

# Understanding the Supply Chain and how Delays Affect Supply Chain Management

Vanessa Zamy

Dora Pepo

Professor Rifat Sipahi





# Supply Chain Disasters



General Motors (GM): in the 1980s, CEO Robert Smith ordered a robot manufacturing system that cost billions and turned out to be a failure.

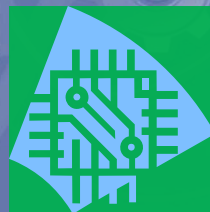


Adidas: in the 1990s, Adidas opens a new warehouse that needs a system to track orders. The new system fails and 80% of the orders are not fulfilled.



Toys R Us: in 1999, Toys R Us was getting Christmas orders from the website but couldn't fulfill all of them. It later sold its company to Amazon.com.

Cisco: in the 1990s, Cisco is unable to see that its demand is decreasing and its inventory is increasing. The company loses \$50 million and its stock price cuts in half.



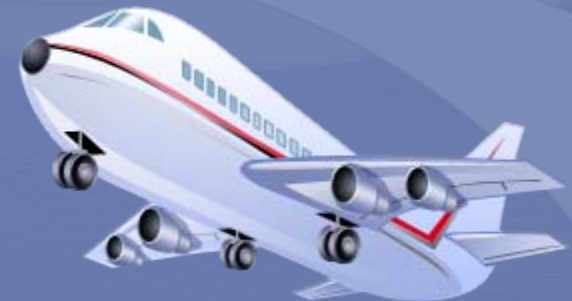
[http://www.scdigest.com/assets/reps/SCDigest\\_Top-11-SupplyChainDisasters.pdf](http://www.scdigest.com/assets/reps/SCDigest_Top-11-SupplyChainDisasters.pdf)



# Objectives



- How does shipping and manufacturing delays affect a company's inventory level?
- How does shipping and manufacturing delays affect a company's supply?
- How does shipping and manufacturing delays affect a company's profit?

