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# Optimal Inventory Policy for Two-echelon Remanufacturing

Ferrer, Geraldo

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# Optimal Inventory Policy for Two-echelon Remanufacturing

Prof. Geraldo Ferrer

Graduate School of Business and Public Policy

# Introduction

- **OBJECTIVE:** Identify the inventory policies that will fit a remanufacturing environment:
  - sequential disassembly and selection processes
  - random yield in each process
  - known demand
- **ASSUMPTION:** There is no shortage of used goods to feed the process:
  - plentiful stock of used goods
  - uncertainty is generated by the wear state

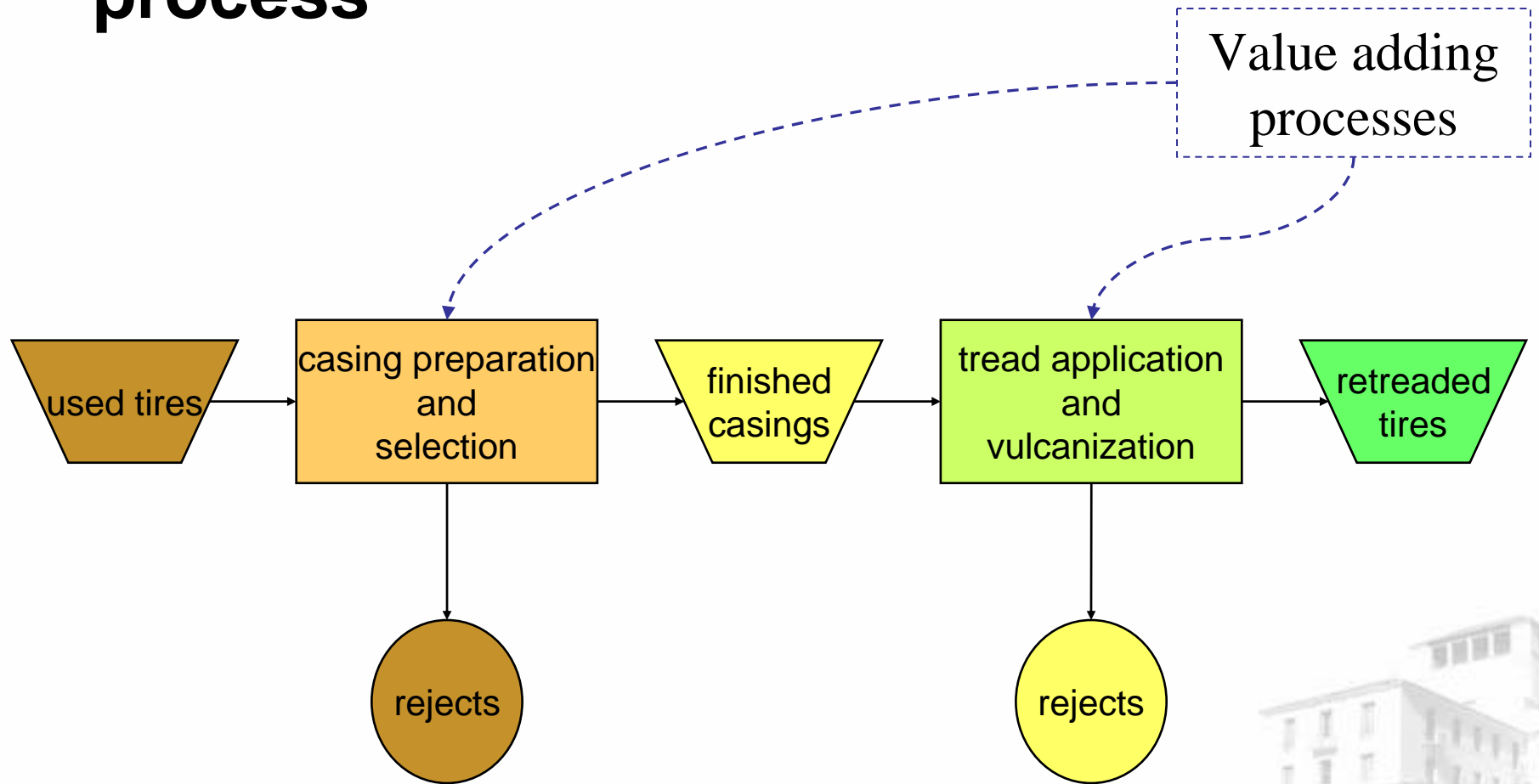


# Some related literature

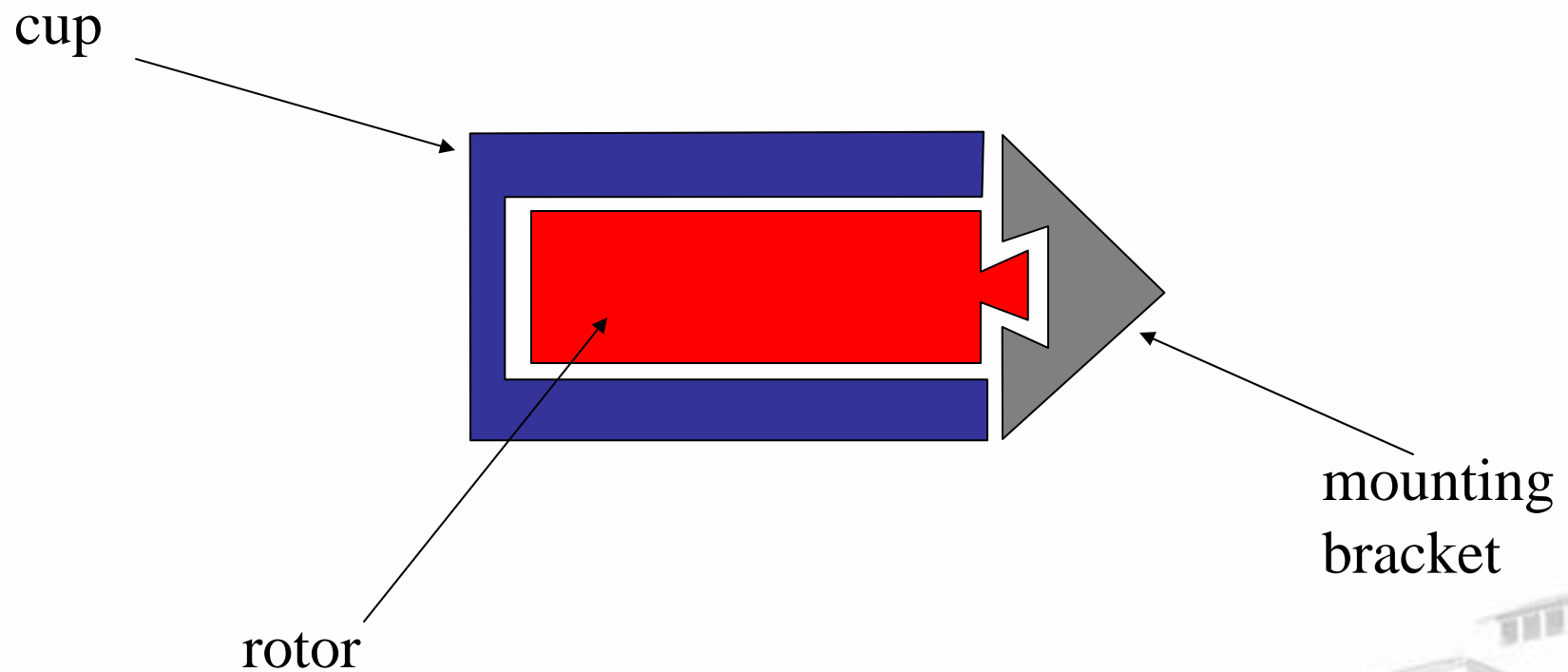
	Single Process		Multi Process	
	Constant Process Yield	Random Process Yield	Constant Process Yield	Random Process Yield
<b>Constant Demand</b>	Harris 1913	various	Clark, Scarf 1960	
<b>Random Demand</b>	various	various	DeBodt and Graves 1985	



