Cost Considerations in Design

2019w

Client generally wants to know

1. what can be done,
2. when can it be done and
3. how much it will cost.

Let's focus on the "how much it will cost".

Product Cost

- **Cost of Goods Sold**

  – Cost of goods sold (COGS) are the **direct costs** attributable to the production of the goods sold by a company.

  (source:http://www.investopedia.com/terms/c/cogs.asp)

Direct vs. Indirect Product Costs

- **Direct costs** – costs easily connected to the item such as the costs of the labour, components, and materials that are used to make the item.
- **Indirect costs** – costs that are not easily attributed per item to the production of an item, such as supervisor's wages, software licenses, utilities, insurance, lease payments, etc.

Price vs. Cost

- Price = rate vendor charges customer
- Price = Product Cost + Markup
- Markup contains amounts to cover **indirect costs** and **profit**

Value vs. Price

- Value = Price
  - In most profit seeking cases, value, not cost, should determine price. If you are selling something you have made, it doesn't matter what you paid to make it; set your price on what the market is willing to pay.
  - We use currency as a proxy for value

Variable vs. Fixed Costs

- Variable Costs – costs that change as production volume changes. Additional parts = additional material +labour costs
- Fixed Costs – costs that don't change with production volume such as tooling, supervisor's wages, lease payments, insurance, etc.

Fixed Costs and Variable Costs
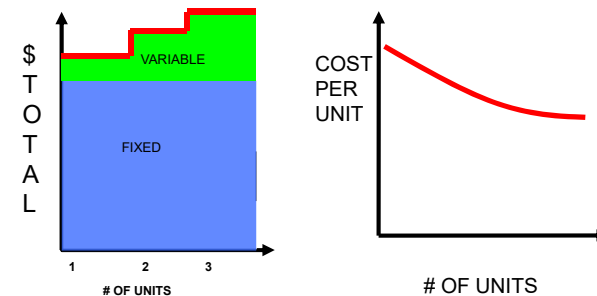
Are Direct Costs the Same as Variable Costs

- No – a direct cost is directly linked to the production of a specific item. While this typically includes variable costs it can also can include fixed costs that can be directly linked to a product such as cost of a special machine used only for that product.

Off the Shelf Items

- Purchased rather than made. E.g. components that are integrated into assemblies e.g. bearings, fasteners, motors, etc.
- A.K.A. "Buy Parts"

Undefineds

- An amount representing the cost of items that do not appear on a parts list, yet are needed to complete an assembly. E.g. grease, lubricants, adhesives, wipes, cleaners needed to get parts to fit together. These are typically a small percentage of the total cost yet should be included in cost figures.