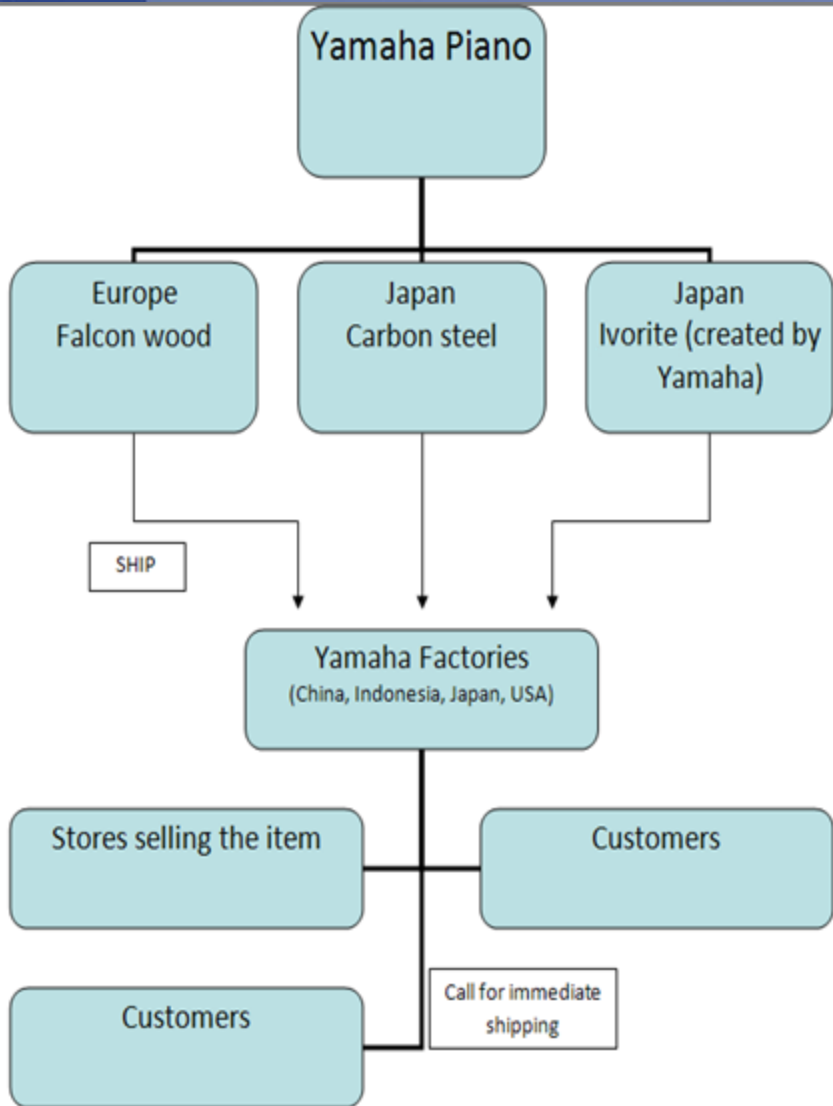




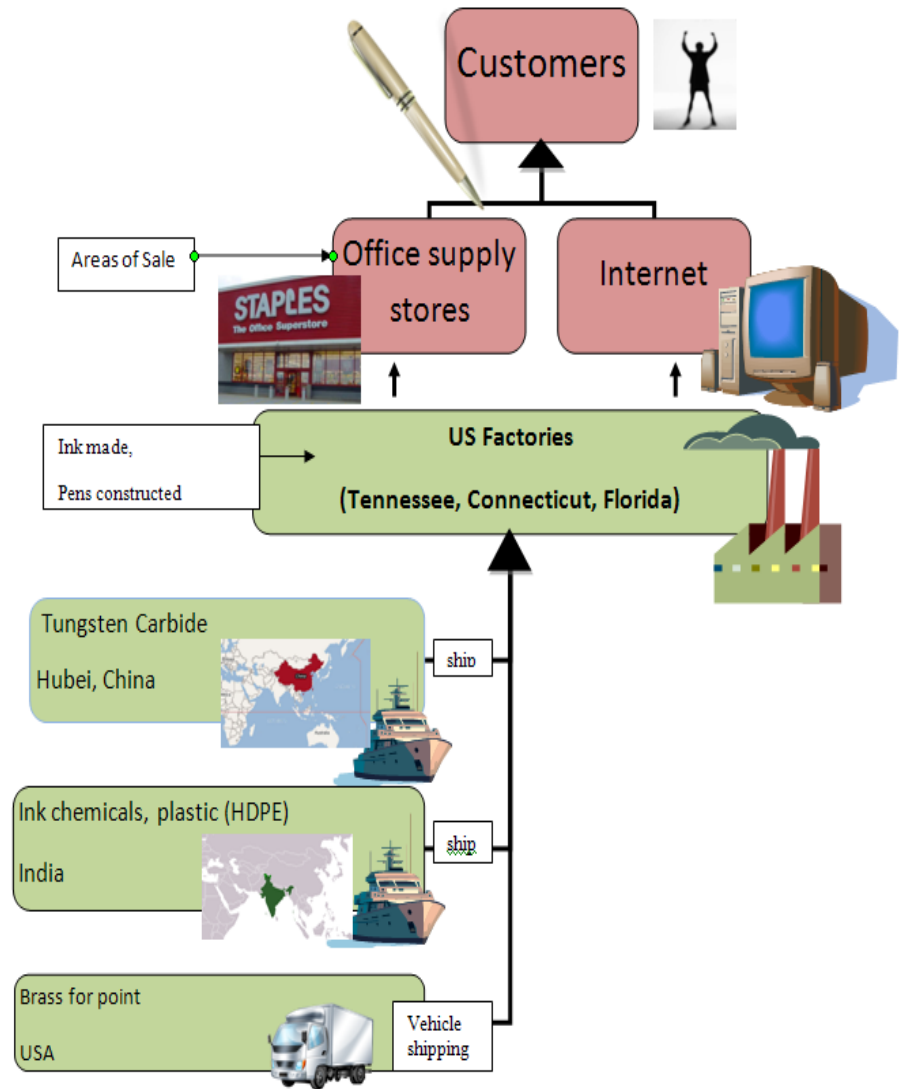
# Basic Terms



# Product Charts

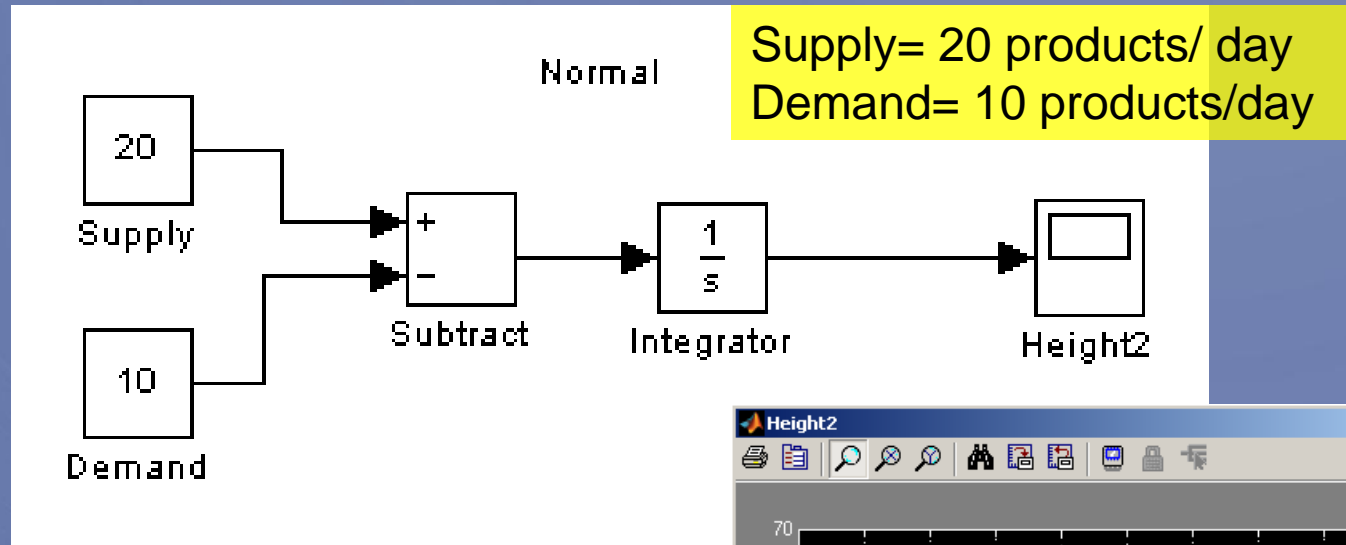


Yamaha Piano



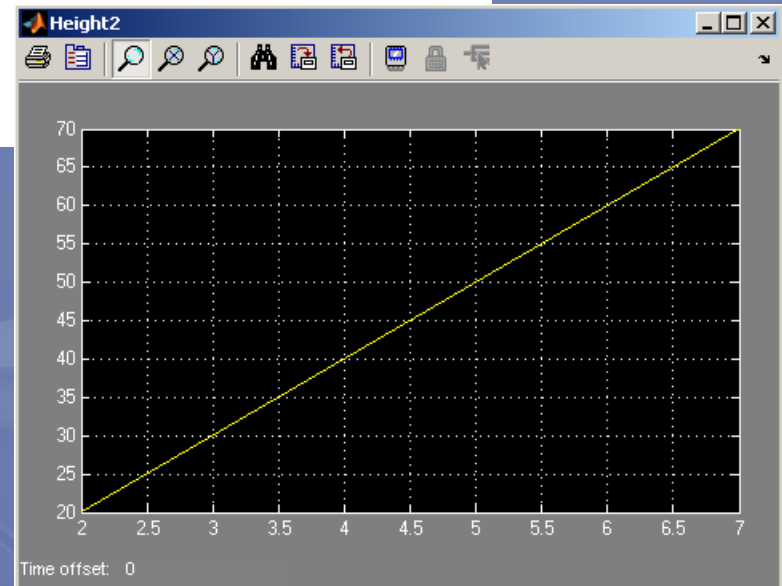
Ballpoint Pen

# Simple Supply Chains



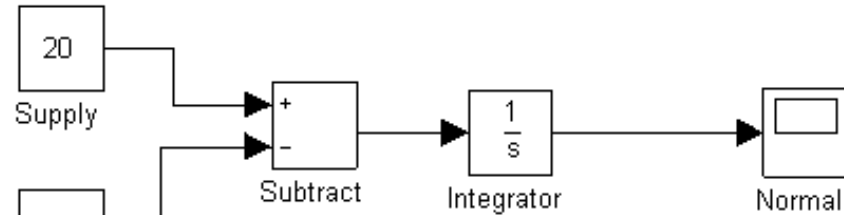
$$\left( \int \frac{\Delta H}{\Delta t} = S - D \right) = H$$

(Integral of height through time = supply-demand) = HEIGHT

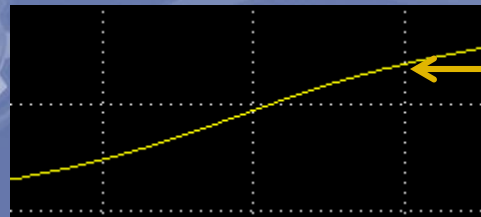
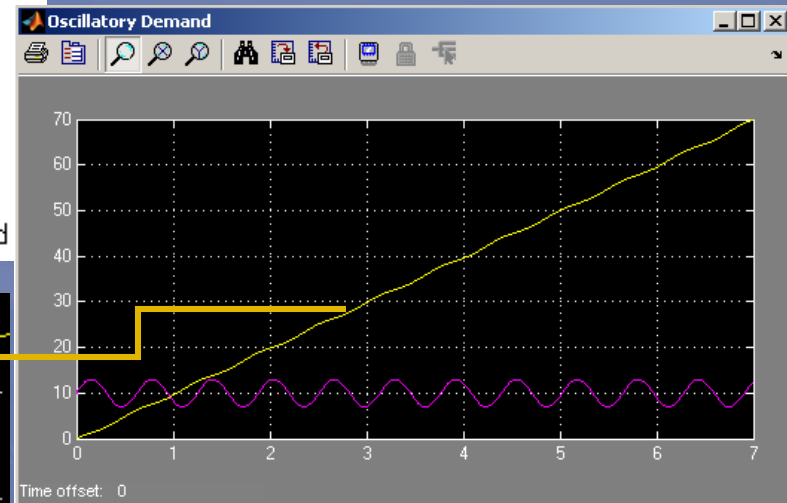
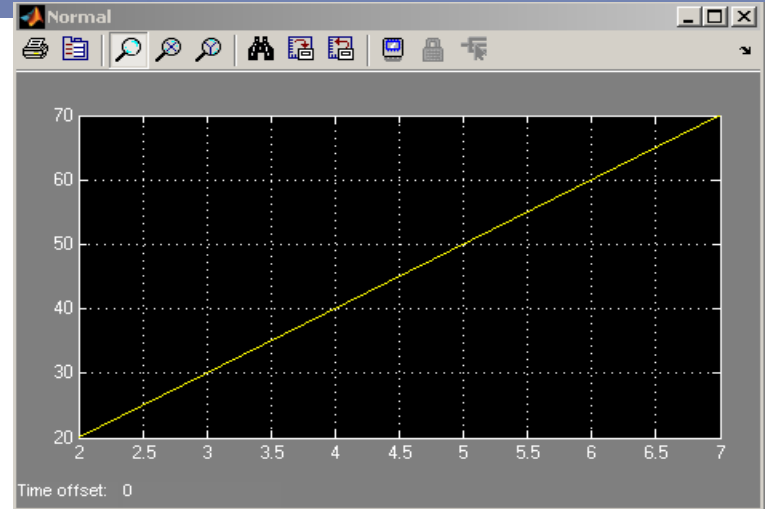
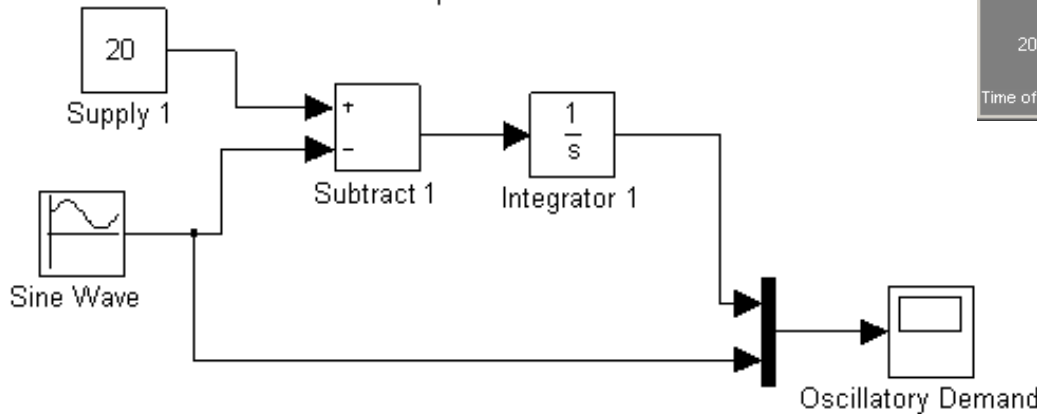