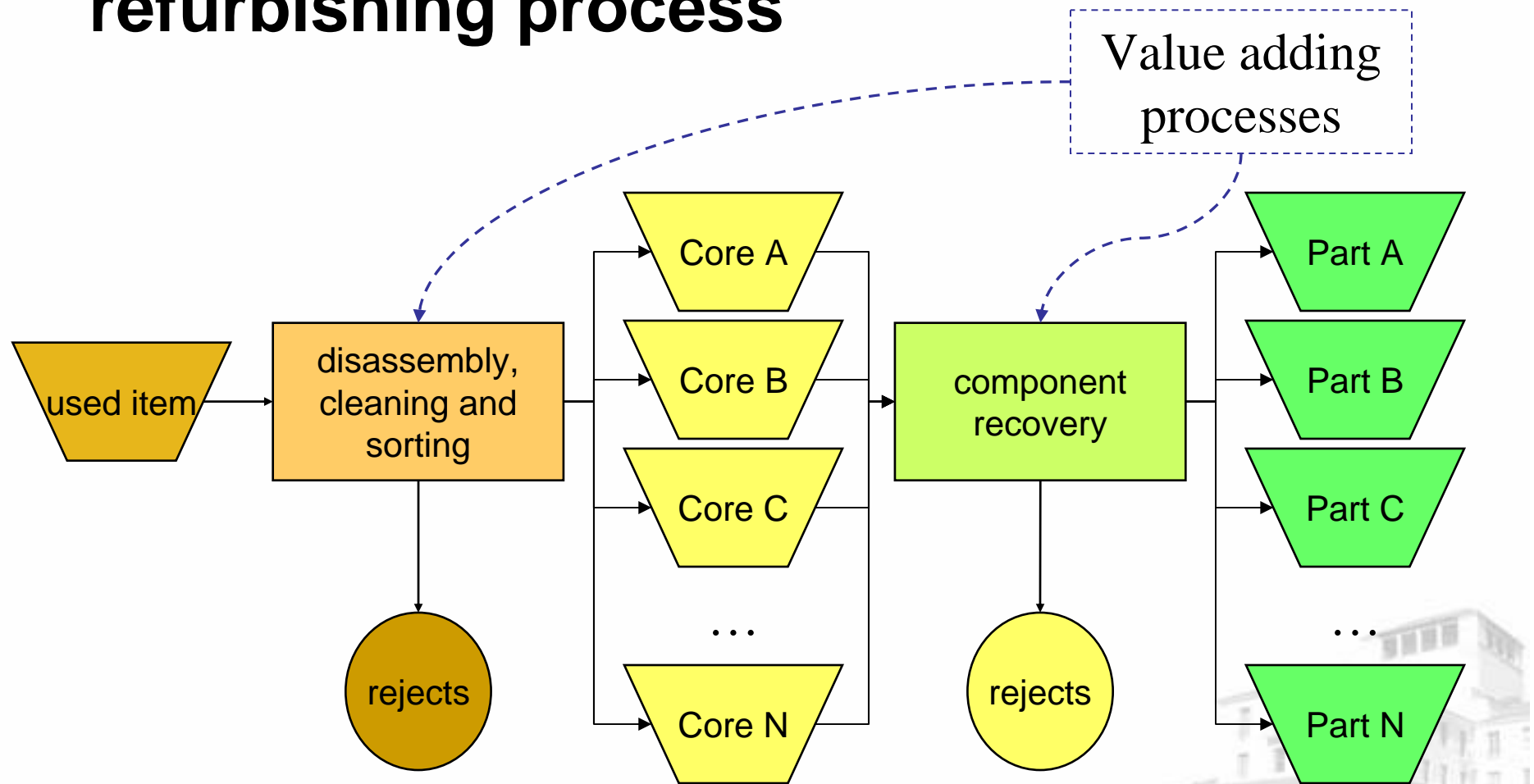
# Used tires flow in the retreading process



