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What's next for electronics devices?

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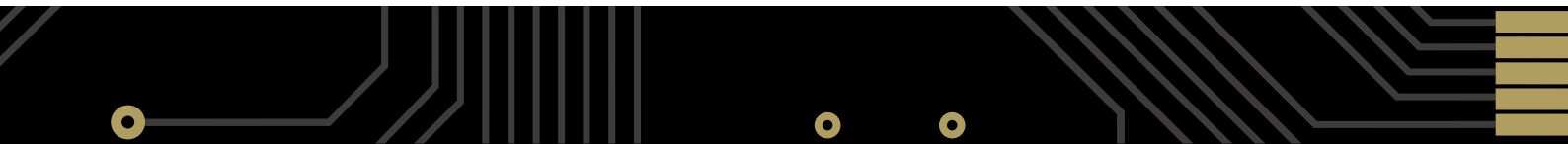
April 2009



Synopsis

Organizations creating the next generation of electronics products must design product experiences, not just the devices themselves. Why? Because the next generation of electronics won't be stand-alone devices. They will be an intelligent part of an interconnected ecosystem that will offer far more than the metal, silicon and plastic from which they are made.

The true value of a product and the intelligence necessary to connect to a wider product ecosystem is defined by the soft elements of the design. So why do we ignore the obvious and continue to design products back-to-front?

We need to reverse our traditional design thinking so that designers are free to take a holistic approach to the product development process and tackle the design as one focused task. The soft elements should be the focus and the place to start. The hardware should really be developed to suit the soft elements it will host, not vice versa.

When we take a holistic approach to product design, we can develop intelligent devices that become the means to connect a customer with the device manufacturer and act as a conduit for ongoing interaction and value between the two. This elevates the customer experience beyond the confines of the product casing and creates a mechanism for ongoing innovation.

This white paper explains why a fresh approach to design is necessary, and takes a look at how designers need to respond to a fundamental truth of the electronics industry: rapid and ongoing technological change is inevitable, and those that don't embrace it may not have a future at all.

The electronics industry has grown up. It's no longer a toddler lurching from one major advance to the next. It's no longer a pimply-faced teenager with an attitude and more chutzpah than experience. It's now a mature adult of an industry. Unfortunately, it's at the start of one giant mid-life crisis!

There's a new generation of consumers coming through who are both comfortable and conversant with the highly-connected, technology-driven world in which we now live. And they have an insatiable appetite for the new. Electronics to them is not a product, it's a lifestyle.

Can the electronics industry satisfy the demands of this next generation? Not with old generation thinking and design processes it can't.

The next generation of electronic products won't be stand-alone devices, as they have been in the past. Rather, devices will be an intelligent part of an interconnected system – a product 'ecosystem' – that will offer far more than the metal, silicon and plastic from which the devices themselves are made.

In essence, electronic devices are moving away from the centre of the electronics design universe and becoming satellites of a much bigger device ecosystem. The devices and the ecosystems behind them are intimately linked, and both go to make up the total user experience.

Apple's iPod is a good example of this. The iPod device owes its success as much – or even more – to the music purchase and download systems that sit behind it than to any intrinsic properties of the device itself.

And while consumer electronics present the most visible evidence of this trend, all sectors of the industry from medical to industrial electronics are going this way. The users of electronics, whether in the medical, industrial, consumer, or any other sector for that matter, are demanding that their products do more, are easily upgradable, offer services beyond the device itself, and do all this faster and cheaper than they did yesterday!

Are we there yet?

So how are electronics companies responding to this demand? Try this experiment. Visit your local consumer electronics store every week to 'stay current' with what's happening in the electronics world. After a few months you will notice an interesting trend. Other than gradually increasing specifications (capacity, speed, memory size, etc.) and a gradual decline in prices, there really isn't much that's new!

Sure there is plenty of technology on display. But there is precious little in the way of truly new devices or concepts. Each week you will see a bunch of new models of the existing devices, often with very little separating them from their predecessors, even at the aesthetic levels. On the surface the world of electronic products gives the impression of rapid movement. Dig deeper and you'll see that real innovation and change move at a much more leisurely pace.

