Accelerating Design For Complex Products

When a product has many interdependent parts, the ability to bring it to market quickly depends more on making all the pieces fit together and on synchronizing efforts than on the rapid design of individual pieces. This article will cover the critical points that are needed to allow you to meet an aggressive schedule without sacrificing a design of which you are proud.

by patrick barrett and preston g. smith

Develop the Product Architecture Jointly

Change is virtually certain as your design proceeds. As as a product becomes more complex, the effects of change can become more disastrous. Seasoned designers don't attempt to fight change. Instead, they plan their designs so that changes affecting one part does not ripple through, requiring redesign of adjacent portions. They think very carefully about the organization of the product's structure—that is, its architecture—because this is an important tool to isolate the effects of change. However, the difficulty in arranging the architecture effectively is in forecasting where change is likely to occur.

Consequently, if you don't have a good crystal ball to exploit the power of architecture, you can help predict where design changes will occur by explicitly involving those who are likely to initiate change in the design process, such as those in sales, marketing, purchasing, QA, quality assurance, manufacturing, and finance—maybe even key customers. Convene these individuals at the beginning of the project. Pick the most outspoken critics you can find. It is far better to hear from the skeptics at the outset than to have their changes appear as surprises later.

Ask these people where they believe change might occur. What are the areas of uncertainty regarding customer requirements? Are there weaknesses in areas of market knowledge? Where is the technology changing fastest? Where is the supply chain for the components we might need? Do you know where and how you will manufacture the product?

Once this information has been gathered, you can retreat to a quiet conference room with a few of your technical cohorts and plan an architecture that fits the pattern of likely changes. You can plan where to place interfaces that will act as firewalls and determine how robust to make them—maybe perhaps including a few extra conductors, holes, or margins to allow for growth where it seems likely. Consider what functionality to place where and how tightly to clump it together.

For example, do you place the cooling module at the center of the main chassis where it might be most efficient, or should it be isolated in a separate module where it can be enlarged later.

Establish Common Modeling Standards

One of the best ways to get a design team rowing in the same direction is to establish common modeling standards. Develop these as a team, but align them with company conventions. Some examples:

- *Establish conventions for naming components consistently.*
- *Develop standard naming conventions for expressions and common parameters*: For example: p20 = 1.345 or wall thickness = 2.5. Use parameters that

communicate their meaning.

- *Use seed parts for a common starting point.:* When the core of certain parts is the same, embed common attributes or parameters in all of them, including datum systems and tags for your product data management system.
- *Develop consistent modeling processes:* This helps one engineer readily understand another's work.

Develop a Model Plan First

Today's engineer must be both a proficient CAD user and an expert designer. Model plans allow the design process to be separated from the CAD process. Being able to focus on each part independently makes both more productive.

A model plan is a series of steps taken before creating a model that address the mission-critical needs and rules of your design. Model plans vary by what works for you, so each designer's plan may be different. The important point is that you take the time to plan initially. You will achieve better results by separating your design thoughts from the tasks of creating CAD models.

Building the Model (Design Mode)

Before turning on the computer, plan your model on paper.

- Identify the model/assembly structure: top level, sub-assemblies, components, etc.
- Identify key inter-part relationships and how/when youwill use them.
- Lay out your sketches and design constraints.
- Plan how your model/assembly structure affects the BOM (bill of materials) and the drafting.
- Ask yourself how the model could fail.

Applying the Model (CAD Mode)

Once you have a model on paper:

- Transfer your paper plan into CAD space: sketch, model, and assemble.
- Develop assemblies, sub-assemblies, and components using your paper plan as the blueprint.
- As you encounter problems, go back to your model plan to see what changed. This is easier to see on paper than in your head.

Leverage As Much Shared Geometry as Possible

Avoid specifying the same detail twice. If geometry is shared, set it up as such and build your design to reference these common elements. Use the geometry-sharing features of your CAD system

(WAVE, Copy/Pub Geom, Inserted Geometry, etc.) and let this manage changes that effect interrelated components. When a feature or component's location in the assembly affects other parts around it, let the CAD model handle it.

For example, if you are designing a plastic enclosure for electronics and the size and location of the printed circuit board (PCB) affects features such as bosses, snaps, or other components, you should build interpart relationships to this PCB rather than re-creating the PCB outline multiple times. Share the PCB outline curves, edges, or surfaces (as your CAD system allows) with the features or components that depend on PCB features for placement or size. Mounting posts in the bottom cover, or reinforcing ribs that maintain clearance in another piece should reference the driving geometry so that if the PCB changes, your model can adapt. Sketches or component placement should reference this outline.

Automate Repetitive Tasks

Automation that saves your valuable design time is good. Automation for its own sake of automation has yields low returns. It doesn't pay to spend the extra time up front automating a one-off process. So be creative:—if 80 percent of your design could can be handled by automation, plan to handle the rest as special cases.

A good example of a company automating frequent design tasks is Monaco Coach Corporation. Their luxury motor coaches incorporate cabinetry that changes with the overall length of the coach but is often essentially similar to a prior model's design. By analyzing its process of cabinet design and understanding which parameters drive the final product, Monaco is developing intelligent cabinet assemblies (solid models and drawings with automated BOM's) that have reduced their design times from hours to minutes.

Keep Everybody Involved

We started by encouraging lots of cross-functional involvement before establishing a top-level design. Reduce last-minute surprises and redirection but be sure to keep hese players involved as the job proceeds to reduce last-minute surprises. The sooner you know about any potential change, the more options you have for dealing with it. Others are unlikely to tell you about the changes they are considering unless you ask them. So ask on a regular basis. **TCT**

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