Perspectives on First Step in Design (Part III)

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?

Don Faria
Senior Vice President, Business Groups, Altera Corp.

Don Faria.

Semiconductors are the key building blocks in the design of medical acquisition and diagnostics equipment, image creation and display applications, monitoring equipment, and an array of handheld portable medical devices. When architecting and designing such systems, product designers look for components that meet the integration and functional requirements of specific applications, as well as flexibility and scalability to offer different product versions. The goal is not having to change the board or even the design, while the solutions offer a declining cost structure over time and volume.

Field programmable gate arrays (FPGAs), with their inherent benefits of integration, flexibility, and time to market advantages, are the primary system level semiconductor device for electronic medical product development. FPGAs are used to replace other semiconductors previously used in these systems, such as DSPs, ASICs, and ASSPs. Designers can choose from various FPGA product options that meet complex logic density and performance requirements as well as simple low power and lower cost application requirements.
The integration capability and scalability of FPGAs allow designers to re-use a

common hardware platform and easily create differentiated system configurations and options that support a variety of feature sets with one basic design. This results in reduced manufacturing costs by eliminating the need to build multiple product versions for a simple feature set or pricing options, thus up-front NRE costs and minimum order quantities associated with ASICs are removed. With FPGAs being reprogrammable, multiple design iterations can be quickly completed and deployed during the development and manufacturing phase, which provides hardware upgradeability when a product is deployed.
Long product lifecycles are another critical design requirement. By using standard semiconductor process technology, FPGAs offer extended manufacturing lifecycle (15-20 years), which protects equipment manufacturers from potential product obsolescence that cause costly redesign.
FPGAs provide a flexible, low-risk first step to successful medical system design by enabling optimum cost efficiencies while providing value-added differentiating capabilities.

Randy Sablich
Vice President and General Manager, Dynamics Research Corp.'s Metrigraphics

Randy Sablich.

If a medical device designer came to us and asked what we would consider the number one step to be in his/her design process, we would offer the following:

"As you think about connecting electrical components in your device, your first consideration should be to understand the interrelationship between: connecting circuit size, connecting circuit density, and connecting circuit purpose.
Overall circuit size drives the process either towards traditional flex circuitry or Extreme Resolution Micro-Flex (ERMF) circuits. Circuit density (total number of traces required and traces per linear dimension) determines whether traditional flex

circuit processes can be used if low density or wide trace dimensions are required; and electroformed or sputtered traces for very high density or small (10-20 micron) trace sizes. And finally, determine the overall connecting circuit purpose&#151whether it will be required to flex and, if so, to what extent. This includes determining if the circuit will carry signal only, power only (and to what capacity), or a combination of both. Again, the limits and benefits of both processes tend to lean in one direction or the other."

Why is this important? Every engineer wants to design the perfect device. Perfection costs money and takes time. So does going down the wrong path and having to start over. Understanding the relationship between these design elements gives the designer a greater perspective of the whole and can help steer him/her in the right direction sooner. It can also provide the subcontractor or component supplier with a better understanding of what is expected of them.

If we can leave you with one thought, [it would be to] understand clearly what you are trying to achieve, and what constraints you have before you, and you will most assuredly have a much greater probability of achieving your end goal.

Miranda Marcus
Applications Engineer, Dukane

Miranda Marcus.

One of the most overlooked considerations in design is also what should be first addressed. This is the consideration of how the product will be assembled. Deciding on an assembly process should be the first step, as this decision will affect the materials that can be used, the size of the part(s), the location and shape of the joints, and numerous other design details.

