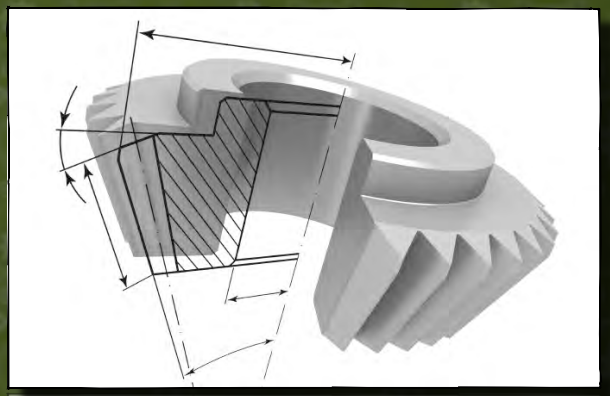
The CAD Revolution...

... and What It Means for You



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Introduction

CAD is a boring, staid and burned out commodity.

With stark clarity, I remember the first time that thought ran across my mind. It was at an analyst event in the middle of a product update briefing. The product manager was in the middle of explaining one of about a thousand new things in the latest version of this particular CAD tool. All of them minutely incremental. None of them groundbreaking. I wish I could say that kind of briefing was the exception instead of the rule, but that just wouldn't be true. Basically, CAD is the software application than innovation forgot. Well, at least for a while.

Then a couple years ago, the revolution started. Google offered Sketchup for the masses. Spaceclaim started suggesting 3D could be used beyond traditional CAD users. Siemens PLM provided both modeling paradigms through newly launched Synchronous Technology. Autodesk started experimenting with new technology in something called Fusion. And most recently, PTC has promised to change the world with Creo. Suddenly, CAD is a hot and vigorous issue worth talking about again.

But something's a little different this time. It's not the same old game of leapfrog played out between software providers. It's not just about getting the latest whiz-bang features in front of CAD specialists. It's not just about detailing out engineering drawings. People are talking about getting sketching and modeling tools in front of entirely new roles. People are talking about process change of all things. It's exciting to see and understand some of the new applications for CAD. But as exciting as it might be, it's a touch confusing and scary too. Why would someone else use CAD? What's the advantage? Will this end up being disruptive? Questions abound.

That's where this series of eBooks might help. They provide a straightforward look at how the ongoing revolution in CAD affects different individual roles and the resulting implications for their organizations. So sit back and take it in. Because it may have taken a little while, but CAD is finally worth our time again.