It's clear that, as yet, the majority of the industry has either not recognized, or is simply unwilling or unable to respond to the changes demanded by a new generation of customers.

The iPod phenomenon

When Apple launches its new devices, even those that are just improvements at the aesthetic level, it attracts so much attention. Why? Because its products are among the few that regularly break the drought of new technology and concepts, and break new ground in the marketplace.
Every release brings with it an expectation of another discontinuous, and potentially exciting, step forward.

With it also comes the wave of imitators, desperately trying to respond to the discontinuity. Within a few months a host of devices appear that attempt to steal, or at least make a dent in, the clear leadership in innovation and perceived technological superiority that Apple has taken – again!

But even as the "iPod Killer" and the "iPhone Killer" devices appear, they seem to make few inroads into Apple's position. Even if they can match the aesthetic and technical design qualities at the product level, or indeed even go beyond it, Apple's position seems unassailable.

The reason is that Apple sells not only a device, but an entire 'ecosystem' that supports it, and makes that device far more than just some hardware and software in a good looking case. This ecosystem, starting at the device and connecting, via the iTunes application on our PCs, to the online iTunes store, seems to shut out competitors and their offerings at a deep and fundamental level.

We all know the story of how Steve Jobs and Apple have taken a complete stranglehold on the market for mobile music players. What is more interesting is how they have held this position in the face of attacks from some of the great companies of consumer electronics, including Samsung, Nokia and Sony. Does it matter if the iPod is the most technically advanced portable music device, or the cheapest? Not in the slightest! The fact that it is backed by a compelling ecosystem makes it effectively immune to competitive products that only attack it at the device level. Apple has created a sustainable competitive advantage by linking its device to a network of services that provide exactly what the customer wants: an easy and convenient way to buy, store, organize and play virtually any music in the world.

And now Apple has moved the fight into the mobile phone arena, taking its relationships with its customers into this new space. It's looking just as intimidating as in the music player market!

A lesson for other markets

Although music players represent just one market, they provide a glimpse of the future for other markets – consumer, industrial, medical, military and automotive.

In some of these markets, the incumbent leaders already have relationships that go beyond just the physical products. But in general things such as service and invested user expertise, grouped under the general hold-all of 'customer loyalty', no longer look quite so robust in the context of the bigger forces of globalization, ubiquitous communication and the commoditization of knowledge that the Internet has created.

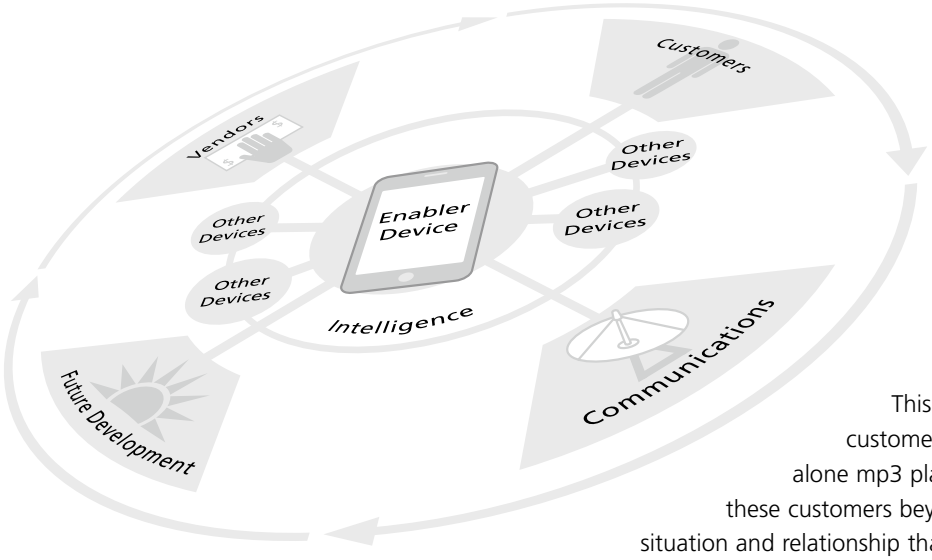
In many markets, including virtually all consumer device markets from washing machines and toasters through to automobiles, there is virtually no defense against these forces. The little customer loyalty that does exist, perceived or otherwise, is only as strong as the last interaction between the customer and the manufacturer.

