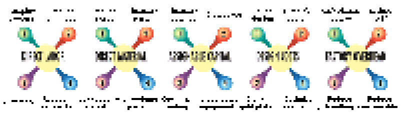
A SIMPLE COST EVALUATOR FOR PRODUCT DESIGN :: Most opportunities to reduce product cost come early in development, when specifics are not yet nailed down. Unfortunately, there are significant obstacles to making early cost trade-offs. For instance, sketchy design information makes formal cost analysis inaccurate. Moreover, few design teams are comfortable with financial issues and are often reluctant to tackle cost before getting their technical act together. Designers need a simple trade-off tool that quickly identifies lower-cost design alternatives with reasonable accuracy.



The evaluation tool is based on several levers, in this case a total of 20, that affect the five factors that make up a product's manufacturing cost.
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GROUNDWORK FOR THE TOOL

Before they can make intelligent trade-offs, designers must understand the factors behind the product's manufacturing cost. (Keep in mind that every company has its own cost-accounting structure, so it is important that designers take time to understand their own situation.) A product's cost structure starts with the most obvious: production materials and labor (often referred to as "direct materials and touch labor"). It is all too common for cost-reduction initiatives to stop here. Bad idea. Although materials and labor are critical, they often represent only a fraction of a product's total cost.

Additional costs include dedicated capital equipment and nonrecurring design. But many companies lump capital investment and design cost into indirect overhead, thereby hiding them from view — and often from consideration. If a piece of equipment is only needed for a specific product, that product should absorb all costs for that equipment. If the equipment will be used on several products, it is not so easily allocated. Likewise, nonrecurring design should be assigned to individual products and included in their profitability analysis.

Things get trickier, however, when dealing with "nonassignable" factory overhead. A firm's indirect overhead is really just a big bin into which all costs other than assignable ones get tossed. Items such as maintenance, inventory carrying and handling, factory utilities, sustaining engineering, and so on, all make up indirect overhead. These costs apply to all products made in a factory, so they are typically allocated by an accounting scheme, most often as a multiplier on direct labor and sometimes direct materials.

Each of the these five major cost factors — direct material, direct labor, assignable capital, design, and factory overhead — can be thought of as a knob on a control panel that designers turn up or down as they design a product. Turning any of these knobs down reduces a product's manufacturing cost and increases its gross margin, providing other knobs are not negatively affected. Cost factors are often connected in subtle ways. For example, in the case of a high-volume product, it may make sense to increase assignable capital investment by purchasing automation equipment because the resulting drop in labor will more than offset the increase.

We can expand this model to consider 20 cost "levers," each affecting one or more knobs on the control panel. Collectively, these levers give designers the level of detail they need. Each lever represents a possible trade-off designers might try in meeting a target cost. The 20 levers are incorporated into a simple trade-off tool that will help designers decide how best to squeeze the last nickel of waste from a new product.

Each cost lever is simply an aspect of design that affects manufacturing cost. Be advised that the cost levers for your products and markets may well be different from the ones listed here. Modify the list to suit your specific needs.

LEVERS FOR DIRECT LABOR

Simplify manufacturing. Can production be simplified by reducing the number of parts, eliminating fasteners and interconnects, designing for top-down assembly, or by using standard tools? Can machine setup and changeover be faster?

Reduce required skill level. It's not just the number of hours that determines labor cost. The skill levels required can have a major effect. The per-hour labor cost can be significantly reduced by designing products to be simple to assemble and test, and relatively easy to adjust or customize.

Automate manufacturing. Automation is wonderful, but it should be used only after careful consideration. Capital depreciation is typically buried in the overhead rate, making automation seem the easy route to lower labor costs. In reality, major capital investment exacts a toll on the profits of every product in a profit center and depletes a company's funds.

Reduce test and inspection. In the strictest sense, test and inspection are non-value-added activities. If you can ensure quality while eliminating any tests or inspections, it's like printing money.

LEVERS FOR DIRECT MATERIALS

Reduce scrap. The cost of scrap can be significant in some industries, such as semiconductor processing and precision die casting, In general, scrap rates are driven by both processes (their ability to achieve required tolerances) and designs (their ability to accommodate process variability without losing quality).

Reduce parts count. A guiding principle of lean design is to "eliminate or standardize." Can a part be combined with others? If not, can it be standardized with other parts in the product? For example, can all the fasteners use the same part number?

Use less-expensive raw materials and parts. Opportunities here fall into two categories. The material selected is "too good" for the application, such as using stainless steel when painted metal would do or letting expensive materials make up for uninspired design. An engineer might specify high-precision electronic components instead of taking the time to design a more-tolerant circuit.

Use high-volume parts. This relates to parts count reduction. If you standardize on a small set of frequently used parts, you save two ways. First, costs such as material handling, purchasing, and inventory management will decrease, thereby reducing indirect overhead. And second, ordering higher volumes of common parts yields supplier discounts.

LEVERS FOR ASSIGNABLE CAPITAL

Eliminate batch processes. Although there are exceptions (which should be justified), small, rapid-throughput equipment compatible with one-piece or few-piece flow is generally more economical, flexible, and movable than batch equipment. Some companies will decide that a new production line requires investment in capital equipment. Then they look at cost versus capacity and decide that if bigger is better, huge is better still. So they buy a hulking new machine that has long setup times, five times the capacity needed, and takes a tower crane to move.

Outsource capital-intensive processes. Purchasing capital equipment is like getting a tattoo; it seems like such a good idea at the time, but the enthusiasm wears off long before the tattoo. Acquiring capital equipment means keeping it utilized, which can constrain future design decisions. It will also take overhead, much of it hidden, to maintain and will require skilled people to use it. All these costs must be reimbursed before you see the first dollar of real profit.