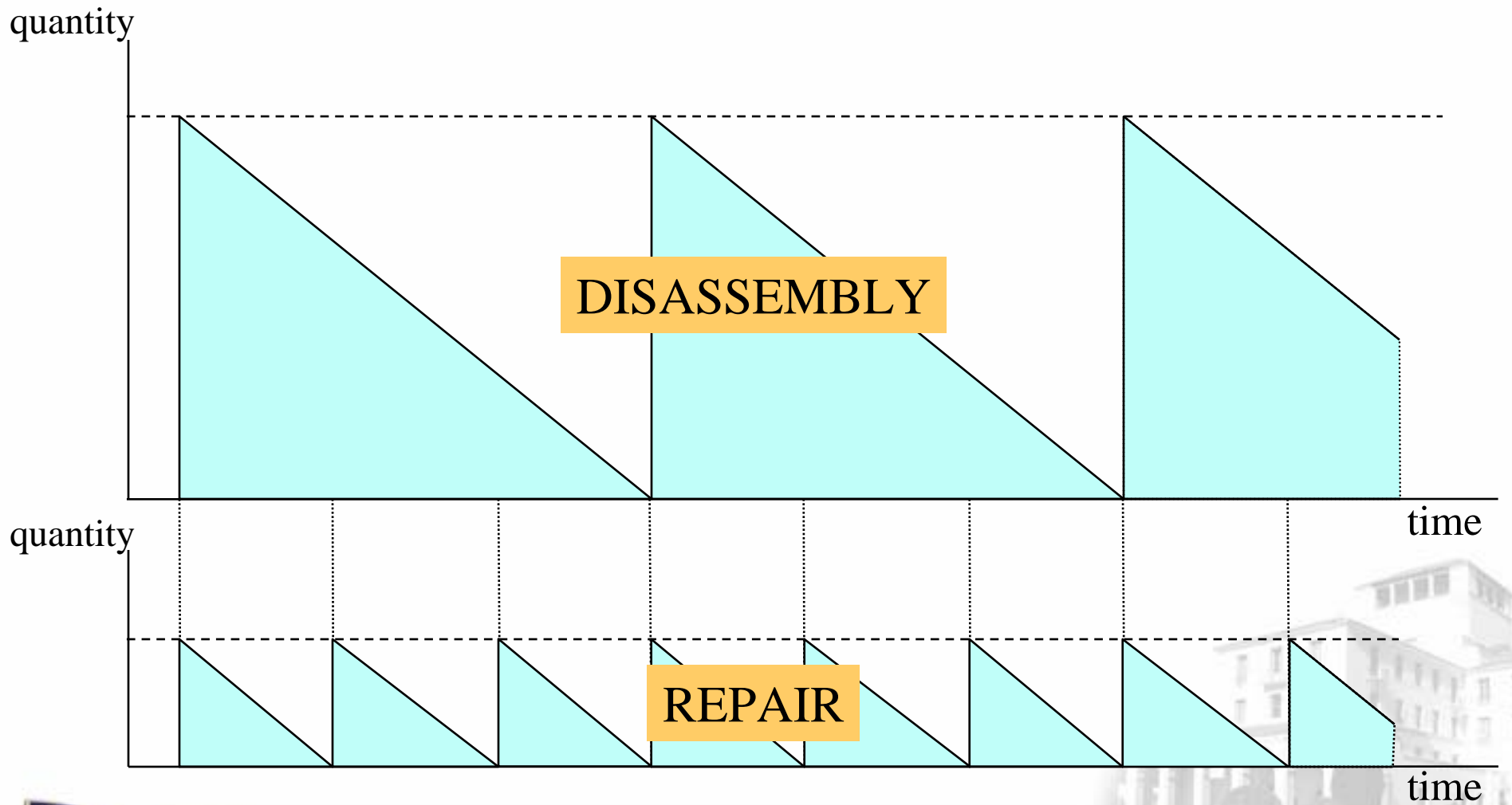
# Electric Components



# Material flow of complex equipment