Market Alert

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Synchronous Technology: The Best of Both Worlds for Engineering Organizations?

When it comes to computer-aided design tools, engineering organizations are caught between a rock and a hard place. Managing complex feature interrelationships bar the way for those considering the move from 2D to 3D. Lack of feature-based modeling expertise of experience with a specific model hampers design reuse. Lack of interoperability translates into design recreation in multi-CAD environments. However, the significant benefits of parametric modifications put design organizations in a conundrum: is the use of 3D parametric feature-based tools worth it?

The emergence of direct modeling technologies, which allow the manipulation of design geometry with little regard of how it was built, offers significant hope when applied appropriately. However the tools offering these capabilities have, in fact, only been a partial solution. They often lack parametric modification and constraint capabilities that engineering work requires. This shortfall undermines efforts at engineering and configuration automation which rely on parametric control.

In late April, Siemens announced the development of Synchronous Technology that seems very promising. In late May at their Analyst Event in Boston, they revealed how the technology will be implemented within NX and Solid Edge. The result looks to be a mix of dynamic modeling and parametric control. In the end, this may well be the solution that combines the best of both worlds to address the longstanding struggles of engineering organizations.

Challenges to Design Abound

What hard benefits do 3D parametric feature-based tools offer? Aberdeen Group's *The Transition from 2D Drafting to 3D Modeling Benchmark Report* found that the Best-in-Class build half the prototypes and execute six fewer change orders compared to Laggards. But realizing these benefits are not as simple as installing software and training the users. Serious challenges crop up in management of performance, failed attempts at design reuse and recreating designs in multi-CAD design environments.

The Heavy Burden of 3D Design

It's well known that parametric design comes with a steep learning curve and heavy burdens on virtual memory and network bandwidth. But what are the lasting challenges that companies encounter with 3D design? *The Transition from 2D Drafting to 3D Modeling Benchmark Report* found that once companies make the leap to parametric design, the major challenges are around managing feature inter-relationships and design performance (Figure 1). The inherent interaction of features and control of parametrics can

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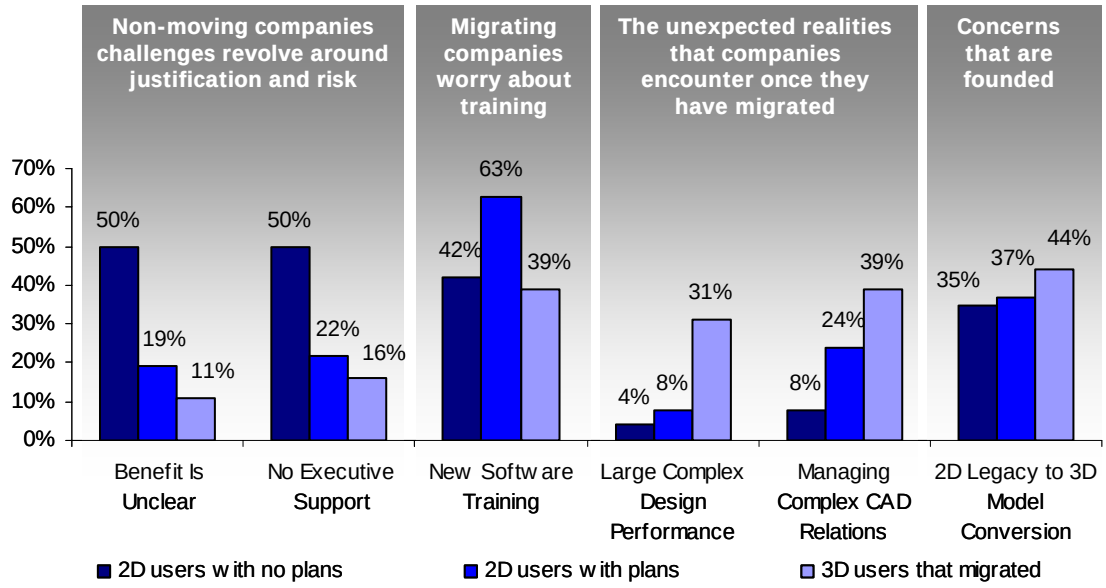
result in difficulty in managing change to designs, readily reusing designs as well as recreating designs for everyday user.

