Cost Savings at the Expense of Quality, Safety, and the Environment. A Plastic Molding Example.

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A Difficult Choice in a Competitive Market

In order to provide the lowest price and remain competitive in the electronics industry, a company may need to decide between:

A) Quality Components, or Lower Cost
B) Product Safety, or Lower Cost
C) Environmental Compliance, or Lower Cost
D) All of the above

It is easy to say that there is no compromise, and a successful company must provide a product that does not compromise. The reality of today's electronics industry is that the pursuit of low cost components is driving the market, thus significant trade-offs are being made. Components that cut corners or contain inferior materials are generally less expensive, but can come with hidden costs.

While the above question applies to many segments of the electronics industry, the providers of bobbins, headers and toroid mounts to the magnetics segment offer a unique look at this dilemma and highlights the difficult choices being made in a competitive market.

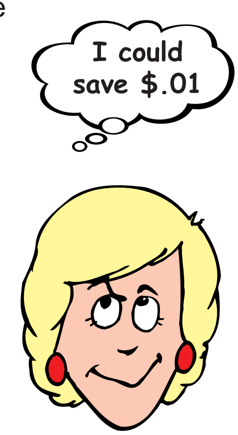
To achieve lower costs, companies are making quality, safety and environmental trade-offs in favor of lower component costs. The trade-offs are often made without understanding the cost and risks being transferred from purchasing to more costly portions of the product manufacturing process, or to the customer.

Lower priced components will always be available that will compromise quality, safety, or the environment. But the compromise comes with risk of additional costs that are difficult to measure, so companies usually don't. In many cases, cheaper components only transfer costs to a more expensive portion of the manufacturing process, and since the risks assumed are not well understood, they may not be worth the cost savings.

Component Cost vs. Quality Compromise

For companies buying and using plastic moldings, quality is a relative term based on the demands of the application. The quality of a low cost, somewhat disposable product does not require the same quality as critical component in a medical or aerospace device. But quality is not just a product attribute; quality extends to include on-time delivery, consistent raw materials, predictable production, responsiveness, accurate records, and transaction ease. The cost of delayed production due to a new vendor's late components, or components that fail inspection can quickly overcome any component cost savings.

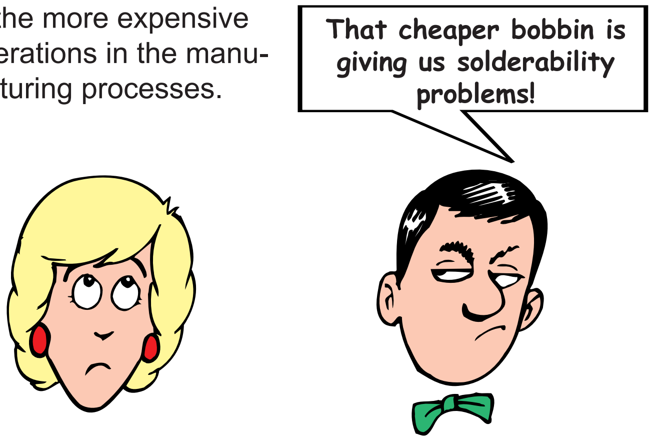
A $.01 cost reduction on a $.08 bobbin is a 12.5% savings; which sounds as though the purchasing group is doing a great job. Over 50,000 bobbins, the savings is $500. As long as the transaction for the $.07 component goes as smoothly as the $.08 component would have, the saving will be realized.



If the transaction doesn't go as well as the previous vendor, additional overhead expenses will be incurred. Quality or delivery problems will add the costs of modifying delivery methods, adjusting production schedules, extra inspection, extra payroll, and QC documentation. This does not include the cost of lost production time, or customer dissatisfaction, which are difficult costs to measure. A $500 savings can evaporate very quickly.

The manufacturer should also consider the cost of the $.08 bobbin compared to the cost of the entire component or assembly. If the bobbin is less than 10% of the cost of a transformer, and the transformer is 10% of the cost of the power supply, the $.01 savings on the bobbins would be 0.125% of the potential cost of the power supply. If a delivery or quality problem delayed the shipment of 50,000 systems for even a week, the actual costs could be many times more than $500 in component savings.

When you consider all these costs, a company may be eroding profitability while they think they are improving it. Costs aren't being cut in purchasing, they are being transferred to the more expensive operations in the manufacturing processes.



This assumes you discover a quality issue before the systems are built and shipped to the customer. If the problem occurs after the customer gets the system, that $500 savings will easily be buried under the cost of replacing defective parts and repairing a damaged customer relationship.

