Lecture #22

ERDM

Prof. John W. Sutherland

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From NSPE Code of Ethics

- **Web site: http://www.nspe.org/ethics/eh1-code.asp**

  From the Preamble:

  "... the services provided by engineers require honesty, impartiality, fairness and equity, and must be dedicated to the protection of the public health, safety, and welfare."

- **This obviously includes the environment!!**

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Last Class

- **We looked at system/logistic issues associated with assembly.**
  - **Facility layout**
  - **Assembly sytems**
  - **Modeling systems with discrete event simulation**
  - **Inventory & Inventory cost models**
  - **Warehouse & distribution issues -- modeling**

- **There are analogous issues for disassembly!**

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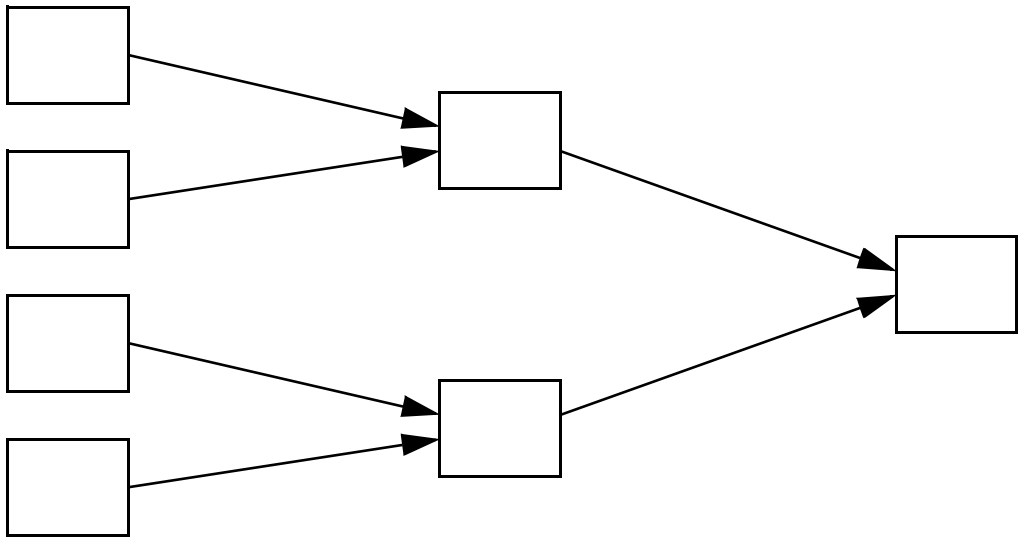
Part Flow - Assembly



Manufacturing system is focused on taking individual parts and combining them to produce a product

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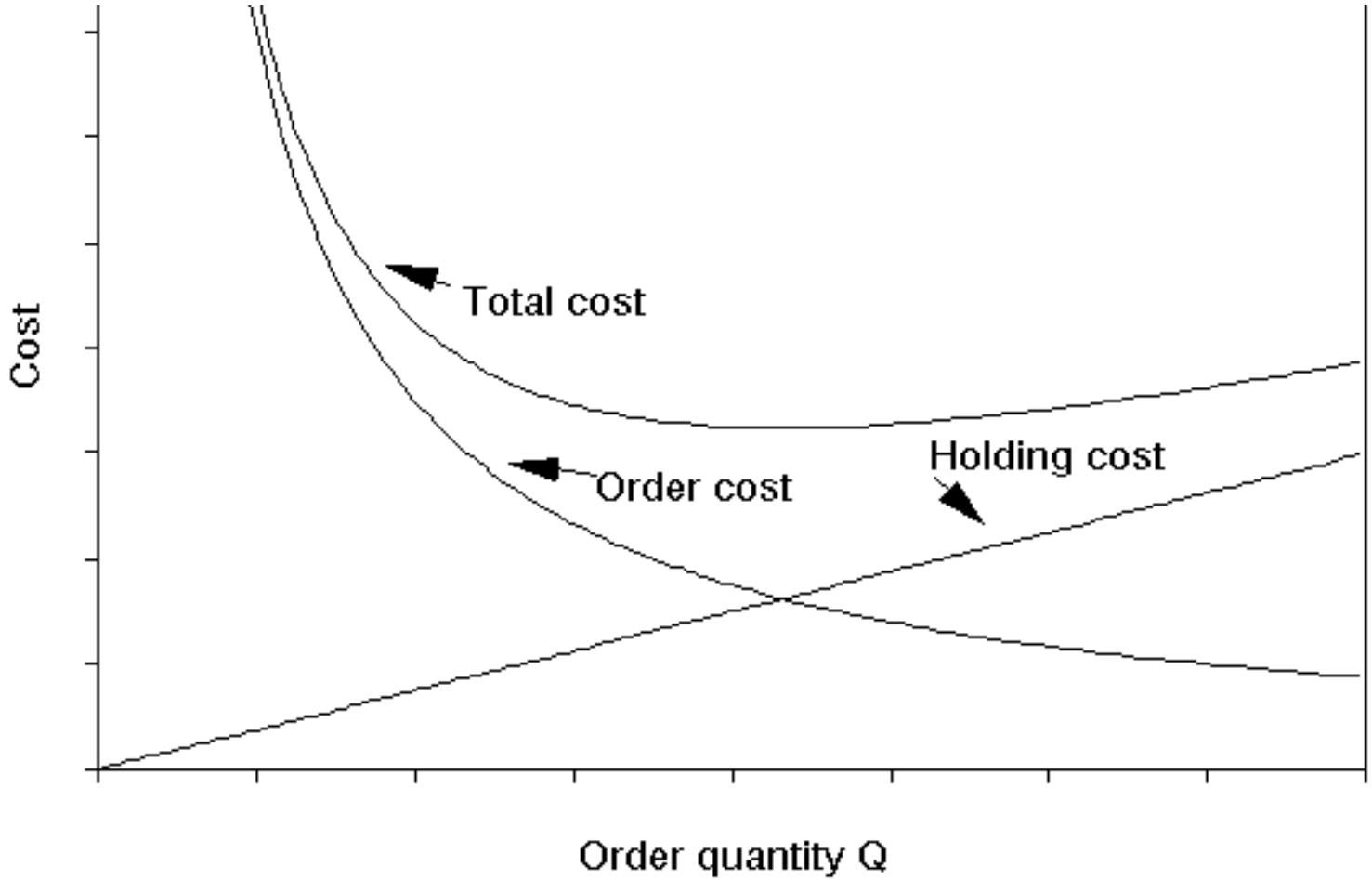
Inventory Costs



