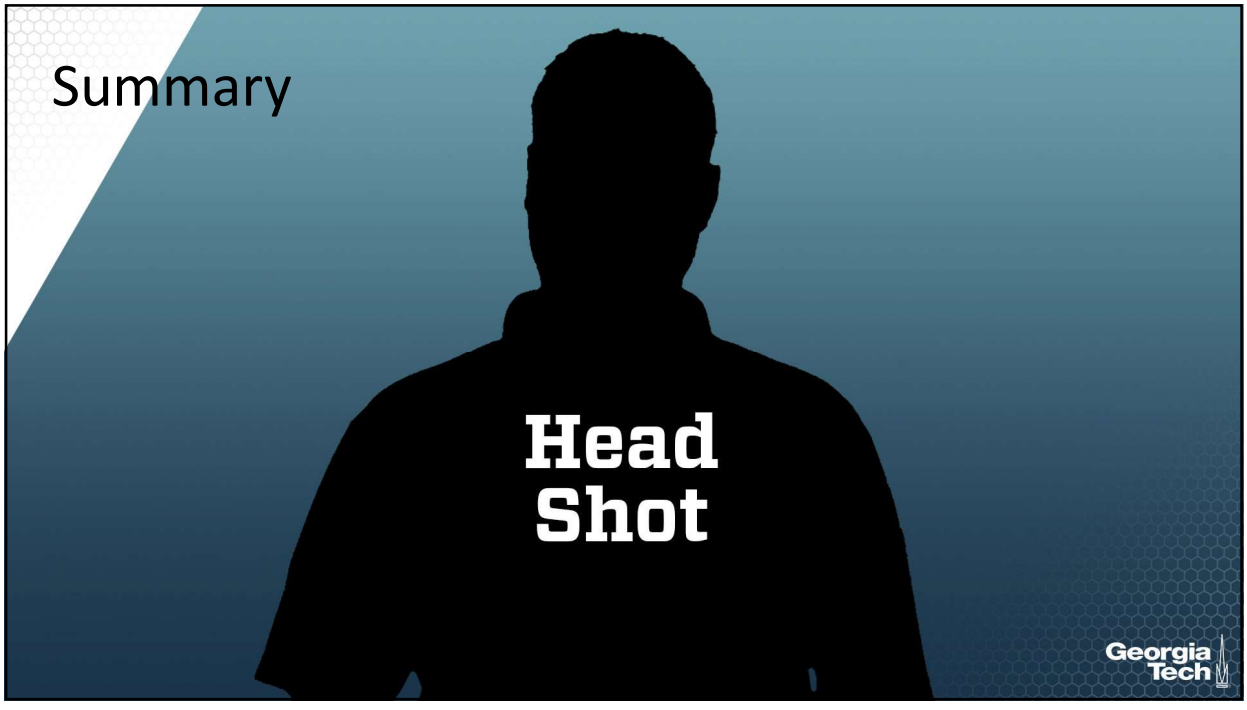
Summary



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Bob Myers

Lecturer
Scheller College of Business

Inventory Management 2

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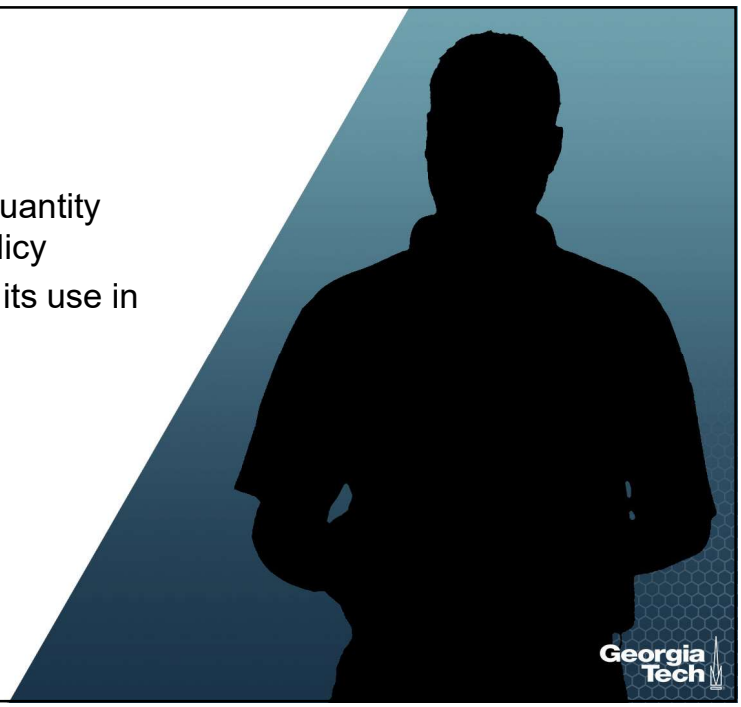
Learning Objectives