Contingency

The amount of additional resources required to go to keep manufacturing going in case of a disruption. E.g. cost of changing suppliers, accounting for material and component price increases, etc.
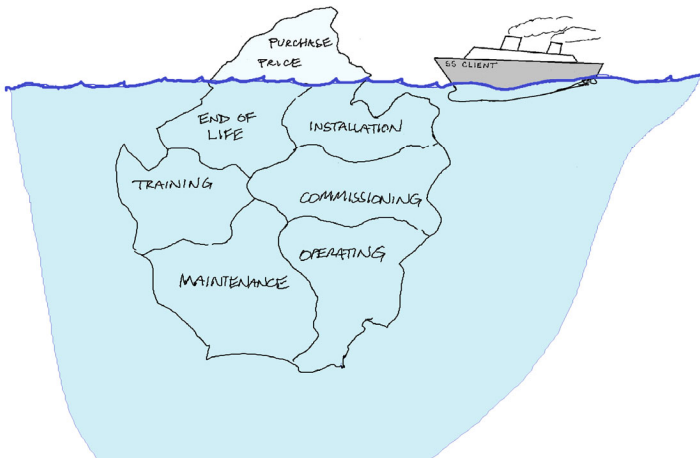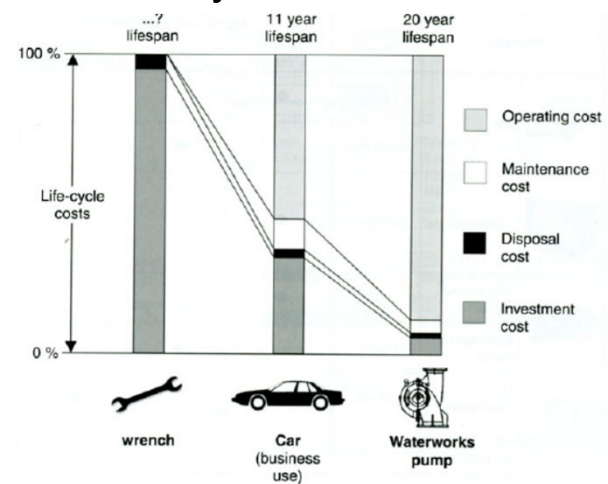
Design Defines Major Cost
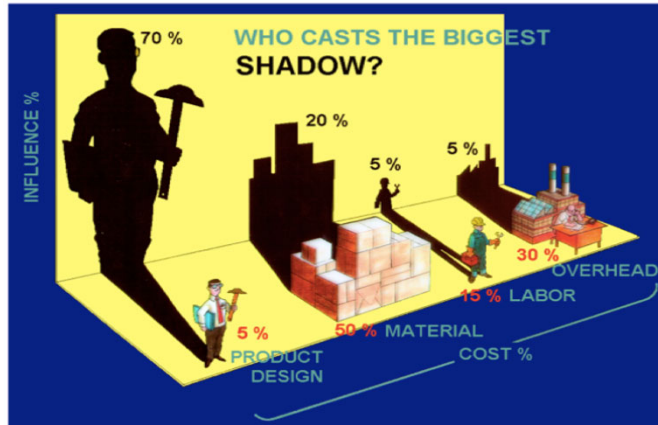
Source: Ford Motor Company

Rule of 10s

- A technical change that costs $1 at task clarification (needs) costs $10 at the design stage, $100 at production planning stage, $1000 if made during production and $10,000 if made after shipping.

Hidden Costs

Lifecycle Costs

Rules for Reducing Lifecycle Costs

1. Choose low loss, reliable, life-span-optimal design. E.g. low wear bearing surfaces (rolling versus sliding)
2. Low one-time costs
   a. lower transportation costs by reducing volume, weight, removing need for special packing and handling
   b. lower set-up and training costs
3. Low operating cost
   a. Save energy; reduce energy loss
      i. avoid energy transformation
      ii. utilize waste energy
      iii. minimize frictional losses for sliding contacts by favouring rolling over sliding, pivots over linear motion, minimizing force
      iv. minimize losses in fluid flow by minimizing velocity, change in velocity, change in pressure.
      v. optimize operation (CVT in newer cars greatly improves fuel efficiency)
   b. Reduce costs of operational and auxiliary materials
      i. E.g. if you need consumables, use commonly-available ones e.g. avoid using specialty lubricants
      ii. Minimize the number of places where additional consumables are needed e.g. lifetime lubricated cartridge bearings never need additional lubrication
      iii. Favour materials and processes that can easily adapt to product changes
4. Low maintenance costs
   a. Minimize need for inspection and service. If you can't do this, make the procedures easy to follow so that less specialized knowledge, tools, equipment and supplies are required so anyone can do it; for instructions favour explanatory pictures rather than words, number operations, use colour
   b. Repair costs lowered by use of easy to exchange, low cost replacement parts

Estimating Costs

- Published Data
- Online Pricing
- Compare to historical data (experience)
- Consult experts – professional estimators
- Vendor quotes
- Competitor Pricing (work backwards)

Cost of Raw Materials

- Commodity Markets (London Metal Exchange https://www.lme.com/)

US$: 29 October 2019	
LME Aluminium	1,737.50
LME Copper	5,879.50
LME Zinc	2,586.00
LME Nickel	16,680.00
LME Lead	2,267.00
LME Tin	16,725.00
LME Aluminium Alloy	1,350.00
LME NASAAC	1,130.00
LME Cobalt	35,500.00
LME Gold*	1,489.00
LME Silver*	17.815
LME Steel Scrap**	252.50
LME Steel Rebar**	414.50