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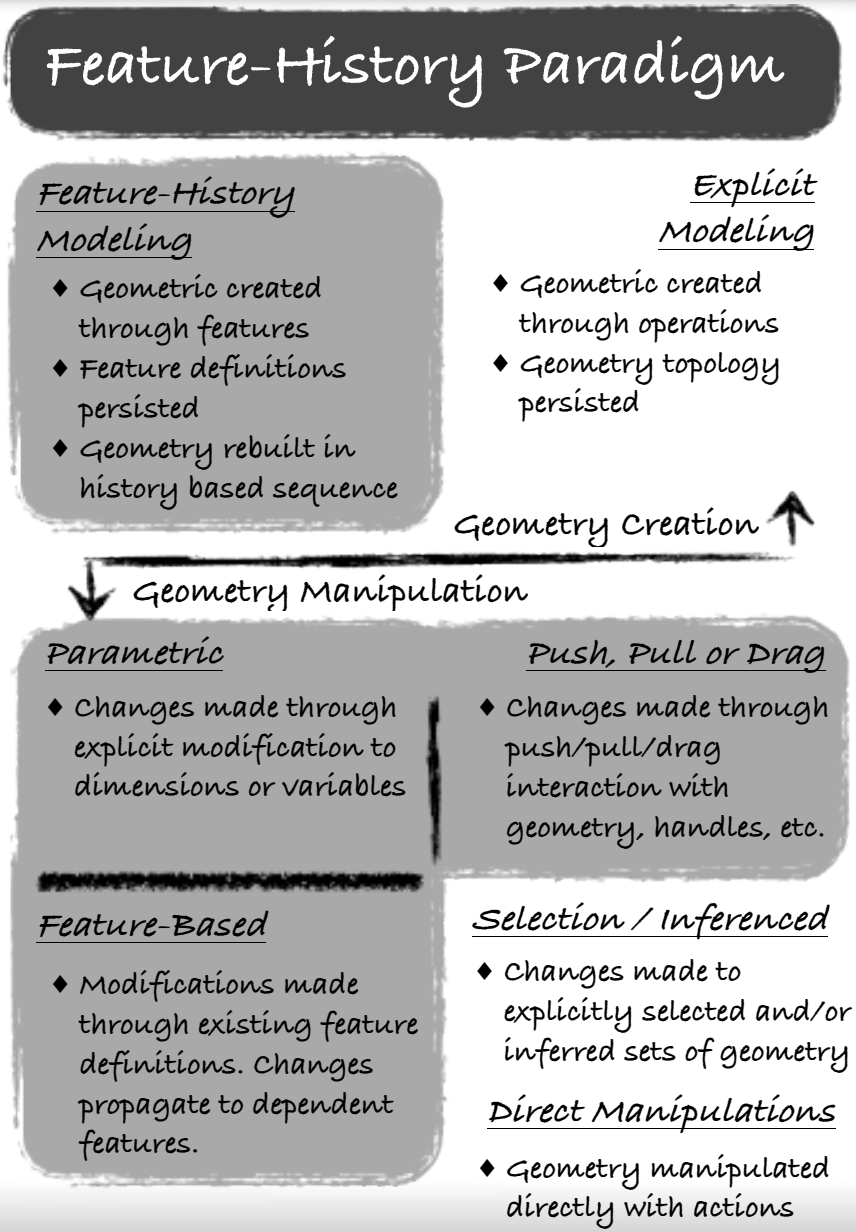
A Powerful Yet Taxing Path...

Before we can understand the impact of the CAD revolution, it's important to understand how the technology works and it's resulting implications. Here's the quick overview of the feature-history paradigm, the basis for traditional CAD.

- The building blocks of a 3D model are geometry features that are parametrically controlled. Some examples are sketch-based extrusions and rounds.
- The features are placed into a history based sequential order. Furthermore, successive features often use geometry of prior features as references, generating a network of parent-child like interdependencies.
- The features can be changed by modifying parametric dimensions or variables or through dynamically pushing and pulling geometry.
- Modifications however are limited to the initial feature definitions used to create the geometry.

Because of the way this technology paradigm works, there are some implications for users.

- Parametric control and interdependency in the feature history enables very intelligent reactions to changes as well as powerful design automation. Models can morph in an automated way to represent various product configurations.
- There is an overhead cost to this power though. Specific knowledge and skills must be gained and retained to both build as well as manipulate models based on a feature-history network.