Optimize tooling cost. One of the most powerful cost-saving concepts to come out of Japan Inc. in recent years is Toyota's "Production Preparation Process (3P)." There is a real gem in this methodology called the “Seven-Alternatives” process. The idea is that for every significant cost in a product, designers should consider the advantages and disadvantages of seven alternative manufacturing processes. This can be a mind-expanding experience, particularly if your designers tend to use the same few processes over and over again.

Avoid dedicated equipment. It’s scary enough investing in expensive capital equipment, but if that equipment will be dedicated to a single product, the risks are even greater. What if the product bombs? What if the equipment turns out to be more costly to operate than expected? Capital equipment should only be purchased in support of a core process, something your firm will be doing regardless of whether any single product thrives or dies.

LEVERS FOR NONRECURRING DESIGN

Reuse existing designs and processes. Reusing a design is just like printing money. It saves nonrecurring design cost and gets the product to market quicker as well.

Eliminate unnecessary complexity. One of the greatest compliments one can pay designers is to describe their designs as “elegant.” Elegance means that high performance, quality, and customer satisfaction are combined in a remarkably simple way. This requires innovation, insight, an artful touch, and a healthy desire to make money.

Avoid gold-plated designs. Gold plating means overshooting customer’s needs. If a car with four wheels is good, then why not a car with six wheels? If a VCR with a remote control is good, why not clog it with a hundred meaningless buttons? Customers will not pay for performance or features that overshoot their needs, but your firm pays for the cost of including them. Focus on solving customer problems and keep the gold on your company’s ledgers.

Optimize “make or buy.” If you buy a part instead of making it, you may not need to design it. Suppliers have smart engineers to help tailor products to your needs. Typically, if the customization is within reason, their nonrecurring design is free. In fact, many suppliers, particularly in mature, commoditized industries, will do a complete set of drawings before you even commit to an order.

LEVERS FOR OPERATIONAL OVERHEAD

Avoid major changes to factory layout. The most competitive companies in the world sell products that look like they’re customized for every single buyer, yet the factory can’t tell the difference among them. It saves money to use existing work cells, flow lines, capital equipment, material-handling equipment, storage, and logistics.

Reduce raw material and work-in-process inventory. The cost of carrying-inventory can be a significant contributor to indirect overhead. Using Just-in-Time (JIT) inventory management is key, but engineers must be thinking about JIT during design for it to work effectively.

Reduce material handling. It consumes labor, floor space, and in some cases, capital equipment. Think about how parts and materials for the product will be handled. Are heavy subassemblies easily maneuvered? Are there crane hooks, handles, or other such features that reduce handling labor? Can large and cumbersome structures be designed as modules?

Reduce consumables. In some industries, consumables or materials used up as part of manufacturing are quite expensive. Examples include wear on tools and cutting devices, lubricants, abrasives, glues, paints and finishes. This is particularly important if the product is the only one in the factory requiring a specific consumable.

USING THE TOOL

At this point you might be thinking cost reduction is just too complicated. After all, it’s hard enough to get performance and features right. Now you are being asked to consider an entirely different, and admittedly complex, set of trade-offs. Fortunately, the tool provides a relatively simple means to evaluate the interactions between the 20 variables, albeit in a semiquantitative way.

In the tool, a simple piece of paper, the 20 cost levers are listed along with a weighting factor, a multiplier that captures differences in the relative importance between levers for your situation. For example, a low-volume, high-value, complex product would have different weighting factors than a simple, high-volume commodity.

For simplicity, limit weighting factors to integers between one and five. If the range is larger, the tool can yield unrealistically skewed results. For an easy first cut, set all factors to one and let the tool generate qualitative but still useful insights. The tool can be expanded to include as many options as you wish.

One way to use it is to begin with a "default" design, perhaps one just like your company's previous designs. Or you might start with a "performance optimized" design that has all the horsepower and features, but at an unacceptably high cost. Set all of the default scores to zero.

Have your team come up with alternative designs that move one or more of the cost levers in the right direction. Discuss these options to get a rough understanding of them. What materials would be needed, how much capital equipment would be required, and so on. Go through each lever and decide how the new design would compare to the default option. If the new design costs less because of a specific lever, give it a positive score (using a range of integers from -5 to 5). If a lever increases costs, give it a negative score. The magnitude of a score should be roughly proportional to its estimated effect on cost.

Naturally, pulling numbers out of the air is not nearly as accurate as ferreting out real cost estimates for options being considered. Try to agree with your design team on the meaning of a -5 score or 5 score, and be consistent. (Note that a score of zero means the new design is not significantly different from the default design for that particular lever.)

Once you've completed scoring, multiply each lever score by its weighting factor to generate a total weighted score for each design. A positive total score (relative to the default design option set to zero) indicates the alternative should have cost advantages over the default. A negative total score says you are better off with the default design. Given the subjective nature of this tool, total scores that are close together (within five points or less) are essentially a tie.

One of the best features of this tradeoff-tool is that it only takes a few rough design concepts to begin using it. But remember, it is only an indicator of promising new directions to pursue and a way to evaluate various possibilities. Give it a try on your next design. This technique can be the product-cost equivalent of Lasik surgery for the development team. Their eyesight for cost-reduction opportunities will be much improved through its use.

This article was written by Ron Mascitelli, a project-management specialist and president of Technology Perspectives, a training firm specializing in product development and project management. His latest book, *The Lean Design Guidebook: Everything Your Product Development Team Needs to Slash Manufacturing Cost,* is available through his **Web site** (design-for-lean.com) and on **Amazon.com**.

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