# Oscillatory Demand

Normal

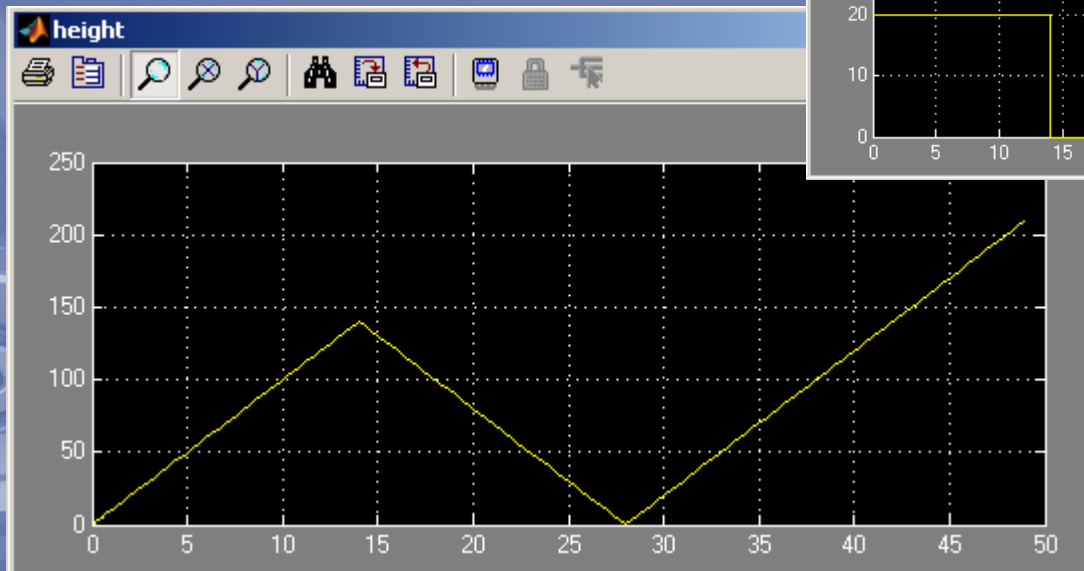
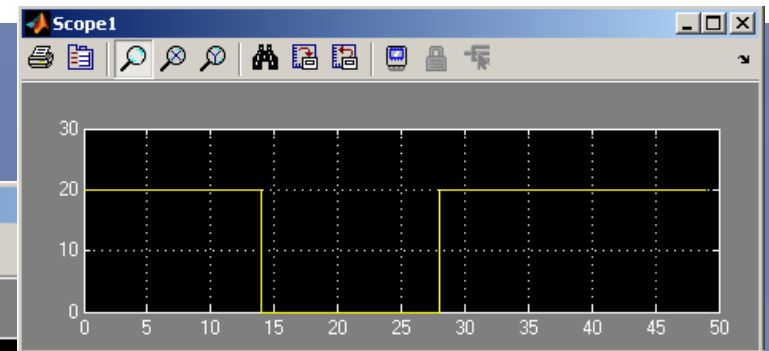
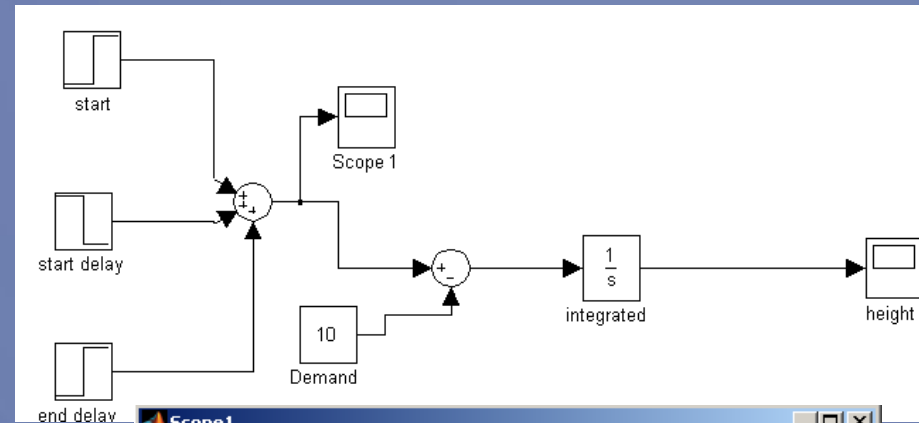


Displacement



# Supply Interruption

- Causes the shipping to arrive later or go slower than expected or desired
- Causes inventory to reach the desired at a later time
- Most companies have to deal with supply delays





# Regulating Supply Chains

REGULATE supply chains = CONTROL supply chains.

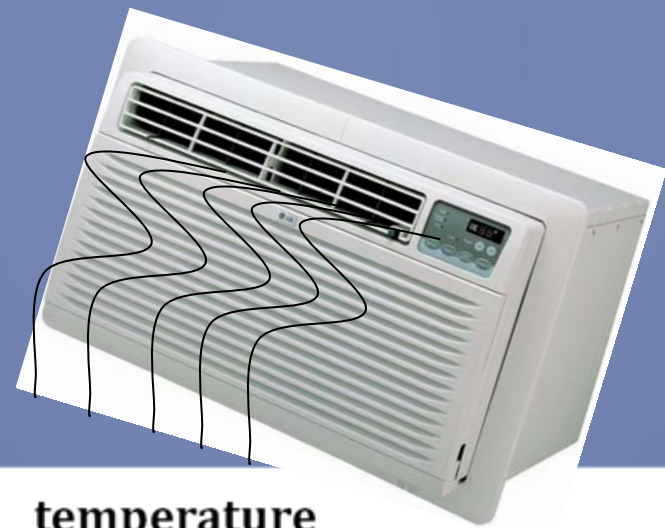
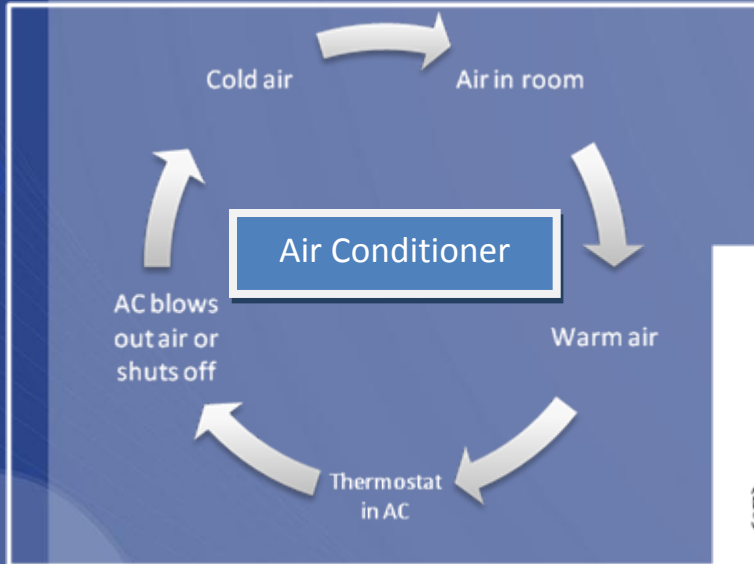
**Control:** the act of regulating or commanding an entity to perform a desired action.

