Fundamentally, engineering is about change.

It's about iteration, exploration and discovery. It's about trying something, seeing it fail, trying something else, seeing it succeed. It's progressively solving problems and improving your design. Therein lies the brilliance of engineering. But that doesn't mean development is easy. Quite the contrary. All that change is chaotic.

How does CAD fit into this picture? You would think a software tool like CAD would make it *easier* to make changes. But in reality, using *traditional* parametric modeling approaches can make changes *more difficult*. Features and parameters are powerful indeed. But if you're not careful, making late stage changes or reusing existing models can result in feature failures or even model recreation. On the other hand, working within imported models means parameters, features and design intent have been stripped out. In either case, that translates into working nights and weekends because that deadline isn't moving. Unfortunately, in the later stages of the development cycle, *more* design agility is needed, not *less*.

A recent resurgence in CAD innovation is changing the landscape for these issues however. Old as well as new technologies are being applied to longstanding issues, just like this one. This eTopic looks deeper at this need for agility in the design process. Specifically, it digs deeper into the challenges of traditional CAD in this regard as well as how the latest CAD advancements offer capabilities to address design agility needs.

What exactly limits design agility in traditional CAD?

It all starts with the feature interdependencies. As you model with parametric feature-based approaches, each feature is based on prior ones; resulting is a highly interdependent network. CAD experts use these relationships to drive incredibly powerful and intelligent change. But as a model gets more mature, that network can become increasingly constraining. Unless you've carefully plotted and planned, you can find yourself with a failure-prone mess. Therein lies the reason many users have such difficulty in modifying other's models (*Figure 1*). Instead of helping iterate, explore and discover new design choices, complex CAD models fight against you instead. That's troublesome when you are trying to make a last minute change.

When it comes to imported geometry, quite the opposite is true. There is no complex feature network to navigate and manage. But that also means there is no mechanism in the models to initiate any change. Users of CAD systems relying on parametric feature-based approaches are left with few options other than to remove and recreate different pieces of geometry that they want to change through parameters and features. Respondents to survey research identified issues around importing and modifying models here as well (*Figure 1*).

In either scenario, there are some serious implications for designers and engineers. Ultimately, this translates to the fact that fewer design options are explored, meaning you're not getting to better designs. Or, in the case of design change that must occur, designers and engineers work nights and weekends to make it happen.

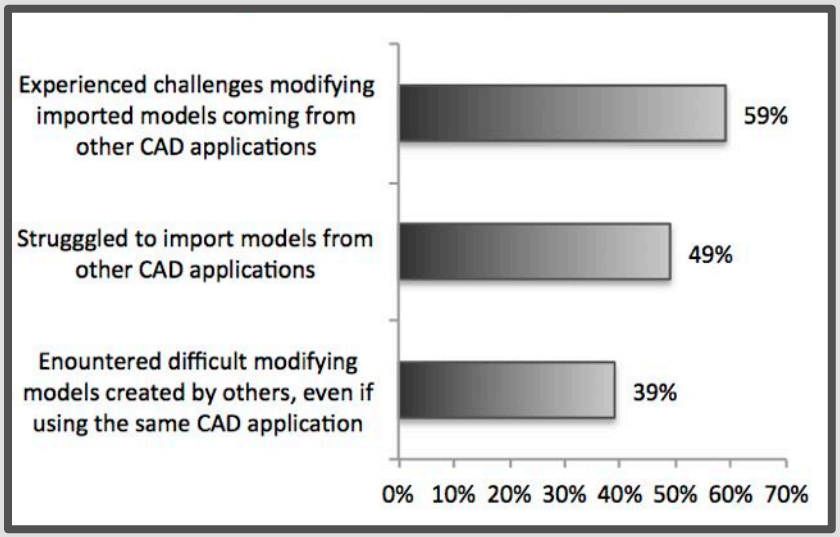

Figure 1: Challenges in Making Design Changes

Source: 2011 PTC Survey on CAD Complexity

How do recent CAD innovations improve design agility?

In general, there are three major capability sets that have relatively recently been integrated into more traditional CAD applications that impact design agility.

- ***Direct Changes to Feature-Based Models:*** Parametric feature-based modeling approaches aren't going away; the offer too much power, intelligence and automation. In fact, they will likely remain the most frequently used means to design products. The ability to make direct modeling changes to parametric feature-based models with push, pull and drag interactions. This combination of approaches offers the most streamlined means to make changes quickly in support of exploration, iteration and discovery in design. The advantage is in avoiding feature failures that stop casual, and sometimes expert, users in their tracks.
- ***Recording Direct Modeling Changes:*** But there's more to it than simply *making* the change with direct modeling. Many companies invest significant time and effort in building up a model through feature-based approaches. So you need a mechanism that captures the quick and easy direct modeling changes in the context of a feature-based model. In fact, there may be the need to move back and forth between using direct modeling and feature-based modeling approaches.
- ***Recognizing Intelligence in Imported Models:*** Design agility isn't just about importing files in just about any CAD format. It's also about being able to make changes to those designs once they are imported. Because imported CAD models don't bring any sort of intelligence with them, the CAD application needs to recognize the inherent design intent that exists in geometry.

In combination, these three relatively new capabilities of today's CAD can impact the productivity of designers and engineers.

Summary and Conclusion

In this eTopic, we've talked about the intersection of CAD applications and the need for design agility in product development. Here's a recap of the major points.

- Engineering and design is all about iteration, exploration and discovery. As product designs progress, *more design agility* is needed to meet the fast paced demands of development.
- With *traditional CAD*, as models are built up with parametric features, a complex interdependent network is created. As constraints and dependencies are built into the model, this network allows *less* design agility, not *more*.

In the past few years, several new technologies have emerged in the CAD industry that are innovative and can have an impact on design and engineering. Here are the three that are most critical to design agility.

- The ability to enable direct changes including push, pull and drag interactions to be used to modify parametric feature-based models. This capability provides *more* design agility.
- However, given the importance of parametric feature-based models, the ability to *record direct modeling changes* of parametric feature-based models is critical. This enables organizations to improve design agility but also preserve the work they have done with parametric feature-based approaches.
- When working with imported models, the ability to recognize the inherent intelligence that exists in geometry is critical to design agility. Users can make changes without investing significant time to recreate the model.

All of this is about more than just leveraging the latest in CAD technology. Increasing design agility translates into exploring far more design alternatives and ultimately improving the product. But these advancements also mean designers and engineers don't have to spend time fighting the CAD application to make necessary changes. That means more time for design. But it is also far more fulfilling. In the end, it's a win-win for the individual and the company.

For more information on design agility, please visit http://www.ptc.com/product/creo/flexible-modeling-extension. Underwritten in part by PTC, all concepts and ideas developed independently,

Chad Jackson is the founding Industry Analyst for Lifecycle Insights and publisher of the blog engineering-matters.com. He investigates and writes about the issues that matter the most to engineering. He can be reached at (512) 284-8080 or chad.jackson@lifecycleinsights.com.