The challenge (and the opportunity) for all players in these markets, no matter how big or small, is to build a differentiated position that is sustainable in these times of such dramatic change. The music player market example points the way. Those who can lift the whole user experience in their market to a new level, whether they be the traditional leader or the new kid on the block, will find very little to stop them.

The ecosystem concept – a real "win-win"

Looking at the mobile music market, and Apple's position in it, it is pretty obvious that it's not the iPod on its own that makes the difference. It's the whole ecosystem that provides the sustainable advantage. The ecosystem, with foundations in the Internet, is provided by the combination of the device (the iPod or iPhone) and the iTunes application running on the PC.

At a more conceptual level, the device is simply part of a channel through which the customer establishes and maintains the relationship with the device's manufacturer. The device is an essential element because it is the node at which the customer plugs into the ecosystem. From the perspective of the manufacturer, it then becomes the pipeline through which continuing value can be delivered to the customer.



If this value is successfully delivered, then when consumers look for new or additional devices it's highly likely they will see it as simply a process of adding more points of contact with the ecosystem they are already familiar and comfortable with. In other words, it will be a lot easier for the customer to buy more devices from the same manufacturer, rather than go with another device that will not be able to make use of the ecosystem in which they have already made an investment.

This is a win-win situation for Apple and its customers. Customers get much more than a stand-alone mp3 player, and Apple gets ongoing business from these customers beyond selling them a single product. It is this situation and relationship that other device vendors must create with their customers in order to compete.

Implications for product development

For many product manufacturers, thinking at the ecosystem level will require an entirely new way of looking at the product development process. It's going to be significantly more challenging to develop and deliver a whole product experience than it currently is to produce a standalone device in a box.

It won't be sufficient to switch from today's static design process – a process that has been in use fundamentally unchanged since microprocessors hit the mainstream – to tomorrow's slightly bigger and better static development process. What we need is a fundamental rethink of approach when it comes to electronic product development. And this needs to happen sooner, rather than later.

As the Apple example shows, designing products that are part of a wider experience and which can ultimately plug into a larger ecosystem is happening today. But it's done in a very ad hoc way. The reason for this is that the way we design products has evolved from a hardware base. The focus of design has been, up until now, firmly on the devices.

To move forward, organizations and individual designers need to raise their gaze above the device level and look towards the experience their customers want, identify the functionality that supports this, then come up with innovative ways to deliver that functionality and experience using all the technology of the day. Recognizing this and embracing the challenges (opportunities) associated with it is essential if designers and companies want to remain relevant as the future unfolds. The only alternative is to watch the industry pass you by.

Thinking outside the box

Imagine for a moment that your company is in the business of developing air conditioners. You can take on the local competition by designing more efficient, quieter, more powerful systems than they do. Or you could undercut them on price. But what happens when the imports undermine these advantages? Who wins then?

The alternative is to pioneer a new generation of air conditioners that offer a different kind of customer experience. Add connectivity to the device and make it simple for someone to connect to the device from anywhere in the world and either monitor the system or interact with it to, say, turn the system back on prior to returning from a vacation. You could even develop an iPhone application so you can control it from your car on the way from the airport, once you've felt and experienced the heatwave.

Simple remote interaction is only the tip of the iceberg. Imagine a smart air conditioner that is intimately linked to the manufacturer. It can communicate with the manufacturer's systems on a regular basis to report its performance. A drop in energy efficiency, for example, can be monitored and responded to before a system failure actually happens, or a maintenance visit can be scheduled to replace filters that are becoming clogged.

Similarly, the setup of the air conditioner and the customer's preferences for temperature and humidity in each zone could be monitored and backed up onto the manufacturer's system. When a new device is acquired, either at end of product life or as a warranty replacement for a failure, the customer's settings can be transparently downloaded into the new device. If the customer moves into a new house and buys an air conditioner from the same manufacturer, the new system could be automatically calibrated to provide the same comfort levels that the customers are used to. All without any customer intervention. This could be of considerable commercial interest to the manufacturer, which might be based in (say) Korea or Japan, and which now no longer necessarily has to maintain an expensive service organization in the country where the unit is in use.