Examples of control:

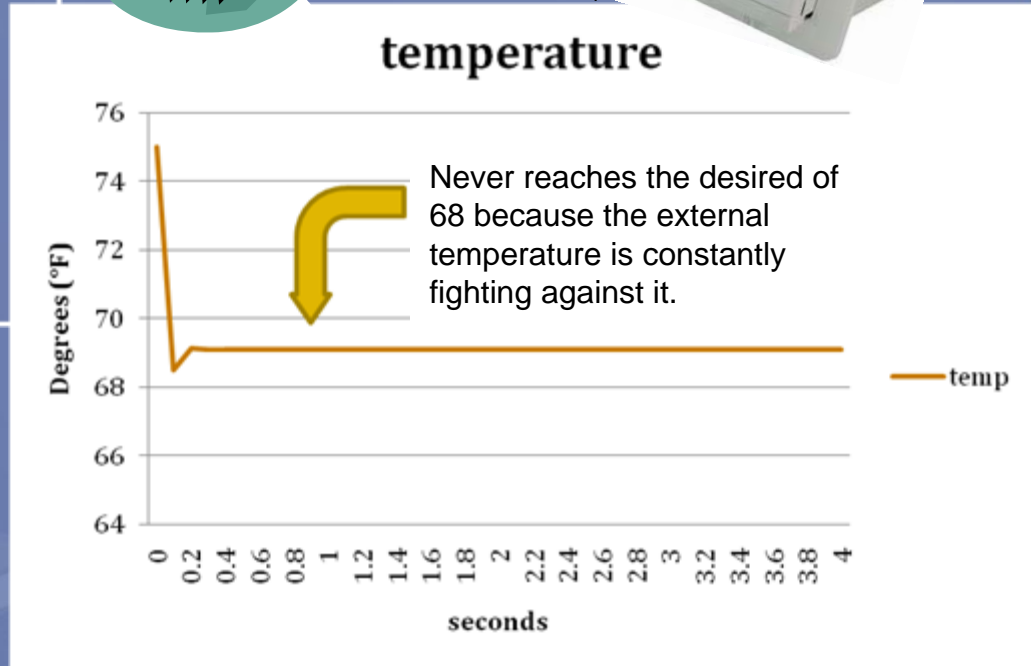
- Air conditioners
- Cruise control
- Robots
- Airplanes



# Air Conditioning



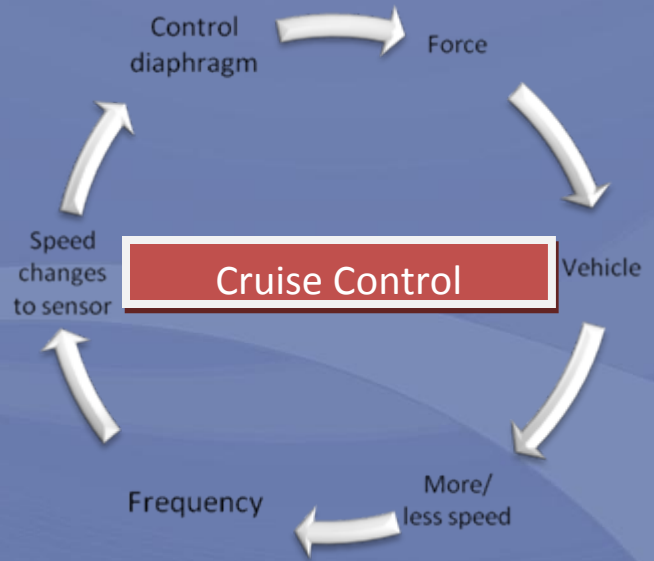
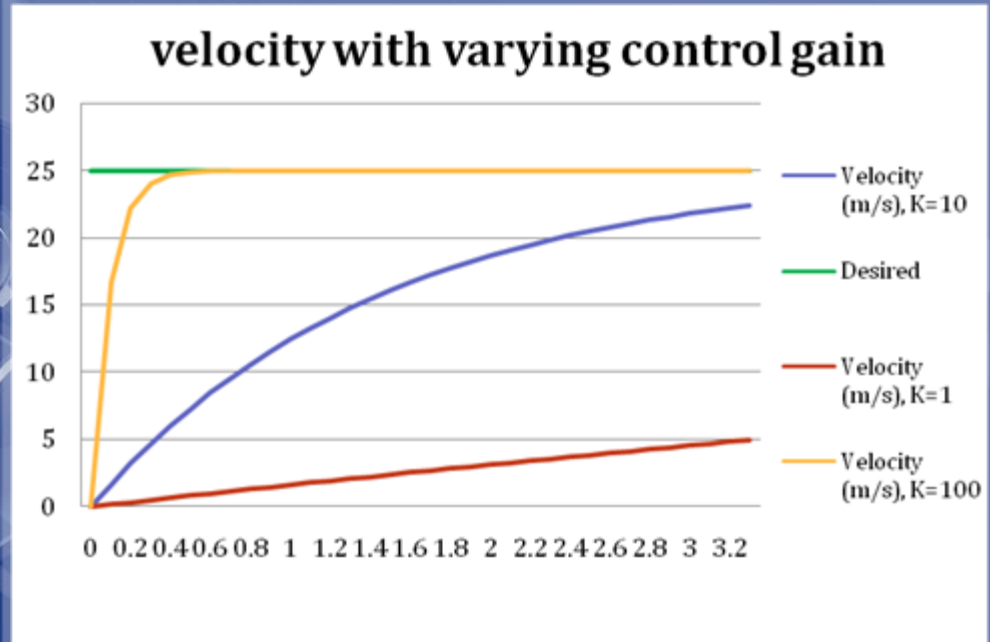
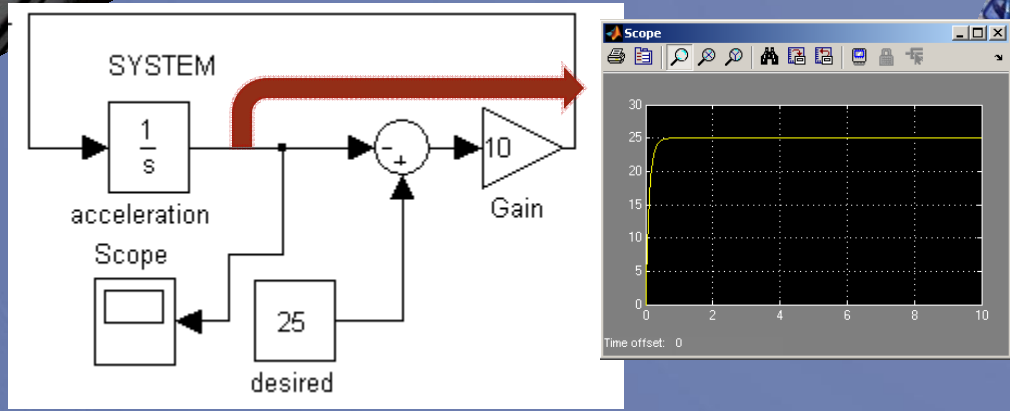
This control system works by analyzing the current temperature in the room uses energy to blow out cool air until the desired temperature is met. Once it is established the AC turns off, but keeps sensing the temperature of the room