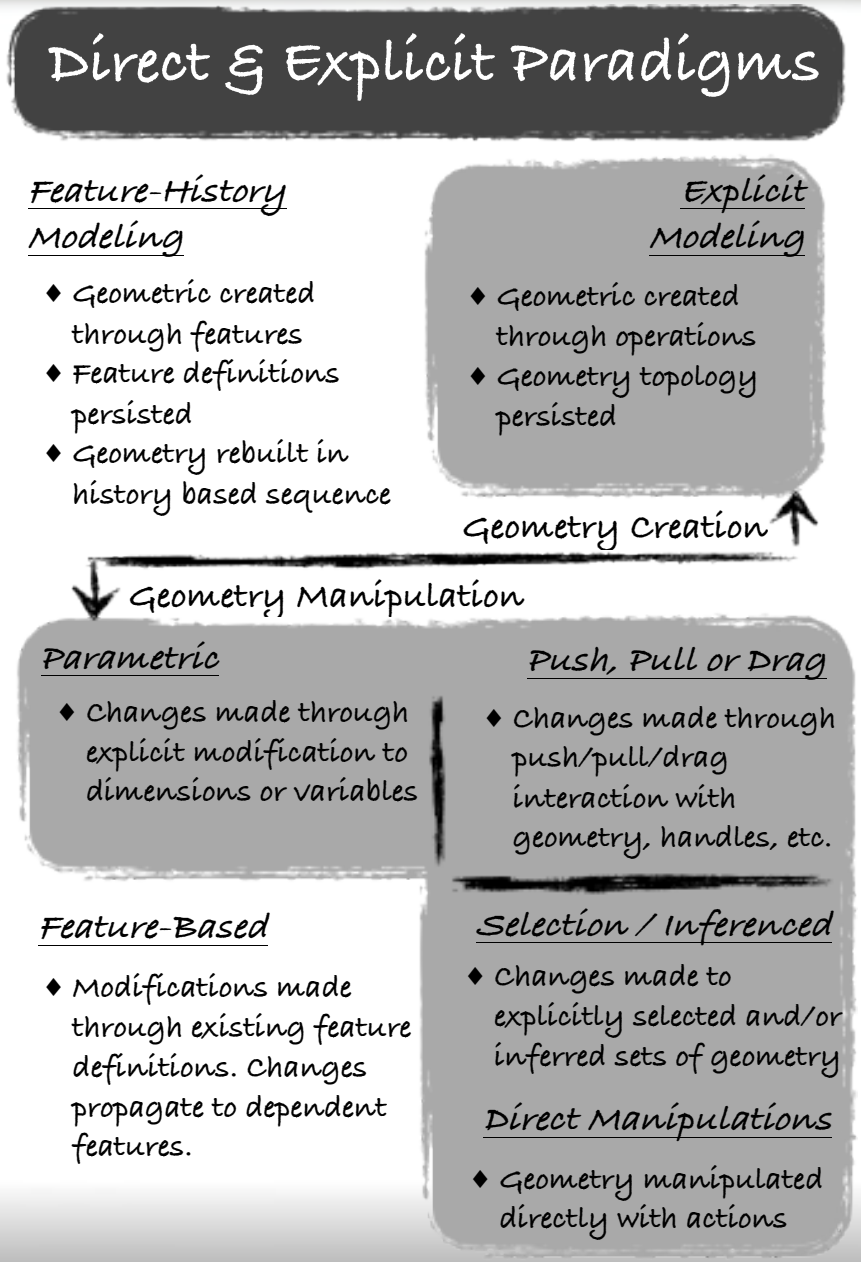
A Path a Little Less... Constrained.

So what's the alternative to feature-history paradigm? Its a combination of explicit and direct paradigms that has actually been around for some time. Here's the rundown of how it works.

- Geometry can be created as features or as individual operations. Then, instead of remembering the history based sequential order of features, the geometric topology definition is preserved. As a result, there is no network of interdependencies between features.
- Manipulation of geometry is a two-step process. First, users select the geometry they want to change. This can be augmented with geometry inference; a capability that automatically and intelligently determines what else should also be modified. Second, the user primarily uses a push/pull/drag interaction to manipulate the geometry. Alternatively, parametric modifications to geometry can also be made.

Just as before, there are some implications as a result of using this type of modeling paradigm.

- The knowledge and skill overhead to using this modeling paradigm is low. There is no network of interdependent features to manage.
- Without a network of interdependent features, there is no basis for design automation or intelligent reaction to change. These models cannot be morphed in an automated way.