- Explain Economic Order Quantity and its use in Inventory Policy
- Explain Reorder Point and its use in Inventory Policy



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HOW MUCH Should We Order?

- Demand is known and constant: **D** units/yr
- We have a known ordering cost, **S**, and immediate replenishment
- Annual holding cost of average inventory is **H** per unit
- Assume Ordering and Inventory costs only relevant costs

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How Much Should We Order?

Total Cost = Ordering Cost + Inventory Cost

- Ordering Cost = (number of orders per year) X (cost per order)
- Inventory Cost = (average inventory) X (holding cost per year)

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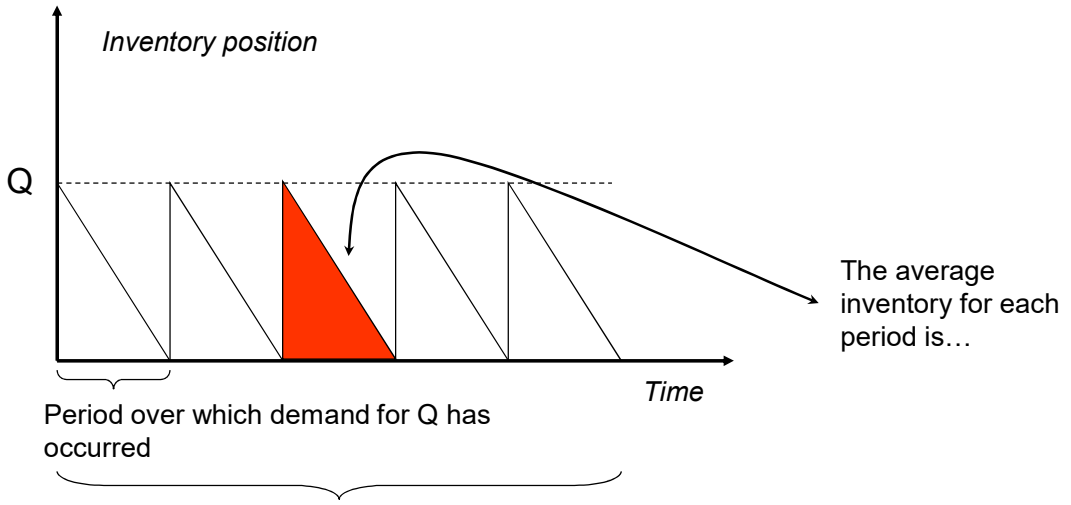
Say we order in batches of **Q**



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Cost Elements

Ordering Cost = (number of orders per year) X (cost per order)

$$\text{Ordering cost} = \frac{D}{Q} \times S$$

Inventory Cost = (average inventory) X (holding cost per year)