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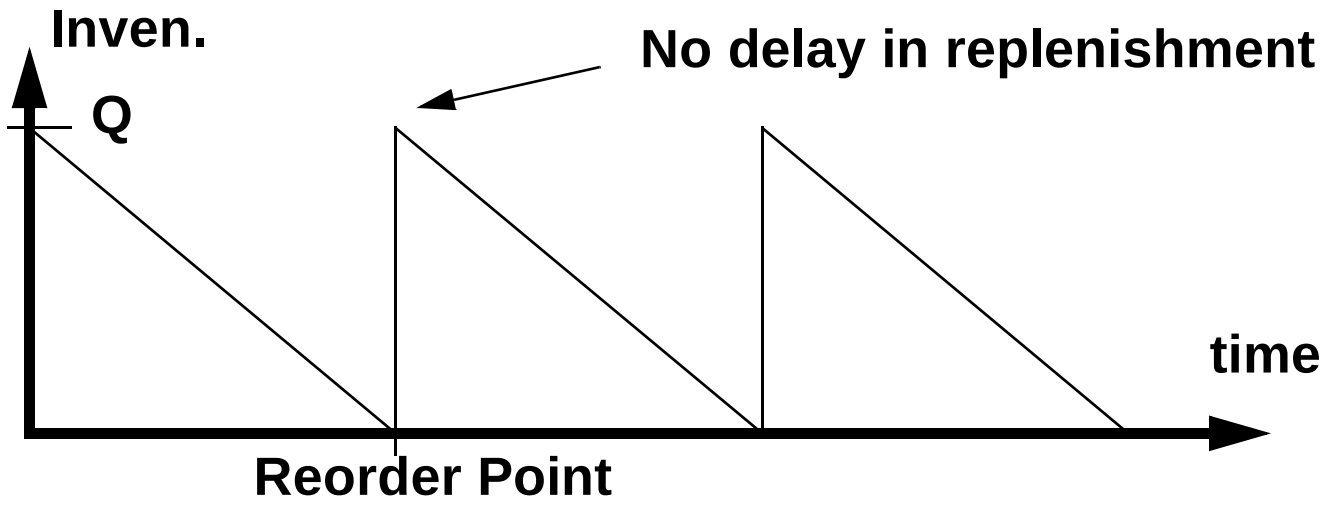
Inventory



Total Cost = $R*(C_0/Q + C_1) + Q/2*H$

Take deriv. & set =0, solve for $Q = sqrt(2RC_0/H) = EOQ$

For R=1,000,000/year; C_0=$100; and H=$1/part/day

Q = 14142 (Note that R=1M is about 20k per week)

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Modeling: Warehouse & Distribution Problems

- **Where do we locate the warehouses?**
  For example, I have 5 stores, where should I put my warehouse??