refurbishing process

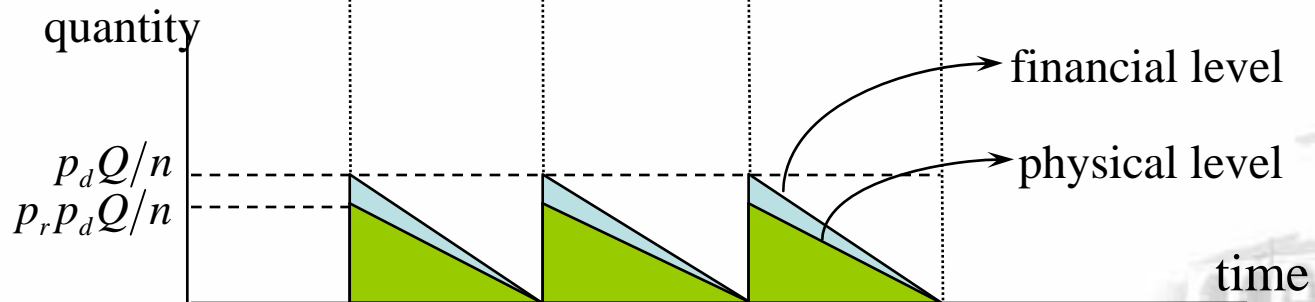
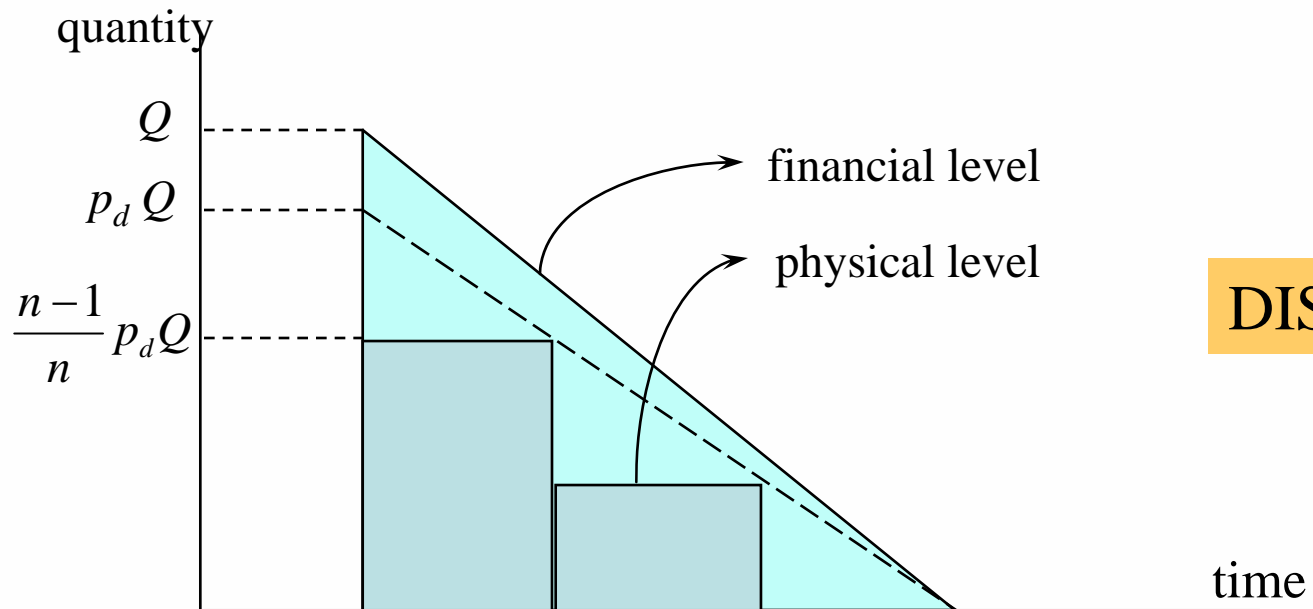