The CAD Revolution... and What It Means to You

The Status Quo of Traditional CAD

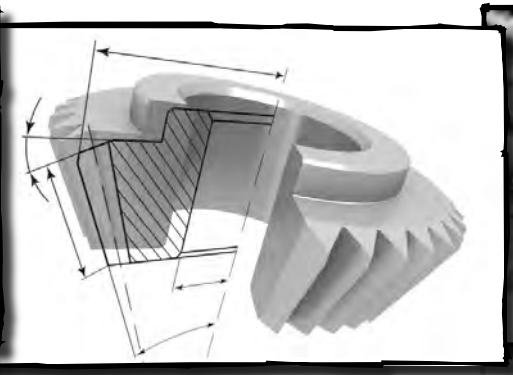
As modeling technology in the industry matured, initial thoughts on the use of CAD formalized into consensus. And over time, consensus settled into a number of assumptions. Assumptions that practically no one challenged any longer. Here's the quick list.

- **2D CAD is for laggards.** It's not the most professional thing to say, but it has been the industry drumbeat for years. The use of 2D CAD has always been painted as an intermediate step on the way to 3D CAD. Those who stayed on 2D have been seen as procrastinating the inevitable. Over time, a serious stigma developed around 2D. And the stigma stuck.
- **Pick a 3D modeling paradigm and stick with it.** By and large, the feature-history and direct paradigms have been seen as mutually exclusive. Organizations often went down one path, never looking back regardless of the advantages or accessibility of the other paradigm. But sometimes it went beyond that, with proponents on both sides arguing with great passion and fervor. For many, it became personal.

The New Rules of the CAD Revolution

With a revolution in technology, CAD suddenly gained some mindshare in the industry again. People started to ask questions. Did the old assumptions about CAD still apply? And after revisiting some issues that hadn't been challenged in years, some new thinking emerged.

- **2D CAD is a legitimate design tool.** Now don't get me wrong here. No one wanted to go back to manually creating 2D drawings. However, there's been an admission that designing products is truly distinct and different than documenting products. And in that case, designing in 2D is entirely legitimate means to capture concepts, develop and mature designs and make design decisions.
- **Use complementary 3D modeling paradigms.** Many in the industry would agree that each modeling paradigm has strengths and weaknesses. And interestingly, one's strength actually compliments the other's weakness. The new thinking is to leverage both paradigms, switching between the two and using the right one for the right job. It's no longer an either-or decision. It's both.



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What's it mean for CAD Specialists?

If there's one thing we know about CAD specialists, they are the top experts in the feature-history paradigm. They've learned how to build and navigate networks of interdependent features as well as diagnose problems when they occur. They're masters of their trade.

The Partially Fulfilled Promise of Reuse

One of the great original advantages behind the feature-history modeling paradigm is reuse. The idea has been to morph an existing model into a new one with changes. But there are sometimes problems. In unstable models, small tweaks can start a chain reaction of failures in the network of interdependent features.

Given time, CAD specialists can readily seek out and resolve those problems. In some cases however, it can actually be faster for them to do a complete or partial rebuild of the model instead. Either way, they end up spending valuable time fixing or rebuilding models instead of creating new ones.

Realizing the Reuse Promise

For CAD specialists, the new vision for CAD is all about flexibility and power. Direct modeling can be used to modify legacy models and reuse other's models without needing to recreate it or invest lots of time fixing it. Feature-history modeling can be used to explicitly define geometry or programmatically automate modeling. The biggest advantage however is both of these modeling paradigms can be used in a complimentary fashion, offering the right tools at the right time.

Final Thoughts for CAD Specialists

There's really no doubt that CAD specialists could fix or rebuild models so they could morph into new designs. But is that really a great use of their expert skills and knowledge? Instead, leveraging complimentary modeling paradigms lets them find the shortest path to the final goal. In turn, that let's them focus their expert knowledge and skills more on modeling new parts and products.

Issues with Traditional CAD	The Change with the CAD Revolution	Advantage and Benefit
In feature-history paradigm, CAD Specialists must often fix or recreate models, instead of reusing them, due to complex interdependencies between features.	Capabilities provided through direct and explicit paradigms allow quick and easy edits to existing models without feature manipulations.	Time that CAD Specialists would have spent fixing or recreating models can be applied to new development projects instead.