- **How do we minimize distribution cost?**
  What is the best route for trucks to take in distributing our products - Traveling Salesman problem

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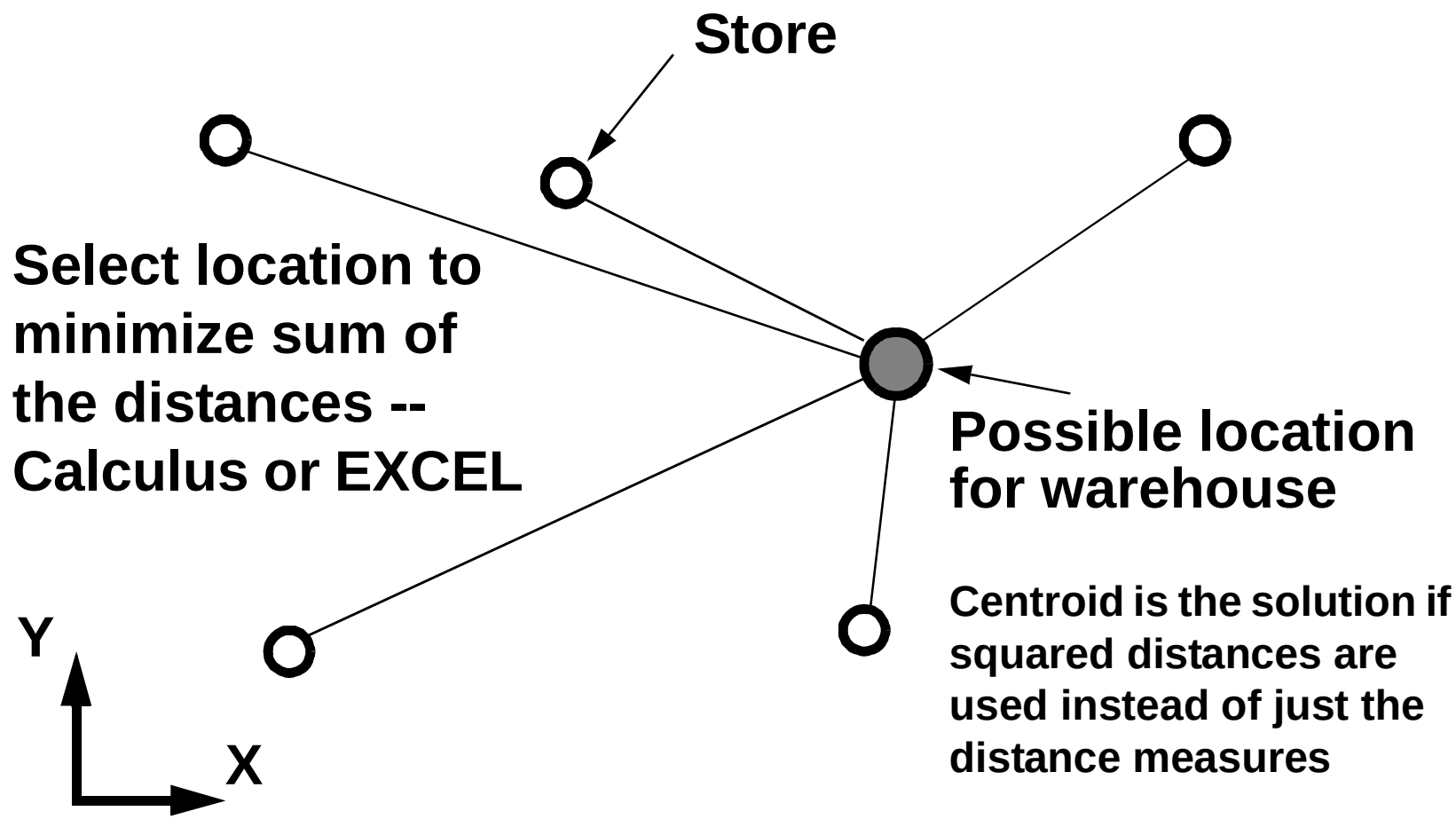
Warehouse Location Situation



