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Inside this issue:

Carolina Product Design offers information in this publication on a bona fide basis, believing it to be accurate. The reader and/or end-user should review all articles for correctness before incorporating suggestions or information into your designs or making decisions based on that information.

The Product Design Process— Gathering Product Requirements

by Bob Lynch

Based on our experience in both large and small projects, gathering product requirements can be a bumpy ride. Even supposedly simple projects can overlook significant requirements. There are numerous examples of inadequate requirements resulting in gross product failures. Even auto manufacturers with hordes of engineers struggle with well engineered cars that perform poorly in the market place. It is important to ask questions like what went wrong with the requirements process? What do we learn

"Even auto manufacturers with hordes of engineers struggle with well engineered cars that perform poorly in the market place. "

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What Do World-Class Design and Profitability Have in Common? *by Montie Roland*

In today's uncertain economy many companies and consumers delay purchasing even high priority items. With corporate expenditures at a low, just being competitive is not enough. If a new product is to succeed, it must be compelling. In good economic times the perceived need for industrial design often decreases. Instead, the emphasis shifts to issues that engineers place as priority, revolving around specifications and meeting legacy requirements. If a product doesn't meet the customer's requirements it will not succeed in the marketplace. However, if we don't look at the product wholistically the purpose of the product – to serve the user – may get lost in the rush to get the product out the door.

"Good Enough" is a phrase that makes many engineers wince. When we go to engineering school we are taught to do exact calculations. The engineer can then apply tolerance to a nominal value and see if the calculated value falls in the acceptable range. Unfortunately, many of the variables and issues inherent to product design are not easily quantifiable. It is often a struggle to determine what is truly important to the user and to the marketplace. When specifications are challenged, it is common to either find legacy specifications that are no longer relevant or specifications that greatly exceed the end user's real needs. Product managers must take a critical look at every line in a specification. They must also be willing to expand their expectations and create wish lists. Items on wish lists are often easy to incorporate into a product if they are known at the beginning of the design cycle. These are some of the reasons why the

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World-Class Design and Profitability

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dialogue between the product manager and the members of the design group is so important. Unfortunately, many design groups spend a large portion of their time and effort trying to meet irrelevant specifications, while never even attempting to include valuable features that could be inexpensively added if they had known about them up front.

An example is shutting a car door. Anyone who commutes to work opens and closes their car door at least four times a day. If you multiply that by the number of days in the year and then by 60 years, you find out that you will probably open and close a car door more than eighty-seven thousand times in your life.

Now imagine going to the car dealer. You get out of your Yugo and shut the door behind you. You walk across the parking lot and open the door to a brand new Lexus. Will you notice the difference in how the Lexus door opens and closes? The answer is YES! You may not stop to think about the differences such as the weight of the door, the silky motion and the smooth closing action of the door catch. However, you will definitely notice the Lexus' luxurious feel. Both car doors meet the basic functional requirements. They open and close with a single motion. They keep the rain out and provide the user with a sense of isolation from the outside world. Both doors have windows that raise and lower. However, there are some significant design differences. The Lexus' door is much heavier and sits on more precise hinges. The Lexus has electric window lifts. The Lexus door is much thicker and has better sound insulation. Even the door handle and door latch action on the Lexus are significantly smoother. In a luxury car, great care is taken in how the door looks, feels and operates. Those subtle differences are part of the reason why marketers of the Lexus are able to justify the cost difference between the Lexus and other vehicles. Now imagine what it would mean to the sales of your product if you were able to differentiate your product as dramatically in its market space!

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Another example is the Oxo™ Good Grips™ utility knife. The knife was designed for Oxo International by an industrial design firm. Since the introduction of the Good Grips™ knife, there has been a trend to more user-centric knives. Why was this knife so successful in a very crowded and very mature market space? Was it because of the fact that the handle of the knife was soft, easy-to-clean, ergonomically-designed and very comfortable-to-use when marketed against hard, wooden-handled knives which haven't changed for hundreds of years? The answer is a resounding no! The knife combined all these wonderful traits with a state-of-the-art blade that was incredibly sharp. Its success wasn't just because of some really cool handle design, but because it does its job incredibly well. It is easily useable by the widest possible range of people. The industrial designers worked with the engineers to create a superb product from the ground up. There were no racing stripes added at the last minute for market pizazz. Just a product designed, from the beginning, to do its job superbly well.

Would a traditional, wooden-handled knife with the same blade technology as the Oxo knife have been as successful? Would it have gained the same amount of market share in the same short period of time? The combination of great engineering and great industrial design resulted in a knife that worked so well that it established an entirely new genre of knives in a crowded and very mature market. The finished product gave consumers a compelling reason to purchase this knife. The Oxo™ type of success is what we want you to achieve for your new product.

Who made the decision to concentrate so much engineering and design effort on the door? Who made the decision to concentrate effort on the handle and the blade, not just tweaking a centuries-old design? In smaller companies, many of these decisions are not addressed by marketing and end up being shrugged off onto engineering. The problem is that engineers are usually better at meeting specifications than prioritizing softer issues (such as look, feel and usability). In larger companies, the bridge between marketing and engineering often comes in the form of an industrial design group. In smaller companies the industrial design portion of the development process is often neglected. The result is often products that are specification-centric instead of user-centric.