Because the value here lies increasingly in the services provided 'outside' the actual device, a company can sustain differentiation from its competitors and maintain revenue over the long term without having to rush out new models every five minutes to combat tactical moves in the marketplace.

Redefining design in an evolving industry

If we accept the need to raise our design focus beyond the nuts and bolts of the product, how do we change the way we design products to respond to the challenges posed?

The first clear requirement for building next generation devices is that they be both connected and intelligent.

Adding these capabilities at the hardware level represents an incremental change in the 'hard' elements of the design. In practise, adding the necessary hardware to allow a device to connect to the Internet is fairly simple. A USB port, for example, can allow a device to be plugged into a computer that can, in turn, connect to the manufacturer's system via the Web. Similarly a mobile phone chip embedded in a device could provide a way for a manufacture to connect wirelessly with devices.

Adding the physical connection path is one thing. Really, it's what you do with this connection that is the important thing, and where the biggest challenge for designers lies. After all, it was one thing for ET to phone home, but it would have been ultimately futile if nothing intelligent was there to take the call!

So the real enabler of next generation devices is in our ability to add 'intelligence' to devices to make them versatile portals into the product ecosystems we create. Microprocessors have allowed intelligence to be added to devices at relatively low cost and over the last 25-30 years. They created something of a revolution in the way we design electronics. They have allowed fixed hardware to be replaced by software algorithms and are now the basis for today's intelligent devices. What makes a smart phone smart has very little to do with the hardware it's made from, and everything to do with the software that runs on it.

Software was revolutionary in electronics because it was...soft! Before the microprocessor, everything that a device did had to made to happen by wiring together components. You wanted more stuff to happen, you had to add more components and wire them together. Intelligent devices need to do an awful lot. That would mean more components and wire than would be practical, or indeed possible to design and build. So replacing a huge amount of dedicated, fixed-purpose

hardware with a small amount of general purpose hardware (a microprocessor) and software allowed designers to do things no-one had ever dreamed of doing before.

Over the last few years, a new type of device has brought about a second revolution in electronics design. Programmable hardware devices, in particular FPGAs, are changing the way designers think about circuitry. These chips are like a blank canvas for designers. Their function is not fixed during manufacture like other chips, but can be programmed by the end designer to perform almost any hardware function wanted. They're versatile and they have reached a critical price/performance threshold.

Although today they are largely used as straight replacements for fixed electronics hardware, as with microprocessors they have the potential to fundamentally change the way we design electronics. They bring a 'fluidity' to the hardware development process that can transcend the traditional software/hardware divide. They now represent a largely untapped potential when it comes to pioneering new ways to design and bring intelligent products to market. For the first time designers can think of manipulating the underlying hardware as easily as they have modified software in the past.

As with the advent of microprocessors, this will allow designers to do things that simply haven't been possible before.

Harnessing this potential, however, has significant implications for both designers and electronics companies. As functionality is migrated into a completely soft realm (created with a combination of programmable hardware and traditional software) it will require a new era of multi-disciplinary design where each of the traditional design processes intimately and coherently interact. Designers will need to stop thinking of a design in terms of discrete hardware, programmable hardware and software, and instead define a design in terms of its functionality and then map this functionality to the most appropriate implementation.

To do this within the traditional design framework would necessitate an expansion – and marked increase in complexity – of traditional electronic design tools, and added pressure on design engineers to extend their skill-base and knowledge to deal with the revolving door of new technology.

These factors would conspire to place electronics designers in the position of using an expanded set of traditional design paradigms that struggle to cope with this new complexity. Coupled with the pressure to reduce design cycle times, today's designers are forced to develop products in ways that do not harness the most valuable skills in their armory: innovation and vision.

To break down the barriers that stand in the way of fully harnessing the latest technology we need to take a critical look at electronics design, how the process is currently tackled, and how it must change.

Challenging design conventions

Beyond the business marketing strategies that affect how products are designed, it's worth critically looking at our traditional understanding of the processes involved. Basically, to begin to understand and harness the potential that programmable hardware devices like FPGAs afford us, we need to throw away the old design rule book and look at the whole thing with fresh eyes.