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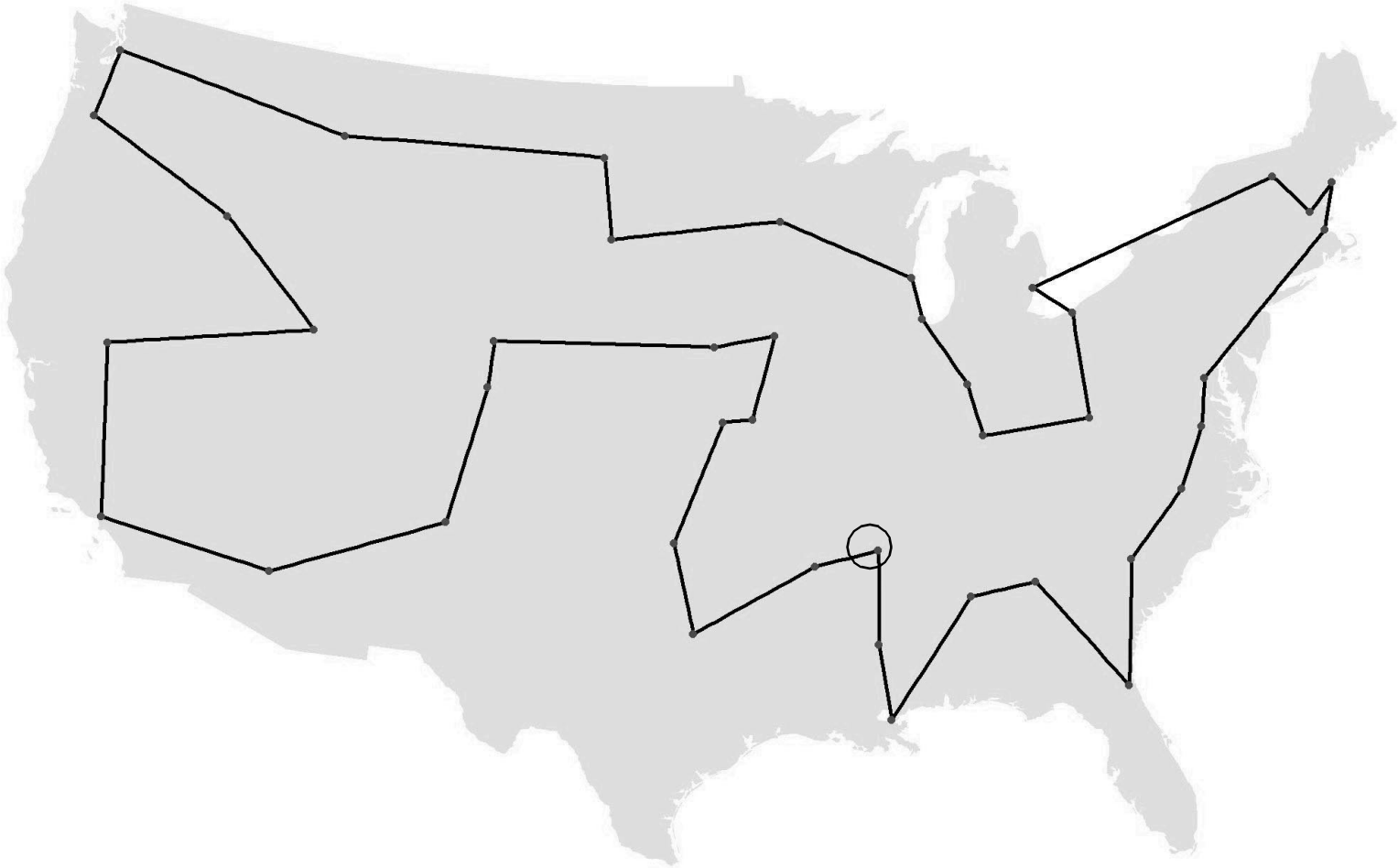
Travelling Salesman Problem

(path to be taken to distribute our products)