$$\text{Inventory cost} = \frac{Q}{2} \times H$$

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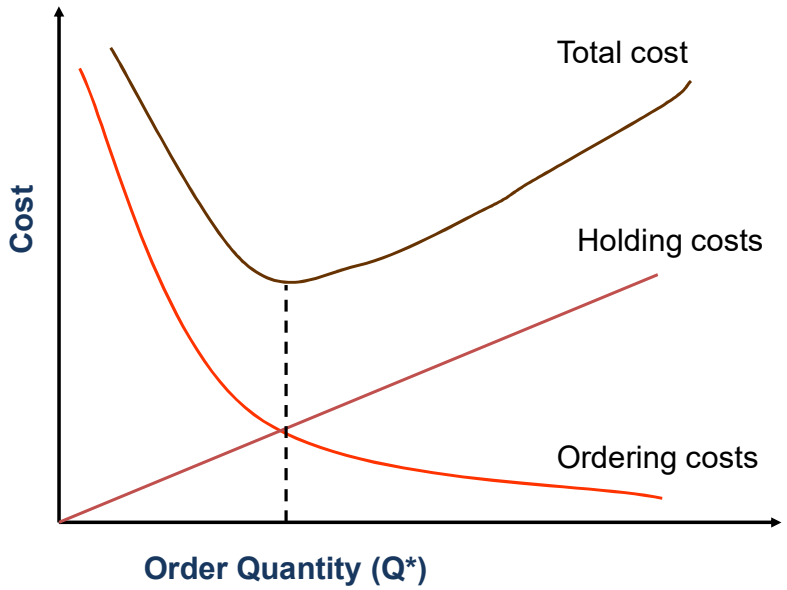

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Economic Order Quantity = HOW MUCH

- Set Ordering costs equal to Holding cost

$$\frac{D}{Q} \times S = \frac{Q}{2} \times H$$

- And solve for Q. We will call this Q* (because it is the Q where Ordering cost equals holding cost)

$$Q^* = \sqrt{\frac{2SD}{H}}$$

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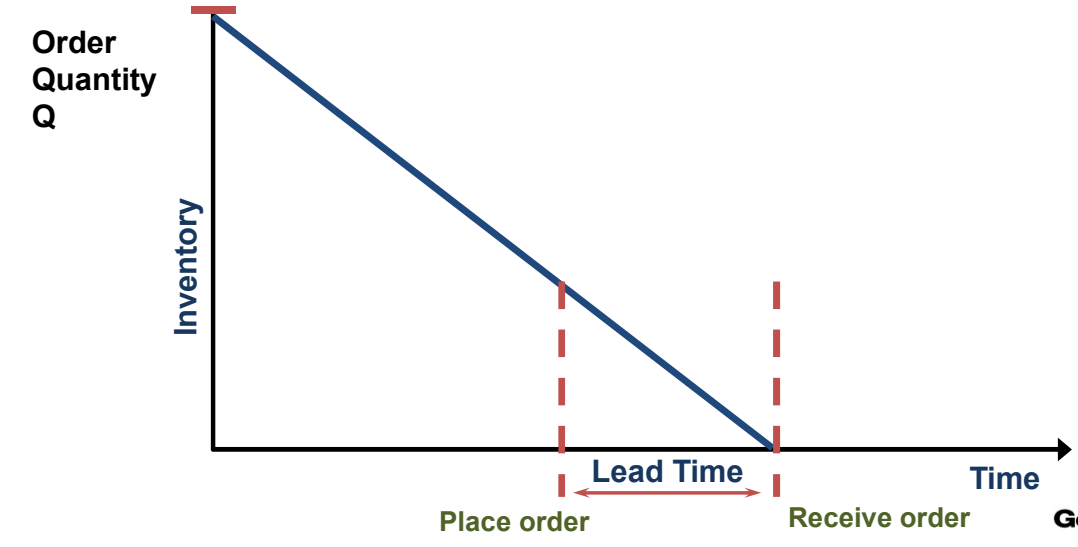
WHEN Should We Order More?



