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BOM cost, and profitability

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BOM cost, and profitability

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In the previous issue, in my article entitled: "When the going gets tough – smarter design wins" I wrote:

> "This is why most designers were brow-beaten into thinking it was vital to cut every last penny from the Bill of Materials, or BOM. (This was never true, just a symptom of lazy management, for rather obvious reasons that I plan to explain in a future article.)"

So here we are, reading that future article.

If you already know the reasons why the BOM cost has (almost) nothing to do with the profitable selling price, you are allowed to skip directly to the next article in this issue, or maybe peruse a few adverts and think about buying something.

Still with me? In the early 1980s I was working as an electronic designer, and found a new chip that would replace a whole circuit board containing about 60 components. I took it to my Technical Director (it was a small company) expecting to be patted on the back, but he asked me how much this IC cost.

I don't remember now, how much it was. But I do remember the TD saying that because it cost £1 more than the components it would replace, using this IC would mean we had to increase the selling price of the product by five times as much as the increase in the component cost – i.e. by £5.

Well, I stood there completely flabbergasted! After I had spluttered and made no sense for ten seconds, the TD explained that the profitable price for a product made by our company was calculated by taking the BOM cost and multiplying it by five.

I hadn't known that, and since then I have come across other manufacturers using the same stupid and totally-without-foundation basis for setting their selling price, all of them with different multipliers depending on the type of product and volume it was sold in, etc.

At the time of the above story I was in my early 30s, and – being a rather slow developer as far as assertiveness went – I felt unable to tell the TD that I had never heard anything quite so daft in my whole life.

I just mumbled a few things and left his office – my back sadly unpatted – and started looking through the jobs advertised in the engineering magazines, hoping to find an employer where some semblance of sanity might be found at board level.

(Now that I work for myself, I can say that I have finally achieved that goal – but then (as Mandy Rice-Davies (Google it)) would no doubt agree – I would say that, wouldn't I!)

Few companies have a system that accurately costs all the various things that go into making a product. It takes a lot of work, and some intelligence, to set up such a system, and keep it up to date as time goes on.

The BOM cost is about the only part of the product for which data is readily available, so – rather than do a proper calculation – many directors *pretend* there is a fixed relationship between the profitable selling price and the BOM cost, and guess at a multiplying factor. In the above (true) story, they had guessed the number five.

To show why this approach *can't* work, I'll list some of the things that need to be taken into account to set the profitable selling price of a product.

1. Corporate Overheads

This category includes the following, at least, none of which are related to the BOM cost:

- All wages and salaries, to everyone from the cleaners to the directors, including the engineering design department.
- Company vehicles.
- Costs of marketing and sales (exhibitions, brochures, websites, travel expenses and all those slap-up expense account dinners that it is hoped will make potential customers regard your products more favourably).
- Costs of product design and development, including all of the computers, test and simulation gear used by the design department to invent new products, plus the cost of manufacturing and testing prototypes.
- Rental or mortgage costs for the corporate buildings, and the maintenance and repair of same.
- Supplies of electricity, water, gas, and the treatment of waste.
- Payments of national insurance and pension contributions, local government taxes, and taxes on profits.
- Various insurance premiums, and bank interest on loans.
- Costs of machines, computers, hardware, automation, etc., that are used to manufacture the products, inspect and test them, and rework the (hopefully!) few products that need it.
- Cost of storing and shipping manufactured products.
- The Christmas party.

2. Dividends it is hoped to be able to pay to shareholders...

- Plus performance-related bonuses it is hoped to be able to pay, to whoever is employed under such terms and conditions.

Not related to BOM cost.

3. The BOM cost

- The total cost of the materials and components used to make the product.

4. Cost of manufacturing and rework

- The total cost of fabricating things, assembling them with the other components, to make a product which is then tested.

  This depends upon the product's design, and the degree of automation used in fabrication, assembly and test.

- Rework costs depend upon the product's design, the skills of the fabricators and assemblers, and the degree of automation used in fabrication and assembly.

None of these are related to the BOM cost.

5. Warranty costs

- These depend upon the product's design. Pressure on the BOM cost and/or timescales causes designers to cut corners that could result in increased warranty costs.
- Many companies have failed, because – as the direct result of inadequate design – their warranty costs exceeded their profits.

None of these are related to BOM cost – except insofar as higher quality materials and more reliable components generally cost more. But the main determinants of reliability are design expertise and manufacturing quality.

Items 1, 2 and 5 in the above list are paid for by adding an amount to the cost of each product manufactured, called the "Gross Margin". In most manufacturing companies it is greater than the total cost of manufacturing a product (items 3 and 4).

So, more than half of the selling price of a product has nothing at all to do with what it cost to manufacture (and only a fraction of the manufacturing cost has to anything do with the BOM).