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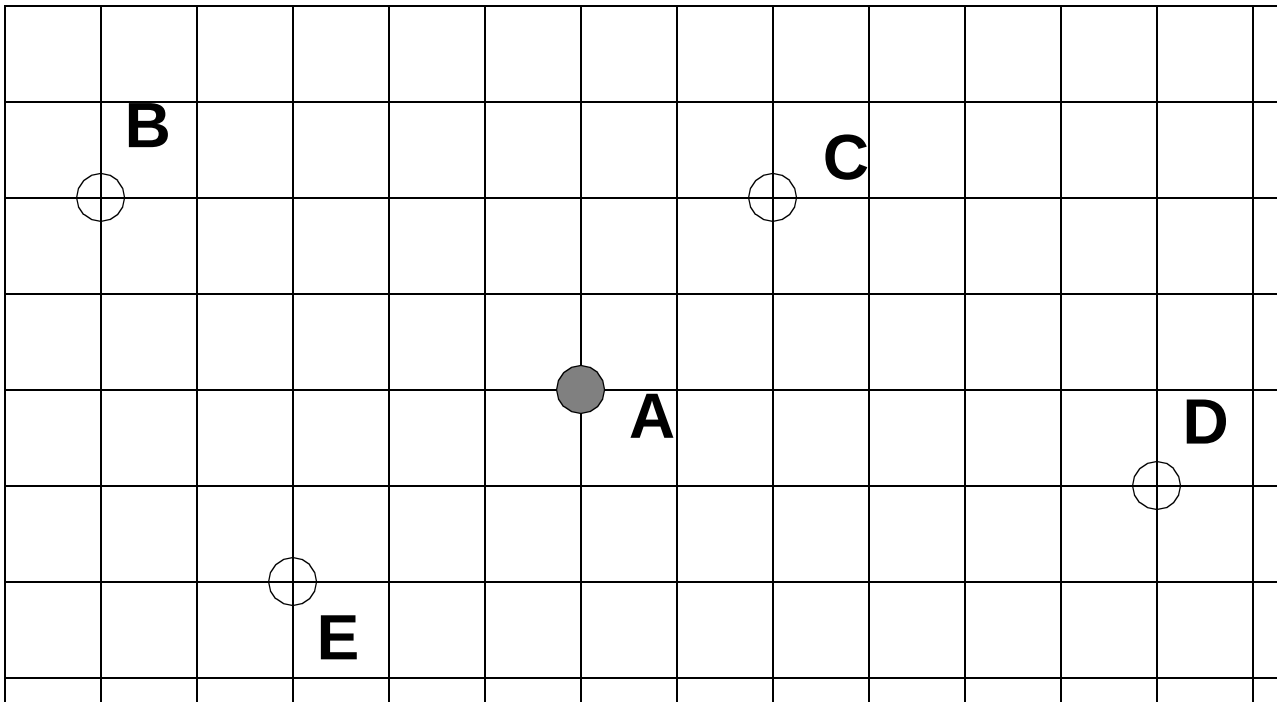
Route Selection

- **A truck is loaded with products at the warehouse. In what order should we stop at the stores?**



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The Distance Matrix

Distance Matrix -- Matrix is symmetric

$$\begin{bmatrix} 0 & 5.4 & 2.8 & 6.1 & 3.6 \\ & 0 & 7 & 11.4 & 4.5 \\ & & 0 & 5 & 6.4 \\ & & & 0 & 9.1 \\ & & & & 0 \end{bmatrix}$$

Add labels!!

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Branch & Bound Method

Start at A, assume a path from A-B-C-D-E-A

A-B: 5.4

B-C: 7

C-D: 5

D-E: 9.1

E-A: 3.6 or D-E-A: 12.7 (E is last node -- return to A)

Distance = 30.1 -- this serves as our upper bound.

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Branch & Bound Solution

- **In our first branch, instead of going from C-D-E, consider C-E-D. Of course A-B-C is (12.4)**
  C-D is (6.4) & E-D-A is (15.2). Total is 34. Higher than our upper bound, so we don't wish to consider. Branch below C has been "fathomed".

- **Move up the branch to node B. Consider alternatives to B-C. How about B-D? B-D is (11.4)**

- **and so forth....**

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Collection Systems

- **Situations:**
  - **Recycling Centers -- where to locate them? -- reverse warehouse problem.**
  - **Recycling Trucks -- what path should they take? Travelling Salesman Problem**
  - **Recovery of takeback products -- collection centers & transportation**

- **Can existing distribution systems be used for takeback? -- Logistical systems used for reverse logistics?**

