USING SIMULATION TO BENCHMARK TRADITIONAL VS. ACTIVITY-BASED COSTING IN PRODUCT MIX DECISIONS

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Outline of Presentation

• Product mix decisions - motivation and context
• Cost estimation for product mix decisions
  • What is traditional costing?
  • What is activity-based costing?
• How is simulation used in product mix decisions?
• Benchmarking experiments
  • Design
  • Nonfinancial results
  • Cost Analysis
• Conclusions
Product Mix Decisions

- Focused factory vs. full line producer
- Introduction of new product lines
- Choice of products to outsource
- Product abandonment

Failings of traditional job costing in product mix decisions:

- Product or job cost distortion due to misallocation of overhead
- Failure to estimate changes in overhead that are consequences of a product mix decision.
Cost Estimation in Support of a Product Mix Decision

The purpose of all costing methods is to estimate the costs associated with a product mix for use in decision making.

Traditional and activity-based costing both obtain a unit cost for each product and estimate costs and revenues on the basis of that cost. They differ with respect to:

- How unit cost is derived
- Costs considered in decision
Traditional Job Costing

(Also called direct labor method.)

Manufacturing costs

1. Direct materials
2. Direct labor
3. Manufacturing overhead

Nonmanufacturing costs

1. Marketing or selling
2. Administrative
Estimating Costs by Traditional Job Costing

1. Compute overhead rate.

   \[
   \text{Overhead rate} = \frac{\text{Total manufacturing overhead}}{\text{Total units in activity base}}
   \]

2. Calculate units of product and units of activity base for product mix.

3. Compute direct material, direct labor, and overhead costs and sum.

   \[
   \text{Direct material cost} = \sum_{\text{all products}} \text{unit cost} \times \text{product volume}
   \]

   \[
   \text{Direct labor cost} = \text{unit labor cost} \times \text{direct labor hours}
   \]

   \[
   \text{Overhead cost} = \text{overhead rate} \times \text{activity base units}
   \]
Relevant Costs

Use all costs in decision-making except **unavoidable costs**:

1. sunk costs (e.g., the book value of an old machine), and
2. future costs that **do not differ** between decision alternatives (e.g., regular time labor costs if actual hours cannot be cut, such as if no hiring or layoffs can be done).
Problems with Traditional Job Costing Practices

1. Computing overhead on the basis of direct labor or machine hours which represent 5-10% of total manufacturing costs when overhead may represent 60% or more of manufacturing costs.

2. Ignoring nonmanufacturing overhead when it includes relevant costs.

3. Allocating batch and product level expenses to individual units.
Activity-Based Costing

Differs from traditional costing in that:

1. Activity-based costing traces costs directly when possible.

2. Activity bases are not restricted to direct labor or machine hours, but can be anything that causes products to generate cost differently. Activity bases are called cost drivers in activity-based costing terminology.

3. Overhead is broken down into multiple categories, each with its own cost driver. Allocation rules can be more sophisticated than simple multiplication.

4. All relevant costs are considered, including relevant nonmanufacturing costs.
Simulation in Product Mix Decisions

“Factory in a Computer” Concept

• Predict performance measures which are related to costs
• Considers dynamic interactions which other estimation techniques do not
• Limited by scope and detail of model, measures only what is modeled
• Each run represents a possible outcome, many trials can be run and many outcomes examined
Benchmarking Experiments

**Problem:** Find most cost effective way of dealing with demand exceeding capacity by means of product mix (choice of what to outsource, target market, or how to focus factory) rather than by adding capacity.

Use simulation model as “*factory in computer*”.

Estimate cost of producing each of three product mix decision alternatives under various scenarios by:

- traditional direct labor-based costing
- activity-based costing

Compare with costs derived by direct conversion of simulation performance measures.
Manufacturing System

Product Mix

<table>
<thead>
<tr>
<th>Product</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand %</td>
<td>60%</td>
<td>20%</td>
<td>15%</td>
<td>5%</td>
</tr>
</tbody>
</table>
### Independent Variables

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Meet 80% of demand, all reductions from W</td>
</tr>
<tr>
<td>B</td>
<td>Meet 80% of demand, eliminate X</td>
</tr>
<tr>
<td>C</td>
<td>Meet 80% of demand, eliminate Y and Z</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Setup time in minutes (multiple setup times indicate part dependent setups)</th>
<th>Aggregate production (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAW</td>
<td>DRILL</td>
<td>GRIND</td>
</tr>
<tr>
<td>1</td>
<td>60</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Production relative to capacity is held constant across all scenarios.
Dependent Variables

- Backlog in days
- Time in system in days
- Cost
Nonfinancial Performance
Backlog in Days
Nonfinancial Performance
Days in System

Using Simulation to Benchmark Traditional vs. Activity-Based Costing
Cost Analysis

Estimate costs for each alternative of each scenario by:

1. Traditional, direct labor-based costing
2. Activity-based costing with inverse product volume as cost driver for
   a. setup cost
   b. overtime cost

Compare with costs derived from conversion of simulation performance measures.

To obtain overhead rate for direct labor-based estimates and multipliers for activity-based costing estimates, we ran baseline simulations at 20% less than total demand with reductions taken from all products. We derived costs directly from simulation performance measures.
## Conversion Calculations

<table>
<thead>
<tr>
<th>Category</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct mat’ls</strong></td>
<td>$\sum_{all \ products}$ unit direct mat’l cost $\times$ prod. vol.</td>
</tr>
<tr>
<td><strong>Direct labor</strong></td>
<td>labor rate $\times$ total proc. time</td>
</tr>
<tr>
<td><strong>Indirect labor</strong></td>
<td>indirect labor rate $\times$ (regular time + backlog $\times$ overtime multiplier)</td>
</tr>
<tr>
<td><strong>Indirect mat’ls</strong></td>
<td>$\sum_{all \ products}$ unit indirect mat’l cost $\times$ prod. vol.</td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td>fixed rate + base const. $\times$ time operational + proc. time multiplier $\times$ proc. time</td>
</tr>
<tr>
<td><strong>Misc. factory</strong></td>
<td>usage rate $\times$ proc. time</td>
</tr>
<tr>
<td><strong>Setup</strong></td>
<td>labor rate $\times$ setup time</td>
</tr>
<tr>
<td><strong>Idle</strong></td>
<td>labor rate $\times$ idle time</td>
</tr>
<tr>
<td><strong>Overtime</strong></td>
<td>labor rate $\times$ (1 – overtime rate) $\times$ backlog $\times$ no. of machines</td>
</tr>
</tbody>
</table>
Scenario 3. Low Setup Times

Using Simulation to Benchmark Traditional vs. Activity-Based Costing
Scenario 2. Medium Setup Times

Using Simulation to Benchmark Traditional vs. Activity-Based Costing
Scenario 1. High Setup Times

Using Simulation to Benchmark Traditional vs. Activity-Based Costing
Conclusions

How well does activity-based costing work? **VERY WELL!**

- The key to success in using activity-based costing is the selection of appropriate cost drivers.

- Simulation can be used to test effectiveness of cost drivers for activity-based costing analyses.

- Will simulation design studies of the future include a section analyzing the effectiveness of various cost drivers and recommending cost drivers that most accurately predict costs for the system under study?