(Yes, we all know of sweatshops, and companies selling motherboards with the very first batches of the latest Intel processors, for which the above descriptions are not very accurate. But I'm talking about typical western European, Australian or American companies, that readers might find themselves working for.)

It's quiz time now for those hardy readers who have braved the many column-inches of graphics-free text above, and made it this far!

Question 1 (in your own time): How many of the five categories above, bear even a slight relationship to the BOM cost?

Question 2 (in your own time): There is no Question 2.

Those who answered: "*Just one - item 3 in the list (plus maybe a tiny bit of item 5*)" can go to the head of the class! You are smarter than the Technical Director in my earlier story (despite his Ph.D) and the rest of his fellow directors.

Of course, if you take an established product that is doing well and is clearly profitable, you can take its selling price and divide it by its BOM cost and get a number.

If every future product: used the same components designed in the same way to do the same functions; was assembled using the same skills and technologies; was purchased in the same quantities by the same customers, and *nothing else changes either* (e.g. salaries, rents, dividends, taxes, etc., etc., and the cost of the Christmas party) – the same BOM multiplier will give you an accurate value for its profitable selling price.

But this is based on totally unreasonable assumptions that are *never all true*.

I've never worked on two sequential projects that used the same technology from one to the next, and my experience seems typical for electronic designers. For example since 1970 I've seen printed circuit board (PCB) manufacturing technology go from:

- Single-sided tracking (semiconductor devices no more complex than a single transistor), to
- Double-sided tracking with soldered pins to connect the two sides, to
- Plated-through-hole (PTH) technology with two layers (carrying opamps and TTL up to 16 pins), to
- PTH with four layers, with track-and-space at 230µm (9 thou) without cost penalty, to
- PTH with as many layers as you could want, with track-and-space at 100µm (4 thou) without cost penalty, carrying devices with 1,000 pins containing over 100 million transistors, to
- Microvia (High Density Interconnect, HDI, according to the IPC, www.ipc.org) with blind and buried vias, and as many layers as you could want.

At every technological step in the above progression, the PCB manufacturing and buying departments warned that the cost of the new PCB technology was higher than the old one, so the selling price of products that used the new technologies would inevitably have to increase.

But as we all know, having the benefit of hindsight, the cost of electronic products has continually *reduced* even while their performance and functionality has increased, *because* of the use of more costly new technologies.

Let's now look at a couple of quite reasonable scenarios:

A) A complex circuit that occupies a whole PCB can be replaced by a single IC.

Disadvantages: Increased BOM cost

Advantages: Fewer solder joints to fail, leading to smaller proportion of products needing rework; better reliability; lower warranty costs, plus a smaller (hence more attractive product) with smaller packaging and shipping costs, all leading to increased customer satisfaction; lower cost of future sales; increased sales volume and market share.

Would it be reasonable to deny using the new IC because of its higher BOM cost?

Would the selling price of the product *really* have to increase because of the increased BOM cost?

B) A 30p heatsink was omitted, due to pressure to meet the budget BOM cost. The designer persuaded himself it would be OK, when he measured the temperature of the IC concerned and found that without the heatsink it was just below its maximum temperature rating.

But in most engineering undergraduate courses, they do not teach that semiconductor reliability typically halves for every 10°C rise in temperature. So the designer didn't realise that adding a 30p heatsink would have reduced the temperature of the part from 150°C to 90°C, increasing its reliability approximately 100-fold.

Since the IC in question was the most highly-stressed component in the product, the reliability during the warranty period turned out to be dominated by this IC, and the warranty returns rate was 25% during the winter months, 75% during the summer.

Similar percentages of repaired products were returned under warranty a second time, when the same IC failed again. The reputation of the manufacturer's brand of products went into free-fall.

Finally they figured out what the problem was and added the 30p heatsink, reducing the returns rate to under 1%.

Do you think it was it reasonable to omit the 30p heatsink to meet the BOM budget, without consideration of the possible consequences for warranty costs; customer satisfaction; cost of future sales; market share, etc.?

Of course, the designer was only one year out of university and had never heard of Arrhenius or his famous curves. But – knowing that this was the situation – someone should have been watching out for this kind of problem. Without competent, experienced technical oversight, manufacturing companies become places where designers learn the hard way to design cost-effective and profitable products – at a potentially ruinous cost to their employers.

Well, if you read this far and *still* think that the BOM cost is the prime determinant of the profitable selling price – I just don't know what more I can do!

But I can suggest that you may enjoy a much more successful career in banking or politics, where consuming or losing huge amounts of other people's money doesn't seem to matter very much.

Keith Armstrong is President of the EMC Industries Association, www.emcia.org