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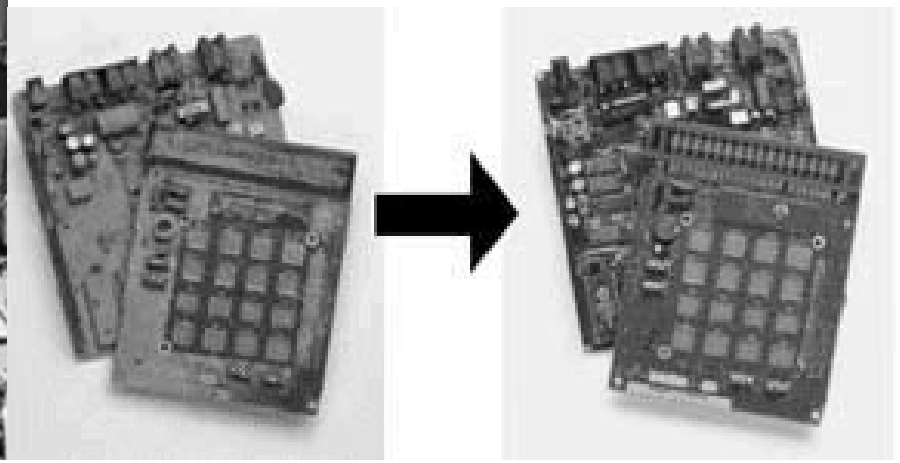
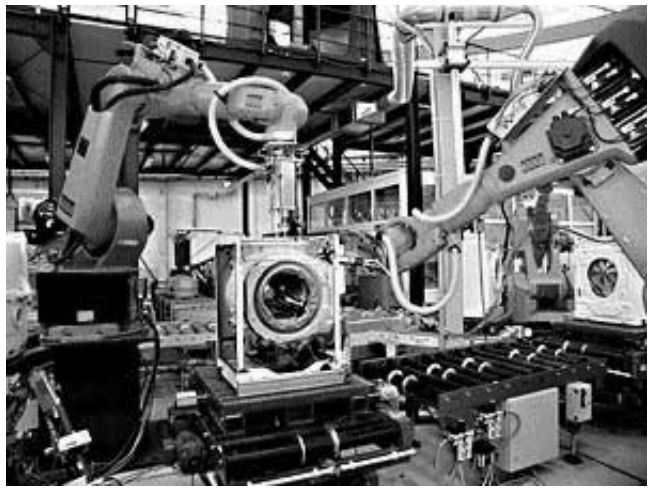
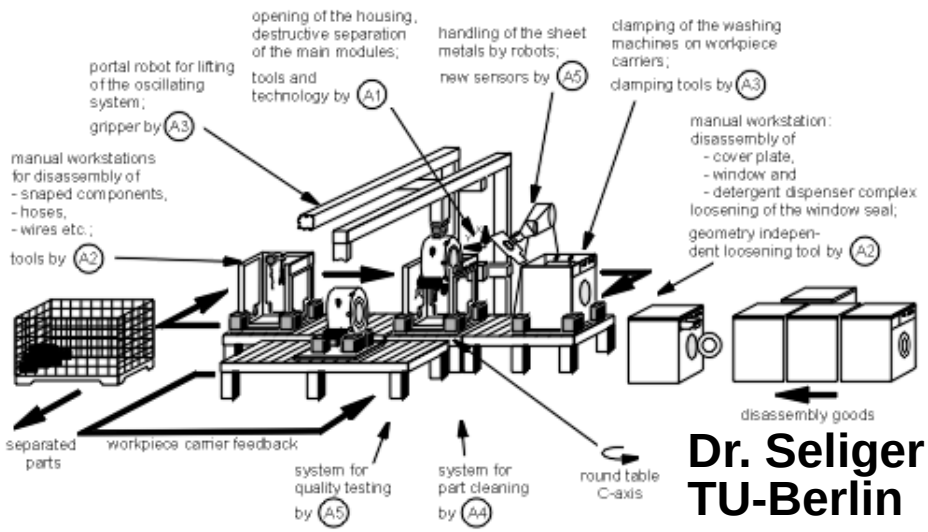
Demanufacturing Systems







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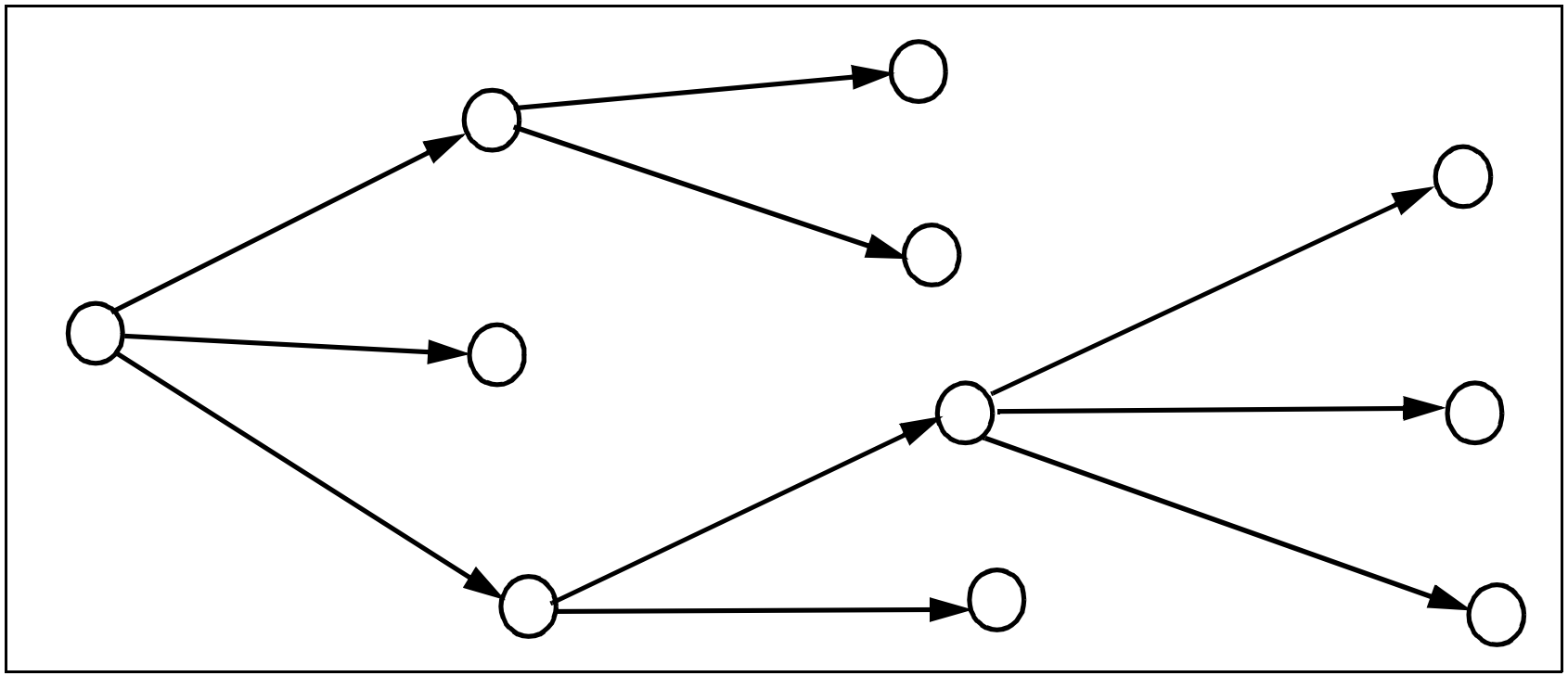
Disassembly Systems

