The CAD Revolution...

... and What It Means for Manufacturing Engineers

Published by: Lifecycle Insights
Introduction

There’s no doubt: to drive growth in the recovery, products are important again. And while there are many challenges developing a new design, manufacturing engineers are the ones that have to turn them into reality. You have to make the rubber meet the road.

For you, CAD isn’t the center of the universe. Sure, you have to design tooling. But you also have to close the loop on the product’s manufacturability and generate toolpaths to drive equipment. Over time you’ve cobbled together your own set of software tools to get the job done. But with all the buzz about CAD today, you wonder if there might be something in it for you.

That’s where this book comes in. In it, you’ll find some insight into what’s behind the CAD Revolution and how it affects you, the manufacturing engineer.

The Change in Modeling Technologies

Before we dive into the implications of the CAD Revolution for manufacturing engineers, it makes sense to set a baseline about the modeling paradigms themselves.

♦ Feature–History (Parametric) Paradigm: Model geometry is generated from parametric features placed in a sequential order. References between successive features result in network of interdependencies.

♦ Explicit and Direct Paradigms: Model geometry is build with operations and directly preserved. Users select geometry and then use a push/pull/drag interaction to manipulate models.

For more information on differences between these two paradigms, read the third and fourth pages in the eBook, the CAD Revolution and What It Means for You.

Chad Jackson is the Founder and President of Lifecycle Insights, a research and advisory firm that studies the issues that matter most to engineering. Results of studies are published on engineering-matters.com. Chad can be reached via email or (512) 284-8080.
Design for Manufacturability

No matter how brilliant the design, a product’s form, fit and function must be tempered with the reality of manufacturability. Ideally, a manufacturing engineer gets the chance to provide feedback before it passes through design release.

A Great Idea with Execution Challenges

The concept of a manufacturing engineer reviewing and suggesting changes is a longstanding one. And while it’s an outstanding idea, closing that loop has been painful to execute. Using parametric feature-based CAD to capture what are often simple design suggestions is asking a lot of manufacturing engineers: both in terms of CAD knowledge and the management of feature failures. Using markups to capture suggested changes requires some interpretation to translate it back to the original parametric feature-based CAD model. And that, of course, opens up the potential for human error.

Using the Right Tool Without the High Price

In the context of the CAD Revolution, manufacturing engineers aren’t forced into choosing between two problematic choices. Instead they can leverage a number of tools in an interoperable suite. With interoperable viewing and markup tools, there is little to no interpretation required as annotations are made directly to the original design model. Also, direct modeling tools let the manufacturing engineer experiment with actual design changes, leaving no ambiguity. This approach lets the manufacturing engineering get involved early without being a CAD specialist or leaving room for error.

Final Thoughts on Design for Manufacturability

Incorporating feedback from manufacturing engineers has always seemed like a good idea but was often infeasible. However integrated suites of viewing, markup and modeling tools enable organizations to address manufacturability early and accurately.

Effect of Incorporating Feedback

<table>
<thead>
<tr>
<th>Ability to incorporate feedback</th>
<th>Cost to make change</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
</tr>
</tbody>
</table>

Project Timeline
Designing Manufacturing Tools

Another responsibility of manufacturing engineers is to design tooling such as jigs, fixtures, molds and dies. Unfortunately, it’s not as simple as it seems.

The Many Challenges of Tool Design

The starting point for most tooling design is the product model, which is frequently designed with parametric features. Because these models often come from different CAD applications, minor tweaks and fixes to geometry are typically required. Then, manufacturing engineers have been forced to choose between using parametric features with its ability to automate tasks and embed intelligence or direct modeling with its quick, simple and easy approach to design, even if both were applicable to the design. And last but not least, manufacturing engineers had to either wait until the product design was finished, delaying the start of their task, or find a way to propagate design changes to the tooling design. In aggregate, these challenges have added up to schedule delays, wasted time and a lot of frustration.