The CAD Revolution... and What It Means to You

What it means for CAD Managers

There's no doubt that being a manager during the recession was difficult. For a team whose bandwidth is determined by how many bodies there are in front of CAD workstations, staff cuts hit hard. With practically every project undermanned, productivity is paramount.

Unpredictability Undermines Productivity

Some days they love it. Some days they hate it. But what's always the same is that manipulating models with the feature-history paradigm is a complicated task. It's difficult to predict if a team will be able to turn an old design into a new one or they'll have to recreate it from scratch. That makes it terribly hard to stay on schedule.

And they don't mind helping out others, but there's endless lists of requests for help with CAD whether it's an engineer modeling up a new concept, an analyst prepping a model for simulation or a manufacturing engineer trying to figure out why his model is failing. And that can certainly make it difficult to be productive.

Addressing Reuse, Enabling Other's Independence

For CAD Managers, a major boon of the CAD revolution is the elimination of the unpredictability around design reuse. The direct modeling paradigm offers new tools to manipulate model geometry without the fear of catastrophic failures.

But there's more to it for CAD Managers than just addressing reuse. Part of the promise of the CAD revolution is enabling many other roles to be productive with CAD. That means the endless list of request can be dramatically reduced, if not eliminated.

Final Thoughts for CAD Managers

For CAD Managers, there are two major issues that undermine productivity: the unpredictability of design reuse and other's requests for CAD assistance. The CAD revolution addresses both head on. Tools in the direct modeling paradigm directly address design reuse needs. The vision behind the CAD revolution places role suitable tools in the hands of others.

Issues with Traditional CAD	The Change with the CAD Revolution	Advantage and Benefit
With feature-history paradigm, difficult to predict extent to which past designs can be reused. Also, other roles constantly need assistance with modeling tasks.	Capabilities of Direct and Explicit paradigms enable higher rate of reuse, increasing predictability. More accessible forms of CAD enable other roles to work independently.	Letting CAD Specialists and other roles use the right tools for the right job saves time in the schedule and makes workload far more predictable.

The CAD Revolution… and What It Means to You

What it mean for Product Engineers

Being an engineer today is no easy task. You have to wear many hats while rushing between your desk, the test lab, the shop floor and everywhere else. And between it all, you have to capture your ideas and concepts quickly so others can take action.

Going Rogue with Concept Design

What is the best way to capture design concepts? It has always seemed like 3D CAD would be a great fit because of its ability to quickly explore design iterations. But that potential has never truly been realized. Engineers are constantly juggling the lifecycle responsibilities of their products. And as a result, they'll only ever be an infrequent user of any application, including CAD. In turn, they can't dedicate the time necessary to gain the knowledge and skills to effectively use the feature-history paradigm. Instead, engineers often go rogue with faster and simpler to use 2D CAD, even with the stigma.

Productive Concept Design without the Overhead

For engineers, the CAD revolution is all about enabling them to capture their concepts without making them CAD experts. Because the barrier to using 2D sketching or direct modeling is relatively low, engineers don't need extensive knowledge or skills to capture their concepts. Furthermore, these modeling methods are also integrated with the feature-history paradigm, enabling CAD specialists to use them, instead of recreating them, to build detailed models. In all, there's no need to go rogue anymore.

Final Thoughts for Engineers

Traditional CAD has always held great promise for engineers to capture their concepts. However, engineers simply can't afford the time to become CAD experts. The CAD revolution puts 2D and direct modeling tools into their hands, letting them productively capture concepts without the knowledge and skill overhead. In short, CAD has become accessible to the engineer.

Issues with Traditional CAD	The Change with the CAD Revolution	Advantage and Benefit
Skill and knowledge overhead of feature-history paradigm too high for engineers, who are infrequent users. Often use 2D drafting tools instead, creating unusable deliverables.	Direct modeling and 2D sketching tools enable engineers to capture concepts and ideas quickly without high skill and knowledge overhead.	Engineers can independently capture their concepts in a deliverable format that CAD Specialists can leverage to create detailed models later in the design phase.