External temp: 80°F  
Desired temperature: 68°F

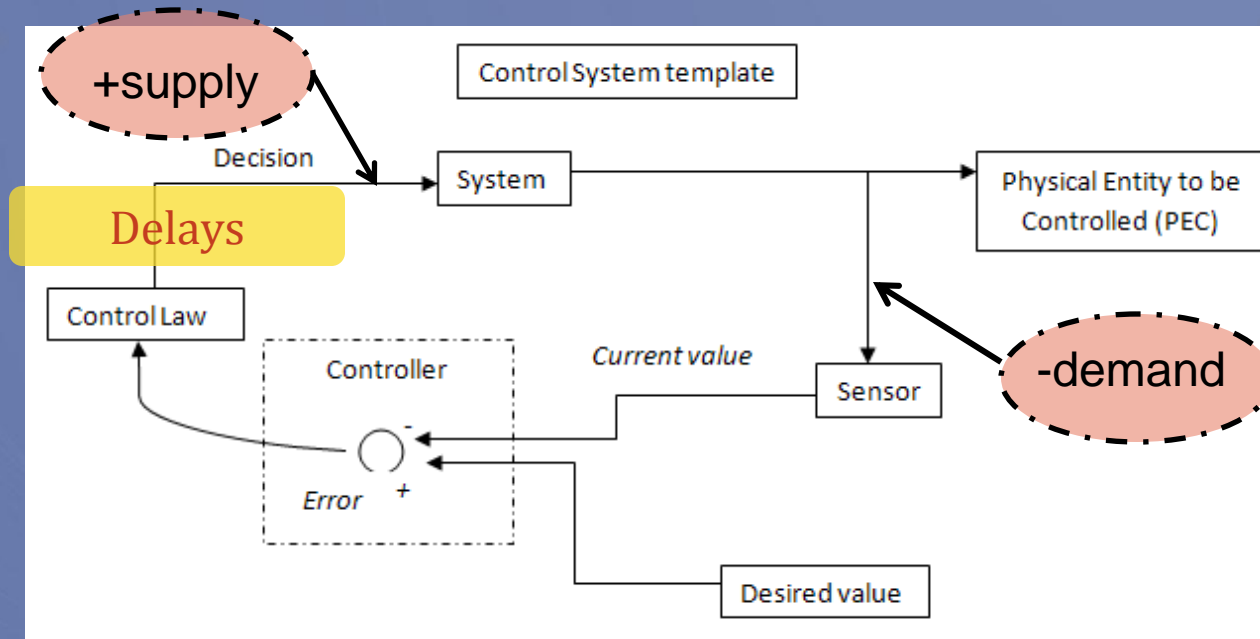
# Cruise Control

Control system





# Control in Supply Chains

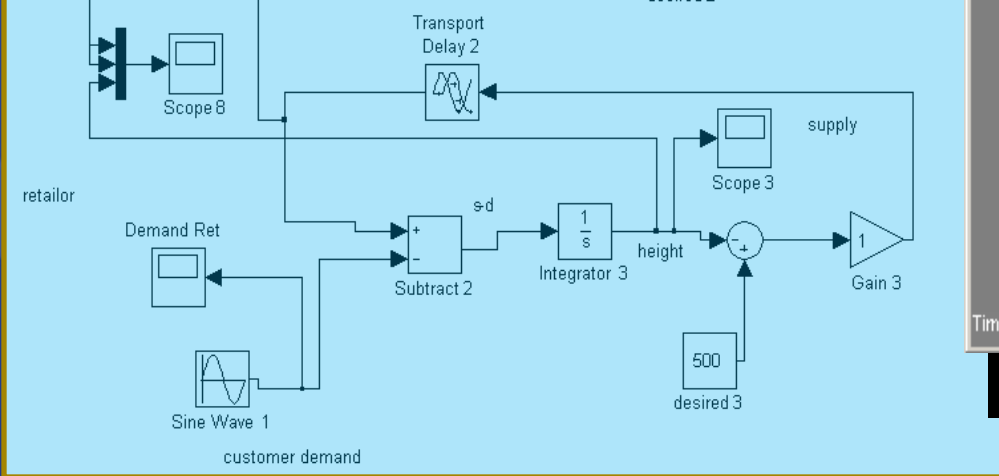
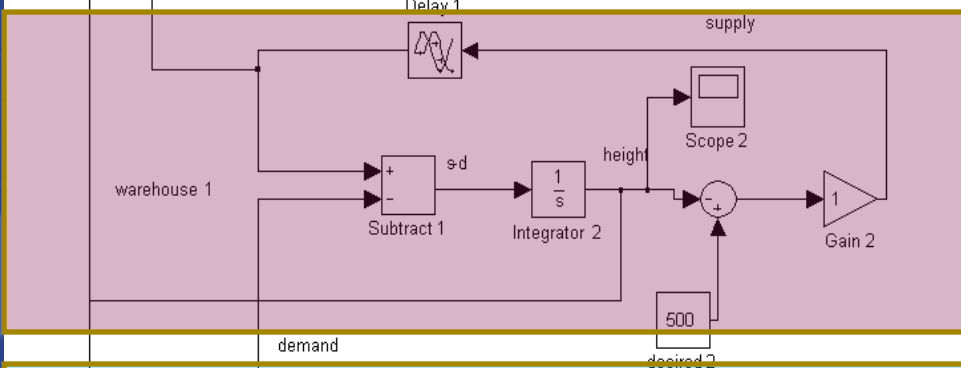
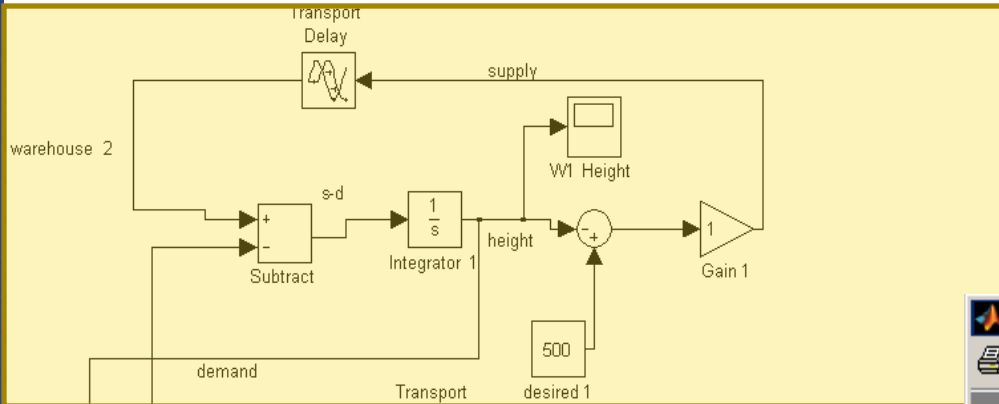


1. Add a desired inventory level.
2. Calculate how far away the inventory level is from the desired level. This is equal to the error.
3. Multiply the error by a gain.
4. That number is now the amount of supplies the manager orders and receives.

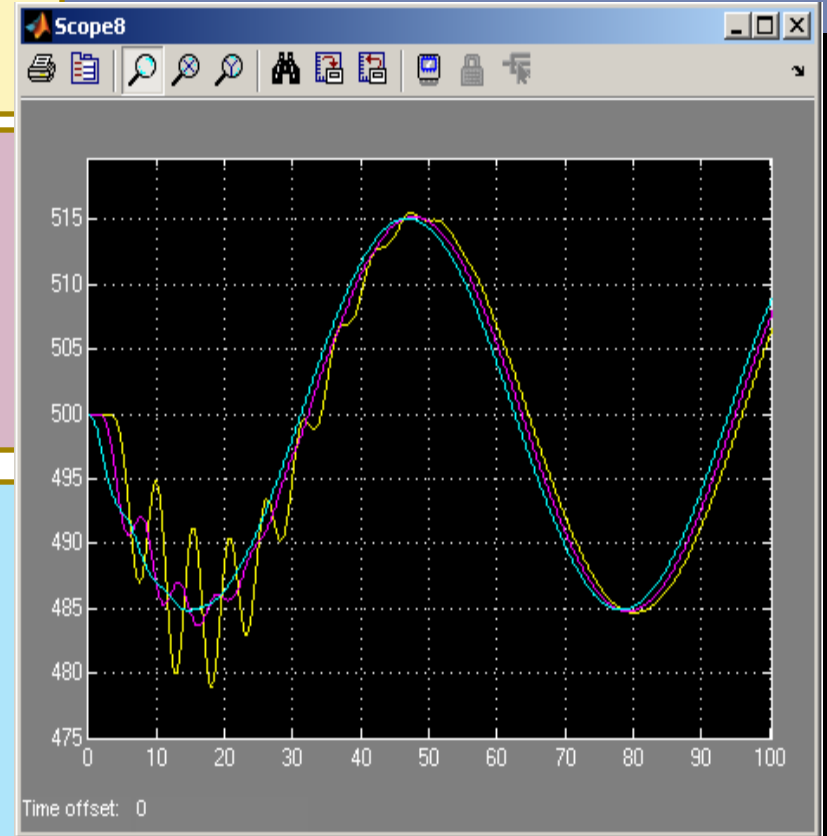
## Supply chain :