- **We have briefly discussed how we might look at an assembly process. What about the reverse??**



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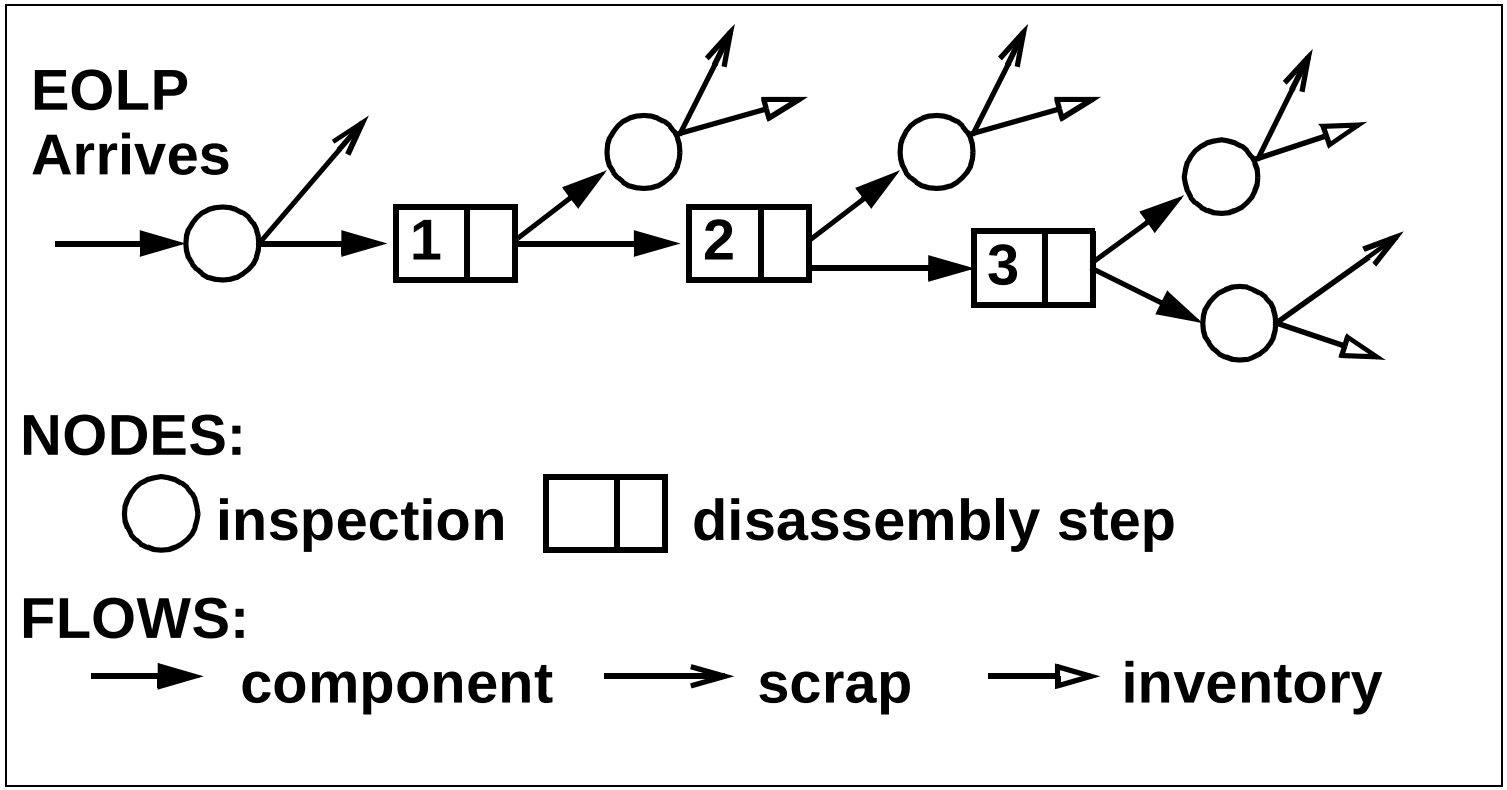
Disassembly Operations