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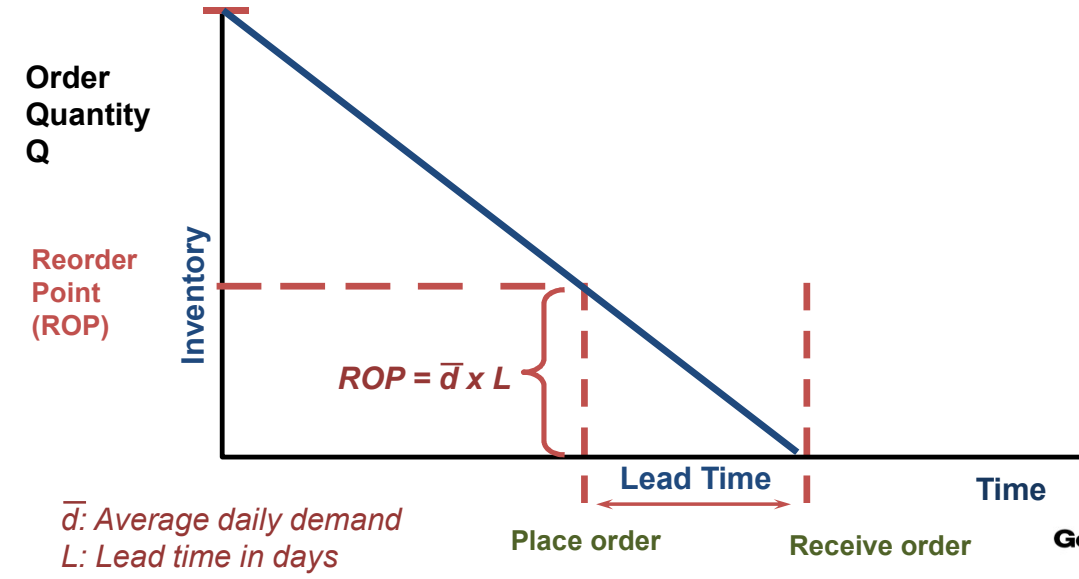
WHEN should we order more?



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Putting Together as an Inventory Policy

- Monitor inventory level.
- When the inventory level drops to ROP, place an order for Q* more.

$$ROP = \bar{d} \times L$$

$$Q^* = \sqrt{\frac{2SD}{H}}$$

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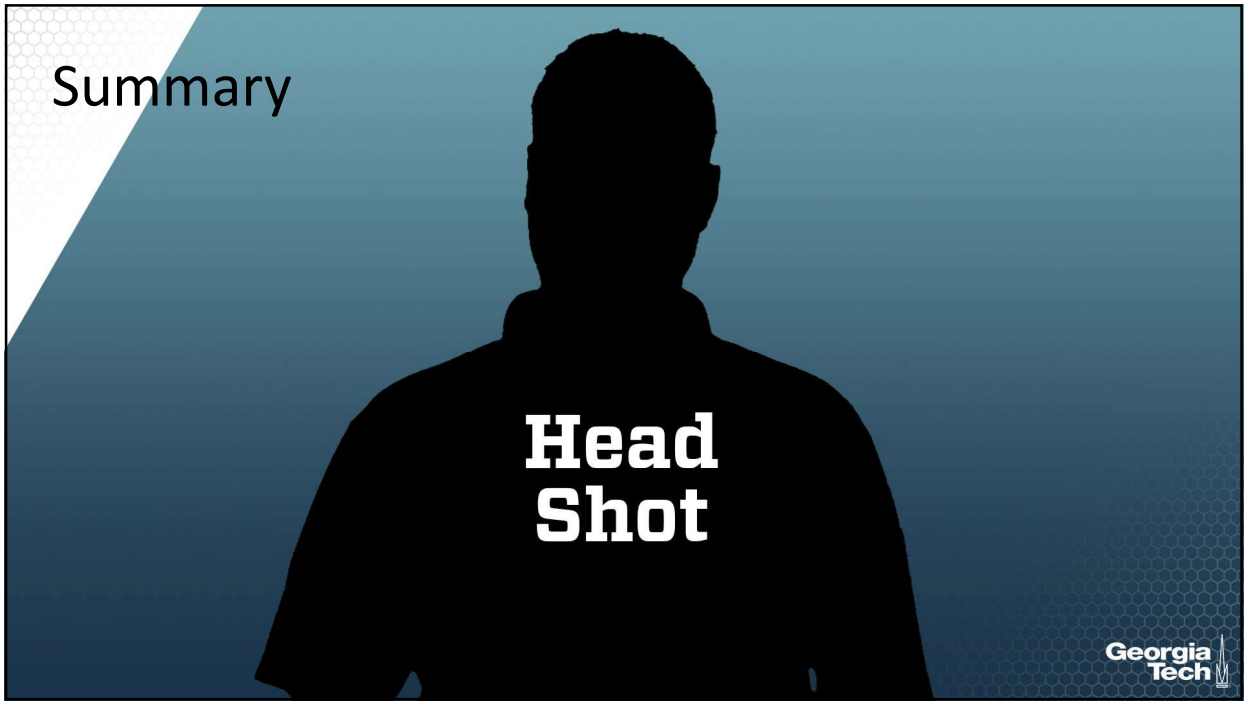
Summary