PEC = Inventory levels  
System= reservoir  
Sensor=manager/ computer (monitors inventory levels)  
Decision maker= manager/computer (places order)  
Control Law= gain (aggressive/ subtle)





# Two-Echelon Problem



# BULLWHIP EFFECT

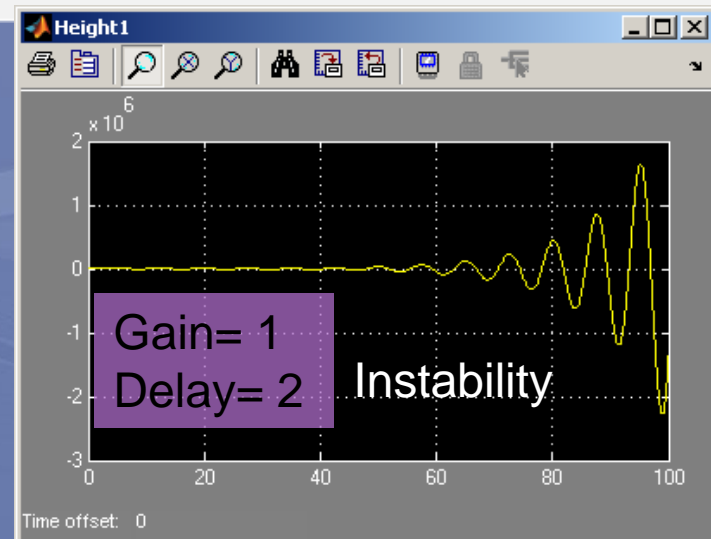
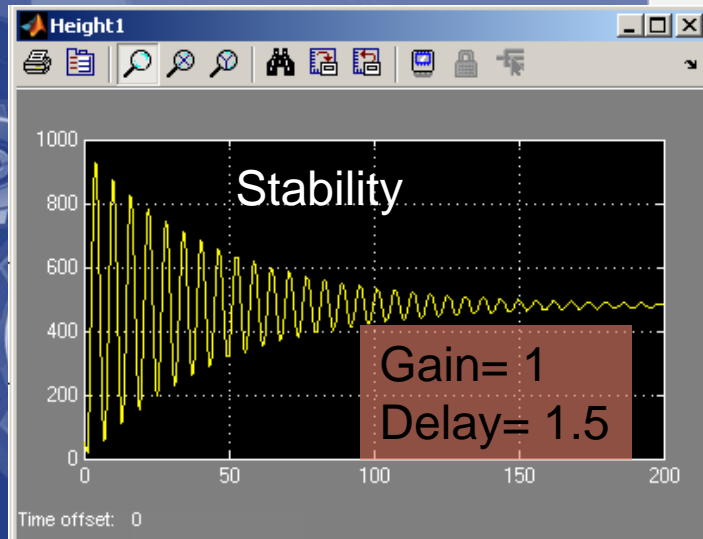
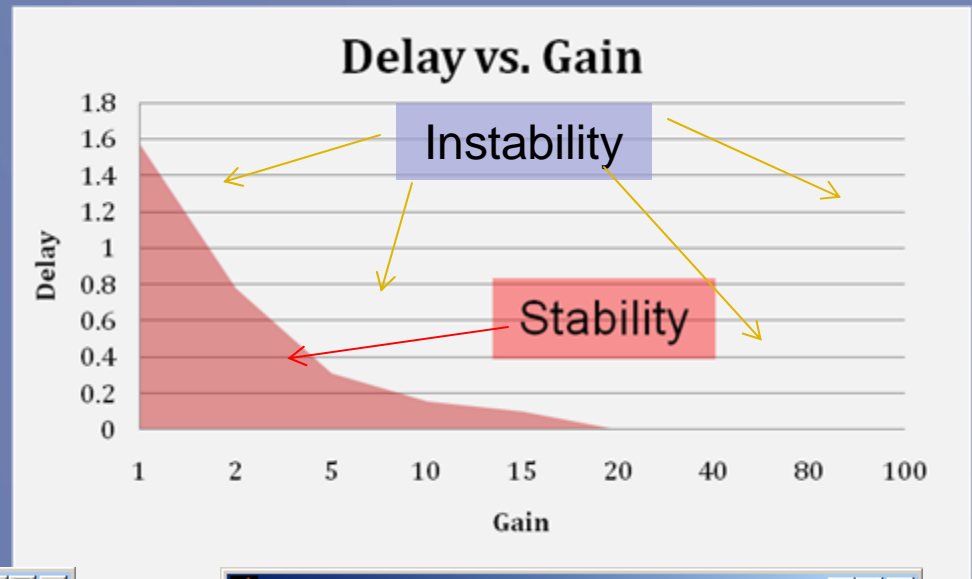
# Stability/ Instability

Stability = inventory level reaches the desired value

- Converges

Instability = inventory level moves farther and farther away from the desired level

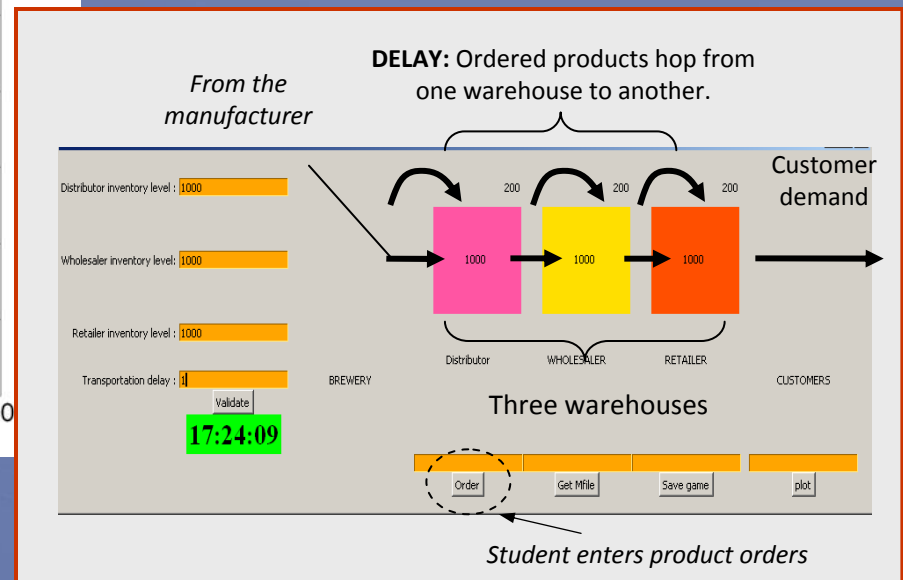
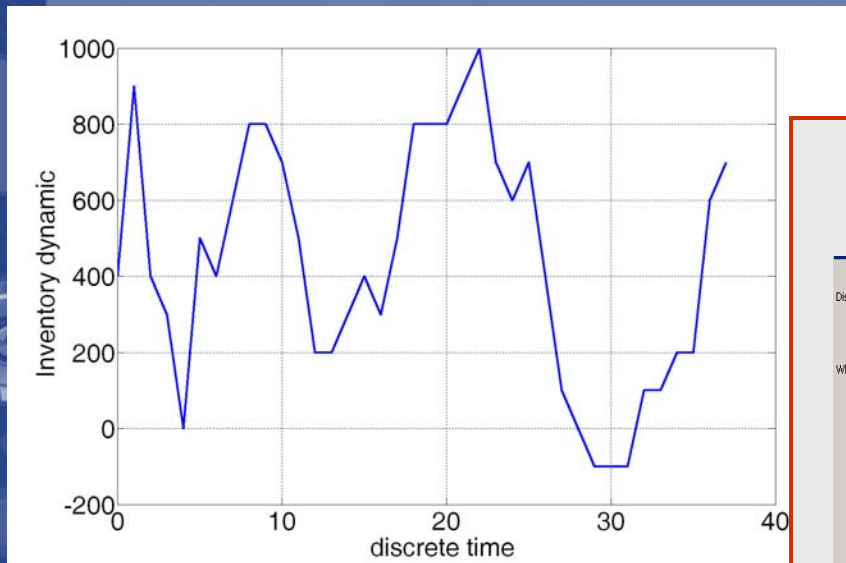
- Diverges