Whether your final assembly will consist of mechanical joining processes, such as snap joints, screws, and staking, or welding processes, such as ultrasonics, vibration, hot plate, or spin welding, this decision can have far reaching consequences on your part design. When making this decision, many factors must be weighed. What is the final application? Is a hermetic seal needed? What is the planned production rate and run size? How much floor space is available? What are

the strength requirements? How large is your part?
In the business of plastic bonding, I see part designs everyday for which the consideration of how to assemble the product is left to last. Putting this decision off can cause delays in production, inability to meet production rate, inability to achieve the type of seal desired, and added costs for mold changes and/or strenuous prototype runs. Struggling to produce the desired results when you are out of time and money is an unpleasant process for all involved.
Luckily, it is an experience that can be avoided with a little planning ahead. Every assembly process has specific benefits and drawbacks that must be considered in conjunction with the production and performance goals of a new product line. If you are unsure about the assembly process that best meets your needs, don't hesitate to contact a consultant. Dukane, for one, will provide a free feasibility study and joint design recommendation for your product, to help you in the "design for assembly" process.

Marko Mailand, Ph.D.
Project Manager, Analog-Mixed-Signal IC Development, ZMD AG

Marko Mailand.

Today, mobility and flexibility are key criteria in various medical application fields. Products with merged functionalities are in demand, such as sports watches with both medical readings (e.g., blood pressure or heart rate) and consumer features (e.g., compass, barometer, etc.) In addition to features, the number, size, and power consumption of an application's components become essential parameters when thinking about specific applications such as controlled micro-infusion pumps; small, wearable blood pressure meters; or mobile home electrocardiograms.

Often sensor element readouts must be analyzed to obtain concrete diagnostic or indirect control information. Therefore, a suitable sensor interface is required for accurately processing the information. A top-down development approach can benefit the application developer. For example, ZMD's experienced system architects can support developers in setting up, modeling, and simulating complete applications and provide specific key components.
Imagine designing a wearable blood pressure meter merged with a compass. You might think you need several components: a pressure sensor, a two-axes magneto-resistive position sensor, three analog-to-digital converters (ADCs) or a multiplexer and one ADC, a microcontroller, a battery, a supply voltage controller, and a display&#151but wait! Considering the intended application versus the components, we recommend integrating the ADC(s) and the multiplexer into one application-specific IC (e.g., the multi-channel sensor interface ZMD21013). If the interface IC additionally implements ratiometric topology (e.g., ZMD21013), the power supply control becomes dispensable. Another advantage of integration is that the IC's subcomponents can be designed to optimize precision, stability, and power

consumption for the best overall system performance. Space requirements can also be relaxed with customized integration.
Of course, this approach requires more development effort than simply combining a handful of devices, but it culminates in a technically leaner and more cost-effective solution&#151often a strong competitive edge.

Michael B. Checketts
VP of Technology, Technical Services for Electronics Inc.

Michael B. Checketts.

As a contract design/manufacturer of interconnect solutions, TSE finds it most important to first ensure that product specifications (design inputs/outputs) make sense for what the customer wishes to accomplish. We focus most upon distinguishing between customer "wants" vs. "needs." Much of what is needed does not necessarily fit the priority of what is initially requested. Although not always the case, we find that by focusing upon needs, many designs can be significantly simplified for improved manufacturability.

Once design needs are established, and because of our core competencies, we generally begin our focus upon electrical/electronic criteria, then DFM (Design for Manufacturability). Our NPI (New Product Implementation) process, utilized correctly by our project teams, really helps isolate the remaining variables. The natural sequence of project events, as shown below, will "route out" other variables for the best DFM. The key we use is to allow each NPI step and team member complete veto power to kick the project back to a previous step until all team members are satisfied that design, functionality, manufacturability, cost, and long term cost reduction options are optimized.
<u>NPI Phases</u>
1. Feasibility
2. Product Development
3. Process Development
4. Pilot Build
5. Manufacturing Transfer
6. Sustainment
There are certainly occasions wherein the first critical parameter (in this case, electrical/electronic specs) may need to be changed (generally strengthened) to ensure that product robustness or critical functional parameters will be met consistently. This may, as a result, require further refinement of other material or process specs. Subsequent alteration in the selection of materials, or processes, must of course meet the rigors of the established/approved functional user specifications.
This process works well for TSE, but may need to vary slightly for other

organizations with different core competencies; though regardless of where one starts, there may always be some form of the "chicken and the egg" argument to be resolved. However, if customer needs are kept as the top priority, and a good NPI process is adhered to, the project will be successful.

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