As demonstrated by the Oxo™ knives, user-centric products aren't limited to high-end luxury products. User-centric products tend to build loyal customer bases and repeat sales. The key element in developing a user-centric product is to insert the task of industrial design into your design and development process. Industrial designers take into account the various issues of function, form,

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Use FEA for Better Products Faster *by Michael Hiller*

Product designers are often faced with difficult design questions. Will my new product fail in the field? Will it bend? Will it fatigue? Will it overheat? Is the magnetic force enough? Is there adequate air or fluid flow? What is the backpressure? What is the lead-time for prototypes and physical testing? Is the prototype budget large enough? Can we cut development time and beat competitors to market? Engineers and product designers continue to lose sleep over questions like these.

Now, with the advent of powerful 3D CAE (Computer aided Engineering) software, it is feasible to "prototype" new products rapidly on the computer. These "virtual" prototypes can be used to predict product performance (and failure) early in the product development cycle when design changes are swift and inexpensive.

CAE simulations can be performed using commercial 3D finite element analysis (FEA) software. FEA Software (such as ANSYS, www.ansys.com) can import existing CAD geometry and can incorporate "multi-physics" effects and interactions between one or more of the following:

- *Structural* (stress, strain, deflection)
- *Thermal* (peak temperatures, thermal gradients, heat flow)
- *Fluid Flow* (pressures, flow rates, wall forces, stream lines)
- *Magnetic* (magnetic force, flux, magnetization, charged particle trajectories)
- *Electric Field* (voltage potential, current, heating, particle trajectories)

FEA simulations can be performed on micron-scale devices (like IC chips and MEMs) as well as very large man-made (or even natural) structures such as cranes, bridges, buildings, dams, ships, mine shafts and tunnels, rock foundations, etc.... In addition, manufacturing equipment and many manufacturing processes can also be simulated and optimized.

FEA software also facilitates sensitivity and design optimization studies (iterative processes) so that shapes and/or materials are incrementally varied and automatically exploited for maximum benefit. Since many, if not all (eventual goal), physical prototypes are shaved from the product development schedule, products can be brought to market faster and at lower cost! Uncertainty and risk are also reduced.

Of course it takes education, skill, and experience to properly leverage FEA software to obtain meaningful and reliable results. Investments in training, implementation, result validation, and on-going mentoring are warranted in order to individualize an optimum design-analysis process and fully understand the effects of assumptions, simplifications, and numerical limitations.

For mid-to-large companies having analysis intensive products, the investment to properly implement, customize, and maintain an in-house FEA capability is easily justified as productivity rapidly ramps up and more optimized products are produced at lower costs.

Small and mid-sized companies with less frequent FEA needs may discover they can cost-effectively outsource FEA projects to consult-

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from product requirement failures?

We encourage our customers to follow these five steps:

1) Establish ownership of the product requirements. The requirements owner can be the financier, the product planner, the inventor or the lead engineer, but someone must own them. The owner must have a clear vision of the finished product.

2) Document the product requirements. Establish a starting point. Written product requirements become the basis for product specifications, functional objectives, cost objectives, and manufacturing plans.

3) Review the product requirements. As the product milestones are achieved, hidden requirements are likely to surface. Update the product requirements to reflect new information after carefully considering downstream effects.

4) Communicate with all stakeholders. This sounds like a time consuming process but all the stakeholders should agree to the requirements and evaluate all prototypes. These forms of communication validate the requirements and assure the product reflects the product vision.

5) Construct and evaluate prototype models. Early in the development process, construct prototypes for touch and feel. Touch and feel feedback may validate requirements. Frequent staged prototypes may be required.

If we don't accurately define a math problem, we will solve the wrong problem. Accurate requirements gathering equates to proper definition of the math problem for any product development project. Experience has proven this to be a critical step to a successful product.

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ants while reducing overhead and overall project costs. In fact, consultants often work in parallel with in-house development staff, thus reducing bottlenecks experienced when in-house engineers stop designing to do analysis work.

Those who dabble with FEA quickly realize that it is deceptively easy to generate "pretty" contour plots, while it is decidedly more challenging to generate "correct" and useful data. In any case, the benefits of enlisting experts often outweigh the costs.

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World-Class Design and Profitability

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available technology, manufacturing cost and users to synthesize a design. The external appearance is only a small part of the industrial design process. This is also the part of the design process where the vast majority of the product innovation occurs. By looking at the product wholistically, the design team gets a glimpse of the entire life cycle of the product. This is a step in the design process that has a tremendous amount of impact on the economical manufacturability of the product and the success of the product in the marketplace. A well-executed initial product concept leads to drastically improved manufacturability and usability.

Today's reality is that products are becoming more sophisticated. Sophistication can come in many forms, such as advanced technology. Sophistication can also come in the form of a more usable or more visually attractive design. So even a technologically unsophisticated product can benefit from a more robust design process. Making your products better and more successful may be easier than you think. Investing in world-class design to ensure product profitability is key in a cautious economy.

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