**Supply Chain Simulator:**

A Partnership for Supply Chain Innovation

MIT Center for Transportation Studies/
Ernst & Young

10 December 1998

Vision

- A laboratory based simulation environment where corporations and students alike can experiment with various supply chain configurations.
- Users would be able to model complex interdependencies between suppliers, customers, and other channel partners in a faster, less expensive way.
Goals and Objectives

- To expedite supply chain best practice adoption
- To build on the foundation of credibility and expertise enjoyed by MIT and E&Y
- To foster stronger relationships with corporations
- To enhance research tools available to students and faculty
- To generate profits to support other endeavors

The Lab Concept

- A room housing simulation computers staffed by technicians and supply chain experts
- Three different lab sizes were defined and costed:
  - Plant A: 4 Computers/8,000 Workstation Hours
  - Plant B: 10 Computers/20,000 Workstation Hours
  - Plant C: 20 Computers/40,000 Workstation Hours
  - (40 hrs/wk x 50 weeks/yr x # of Computers = WsHrs)
- Our steering committee felt anything larger would be unrealistic.
Recommended Strategy

- We recommend starting with a small lab (8,000 WsHrs) and building flexibility into the system.
- The expected NPV for this approach is $2.7 MM
  - Using discount rate of 20%
- The initial cost will be:
  - $450,000 investment for start-up and development
  - $450,000 estimated annual fixed costs
  - $75 /Workstation-Hour variable costs

Strategic Options

- After 3 years, we will re-evaluate market demand and select from the following options:
  - Expand Capacity
  - Maintain Capacity
  - Contract Capacity
  - Cease Operations

(The lab has been designed to allow flexibility in expansion or contraction with leased equipment, flexible office space and temporary employees)
Lab Plans: Revenue Assumptions

- Student lab time is free
- Corporate client lab time is charged at $250 per workstation per hour
- Potential Revenue = Workstation Hours x $250
  - Plant A = $2 million/year
  - Plant B = $5 million/year
  - Plant C = $10 million/year
  - Assumes 100% Corporate use - Management can allocate hours to student use as it sees fit

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Dynamic Strategic Planning
Po-Hsin Liu, Chris Holt, Anurag Mehra, Rachna Mohanka,
Jason Slibeck, Jim VanderVliet

Laboratory Cost Assumptions

<table>
<thead>
<tr>
<th>Units Workstation Hrs (WsHrs)</th>
<th>Level of Effort (Processing Capacity)</th>
<th>Plant A</th>
<th>Plant B</th>
<th>Plant C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>8000</td>
<td>20000</td>
<td>40000</td>
</tr>
<tr>
<td>2</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Max possible return/result of effort

<table>
<thead>
<tr>
<th>Variable Costs (cost per result)</th>
<th>Plant A</th>
<th>Plant B</th>
<th>Plant C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operators</td>
<td>$25.00</td>
<td>$25.00</td>
<td>$25.00</td>
</tr>
<tr>
<td>Variable Overhead</td>
<td>$12.50</td>
<td>$12.50</td>
<td>$12.50</td>
</tr>
<tr>
<td>Property, Plant &amp; Equipment</td>
<td>$12.50</td>
<td>$12.50</td>
<td>$12.50</td>
</tr>
<tr>
<td>Subject Matter Experts</td>
<td>$25.00</td>
<td>$20.00</td>
<td>$20.00</td>
</tr>
<tr>
<td>Subtotal - Cost per unit result</td>
<td>$75.00</td>
<td>$70.00</td>
<td>$70.00</td>
</tr>
</tbody>
</table>

Variable Overhead $/WsHr $12.50 $12.50 $12.50
Property, Plant & Equipment $/WsHr $12.50 $12.50 $12.50
Subject Matter Experts $/WsHr $25.00 $20.00 $20.00
Subtotal - Cost per unit result $/WsHr $75.00 $70.00 $70.00

Costing Assumptions

- Years to Amortize Investment = 3
- Opportunity Cost of Capital = 0.2

Annual Costs (Total cost/year)

<table>
<thead>
<tr>
<th>Capacity (max possible output)</th>
<th>8,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent and Space $/yr</td>
<td>$50,000</td>
</tr>
<tr>
<td>Salaried Employees $/yr</td>
<td>$150,000</td>
</tr>
<tr>
<td>Equipment and Materials $/yr</td>
<td>$50,000</td>
</tr>
<tr>
<td>Research and Development $/yr</td>
<td>$200,000</td>
</tr>
<tr>
<td>Subtotal - Annual Costs $/yr</td>
<td>$450,000</td>
</tr>
</tbody>
</table>

Annual Production/Sales 8,000

| Actual Unit Variable Cost $/yr  | $131.25 |
| Actual Unit Amortized Investment Cost $/yr  | $26.70 |
| Actual Total Unit Cost $/yr     | $157.95 |

Minimum unit variable cost $131.25 $122.50 $111.25

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MIT/Ernst & Young
The Decision Tree Structures our Evaluation

