Bringing It Home — Electronic Product Design And Development

With strategic alliances to a worldwide network of tooling and component vendors and stateside contract manufacturing houses, design firms can develop products from initial conceptualization to full industrialization in unprecedented schedules. Close interaction and communication between the design firm and the tooling vendors/contract manufacturing house insures a clean, efficient design that produces a quality product — and most importantly, in the shortest development schedule possible.

Bill Jennings

The past several decades have witnessed a disturbing and potentially economically fatal trend in electronic packaging. I am speaking of the industry preferred practice of outsourcing the design, development and subsequent manufacture of electronic devices to the Far East. While the initial recipient of this flood of product development was primarily Japan, external economic pressures have brought Malaysia, South Korea, Hong Kong, Thailand, Taiwan, Singapore, Indonesia, the Philippines and China into the mad dash to support American product needs. Indeed, we now see the Far East companies themselves outsourcing. For example, it is not unusual for a product development effort sourced in Singapore to actually be engineered, tooled and manufactured in Indonesia. However, no matter who the end producer is or how many of them are serially linked to produce the final product, it's still cheaper than doing it in America. Or is it? Indeed, several factors are afoot which are changing this belief and, in an ever-increasing number of cases, it actually is cheaper to design, develop and manufacture products in the United States.

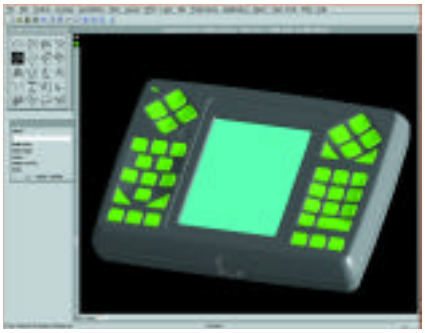
Significant cultural and technological changes have occurred in the American culture in the past few decades, which continue to have a dramatic effect on the electronics industry. These dynamics are redefining electronic products as we know them and forever changing the manner in which these systems are developed.

Photos courtesy of Stone Mountain.

The basketball statscreen and the statscreen scorecard are the first in a new line of hand-held sports statistics organizers designed, developed and manufactured in the U.S.

Americans have fallen irretrievably in love with electronic products. While this affinity covers the spectrum from pure gadget to truly functional, they are especially fond of information and communication devices. Technology has accommodated them with unprecedented advancements in the miniaturization of electronic hardware. One custom integrated circuit is now capable of replacing literally an entire PCB crammed full of electrical components, with associated cost reductions. Consequently, handheld devices now exist for a seemingly endless array of functions. Further, these devices are affordable to an ever-increasing range of consumers. The pace of this technology is such that this year's models are typically outdated before their 90-day warranty expires. The result is shorter and shorter product life spans, as consumers cannot abide owning outdated devices.

This phenomena greatly complicates the ability of company product marketing groups to predict their consumers' needs and desires in the next generation product. The longer it takes to get the product to market, the greater the change in technology. A product that enters the market late, and consequently behind its associated technology curve, is doomed to failure. Lost revenue due to a product which is six months late is easy to calculate based upon projected sales. However, this



The full integration of 3-D CAD software into the design process has given U.S.-based design firms the edge to compete in the worldwide product development market.

can be minimal compared to being beaten to the market during these six months by one or more competitors. It is a well-known fact; the first one on the shelf will continue to reap the sales and profits typically long after the competitors arrive. Now more than ever, time-to-market is everything.

During this same period, a revolution in the mechanical aspect of product design and development has occurred. Two-dimensional (2-D) drawings developed on mechanical drafting tables have been replaced by 3-D CAD solid models generated on powerful Unix and NT workstations. Direct downloading of these CAD files can now be used to develop injection molding and die-casting tools. Complex industrial design surface geometries never before dreamed of are routinely accommodated with these CAD systems. Likewise, finite element analysis (FEA) software which incorporate these solid models allow the designer to minimize wall thickness, clearances, tolerances, etc. with confidence — leading to smaller, less expensive and more efficient electronic packages. But the biggest advantage of this new technology is the resulting speed with which products can be designed, developed, tooled and industrialized.

Some of the larger and more advanced companies in the United States (and indeed the world) are realizing the benefits of designing for manufacturability. There are many axioms of this philosophy, including "Z" axis assembly, minimizing part count, increasing the level of subassemblies to include as many of the components as possible, minimizing the use of non-repeatable operator functions (gluing, taping, soldering, etc.), increasing the use of robotics, etc. These techniques minimize labor costs while increasing the repeatability, and subsequently, the quality of the resulting product. As a result, the assembly labor is becoming an ever-decreasing component of the total product cost. Of course, in order to reap these benefits, a greater amount of effort and expertise must occur in the early non-recurring engineering (NRE) development of the product.

The injection molding and die-casting industry also has had its share of technological advancements in the past few years. Among them is two-shot revolving platen molding, which cost effectively and reliably facilitates rubber or plastic overmolding on plastic. High-speed milling machines and technology are now available, which can cut a tool in a fraction of the time necessary to burn it with electrodes. In-mold decorating (IMD), engineered custom plastic resins, molding analysis software and robotic loading and unloading of machines are now commonplace.