It is easier for a company to measure the savings from buying cheaper components than the potential costs to operations of poor quality or late delivery, so companies measure the former and ignore the latter.

So the company is taking a gamble, and they don't know what it will cost them if they lose. This is what we call 'reverse roulette'. When you play regular roulette in Las Vegas or Macau, you risk a known amount for a chance to win a larger known amount. The odds of success are evident and the greater the risk, the larger the winnings. In component gambling, you win a known amount up front (savings on the component), and assume the risk of losing a larger unknown amount later through production problems and customer dissatisfaction. If you later lose more than you saved, it was a bad gamble.

Reverse Roulette

Most companies that play reverse (component) roulette have no idea of the risks and the costs. Imagine standing at the roulette table and placing a bet without knowing how much you could lose. The dealer says, "I will give you $500, spin the wheel, and then we will know how much money you need to give back." You ask, "What are the odds I will have to give back over $500?" "Don't know," says the dealer, "it could cost you anywhere from zero to millions of dollars, let's spin the wheel and find out."

We can illustrate this point with a real-life example. Micrometals Inc. produces T106-52, which is an iron powder toroid that is one inch in diameter and costs $.10 (HK$.78).

Micrometals has been supplying this high quality part to the industry for over 15 years and it was designed into a power supply used in a high-end server made by a well known computer company. Another core manufacturer was willing to sell an "*equivalent*" part for $.08 (HK$.62) to get the business. The requirement was for 20,000 power supplies with two cores each. At 40,000 cores, this is a savings of $800, (HK$6,240) or 20% for the power supply manufacturer. However, this is only .02% savings of the cost of the power supply, and a .002% savings on each server.

The high end server manufacturer was unaware that the power supply manufacturer had changed core vendor. The substitute part was not equivalent in one important attribute; thermal aging. Micrometals products have superior thermal aging properties so they tolerate higher operation temperatures longer. The substitute vendor's cores did not perform as well as the Micrometals cores. As a result they ran hotter. As they got hotter, the poor thermal aging properties made the parts even less efficient, so they ran hotter, and-so-on until component and power supply failure.

The servers that failed in the field had to be recalled and replaced. The computer manufacturer will receive over $1,000,000 in damages from the power supply manufacturer to cover the tangible costs of the server recall, but not the intangible cost of lost future sales, insurance claims, distribution channel displeasure, and bad press.

Using our reverse roulette example, the power supply manufacturer took a chance on saving $800, but lost the gamble by losing $1 million, plus an important customer. In hindsight, since the upside was very small ($800) compared to the downside ($1 million), it was a bad gamble. Had the power supply manufacturer known the true cost, they would not have spun the wheel.

In this particular case, the reason for the failure was discovered and the company making the gamble had to make good on their wager gone bad. Many times the cause of a problem or cost increase is difficult to discover, and those making the gamble pocket the savings, but don't end up paying when the gamble goes bad. In other words, they enjoy the savings, but the risk gets transferred to others up the product value chain.

The Cost vs. Safety Compromise

Various agencies have developed rules and regulations to keep companies from pursuing profit at the expense of public safety. For plastic molded bobbins, headers and toroid mounts, these regulations center on insulation properties that reduce the threat of fire or user injury.

Underwriters Laboratory (UL) is a non-profit private agency that regulates public safety for a variety of products that include electronic devices. In plastic moldings for the transformer and inductor segment, UL regulations are focused on maintaining the integrity of the insulation system so a short circuit does not occur. This is done by first ensuring the insulation is sufficient, and then it will not degrade over time.

UL conducts extensive testing under UL Standard 1446 that insures the insulation is sufficient, and stable over time. Transformer components like wire insulation, bobbin or winding forms, tape, ferrite, iron powder, varnish, epoxy, and glues each have their own unique chemistry. Often the chemistry of one component, or several components in combination, will have an adverse effect on another component.

UL testing evaluates whether specific transformer components will interact chemically over an extended time at elevated temperature and degrade wire insulation. For example, some phenolic molding compounds include ammonia, which can degrade magnetic wire insulation over time and may contribute to a short circuit that can cause fire or injury.

Transformer tape is an important part of an insulation system. A tape manufacturer like P. Leo in Hong Kong will invest months in expensive UL testing to have their products included in a UL approved insulation system. Once tested and approved, the tape, plastics, and varnish become part of a UL recognized insulation system specific to an operating temperature or class. Using the sub-components listed in a recognized insulation system will insure a reliable insulation and proven sub-component compatibility.

Unfortunately the drive for lower cost has encouraged substitution of untested or lower grade materials. Many times the vendors who offer these 'equivalent' materials have not invested the time and money to have UL test compatibility. As a result, the integrity of the insulation system may be compromised.