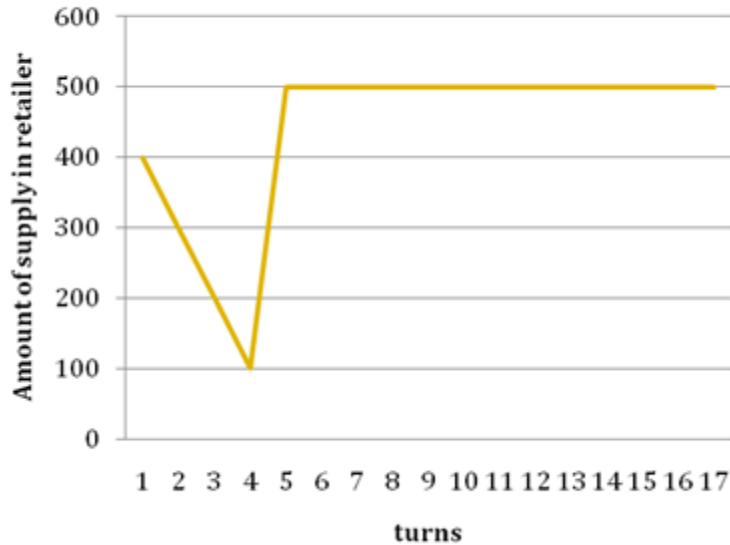
# Supply Management Game

Object of the Game: stabilize the retailer's inventory at a desired level. The demand is constant at 300, meaning 300 of the supply is removed from your inventory each turn.

The order that you place reaches the retailer 3 turns after you have submitted the order. This simulates delays.



## inventory level



Takes a minimum of 5 turns to stabilize the inventory levels.

— inventory level

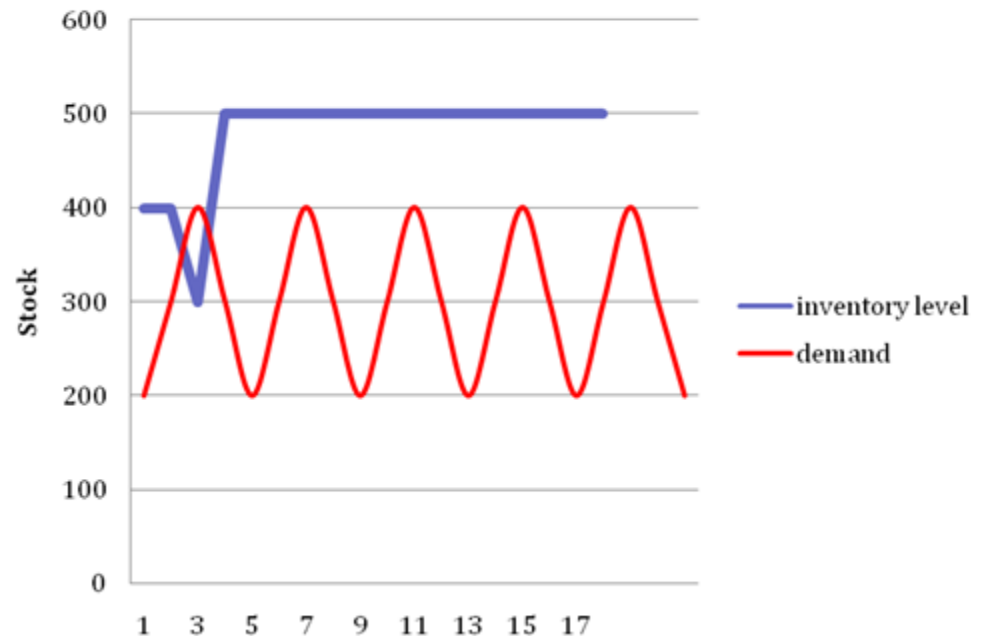
The strategy:

- since the demand is constant and the 3 previous orders are constant at 200, your first order has to make up for the drop in stock. After the target inventory level is reached for the retailer, the orders must match the demand. This stabilizes the inventory at the desired value.

Same concept applies to a different demand. When demand is oscillatory, understanding the oscillations and upcoming demand is key.

**Forecasting:** Companies use the WIP orders and their current inventory situation to determine their next order.

## maintaining inventory levels with an oscillatory demand

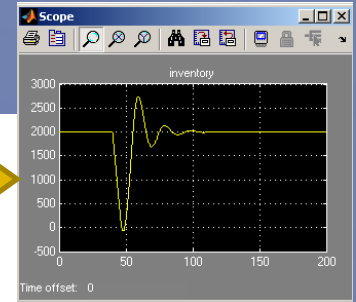
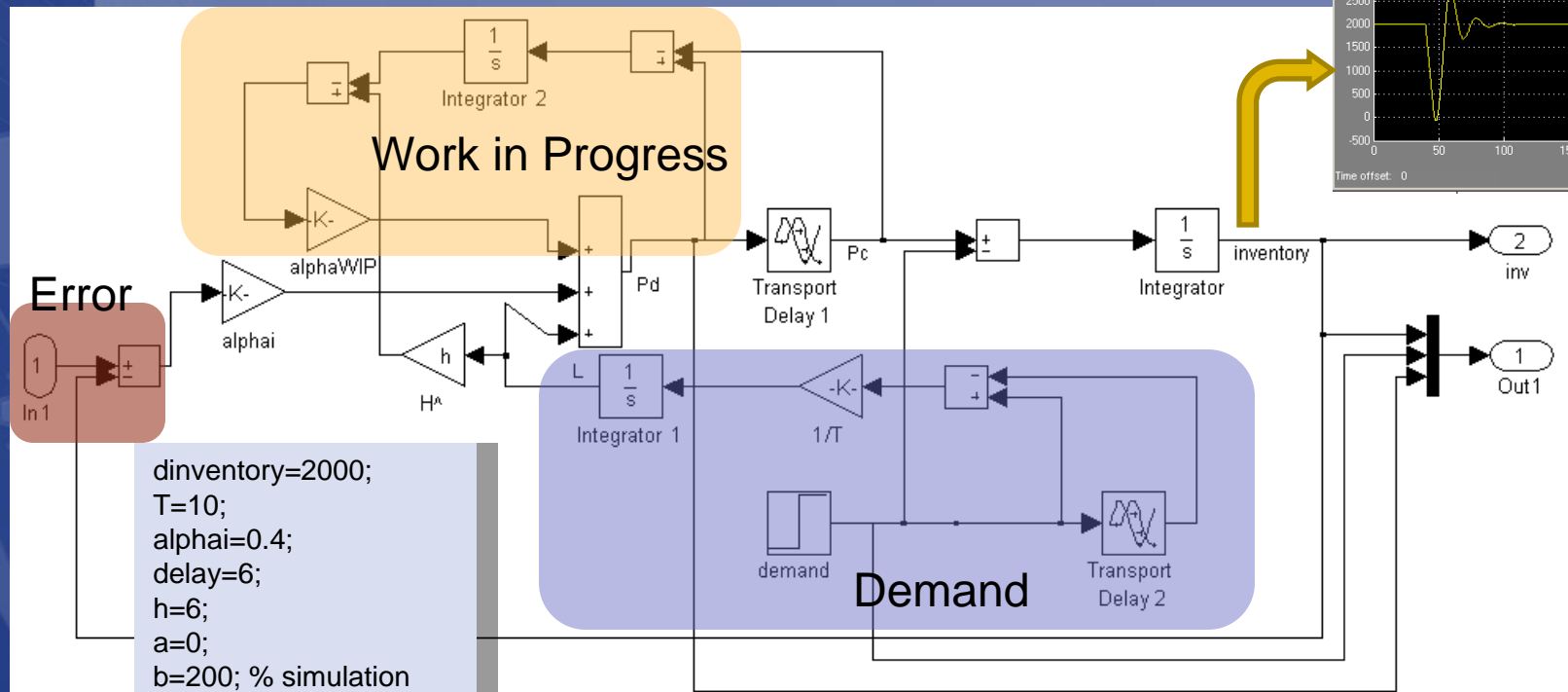