The Right Integration of Technologies

In stark contrast to the past, the future of tooling design is all about modeling flexibility as well as associativity. Specifically, CAD visualization as well as associative parametric feature-based and direct modeling has been integrated into an interoperable suite. CAD visualization provides the ability to read product models from a variety of CAD applications seamlessly and cleanly. Integration between parametric feature-based modeling and direct modeling let's the manufacturing engineer choose the right modeling approach for the job or even intermix the two if needed. And finally associativity within the integrated suite automatically propagates changes from the design model to the tooling model. All in all, it means the manufacturing engineer can concentrate on what is most important: finishing the tooling design.

Final Thoughts on Tooling Design

In the past, designing tooling required the navigation of some sizeable challenges. But in the CAD Revolution, the right set of technologies have been combined and integrated for the manufacturing engineer.

Challenges to Tooling Design

1. Product models exist in wide variety of CAD formats requiring clean up once imported or read.
2. Must choose between parametric features or direct modeling for design of tooling.
3. Changes to product design must be propagated into tool design, even if done manually.
Developing Machining Deliverables

Of course, there’s nothing more real than cutting metal. And ultimately much of a manufacturing engineer’s responsibility is doing just that.

**Serious Issues with High Risks**

As it turns out, some of the challenges of generating machining toolpaths are very similar to the ones of designing tooling. Product models coming from a variety of different CAD packages require time to clean up. Changes to the product model should somehow need to make their way into the machining model. But furthermore, the manufacturing engineer needs tight control of machining toolpaths to produce in-tolerance parts with minimal tool wear while avoiding errors that could damage machining equipment, an expensive investment of capital for the company. With traditional CAD, manufacturing engineers have had to cobble together several tools to make it all work and suffer their collective deficiencies as a result.

### Challenges to Creating Machining Deliverables

1. Product and tooling models exist in variety of CAD formats, requiring rework and clean up.
2. Changes to product design must propagate to machining model, through the tooling design if necessary.
3. Finely tuned controls and validation capability needed to verify expensive machining equipment will not be damaged using machining toolpaths.

### Integrated Machining Technologies

In the CAD Revolution, manufacturing engineers don’t need to piece together their own solutions. Instead, they can use integrated sets of associative applications that work together. Visualization technologies are used to read native CAD files necessitating practically no clean up. Also as the product model changes, so does the machining model, removing any need to manually propagate changes. Furthermore, finely tuned machining toolpath generation controls as well as validation tools have been included to provide confidence that expensive machining equipment is safe.

**Final Thoughts on Developing Machining Deliverables**

Traditionally, manufacturing engineers have been forced to assemble tools to generate machining toolpaths in a piecemeal fashion. But in the CAD Revolution, they are provided an associative and finely tuned set of tools that acts as an integrated set.
Conclusion: What does it all mean?

In this eBook, we touched on a lot of different ways the CAD Revolution is relevant to the manufacturing engineer. However, let’s zoom in on exactly what it means for the organization and for you personally.

**Organizational Implications for the Team**

The problems facing today’s manufacturing engineers are no secret. Closing the manufacturability feedback loop is painful. Product models exist in a lot of CAD formats. Parametric features or direct modeling can be used, but not both. And product design changes must often be manually pushed to tooling and machining models.

The good news is that the CAD Revolution offers a lot of promise. Manufacturing engineers can embed manufacturability feedback right in the design model, work with just about any CAD format, intermix modeling technologies to design tooling and associatively update tooling and machining models with product changes. In turn, for the organization, all that translates into staying on schedule and saving budget by avoiding errors downstream and making the right decisions early.

**Personal Implications for the Manufacturing Engineers**

It’s not just all about the company though. In aggregate, all of these challenges are incredibly frustrating because of the inability to get involved early, the duplication of work and difficulty in dealing with product design changes. But beyond that, they translate into longer hours and more fire drills than anyone would want. The changes in this eBook offer real potential for you to spend more time on less frustrating and more reward work in a far more reasonable work week.

**Final Thoughts**

If you work in a particular job long enough, you can become resigned to that there are no way to solve longstanding pains and frustrations. But in this case, the CAD Revolution offers some very real advantages and benefits to the manufacturing engineer.

To follow the rest of the CAD Revolution eBook series, visit www.ptc.com or follow to Lifecycle Insights.