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Bob Myers

Lecturer
Scheller College of Business

Inventory Management Sample Problem

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Learning Objectives

- Use basic inventory management metrics to determine when to order more and how much to order

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Did you know Buzz owns a used car lot called Buzzlot?

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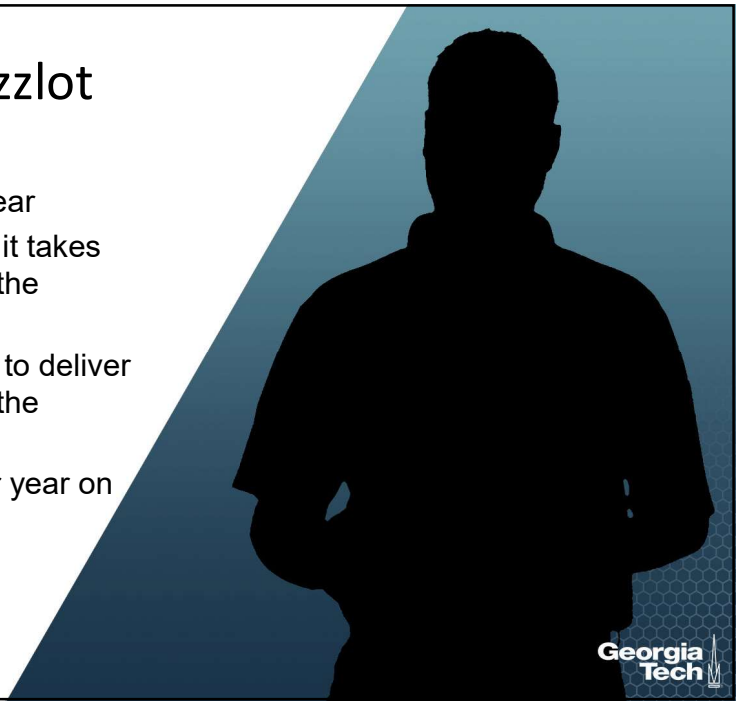
Some Info About Buzzlot

- Buzzlot sold 5,000 cars last year
- When going to Auto Auctions, it takes 10 days to get new cars from the auction to his used car lot.
- It costs $15,000 per shipment to deliver a batch of cars to his lot from the auction site.
- It costs Buzz $500 per car per year on his lot.



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What is a recommended Inventory Management Policy for Buzzlot?

When to go to auction and buy more cars = _____

How many used cars to buy when going to the auction = _____

***assume 365 days per year

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Determine ROP

$$ROP = \bar{d} \times L$$

D = 5,000
L = 10 days

d = D/#days per year = 5,000/365= 13.69 ➔ 14 cars/day

ROP = $\bar{d}$ x L = 14 cars/day x 10 days = 140 cars

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Determine Q*

S = $15,000 per shipment
D = 5,000 cars per year
H = $500 per car per year

$$Q^* = \sqrt{\frac{2SD}{H}}$$

$$Q^* = \sqrt{\frac{2*(15,000)*(5,000)}{500}} = 547.72 \rightarrow 548$$

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What is a Recommended Inventory Management Policy for Buzzlot?

When to go to auction and buy more cars = **When we have 140 left on the lot.**

How many used cars to buy when going to the auction = **Buy 548 more cars when going to the auction.**

***This balances the cost of ordering more cars with the cost of holding them to give the lowest total cost solution.

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