In order to develop products quickly, efficiently and cost effectively, full use of the CAD and manufacturing techniques outlined above must be employed. Further, design for manufacturability methods, including those mentioned previously, need to be included. While there are some companies in the Far East that are aware of and practice these principals, they are in fact very few and far between. The vast majority of these companies have only recently begun developing product in 3-D, and these are invariably running low-end, PC-based CAD systems. Additionally, these are exclusively contract manufacturing houses that specialize in production rather than design. These companies still believe in spending money on every unit (high labor, poor/non-repeatable design), rather than on NRE (low labor, repeatable/high quality design). Add to this situation a 13-hour time difference, language and culture barriers, distance and typically a less than well-defined system requirement specification (supplied by the customer) and the course is set for failure.

In the United States there are design firms that specialize in high-end electronic packaging product design and development. These companies use ultra state-of-the-art CAD and CAE software running on powerful workstations. To support today's aggressive product development schedules, these elite design companies include such things as video conferencing, photo realistic, full-color rendering and prototyping on their list of in-house capabilities. With strategic alliances to a worldwide network (including the United States) of tooling and component vendors and stateside contract manufacturing houses, these design firms can develop products from initial conceptualization to full industrialization in unprecedented schedules. Close interaction and communication between the design firm and the tooling vendors/contract manufacturing house insures a clean, efficient design that produces a quality product — and most importantly, in the shortest development schedule possible.

The above ideals were exemplified in a recent product development effort. Score Technologies, Inc. (Richmond, VA) required an aggressive schedule to meet its market window when it approached Stone Mountain, Ltd. — a VA-based electronic product design and development company — with the requirements for the first in a new line of hand-held sports statistics organizers. Called the Basketball Statscreen, it is a powerful, self-contained, battery-operated terminal capable of downloading/uploading basketball statistics to a stadium scoreboard and/or computer. The product includes a large keypad and LCD, rugged packaging and aesthetic, ergonomic styling. Unsure of much of the mechanical packaging requirements, Score Technologies relied on Stone Mountain to define and develop the mechanical and industrial design concept.

A select group of U.S. product design companies are using in-house prototyping to support increasingly aggressive and cost efficient product development schedules. The proof of concept model on the right was generated in a fused deposition modeling (FDM) prototyping system, while a production unit is depicted on the left.

Stone Mountain installed a portable video conferencing system at Score Technologies to more efficiently communicate during the critical early conceptual phase. It then developed 3-D solid models of the industrial design in Unigraphics, from which it generated photo realistic, full-

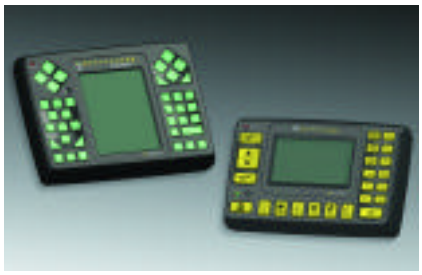


Photo-realistic, full-color renderings such as these may be generated directly from the 3-D CAD models during the design process, allowing customers to visualize the product long before production parts are available.

color renderings, complete with artwork, on photograph quality film and ABS material prototypes on its in-house Stratasys FDM 2000 system. The concept was quickly approved and the detailed design phase commenced. Six weeks later, immediately following another round of proof of concept prototyping of the detail design, a complete set of Unigraphics 3-D solid models was forwarded to an Indiana-based tooling and injection molding company. This company supported an aggressive eight-week tooling schedule, producing first shots on time. Texturing and artwork immediately followed and, within a total of 10 weeks, production parts were available for shipment.

Stone Mountain worked closely with the customer and a Roanoke, VA-based contract manufacturing firm to industrialize the product. The design consisted of three major subassemblies and was developed for manufacturability, low assembly cost and repeatability. All components were self aligning and "Z" axis assembly technique was employed. Consequently, the handoff from Stone Mountain to the contract manufacturing company was literally effortless. The result was a textbook example of state-of-the-art rapid product development. From initial concept to production mechanics a mere five months elapsed. So successful was the project that the same recipe was followed for Score Technologies' next offering, the Baseball Scorecard. This product is presently entering initial production.

The world of electronic product development is quietly — though rapidly — changing. Driving this change is a need to develop systems faster and more efficiently in order to compete in a marketplace exploding with offerings. As lifespans of entire product lines decrease and technology accelerates, time-to-market becomes tantamount to a product's survival. Consequently, past methods of outsourcing product design, development and production to the Far East are becoming less cost-effective due to its inherent longer leadtime. Additionally, recent advances in mechanical design CAD tools and operating systems, design for manufacturability philosophy, engineered materials, processes and tooling development are being employed by an elite group of stateside design, tooling and contract manufacturing firms. It is these companies that are changing the norm of product development and, in essence, bringing it home.

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