Cost and Price of Products and Engineering Economics

ME 4054W
Spring 2012
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Ref: Ulrich & Eppinger text:
Chapter 11 (Design for Manufacturing), Chapter 15 (Product Development Economics)
A friend said...

“Wow, the price at Home Depot for this gadget is $50. I can build one for 10 bucks. I should go into business. I’ll make a ton of money!”

What are they potentially overlooking?
What are the attributes that determine the cost of a product?
Attributes related to the **cost of a product**

- Parts cost
- Volume discounts
- Advertising
- Marketing costs
- G&A overhead
- Variable costs
- Tooling
- Labor cost
- Transportation
- Fixed costs
- Warranty
- Packaging
- Profit
- QC on incoming parts
- Development costs
- Warranty
- Liability
- Inventory
- Clinical trials

*Representative attributes, not all inclusive*
Manufacturing System Model
Manufacturing Costs

• Manufacturing costs are those costs that are directly involved in manufacturing of products. Manufacturing cost is divided into three broad categories:
  – Direct materials cost
  – Direct labor cost
  – Manufacturing (or Factory) overhead cost

• Manufacturing costs are further sub-divided as fixed and variable costs. Variable costs are those directly related to the volume of products manufactured while fixed costs are not.
Elements of Manufacturing Cost

- Manufacturing Cost
  - Components
    - Standard
    - Custom
      - Raw Material
      - Processing
    - Tooling
  - Assembly
    - Labor
    - Equipment and Tooling
  - Overhead
    - Support
    - Indirect Allocation

Exhibit 11-5 from text
Manufacturing Cost

• Cost estimation is an art
• Several layers of detail, use what’s appropriate
• Manufacturing process matters....a lot!
• Volume matters...a lot!
• Everything starts with a good bill of materials (BOM)
• Cost of the prototype ≠ cost of the product!

See Ulrich and Eppinger Chapter 11 for details
Product Costs

• Product cost is more than materials cost plus labor cost
• It must account for all costs required for the production of the product
• Product cost models differ from company to company
Non-Manufacturing Costs

• Non-manufacturing Costs are those costs that are not directly related to the manufacturing of a product. In general, they are divided into two categories:
  – Selling and distribution costs
    • Examples include sales and marketing costs
  – Administrative costs
    • Executive, organizational and clerical costs
    • Product Engineering falls in this category
Development Costs

- Includes many things:
  - Information gathering
  - Market research, patents, ...
  - Engineering design and development, testing, CAD/simulation/...
  - Prototype construction and test
  - Product validation
  - and more...
A novel, aftermarket product for automobiles

• **Given:**
  – 5 year life
  – 10% fuel economy improvement
  – No/low cost to install

• **Assumptions:**
  – 15,000 miles driven/year
  – 20 mpg average currently
  – $2.75/gallon fuel price

What should the selling price of the product be?
A novel, aftermarket product for automobiles

Breakeven cost calculation:

Fuel costs today:
15,000 miles/year ÷ 20 miles/gallon = 750 gallons/year
750 gallons/year x $2.75/gallon = $2062/year

Potential fuel costs with aftermarket product:
15,000 miles/year ÷ 22 miles/gallon = 682 gallons/year
682 gallons/year x $2.75/gallon = $1876/year

Potential annual fuel savings:
$2062 - $1876 = $186/year

Potential fuel savings over the life of the product:
$186/year x 5 years = $930

The price that an educated consumer would pay for this product is less than the savings it will generate. How much the purchaser will be willing to spend depends on a number of factors such as magnitude of initial cost and risk.
The price of a product should ideally be set at a level roughly equal to the purchaser’s perception of the product’s value (e.g., “I need a 2 year payback in order to buy it” or the product’s image “It’s cool, I want it”) The latter is a highly variable individual perception and difficult to accurately define. The availability of competitive products and the passing of time tend to lower the perceived value of a product.

* Representative attributes, not all inclusive
Setting a price

• Estimate the value to end users
  – For products sold in the commercial market, a desired maximum payback period or return on investment often needs to be met.
  – For consumer products, many buying decisions do not a strong tie to payback or return on investment.