What it means for Analysts

When it comes to model geometry, there couldn't be anything that is both more critical and less interesting to analysts. It's the basis of simulation models but to be honest, they don't care how it's created. For them, it's simply a means to an end.

The Challenges of Defeaturing Models

While the CAD model is the basis for simulation models, analysts often remove some pieces of geometry that are irrelevant to the simulation. But unfortunately, because of dependencies between features, removal of a feature can cause others to fail, rendering the model useless. Of course, an analyst could gain the skills to use feature-history based modeling, but with all of the other knowledge required of a simulation analyst, that's not exactly the highest priority. As a result, analysts spend exorbitant amounts of time prepping the model, recreating the model in simulation tools or rely on time-constrained CAD specialists to do the job for them.

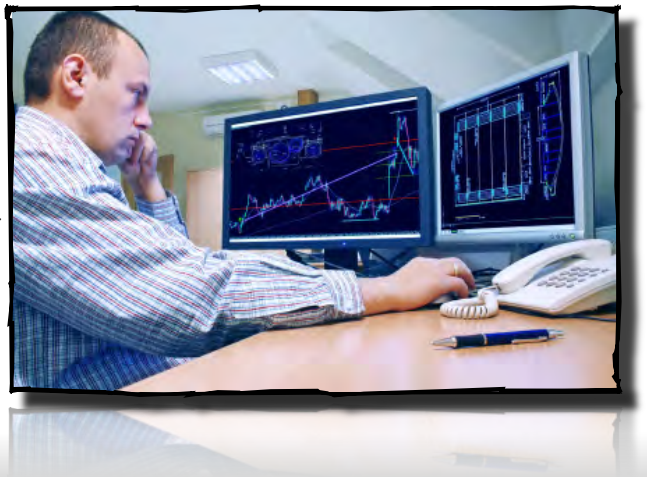
Direct Modeling Enables Analyst Independence

How does the CAD revolution change things? It turns out that the direct modeling paradigm not only offers new ways of modifying geometry, but also offers tools to quickly and easily remove geometry without triggering chaotic failures throughout the interdependent network of features. This means the analyst can perform their analysis preparations on their own without fixing or recreating the CAD model.

Final Thoughts for Analysts

Model geometry has always been critical to an analyst's job. Trouble begins when simplification or defeaturing a model in preparation for simulation triggers feature failures. As a result, analysts can waste tremendous amounts of time fixing or recreating the model or waiting for a CAD specialist to help. The CAD revolution puts direct modeling tools in the hands of analysts, enabling them to simplify models without the threat of feature failures.

Issues with Traditional CAD	The Change with the CAD Revolution	Advantage and Benefit
Simplifying or defeaturing models created with the feature-history paradigm can cause failures, forcing Analysts to fix or recreate them.	The direct modeling paradigm offers quick and easy tools to simplify or defeature models without risk of model failures.	Time that Analysts usually spend fixing or recreating models can now be spent setting up and running more simulations.



What it means for Manufacturing Engineers?

Where the engineer designs the product virtually, the manufacturing engineer must bridge the gap to reality. That not only includes planning out the production process but also the design of the necessary jigs, fixtures and tooling to manufacture the product.

