Moving to advanced design abstraction

Summary

To gather a surprisingly effective snapshot of today's electronics design you need look no further than the nearest geared-up teenager. Amongst the attached electronic paraphernalia of 'essential' technology will be a fine example of the complex relationship between technology and consumer demand, in the humble guise of a portable music player.

Of course there are far more sophisticated and complex products produced by engineering teams every day, but it's the mix of influencing factors that go into the design of this type of device that has a profound impact on mainstream electronic design. Indeed, a quick interrogation of the player's guardian will reveal a few instructive insights into not only the current state of design, but the future path of electronic product design – even though the answers may not be particularly articulate.

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What's hot

The essential element of interest here is what has made this particular portable player the one of choice from amongst the hundreds available on the market, or what has made this product competitively unique and therefore more desirable. The answers will invariably point to what could loosely be categorized as price, form and function.

While price is somewhat of a given, it will always be a major influence over the buying decision. The other elements that hold significant clues are from a product design perspective. The form is the physical appearance and 'look and feel' of the product, while the function is essentially defined by the operating features it offers and how they perform. What's actually inside the unit, beyond perhaps a cursory interest in the storage medium used – say flash RAM or a hard disk – is of little concern and rarely defines the uniqueness of that product.

Turning the perspective towards the manufacturer of our example music player, it's clearly the unique form and function properties that have been engineered into the product that therefore define its competitive strength. What's more, maintaining the market differentiation these unique properties confer is essential to the product's ongoing success, and is in effect, the product's defining intellectual property (IP).

The significance of this is that while the product's form is relatively easy for other manufacturers to emulate, the functional elements in today's designs are invariably held in the more secure software domain. Put simply, design IP contained in the physical domain, such as case hardware and the PCB assemblies, cannot sustain product individuality in a competitive market. By contrast, the 'soft' elements of a design are easier to legally protect and more difficult to reverse engineer, as is the case with the defining IP in the portable music player.

Beyond the design security issues of course, moving a product's design IP from the hardware to software domain opens the opportunity to create far more functionally-sophisticated products. This software-centric approach has in turn redefined both the electronic product design landscape and the methods used to create those products.

The changing role of hardware

As product design increasingly moves towards the soft domain, where the unique and defining elements of that device are now mostly held, the design's electronic hardware is becoming defined as one or more programmable devices connected to the outside world through various physical interfaces.

In the case of the music player example, the physical hardware platform will be composed of very familiar functional blocks – a display screen, user interface controls, a storage medium, scratch memory, data ports and so on. These will invariably be supported by basic interface hardware, but the true functional and defining elements of the player come from software operating on some form of host processor device.

Significantly, circuitry and design used for many of the elements on the physical hardware platform are common across products to the point of effectively being in the public domain. For example, the music player's USB data interface is likely to be based on a low-cost off-the-shelf item from a major semiconductor manufacture, who in order to promote the use of the device, also offers a verified, production-ready circuit design that can be simply dropped in to the project structure. There are clear time saving and economic benefits of using this approach, since most of the work has already

been done by the semiconductor manufacturer's engineers and working to improve upon it will add very little if any value to the end product – one functional USB port is pretty much like any other.

Whether the major hardware elements in a design come from existing IP supplied by manufacturers or are designed from scratch, they no longer define the unique aspects – and therefore competitive advantage – of the product. As a result, redesigning these blocks for each new design project delivers no real value to the product and takes the design engineer away from working on the creative and innovative aspects of a new design.

Electronic product design has now evolved to a point where in effect, large blocks of programmable and interface circuitry are connected together to form a hardware platform which is functionally defined by the software elements it hosts. It is the 'soft' intelligence embedded in the product that provides its uniqueness and therefore market differentiation, rather than the properties of the physical platform it resides on.

A new approach

This changing design landscape is challenging existing design methodologies that have their roots in a traditional board-centric approach, where separate tools create the hardware and software elements from a 'circuitry-up' perspective. As the emphasis shifts towards soft design and the benefits it delivers, time spent on developing common function blocks delivers little value to the final product.

What's needed is a way to raise the abstraction of the design processes so that design engineers can work with functional blocks at higher levels. The potential exists for design methodologies that allow engineers from all disciplines (hardware and software) to simply connect together pre-verified blocks though all stages of the design process. These might be from previous designs or from a library of pre-defined functional elements. In either case, the task here entails much more than just reusing saved sections of circuitry or code.

The crucial point to such a modular, high-level design approach is the design tool infrastructure that supports it, which needs to deliver the interconnection systems and design data management capability that makes the process seamless. As the lines between hardware and software design blur, raising the abstraction level of design processes must be pervasive – or unified – across all stages of the design process. For example, placing an USB block in your design has ramifications at a schematic, board, programmable device and software level, so the abstracted block must inherently represent all these elements and transparently interconnect with universal bus systems.

At this level of design abstraction engineers from all disciplines are free to quickly create designs in a modular connect-the-boxes way, speeding the product development process and freeing design engineers to add value to the final product though innovative IP. What's more, by raising the abstraction at a unified level, the traditionally complex process of bringing all of the elements of a design together – hardware, software and programmable hardware – is greatly simplified. The design is now abstracted as a whole rather than at different, specialized levels within each design discipline, which has been starkly evident when using traditional disconnected design tools.

Working at this level also offers the opportunity to create hierarchical sections within functional blocks that will cater for different implementations of that function, smoothing the path from design to production.

Considering the USB function block again, its value is enhanced by including the connector and its wiring as a partitioned sub-block for example. With this approach an alternative connector could be easily activated or 'loaded' to cater for a different application, say where the music player – or just the USB block – is used in a another product. The design of that overall function block is pre-defined, but is self contained, portable, configurable and can simply wired to other blocks as the application demands.

Harnessing high-level design

Moving the electronic product development process to the next level means creating methods and systems that support the changing roles of hardware and software in today products. As a design's physical hardware becomes increasingly commoditized and the soft elements take over as the custodian of the product's unique intellectual property, design engineers need work in a different way.

Wasting valuable product design time creating familiar hardware that does not add market value to a product needs to be minimized by implementing higher levels of design abstraction and seamless design re-use. The design tools that support this approach must deliver the transparent bus interconnection, file management systems and native design hierarchy control that makes the process a simple 'connect up the blocks' action.

To make the system truly effective, the raised level of design abstraction must also permeate though the whole design process by presenting a consistent interface that allows engineers from all disciplines to easily assemble predefined functional design blocks. When higher levels of design abstraction are natively supported by a truly unified design system, all design engineers can work in the most efficient way while directing their energy and talent at creating innovative electronic products that offer clear and secure product differentiation within the marketplace.