# Multi-Echelon Inventory Process

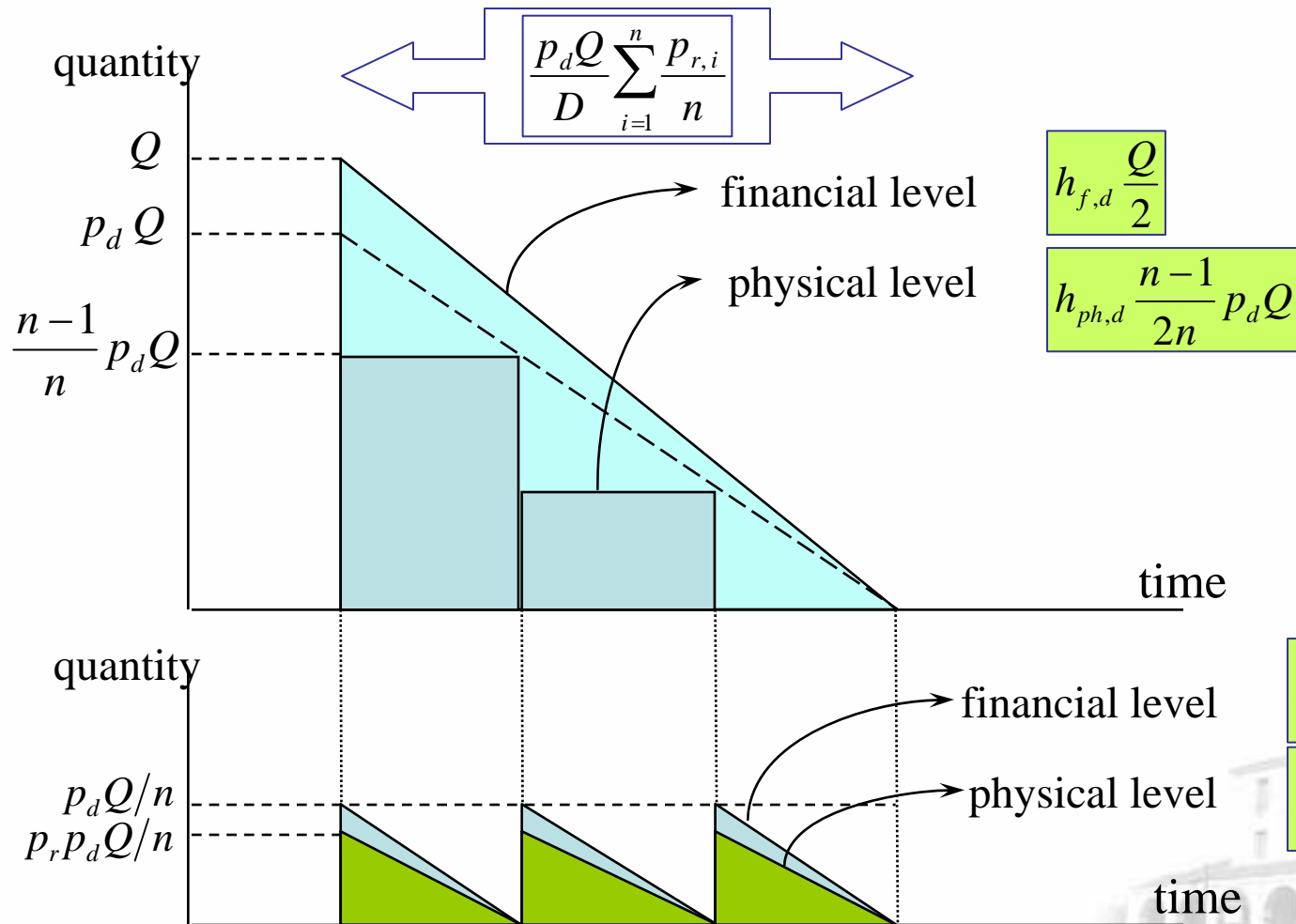




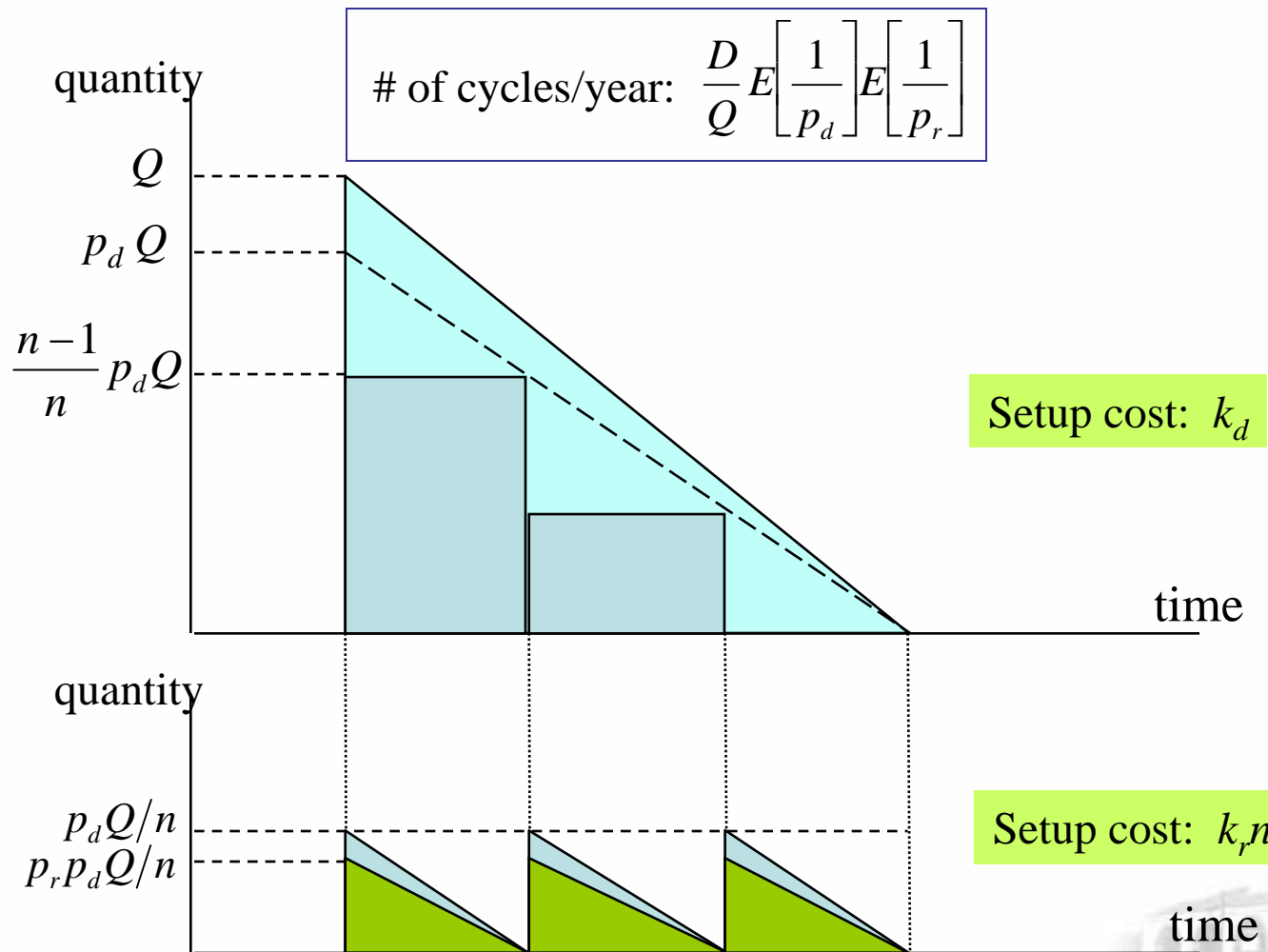
# Financial and Physical Stock



# Financial and Physical Holding Cost



# Financial and Physical Setup Cost



# Optimal Inventory Policy

Considering:

$$\left\{ \begin{array}{l} n = \sqrt{\frac{E[p_d](h_{f,r} - h_{ph,d} + h_{ph,r}E[p_r])k_d}{h_{f,d} + h_{ph,d}E[p_d]} \frac{k_d}{k_r}} \\ H(n) = h_{f,d} + \frac{E[p_d]}{n}(h_{ph,d}(n-1) + h_{f,r} + h_{ph,r}E[p_r]) \\ K(n) = (k_d + nk_r)E[1/p_d]E[1/p_r] \end{array} \right.$$