Once a bobbin or toroid mount is molded, it is difficult to tell if the plastic material used was UL recognized or not. Often a plastic material is molded from an untested, less expensive material, but is passed on as the other recognized plastic. This practice was so wide spread UL had to develop UL746D, which is a molder certification program that requires documentation and the inspection of lot records to verify the source of molding materials.

Still, manufacturers are driven by a competitive market place so inferior or untested materials are being substituted. The buyers have component specifications prepared by their design engineers that require certification from the molder, but companies are less than diligent at verifying component integrity if it may spoil a perceived bargain.

While these untested components can result in unintended quality or operational cost, the risk of gambles with safety regulations are usually transferred to the customer, where the cost can be quite high.

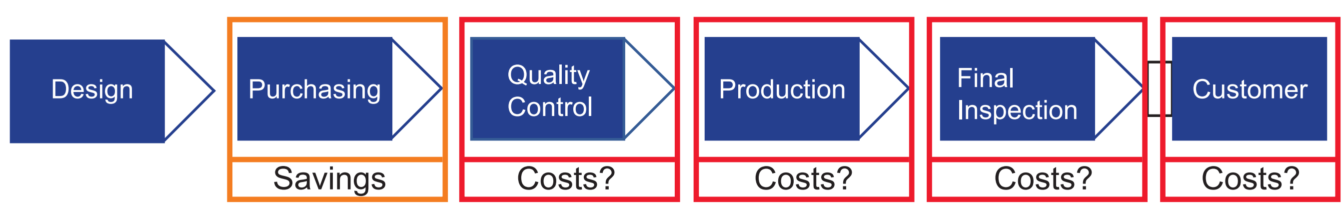


Figure 1: Product Value Chain

Fortunately in the previous example with the inferior cores in the server power supply, the component failure did not compromise the insulation system and product safety. If the gamble had resulted in property loss or personal injury, the cost would have been much higher than $1 million. Usually the company making the gamble is not the company having to pay for expensive product liability insurance.

Cost vs. The Environment Compromise

For plastic moldings, environmental issues have been relatively insignificant in the past. That has now changed. The industry worldwide has developed several programs that limit or eliminate elements and compounds that are harmful to the environment.

The most significant directive is the Requirements on Hazardous Substances, or RoHS. This directive seeks to eliminate or reduce 6 harmful elements or compounds. These elements are;

1. Lead (Pb)
2. Cadmium (Cd)
3. Mercury (Hg)
4. Hexavalent Chromium (Cr6+)
5. Polybrominated Biphenyls (PBB)
6. Polybrominated Diphenyl Ethers (PBDE)

Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE) are flame retardants used to improve a plastic's flammability rating, which is the plastic's ability to self extinguish once it starts to burn. A plastic's flammability rating is determined by UL's specification UL94. Since new RoHS compliant flame-retardants could affect the chemistry of the plastic compound, (and the insulation system) they need to be retested. During the transition, both RoHS compliant and non-compliant versions are available. There will be a tendency to use cheaper non-compliant material until they are no longer available.

Unlike quality or safety gambles, using a non-compliant flame retardant will not make the component or system more dangerous, just illegal.

The next stage of this directive will expand the list to eliminate over 30 elements and compounds. This trend towards environmentally safe products is often delayed, but is unlikely to be reversed. So more time and emphasis will be diverted to the verification of component ingredients.

The most significant banned element in the RoHS directive is not the flame-retardants in the plastic molding, but is the lead that is used in the plating and solder on terminals.

Lead has a melting point of 620.6˚F, (327.5˚C). Tin has a melting point of 450˚F, (231.9˚C). However when they are combined in an alloy of approximately 60% tin and 40% lead, this alloy has a melting point of approximately 361˚F (183˚C). Combined, the melting point is 25% less than tin alone. (See Figure 2)

A combination of elements that create this phenomenon is called a Eutectic Mixture. While it seems like alchemy, it has allowed billions of solder connections to be efficient, inexpensive, and done at a temperature that was not too harsh on the components being soldered. When you "get the lead out", the fundamentals of solder connections change significantly. Solder alloys that are more than 95% tin have a melting point of approximately 450˚F, (230˚C). Components, including the plastic moldings, must now tolerate this 90˚F, (50˚C) increase during manufacturing.