A Lack of Palatable Choices for Tool Design

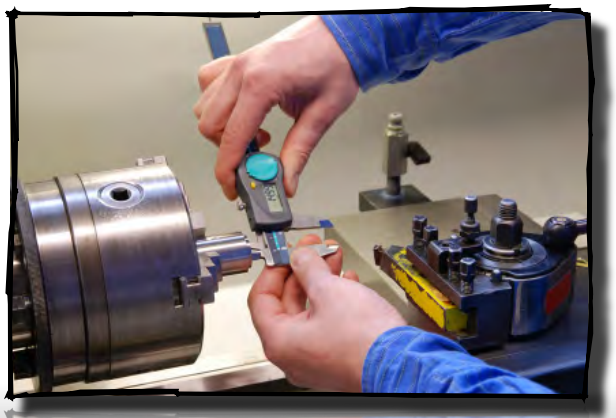
For the manufacturing engineer, it all starts with the CAD model that is released from engineering. While that model is frequently built using the feature-history paradigm, there's no need for the manufacturing engineer, an infrequent user, to make tooling design any more complicated than it already is. So, they have a choice. They can design tooling using the feature-history paradigm, forcing them to use a more complex tool. Alternatively, they can import the design into a specialized yet simpler-to-use application, thereby breaking the associativity between the product model and the tooling model. Both choices were less than ideal.

Simpler Yet Associative CAD for Tool Design

For manufacturing engineers, the CAD revolution offers simpler and easier to use applications for tool design that are integrated with product design. This includes 2D sketching, capabilities from the direct modeling paradigm or even specialized tool design functionality to create the simpler geometry of the jigs and fixtures. As a result, tool design isn't any more complicated than necessary and product changes are propagated associatively.

Final Thoughts for Manufacturing Engineers

In the past, manufacturing engineers had to choose between using complex applications for simple tool design and simpler applications that broke associativity. The CAD revolution lets them avoid the compromise by providing the right capabilities with associativity.



Issues with Traditional CAD	The Change with the CAD Revolution	Advantage and Benefit
Jig and fixture geometry is often simple and doesn't need the more complex capabilities of the feature-history paradigm used to create design models.	Manufacturing engineers can use simpler and faster tools like direct modeling and 2D sketching for jig and fixture design yet maintains associativity with the design model.	Manufacturing engineers no longer need to choose between modeling simplicity and design associativity. They can have both to save time and avoid errors.

Conclusion: What does it all mean?

In the past few years, there have been some dramatic shifts in CAD technology and new thinking about how it can be used. But that alone doesn't necessarily mean you should change what you're doing. First, you have to answer a critical question: what does it all mean to the business? Fundamentally, the answer to that question is increased productivity in two specific ways.

#1: Enabling CAD Independence across the Team

Under the status quo of traditional CAD, other roles brought their CAD difficulties to CAD Specialists to fix or recreate their models. As a result, the organization has been constrained by the bandwidth of that one role.

Under the new rules of the CAD revolution, each of these roles possess right-sized CAD technology that enables them to do their tasks independently, including:

- Engineers capturing design concepts with 2D sketching and direct modeling.
- Analysts simplifying design models with direct modeling in preparation for simulation.
- Manufacturing Engineers associatively designing tooling with 2D sketching and direct modeling.

Ultimately, this independence results in two advantages.

- The elimination many tasks for CAD Specialists, freeing them up to focus on new product designs.
- The elimination of delays caused while waiting for CAD specialists to complete other role's tasks.

#2: Elimination of Non-Value Add Activities

Under the status quo of traditional CAD, occasional failures in models built in the feature-history paradigm instigated a variety of activities that fundamentally do not add value to product development projects, including:

- Fixing or recreating unstable models resulting from reusing or modifying existing designs.
- Creating new 3D models from scratch instead of leveraging 2D conceptual sketches.
- Fixing or recreating models after attempting to simplify them in preparation for simulation.

Under the new rules of the CAD revolution, leveraging the right paradigm within a set of complementary and interoperable modeling technologies can reduce if not eliminate many of these activities. As a result, more of the organization's time can be spent on moving the product development project forward.

Final Thoughts... and a Question

It's been some time since CAD was *really* worth our time. After years of incremental improvements and leapfrog features, the technology advances and new thinking of the last few years offers some real change. And it's not merely interesting. There are some real implications not only for the traditional CAD Specialist, but also for Engineers, Analysts, Manufacturing Engineers and many others. So after all these years of sleeping on CAD, and rightfully so, you may just want to ask yourself.

Is it time to start paying attention to CAD again?

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