Optimal Inventory Policy  $Q^*(n) = \sqrt{\frac{2DK(n)}{H(n)}}$

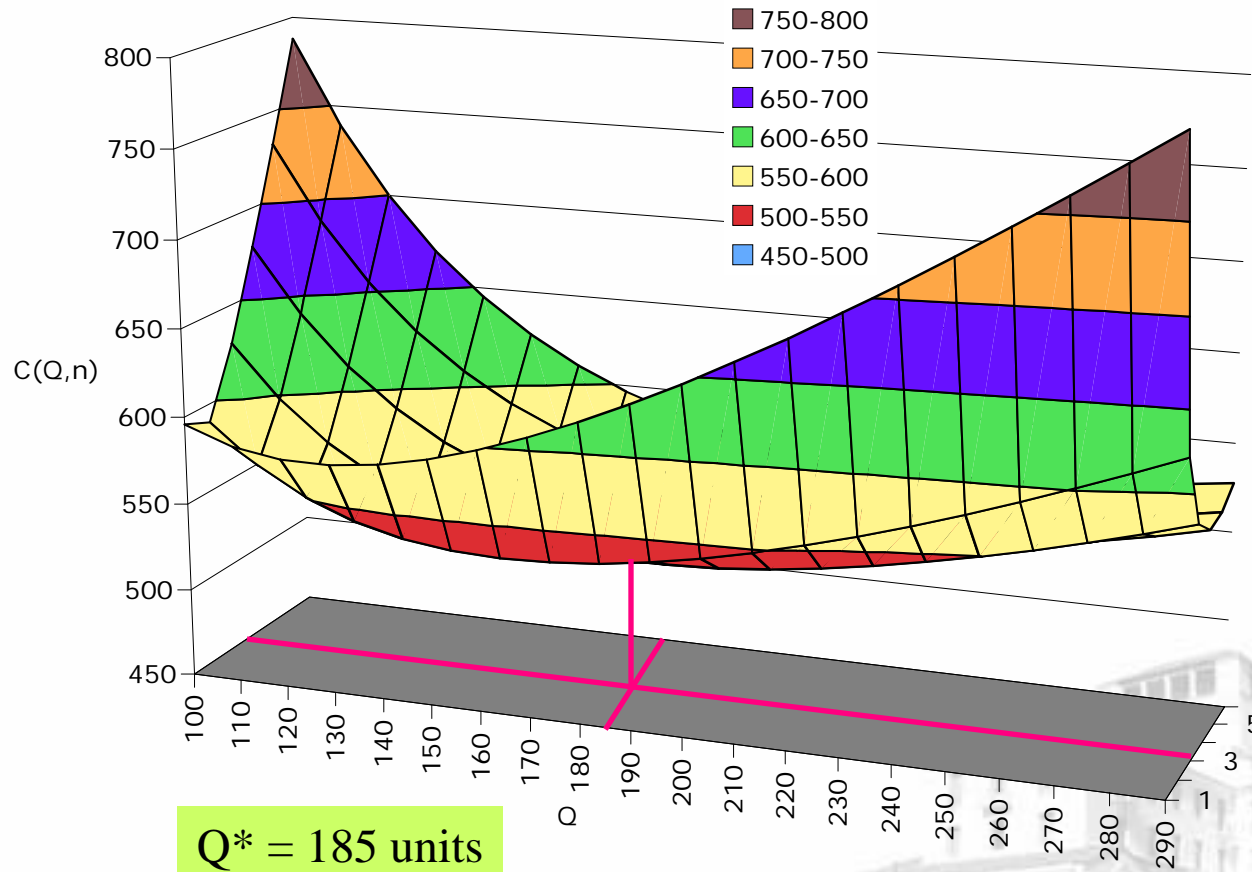


# Example

Disassembly Process:  
 $k_d = \$30/\text{process}$   
 $h_{f,d} = \$0.5/\text{unit-yr}$   
 $h_{ph,d} = \$2/\text{unit-yr}$   
 $p_d = U[0.5, 0.95]$

Repair Process:  
 $k_r = \$6/\text{process}$   
 $h_{f,r} = \$4/\text{unit-yr}$   
 $h_{ph,r} = \$2/\text{unit-yr}$   
 $p_r = U[0.75, 0.95]$

$D = 600 \text{ units/yr}$

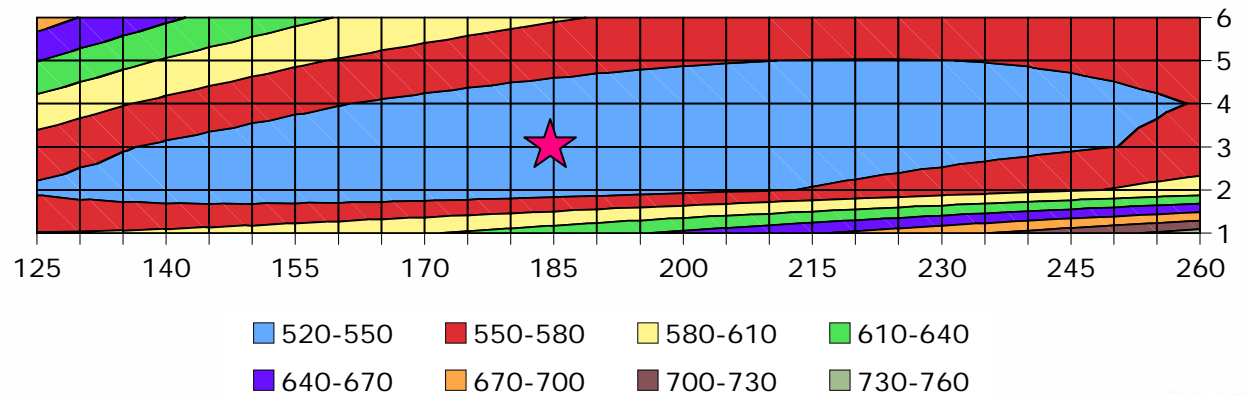


# Example

Disassembly Process:  
 $k_d = \$30/\text{process}$   
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Repair Process:  
 $k_r = \$6/\text{process}$   
 $h_{f,r} = \$4/\text{unit-yr}$   
 $h_{ph,r} = \$2/\text{unit-yr}$   
 $p_r = U[0.75, 0.95]$

$D = 600 \text{ units/yr}$



$Q^* = 185 \text{ units}$   
 $n^* = 3$