# Components of Supply Chains

ORDER

$$p^d(t) = \hat{L}(t) + \alpha^i (\bar{i}(t) - i(t)) + \alpha^{WIP} \left( h \hat{L}(t) - \int_{t-h}^t p^d(\mu) d\mu \right)$$

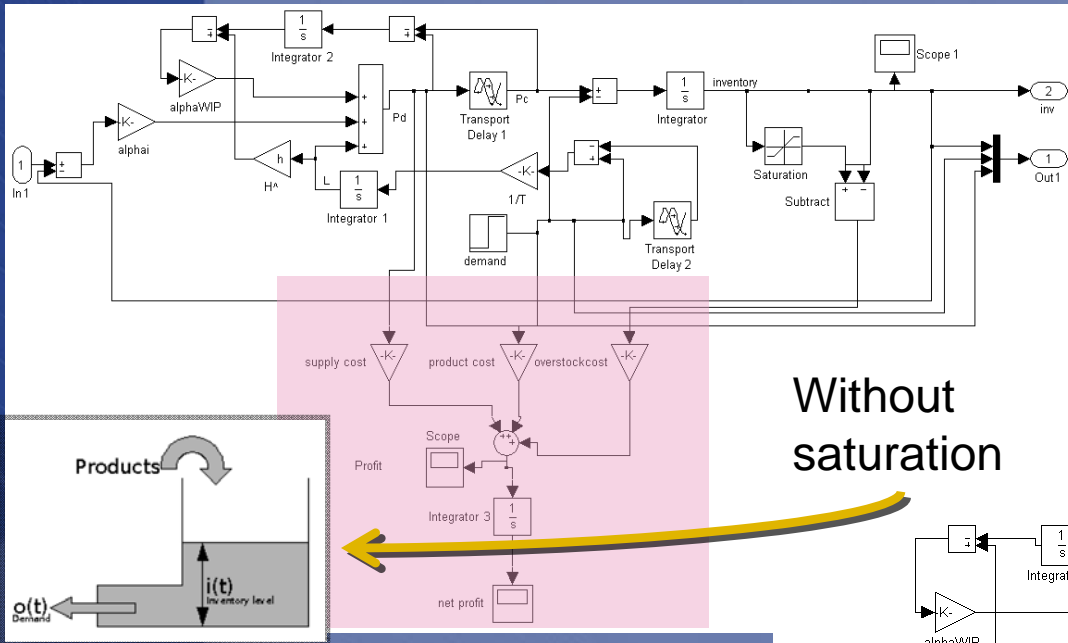


```

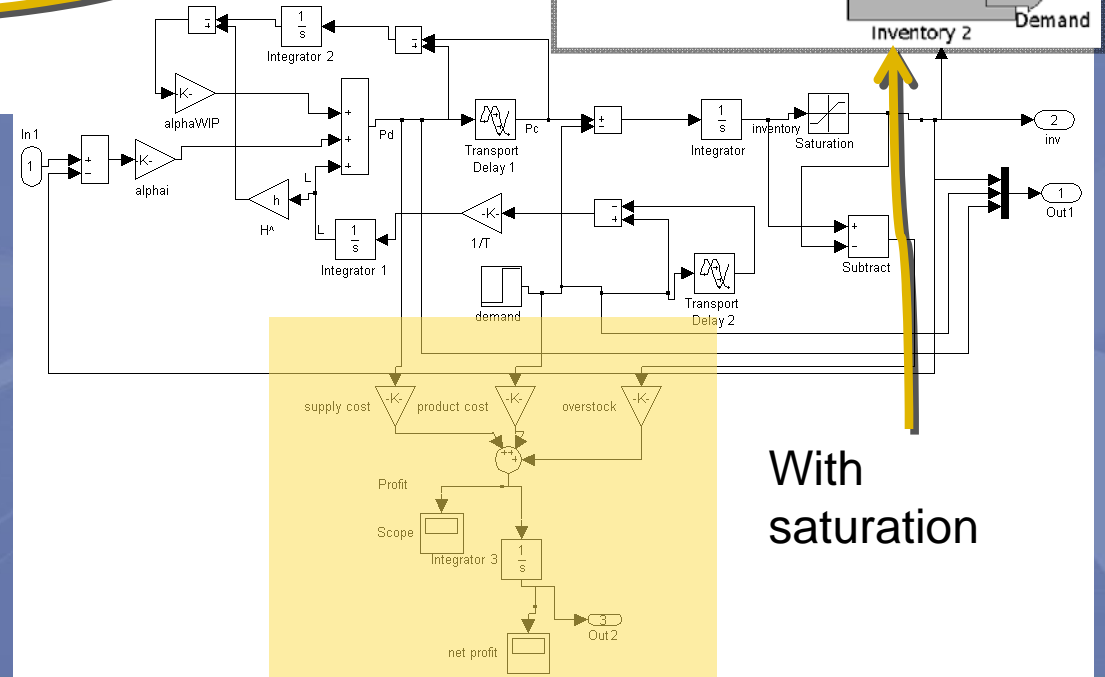
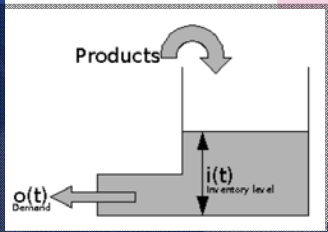
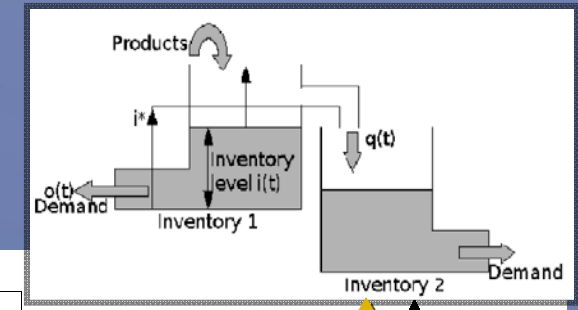
dinventory=2000;
T=10;
alpha=0.4;
delay=6;
h=6;
a=0;
b=200; % simulation
time
beta=.5;
alphawip=alpha*beta;
    
```

# Profit

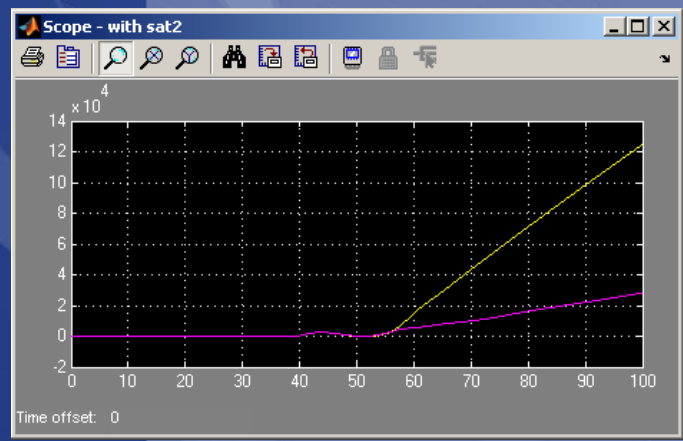
The Profit increases with the saturation. The inventory without the saturation has an additional penalty cost, while the saturated inventory earns \$ for the extra supply they have.



Without saturation



With saturation



# Acknowledgements

Computer Lab... Director Rachele Reisberg

Young Scholars Program:

Claire Duggan

Ryan Sauve

Ben Snyder

David Glidden

Professor Rifat Sipahi