Non-ferrous cash prices, per metric tonne, discovered on the Ring: 12.30-13.15

*Gold and Silver spot price, per troy ounce, established basis LMEselect trading: 18.29-18.30
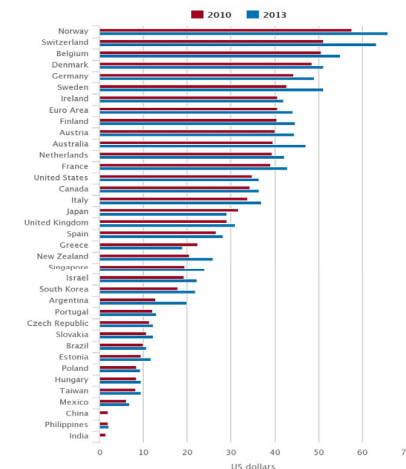
**Ferrous Month 3 prices, per metric tonne, established basis LMEselect trading: 16.25-16.30

Cost of Labour

- Consider productivity, too!

- https://www.conference-board.org/ilcprogram/index.cfm?id=28269

Compensation costs include direct pay, social insurance expenditures, and labor–related taxes. Data for China and India are not strictly comparable with each other or with data for other countries. For complete definitions, country information and a description of data limitations associated with estimates for China and India, see the Technical Notes and Country Notes supplementing this report.
Source: The Conference Board, International Labor Comparisons program

Machine Shop Rates

- Vancouver Area Jobber Shop Rates
  - Machinist rate of pay
    - $30-65/hr; add benefits, overhead profit
  - $80 - $140/ hr depending on capability (machinery, level of skill) needed

■ Quoting method used by a local Vancouver Steel Fabrication shop

Material	Buy for $0.50 to $0.70 a pound, depending on size and shape required (less for light simple shapes, more for heavy structural shapes and plates which we sometimes have to import).
Detailing/ programming	Estimated hours of detailing and programming (when materials to be processed using CNC machinery) required.
Labour	Estimated hours of work required for: • Handling (i.e. more time if heavier) • Processing (i.e. cut to size, bevel edges, forming if required, CNC) • Fitting • Welding (12' to 20' per hour) • Straightening/cleaning
Coating	Galvanizing cost of $0.30 to $0.40 per pound of processed steel (i.e. weighed after galvanizing)
Freight	To coating facility and to site if required
Markup	Varies

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Currency

CAD per 1 EUR

5 Oct 2005 00:00 UTC - 2 Oct 2015 05:08 UTC
EUR/CAD close:1.47922 low:1.21556 high:1.72114

Rules of Thumb Example: Sawmill Equipment Fabrication (Vancouver)

Steel Fabrication:
- 1hr per 50kg for heavy structural components.(>100kg)
- 2hr per 50kg for light structural components
- Add 10% for moving things by crane
- Add 10---15% for stainless steel

Steel Casting
- $7 per kg for 10kg and up

Painting and Coating
- (sandblast with prime and paint/ powder coat)
- 3hr for something about the size of a desk

Wiring
- 4hr to mount a 7 kw motor + running and clamping 5m conduit + pulling wires and connecting motor to junction box

Piping and hoses
  - 4hr to cut, bend, and connect 5m of ½ to 1" pipe and hoses

Courtesy of Carmanah Design, Vancouver

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Suggestions

- Start with parts list and identify material and labour cost or acquisition* cost for each item
- Consider assembly costs
- Consider any handling and packaging required to ready item for shipping/storing

*acquisition cost = what it costs to get OTS parts on site, not just the online price!

Summary

- Product Cost = Material + Labour
- Price = Product Cost + Markup
  - determined by Value, not Cost
- Product Cost = (Fixed + Variable Costs*n)/n
- Design decisions lock in great majority of the cost
- Lifecycle Costs can easily outweigh Product Cost

Web Links

- http://www.mtlexs.com/todays-metal-prices
- https://www.bls.gov/oes/current/oes_nat.htm#51-0000
- https://www.numbeo.com/cost-of-living/in/Vancouver
- https://wageindicator.org/salary/minimum-wage/canada