Lecture #21

ERDM

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Last Couple of Classes

We’ve focused on disassembly. Specifically, we’ve looked at product configuration, fastening systems, and the disassembly operation itself. Why?
- Recycling recovery efficiencies may be improved if part sorting has been performed.
- Remanufacturing or value recovery systems require parts in their “as disassembled” form.
- Maintenance

Let’s envision a situation where a company plans to receive used products. The intent is to recover maximum value from these products.
Manufacturing System Layouts

- Functional Layout

<table>
<thead>
<tr>
<th>Stamping / Forming</th>
<th>Cutting / Shearing</th>
<th>Inspection / Storage</th>
<th>Assembly</th>
<th>Plating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping / Receiving</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing / Cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Line Layout

• Layout problems -- address with IE techniques
• Group Layout

Use group technology coding system to define cells
Part Flow - Assembly

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

- Discrete event simulation often used for system design. How many stations, work handling devices, in-process storage??

- Generally, assembly plan is fixed.

- Parts are clean & undamaged. Part-to-part variation is relatively small. Parts are interchangeable.

- Want to minimize work in process, and inventory in general. 1-Build assemblies to order. 2-Forecast demand & build as needed. 3-Build and store.
Modeling Assembly Systems

- Inventory of Part A
  - Transport
  - Process A
  - Queue

- Inventory of Part B
  - Transport
  - Process B

- Processing Time Described with Statistical Distribution

- Departure Times (Production Rate)

- Assembly
Representative Output

<table>
<thead>
<tr>
<th>Queue Size</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>40</td>
</tr>
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<td>2</td>
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<tr>
<td>12</td>
<td>50</td>
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</table>

<table>
<thead>
<tr>
<th>Time Between Finished Components (sec)</th>
<th>Frequency</th>
</tr>
</thead>
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<tr>
<td>180</td>
<td>0</td>
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</tbody>
</table>
Inventory

- As noted, want to keep inventory small -- minimizes capital investment.

- Purchasing parts -- transaction cost + variable cost.

- Parts stored in inventory incur a holding cost.

- Common problem how often should we be replenishing our inventory? Use R parts per year

\[
\text{Annual Purch. Cost} = \frac{R}{Q} (C_0 + C_1 \cdot Q) \quad (Q \text{ is amt ordered})
\]

\[
\text{Annual Inventory Cost} = \text{Avg} \# \text{ inventoried parts} \times \$\text{/part}
\]
Total Cost = \( R \left( \frac{C_0}{Q} + C_1 \right) + \frac{Q}{2} \cdot H \)

\[ Q^2 = \frac{2RC_0}{H} \quad \text{or} \quad Q = \sqrt{\frac{2RC_0}{H}} = \text{EOQ} \]
Cost Function Behavior

Cost Function Behavior

Cost

Order quantity Q

Total cost

Order cost

Holding cost
Material Handling & Distribution Networks

- Need to have devices/people/equipment to move parts from A to B (AGV’s, cranes, lift-trucks, etc.)

- Packaging operations group products together for shipping (palletized, shink-wrap, boxed, etc.)

- Groups of products to be shipped are accumulated, and then distributed (truck, train, plane, etc.)

- Products may go directly to distributor/retailer, or may be stored in a warehouse until needed.
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
Warehouse Location

Select location to minimize sum of the distances

Possible location for warehouse
Travelling Salesman Problem
(path to be taken to distribute our products)
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?
Demanufacturing Systems

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