Perspectives on First Step in Design (Part VI)

The idea has been thought up, the "napkin sketch" has been made, and the project is ready to move forward. So what's the first "real" step in the design process? This was the question for the participants in this month's Perspectives feature. Ideally, you will be able to take away a tip or two before embarking on your next project.

Q: Once the general idea for a new device is formulated, what aspect should first be addressed in the design process and why is this the critical first step?

Nick Jennings
Product Development Engineer, RTP Company

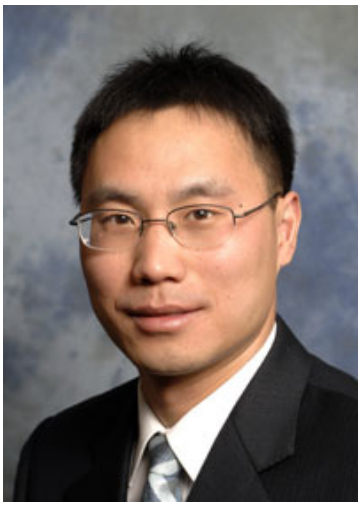
Nick Jennings.

Imagine a thermoplastic material which has characteristics that perfectly match every single requirement of a new design. This very rarely is the case. More often, a designer will need to select a material which satisfies the most important requirements for the application while sacrificing, to some extent, other minor traits. For this reason, material selection should be addressed early in the design process. Prior to material selection, the designer would need to define the geometry and function of the design. In doing this, a clear definition of the performance and environment in which the material will need to function would be generated.

Choosing materials for medical devices can be especially difficult due to the demanding and unique requirements involved. Direct communication between the designer and the material supplier very early in the design process is crucial in developing a thermoplastic material solution that best matches as many critical requirements as possible. The combination of technologies of specialty thermoplastic compounds can be a terrific fit for medical devices. This is due to the

fact that these compounds create a material with a unique set of qualities. Technologies that are of interest in medical devices include color, wear resistance, anti-static, radiopaque, and laser markability.
Communication with the material supplier will also allow for discussion of the unique aspects of medical device design. Sterilization technique, biocompatibility requirements, contact with bodily fluids or tissue, and contact with flow of drugs are all issues that should be addressed directly with material suppliers. These and other application requirements will limit the possible candidate materials. Material selection has a direct effect on other decisions in the design process such as molding, secondary operations, etc. Identifying candidate materials early allows the designer to investigate the other aspects of the design that are dependent on material selection.

Xiaochen Xu, Ph.D.
Systems and Applications Engineer, Texas Instruments



Xiaochen Xu.

For any new product to be successful, it must address existing problems and needs. However, addressing only current problems may not be sufficient. Therefore, in the design stage, we must identify, evaluate, and implement potential future needs from customers as well as plan for potential product upgrades.

For an IC user, the most important thing is to be able to replace or upgrade an existing IC directly by its future versions or related products. No or minimal board level modifications are preferred. Hence, package selection and development, as well as pin-out preliminary definition, are my first considerations in the design process. A successful package selection means an easy upgrade, as well as cost savings, in board layout and assembly. Additionally, a suitable package can ensure IC performance because most of the latest ICs are quite complex, containing both high-speed digital and analog signal paths. Package selection and pin-out definition directly affect these signal paths. In some cases, no existing package is suitable, so a new package must be developed and qualified. Both package development and qualification require significant time and cost. Consequently, it is always better to plan new package development as early as possible.

Dave Beckstoffer
Product Specialist, Portescap, a Danaher Motion Company

Dave Beckstoffer.

The first aspect addressed needs to be the mechanical configuration of the device, confirming how the end output of the device will be delivered. The mechanical design will influence the total package size and throughput of the device, creating the key selling features for the marketplace. In addition, the mechanical design can also trigger key failures in the system, if additional friction is introduced or part tolerances are not properly considered. All of the other design considerations&#151materials, power, and tooling&#151will key from the mechanical components selected.

The critical finalization of the mechanical design is the selection of the motion control; specifically, the ideal motor technology to optimize the performance of the device. Proper selection of the motor requires matching the performance (speed and torque) input of the design with the budget allocated for this component. The mechanical design is then completed and the other aspects of the device may now be considered.
Beginning with other areas of design, rather than the mechanical portion, can lengthen the design cycle of the device, since all selections influence the mechanical design and, ultimately, the effectiveness of the device.

Eric Resnick
VP of Engineering, The Tech Group

Eric Resnick.

Whether following a Design for Six Sigma (DFSS) process or utilizing a Quality Function Deployment (QFD) system, all design processes must start with: "What problem are we trying to solve?" Once the team has successfully answered this leading question and has identified and defined value versus importance, needs versus wants, completed the prioritization and reconciliation of the wants and needs, and converted these qualitative requirements into quantitative specifications, design conceptualization can commence.

Reliability is the one requirement that transcends all requirements and across all devices, products, platforms, etc. Reliability is created from applying sound mechanical engineering judgments, especially around mechanisms. A critical piece of sound mechanical engineering is material science as it is vital to converting a concept into a working reality. Further to the point, the advent of nonlinear finite element analysis (FEA) has enabled engineers to simulate performance without physical prototypes where material selection is the most critical input into the design analysis.
Material selection is also a key cost driver in the commercialized device, and can have relative impacts ranging from the minor to major. Minor impacts would include material supplier changes or even material selection changes within a material family (e.g., different grades of the same resin). On the other end of the scale, the major impacts would include changes between different classifications and types of material (e.g., plastic to steel), where a change like this impacts not only the raw material price, but the process price to convert the raw material into the finished article.
For all devices or products, success will always come down to two requirements: does the thing perform the way it was intended and can we make it and sell it for

the price we expected. And material selection is the key driver for both requirements.

Rick Walker
Managing Director, SMC Design Dynamics

Rick Walker.

If we extend the idea from "First Step in Design" to the first step in product development, we begin with a Marketing Requirements Document (MRD). The MRD would state the market opportunity, feature set for the product, product sales price, required margin, user profile and usage profile, high level environmental requirements, service plan, and so on.

The product champion within the organization usually creates this document and it is the starting point for the engineering team. The engineering team takes this as input to create the Product Specification. The Product Specification is a refined view of the MRD and is the working document between all interested parties in the organization. The engineering project manager authors and maintains the Product Specification. This document will address all detailed technical areas including:
&#149 Electrical/electronic
&#149 Software
&#149 Industrial Design
&#149 Mechanical Engineering
&#149 Tooling or processes for MFG
&#149 Key Technical Risks (critically important)

In every project, there are one or more key technical risks. "The First Step in Design" is to identify those technical risks and address them at the very beginning of the design process. The risks may also be non-technical in nature such as:
&#149 Availability of resources
&#149 Availability of materials or long lead items
&#149 Manufacturing resources, space, or technology

If any risk cannot be solved or if the solution is either too lengthy or too expensive, the project will fail. Tremendous time and money is wasted if a project is launched without properly identifying these risks with the team charging ahead only to run into a roadblock that they failed to identify in the beginning. At best, the team falls back to regroup/redesign and, at worst, the project fails entirely at a significant cost to the organization in cost, time, and morale.