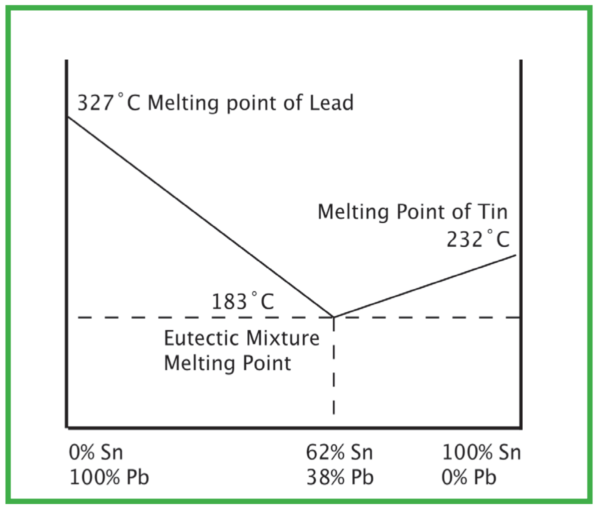


Figure 2: the Tin-Lead Eutectic Mixture

Thermoplastics like nylon, Pet, PPS will start to become soft above 450˚F, (232˚C), especially when heat is transferred up a terminal. If the heat is not managed well and the plastic experiences these temperatures for an extended time, the plastic will begin to get soft around the terminals, which can cause those terminals to "float" out of alignment. Thermoset plastics, like phenolic and DAP, will tolerate higher solder temperatures, but are more expensive and difficult to mold in small or thin sections.

Plastic compound suppliers have been working to provide cost effective materials that are easy to mold and will tolerate higher solder temperatures. Dupont has developed several thermoplastics that will tolerate higher solder temperatures and are very cost effective when the entire molder process is considered. Dupont's Zytel HTN FR52G30LX and Zenite LCP 7130, 5145L, or 5130L offer excellent moldability, especially in narrow and small part sections or walls. These cost effective materials will tolerate higher solder process temperatures and these materials are incorporated into many popular existing insulation systems. For more information, go to, www2.dupont.com/Plastics/en_US/

Using substitute plastics that are not properly engineered for process temperatures, or do not meet the requirements of agency regulations, will once again shift the risk and the cost to another segment of the manufacturing process.

Component Cost vs. Process Costs

In China over the last 5 years, significant savings in labor and component cost have been realized. But there is a limit to how far components can drop in price. Once the cost approaches the cost of quality raw materials, the only way to reduce price is to substitute low quality cheaper raw materials. While the savings in labor and components are approaching the lowest practical limit, substantial savings in process costs and transaction cost are still available. Unfortunately as companies continue to chase lower component costs, they are transferring additional costs into the process. Cost that usually out weighs the component savings.

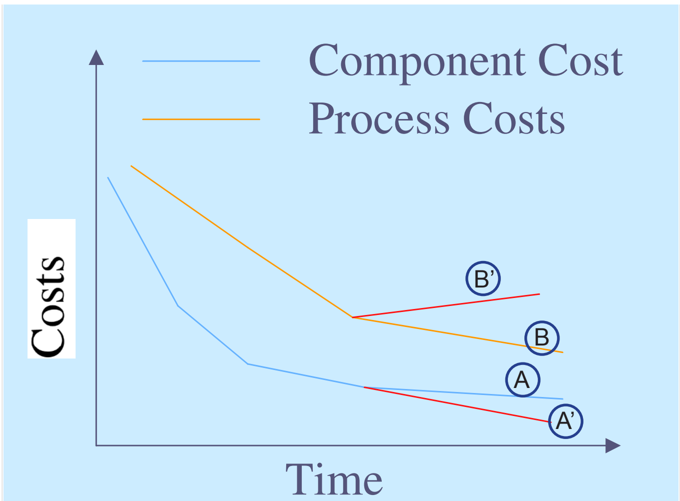


Figure 3: Component Tradeoffs

Figure 3 shows component costs have been going down over time, but the rate of decline slows as the cost of approach the cost of quality raw materials. (A) Companies are still demanding price decreases, so some vendors find ways to get costs below the cost of quality raw materials, which will involve compromises with quality, safety and environmental regulations. (A')

Process costs have also been declining. (B) However as vendors gamble with component quality, their process cost will increase, (B') as risk and cost is transferred to other parts of the process, or to the customer.

The cost of the entire process must be considered in order to ensure a switch to lower cost components do not just transfer the cost and risk to other segments of the Production Value Chain. Elevated solder temperatures and agency regulations require design engineers to evaluate cost and performance trade-offs of plastic moldings more closely, and to set limits for purchasing decisions within performance specifications.

Companies need to develop a way to measure these trade-offs so that quality, safety and environmental considerations are not compromised in the pursuit of purchasing savings. Without knowing the true cost that result, an organization may be penny wise, but pound-foolish.