Using Simulation to Derive Activity-Based Costing Estimates

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Using Simulation to Derive Activity-Based Costing Estimates

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Lincoln

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Objective

Demonstrate how activity-based costing (ABC) concepts can be integrated into a discrete-event simulation model and used to evaluate manufacturing cell configurations
Cost/Benefit Analysis Using Simulation

• Collect data off-line using data generated by the simulation
  – Moore (1990); Krishnamurthi et al. (1994)
    • Based on premise that model exists

• Collect data on-line during the execution of the simulation
  – Christy and Kleindorfer (1990) and McLanahan and Ketcham (1990)
  – Savory et al. (1996); Rasmussen et al. (1996)
    • Add cost collecting routines during model development
Activity-Based Costing (ABC)

- Emphasizes activities rather than departments to isolate factors most likely to contribute towards costs
- Focuses on the causes behind indirect costs
- Traces the causal relationship between different cost-incurring activities and final products produced
- A procedure that often makes it possible to estimate product costs more accurately than using traditional costing systems
A Simple ABC Example

Resources

Resource Drivers

Activity Centers

Activity Drivers

Products

First Stage Assignments

Second Stage Assignments

Cost Pools

Cost Pools

Cost Pools

Labor

Depreciation

Utilities

Tooling
Linear Cell Configuration

- **CNC Lathe #1**
- **CNC Lathe #2**
- **CNC Machining Center**
- **Universal Grinder**

**Arrival Area**
- Arrival of Part A, B, C or D
- Worker

**Inprocess Holding and Inspection Station**

**Depart Area**
- Inspection, Departure of Finished Parts

**Holding**
- Inspection and Inprocess Holding

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U-Shaped Cell Configuration

- CNC Lathe #1
- CNC Lathe #2
- Universal Grinder
- CNC Machining Center
- Inprocess Holding and Inspection Station
- Arrival and Departing Area
- Holding
- Worker
Part Family Characteristics

Processing Sequence

<table>
<thead>
<tr>
<th>Part Type</th>
<th>Batch Size</th>
<th>CNC Lathe #1</th>
<th>CNC Lathe #2</th>
<th>CNC Machining</th>
<th>Universal Grinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Batch Setup Distributions

<table>
<thead>
<tr>
<th>Setup</th>
<th>CNC Lathe #1</th>
<th>CNC Lathe #2</th>
<th>CNC Machining</th>
<th>Universal Grinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>Triangular (30,60,90)/4</td>
<td>Triangular (30,60,90)/4</td>
<td>Triangular (30,45,60)/4</td>
<td>Triangular (20,40,60)/4</td>
</tr>
<tr>
<td>Long</td>
<td>Triangular (30,60,90)</td>
<td>Triangular (30,60,90)</td>
<td>Triangular (30,45,60)</td>
<td>Triangular (20,40,60)</td>
</tr>
</tbody>
</table>
# Part Family Characteristics

## Part Processing Distributions

<table>
<thead>
<tr>
<th>Part Type</th>
<th>CNC Lathe #1</th>
<th>CNC Lathe #2</th>
<th>CNC Machining</th>
<th>Universal Grinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 20, 30)</td>
<td>Triangular (10, 20, 30)</td>
</tr>
<tr>
<td>B</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 15, 20)</td>
<td>N/A</td>
<td>Triangular (10, 20, 30)</td>
</tr>
<tr>
<td>C</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 15, 20)</td>
<td>N/A</td>
</tr>
<tr>
<td>D</td>
<td>Triangular (10, 15, 20)</td>
<td>Triangular (10, 15, 20)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Costing Information

Direct and indirect labor = $12/hour plus a 30% benefit rate

Hourly preventative and repair mainenance rates = $50 and $200

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Purchase Price</th>
<th>Life</th>
<th>Power Consumption</th>
<th>Utilities</th>
<th>Consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC Lathe #1</td>
<td>$120,000</td>
<td>10 years</td>
<td>20 kilowatts</td>
<td>$0.04/hour</td>
<td>$2.00/hour</td>
</tr>
<tr>
<td>CNC Lathe #2</td>
<td>$120,000</td>
<td>10 years</td>
<td>20 kilowatts</td>
<td>$0.04/hour</td>
<td>$2.00/hour</td>
</tr>
<tr>
<td>CNC Machining Center</td>
<td>$100,000</td>
<td>10 years</td>
<td>25 kilowatts</td>
<td>$0.04/hour</td>
<td>$2.50/hour</td>
</tr>
<tr>
<td>Universal Grinder</td>
<td>$80,000</td>
<td>10 years</td>
<td>15 kilowatts</td>
<td>$0.04/hour</td>
<td>$1.75/hour</td>
</tr>
</tbody>
</table>
Simulation Design

- All configurations modeled in SIMAN V
- Data collected and stored primarily in part attributes
- Information accumulated as parts exit the system
- Results for each replication are saved to a file
- After last replication, overall estimates are calculated
- Bills of Activity are generated by the simulation
Summary of Results

• Results are for 52 week period

<table>
<thead>
<tr>
<th></th>
<th>Linear Cell Two Operators</th>
<th>Linear Cell One Operator</th>
<th>U-Shaped Cell One Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Cost per Unit</td>
<td>$35.48</td>
<td>$35.41</td>
<td>$35.38</td>
</tr>
<tr>
<td>Non-allocated Cost for Operator Idle Time</td>
<td>$84,346.26 (42,047.73 + 42,298.55)</td>
<td>$16,872.26</td>
<td>$17,383.73</td>
</tr>
</tbody>
</table>
Summary of Results

• The linear cell with 1 operator is better than 2 operators due to reduced idle time and costs

• The linear cell with 1 operator has a lower non-allocated cost for operator idle time as compared to the U-shaped cell

Which is best?
The integration of activity-based costing with a discrete-event simulation model can provide a cell designer with useful costing information for determining the best cell configuration

– decisions can be made in terms of costs/expenses
– ability to break out non-allocated costs for operator idle time