Take for example the historically-accepted concept that electronic product design is a linear, sequential process that starts with the physical hardware and progresses to the software that resides on it. This design paradigm has its roots in the concept that hardware defines the value of a design – which indeed it did, many years ago – and software just adds functionality to that platform.

Today, this traditional design approach forces designers to lock in the choice of hardware at the beginning of the design cycle so the soft parts of the design can be developed. Software development must proceed within the restrictions of the selected hardware devices. In other words, what you can achieve with software is limited by the hardware you have chosen.

To be blunt, this is now all backwards. Since the true value of today's products is defined by the soft elements of the design – traditional software and, increasingly, programmable hardware – these soft elements should be the focus and the place to start. The underlying hardware that this will be programmed into should really be developed to suit. In this way, the hardware will not restrict the level of intelligence that you can build into the device, and ultimately constrain the critical

properties of the end product – function, connectivity, the user experience, etc.

If we reverse our traditional design thinking, designers are free to take a holistic approach to the product development process by tackling the design as one focused task. They can start the design by exploring and innovating in areas critical to a product's success. Basically, they can spend more time on stuff that matters to the end user.

With the very essence and value of a design existing in the software and programmable hardware, the need for custom-designed hardware is also squarely under the spotlight. As the hardware parts of a design become more standardized, or even commodities, the logical progression is a move to off-the-shelf (OTS) hardware solutions that can be used to support a design's core intelligence. The physical aspects of the design – the way it is deployed to the market – might be in any number of forms, including a complete OTS hardware device, an assembled set of OTS hardware modules or a traditional custom-built PCB assembly.

What's even more compelling is the prospect of OTS hardware that is directly supported by both the design software and the hardware development platform you use to develop and test the product. Designs done in this environment can then be directly and seamlessly moved into the final product. If the system is also independent of FPGA device vendors, the door opens to a flexible, design approach that allows designers to innovate without the barriers imposed by hardware constraints or the complexity and inefficiency of traditional design tools.

A new approach: bringing it all together

There is no doubt that the role of electronic devices in our lives is changing. Where electronic devices once stood alone as self-contained products, we now have smart devices that act as conduits between us and product ecosystems that span the entire globe. The ubiquitous connectivity offered by the Internet today gives us a new frontier to be pioneered. We have so much to gain by raising electronics design beyond the confines of the case in which the board sits.

We are evolving to a world where the features, functions and services that a product connects to are just as important as the physical product that we buy. The implication for electronics design is that the less we rely on fixed hardware to carry the critical functionality of our product, the better. We need to fully exploit software and programmable hardware as vehicles to deliver intelligence into devices. Not only can software and programmable hardware be easily updated to facilitate new functionality as we expand our product ecosystem, it also provides a secure vessel in which embed our unique ideas. Unlike hardware, software and programmable hardware can't be easily copied and produced at a tenth of the cost somewhere else in the world as soon as we release our product.

Real and sustainable market differentiation can only be delivered by the intelligence that we program into our electronic devices. This is what delivers the unique behavior, functions and connectivity to next generation products. It's what allows an organization to plug its products into a bigger ecosystem, and thereby deliver a level of experience and customer relationship that goes beyond the product itself.

For this change to propagate across the industry, not only do designers and organizations need to shift their thinking, but the design systems and methodologies they use need to change. The old 'divide and conquer' approach to design – treating hardware, software and programmable hardware as completely separate endeavours – must be abandoned. To harness the potential that programmable devices offer as a vehicle for delivering device intelligence, we need to unify these traditionally unconnected disciplines in a way that lets an individual designer easily move between them. Only then can a holistic approach be applied to the design process so that intelligent, connected electronic products can be created that offer true differentiation in today's electronics product market.

And it's this holistic approach that must be the new way to do electronics design, because it brings together the needs of the end user, and the freedom to allow you to create a great piece of electronics to meet those needs in a design that provides you with a competitive advantage.

In a highly competitive, global industry where change is inevitable and innovation rules, the time has come for a hard, fresh look at the way we design electronic products. Technological change, if you embrace it, is your ally in producing products and customer experiences that deliver long-term competitive differentiation.