• Also look at:
  – The pricing and value of similar products
  – Differentiation offered by the product
  – The acquisition cost of the product

A product that provides differentiation (from a competitive product) that gives value to the end user can command a higher price. For example, the iPhone commands a higher price than its competitors that provide similar basic functions. Some differentiating features for the iPhone are access to apps and the Apple name/mystique.

Commodities, for example nuts and bolts, all tend to have similar pricing.
What have we learned?

Price $\not= \ Cost$

$\text{Price} - \text{Mfg Cost} \not= \text{Profit}$
Design detail #1

Which is the preferred design from the manufacturability perspective? Why?
Which is the preferred design from the manufacturability perspective? Why?
Prototype Costs

• Need for Bill of Materials
• Low quantity pricing (1-?)
• Split out subassemblies
• Catalog parts vs. fabricated parts

Prototype cost ≠ Product cost!
Prototype BOM

- You will need to create a BOM table for the prototype you will have at the Design Show.
- It must show quantity, part number, source, part cost, extended cost, total cost, etc.
- Include fabricated and purchased parts.
- Make “guesstimates” where appropriate.
- Create in Excel and upload to the team’s Google site.
# Financial Proforma Example

$ values in thousands

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development cost</td>
<td>$(1,500)</td>
<td>$(1,500)</td>
<td>$(500)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp-up cost</td>
<td>$(800)</td>
<td>$(600)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing &amp; support cost</td>
<td>$(100)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
<td>$(250)</td>
</tr>
<tr>
<td>Production cost</td>
<td>$(2,500)</td>
<td>$(3,375)</td>
<td>$(4,000)</td>
<td>$(3,900)</td>
<td>$(3,900)</td>
<td>$(3,900)</td>
<td>$(3,800)</td>
<td>$(3,800)</td>
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<td></td>
</tr>
<tr>
<td>Production volume</td>
<td>5,000</td>
<td>7,500</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
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<tr>
<td>Production unit cost</td>
<td>$(0.500)</td>
<td>$(0.450)</td>
<td>$(0.400)</td>
<td>$(0.390)</td>
<td>$(0.390)</td>
<td>$(0.390)</td>
<td>$(0.380)</td>
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<tr>
<td>Sales revenue</td>
<td>$4,000</td>
<td>$6,000</td>
<td>$8,000</td>
<td>$7,800</td>
<td>$7,600</td>
<td>$7,500</td>
<td>$7,350</td>
<td>$7,200</td>
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<tr>
<td>Sales volume</td>
<td>5,000</td>
<td>7,500</td>
<td>10,000</td>
<td>10,000</td>
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<tr>
<td>Unit price</td>
<td>$0.800</td>
<td>$0.800</td>
<td>$0.800</td>
<td>$0.780</td>
<td>$0.760</td>
<td>$0.750</td>
<td>$0.735</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period cash flow</td>
<td>$(1,500)</td>
<td>$(2,400)</td>
<td>$150</td>
<td>$2,375</td>
<td>$3,750</td>
<td>$3,650</td>
<td>$3,450</td>
<td>$3,350</td>
<td>$3,300</td>
<td>$3,150</td>
</tr>
<tr>
<td>Period discounted cash flow</td>
<td>$(1,500)</td>
<td>$(2,160)</td>
<td>$122</td>
<td>$1,731</td>
<td>$2,460</td>
<td>$2,155</td>
<td>$1,833</td>
<td>$1,602</td>
<td>$1,421</td>
<td>$1,220</td>
</tr>
<tr>
<td>Cumulative discounted cash flow</td>
<td>$(1,500)</td>
<td>$(3,660)</td>
<td>$(3,539)</td>
<td>$(1,807)</td>
<td>$653</td>
<td>$2,809</td>
<td>$4,642</td>
<td>$6,244</td>
<td>$7,665</td>
<td>$8,885</td>
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</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Net Present Value (NPV)</td>
<td>$5,681</td>
</tr>
</tbody>
</table>

**Assumptions:**

10.0% = Discount factor / weighted average cost of capital

**Note:** Items in blue cells are required inputs. The balance of the cells are calculated.
Applying a Monte Carlo simulation or sensitivity analysis to a proforma creates a “big picture” view of the opportunity. Crystal Ball is one software that does Monte Carlo analyses from an Excel proforma.