As products arrive, they are disassembled. Parts are placed into inventory.

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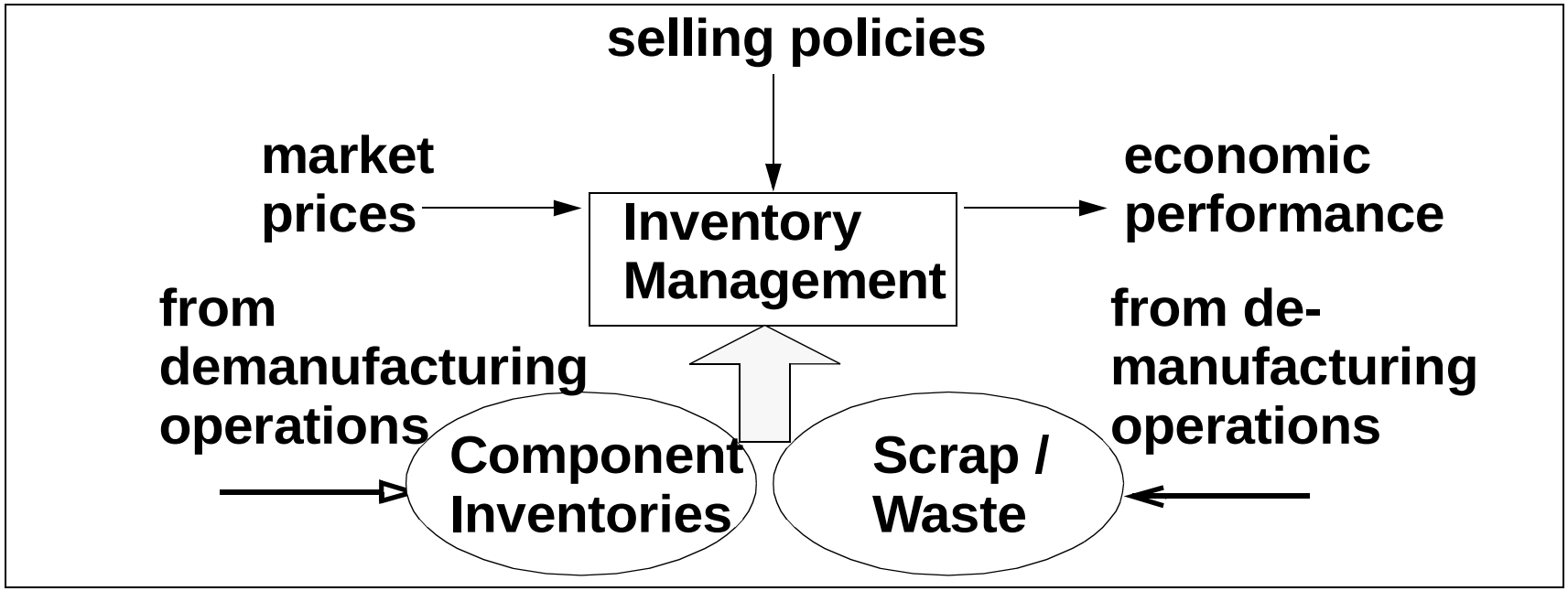
Management of Used Components



- **If disassembled parts can be immediately handled -- no problem. Most often though, they are stored in inventory until needed.**

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Used Parts Inventory

- **We don't want to accumulate parts we can't sell. Remember, there is a holding cost for stuff stored in inventory.**

- **Market price for used components changes over time. We might be willing to sit on some inventory if there is a chance the market price will go up soon.**

- **The demand is not the same for the individual parts recovered from the demanufacturing of a product.**

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