Utility: Driven by more than $

- This utility curve combines the intrinsic values of prestige and research with the financial value of sales to corporations.
NPV and Utility Decision Tree Results

- NPV Analysis supports:
  - Decision 1 = Plant A - 8,000 WsHrs
  - If Cons 1 = High, Decision 2 = Expand to 40,000
  - If Cons 1 = Med, Decision 2 = Expand to 20,000
  - If Cons 1 = Low, Decision 2 = Maintain at 8,000

- Utility Analysis supports the same thing, although:
  - If Decision 1 = Plant B - 20,000 WsHrs
  - And Cons 1 = Low, Decision 2 Changes from “Reduce to 8,000” to “Stay at 20,000”

  - This is because of the intrinsic prestige and research value captured only in the Utility tree, which assigns positive utility values to negative NPVs.

Sensitivity of NPV to discount rate and price:

Price above $150 produces positive net income

<table>
<thead>
<tr>
<th>%</th>
<th>$150</th>
<th>$175</th>
<th>$200</th>
<th>$225</th>
<th>$250</th>
<th>$275</th>
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</thead>
<tbody>
<tr>
<td>15%</td>
<td>($399,864)</td>
<td>$373,298</td>
<td>$319,038</td>
<td>$2,228,430</td>
<td>$3,158,023</td>
<td>$4,120,892</td>
</tr>
<tr>
<td>16%</td>
<td>($395,109)</td>
<td>$357,135</td>
<td>$315,576</td>
<td>$2,159,456</td>
<td>$3,063,335</td>
<td>$3,997,248</td>
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<tr>
<td>17%</td>
<td>($390,450)</td>
<td>$341,710</td>
<td>$311,933</td>
<td>$2,093,390</td>
<td>$2,971,846</td>
<td>$3,878,736</td>
</tr>
<tr>
<td>18%</td>
<td>($385,885)</td>
<td>$326,985</td>
<td>$307,014</td>
<td>$2,030,081</td>
<td>$2,884,149</td>
<td>$3,765,236</td>
</tr>
<tr>
<td>19%</td>
<td>($381,411)</td>
<td>$312,921</td>
<td>$302,729</td>
<td>$1,989,389</td>
<td>$2,800,050</td>
<td>$3,656,347</td>
</tr>
<tr>
<td>20%</td>
<td>($377,021)</td>
<td>$299,485</td>
<td>$298,995</td>
<td>$1,941,100</td>
<td>$2,719,365</td>
<td>$3,551,883</td>
</tr>
<tr>
<td>21%</td>
<td>($372,730)</td>
<td>$286,444</td>
<td>$296,734</td>
<td>$1,855,329</td>
<td>$2,641,925</td>
<td>$3,451,620</td>
</tr>
<tr>
<td>22%</td>
<td>($368,518)</td>
<td>$274,366</td>
<td>$293,871</td>
<td>$1,801,719</td>
<td>$2,576,567</td>
<td>$3,355,349</td>
</tr>
<tr>
<td>23%</td>
<td>($364,381)</td>
<td>$262,623</td>
<td>$290,016</td>
<td>$1,750,238</td>
<td>$2,496,139</td>
<td>$3,262,872</td>
</tr>
<tr>
<td>24%</td>
<td>($360,339)</td>
<td>$251,367</td>
<td>$286,064</td>
<td>$1,700,782</td>
<td>$2,427,499</td>
<td>$3,174,005</td>
</tr>
<tr>
<td>25%</td>
<td>($356,361)</td>
<td>$240,633</td>
<td>$282,993</td>
<td>$1,653,352</td>
<td>$2,361,511</td>
<td>$3,088,572</td>
</tr>
</tbody>
</table>

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Dynamic Strategic Planning
Two options to mitigate risk:

- SlyCor has offered a Put Option to buy our software
  - Pay $500,000 today for right to sell for $3.3 MM in 5 yrs
  - -$3.3 MM is our worst-case NPV - Put is designed to cover us
  - SlyCor would gain desired ownership of our expected software
  - We would gain the ability to cease operations without loss
  - $2.7 MM is our current Expected Value NPV
  - Black Scholes analysis values the put option at $638,436
- We recommend buying the put option

The second option is an alternate product design:

- Option to Incorporate Internet functionality in software
  - Internet functionality would allow an alternate form of expansion to our current capacity assumptions
  - Corporate customers could use the simulator remotely
  - Instead of a fixed 3 year decision point, we would have the ability to expand or contract at any time
  - Increases Net Present Value by expanding capacity
  - Substantial investment would be required to configure the software for Internet access
  - Next step is to quantify this investment
Conclusions/Next Steps

• We recommend proceeding with Plant A.
  – $900,000 for investment and first year fixed costs
• We recommend purchasing the SlyCor put option.
  – $500,000 for 3rd year strike price of $3.3 MM
• Subject to corporate objectives, the Internet option could be explored further.