While not widely anticipated, the slow application performance of large and complex designs and the difficulty of managing complex CAD relationships are major issues recognized by those using 3D modeling, reported by 31% and 39% of these companies respectively. The slow application performance of large and complex designs can be further broken down into a number of specific issues such as graphics lag (reported by 59% of respondents), initial model retrieval times (61%), and model regeneration times (71%). The root cause of these issues reside somewhere between the inherent complexity represented by feature-based design models and the performance capability of hardware.

"Training after switching over to 3D tools was a major challenge. The issue wasn't really the concepts of 3D modeling such as definition of features or parameters. The outstanding issue was educating the users on where the functionality was located within the application."

~ Phil Jones
Ovalstrapping

Figure 1: Challenges to Using 3D Modeling



Source: AberdeenGroup, September 2006

Barriers to Design Reuse

One of the benefits 3D modeling promised to bring product development was the ability to leverage and reuse previous designs. But taking advantage of this capability means overcoming some tricky obstacles (Table 1). Aberdeen's February 2007 *The Design Reuse Benchmark Report* found that the top challenge of leveraging previous designs, reported by 57% of participants, is that modifications to these designs require expert-level knowledge of the CAD tool. Taken into consideration with the number four challenge, only the original designer can change models successfully (40%) suggests that a major barrier to design reuse is that while the capability may be available, it is difficult to take advantage of it.

This can undermine the productivity boost the reuse promises, and often means that while the option to reuse a design is available, many engineers

will simply create redundant designs in order to save themselves the trouble.

Table 1: Top Four Challenges to Design Reuse

Challenges	Response
Model modification requires expert CAD knowledge	57%
Models are inflexible and fail after changes	48%
Users can't find models to reuse	46%
Only original designer can change models successfully	40%

Source: AberdeenGroup, February 2007

Negotiating Multi-CAD Environments

Another challenge of that has emerged in design and engineering organizations is the proliferation of CAD deliverables in a variety of formats. There is no uniform formatting convention for CAD files across different applications, or even across platform versions. CAD formatting issues are often exacerbated when companies attempt to collaborate with suppliers, partners, outsourcers, and even different design teams within the four-walls of the enterprise that all use different design applications. There are a number of methods by which companies attempt to resolve this issue, either by creating designs in different formats and tools, CAD-data translation solutions, or by converting designs to 'flat' formats.

"Developing products nowadays is a combined effort between suppliers, our department, and manufacturing. It's not as simple as everyone uses this CAD system for development because no one's complete set of customers uses a single CAD tool."

~ Bob Wells
DMP CryoSystems

However, none of these present an easy fix. Aberdeen Group's December 2006 *The Multi-CAD Design Chain Benchmark Report* found, for example, that recreating designs in new formats can cause geometry errors (44% of respondents). Forty-six percent (46%) reported that simply different release versions of software create incompatibilities even when companies use one solution. However, what may be more damaging to the productivity of product development organizations is that leveraging multiple CAD design tools creates a gulf between those engineers who are specialized users of one tool and those who attempt to become proficient on multiple tools. 3D modeling tools require a high learning curve. Those who attempt to become generalized users fail to become very efficient or as productive on any one tool. However, those whose specialize on one application can't switch to projects that require the use of other tools, the number three challenge, reported by 41% of respondents.

Table 2: Manufacturer's Top Challenges and for Multi-CAD Design

Challenges	Response
Different CAD release versions create incompatibilities	46%
Recreate designs in new CAD format because of translations geometry errors	44%
Specialized CAD users can't be switched to projects using other CAD tools	41%
Re-create designs in multiple CAD formats	38%
Generalized CAD users aren't as efficient with any one CAD tool	28%

Source: AberdeenGroup, December 2006

The Implications of Evolving Modeling Technologies

So while 3D modeling provides significant advantages in the form of time and costs savings through the reduction of prototypes and change orders, there are serious challenges to using it successfully. While some solutions providers have looked to services like training to address these issues, others have developed new technologies like direct or dynamic modeling.

Why the Problems with Feature-based Modeling?

Findings from a number of Aberdeen reports call attention to the great difficultly users encounter in changing designs created by other users. What is the root causes that bars this simply yet hard to attain ability? It boils down to two simple reasons.

1. Feature interdependency. As a model is built up out of features, a complex network of interdependencies between the features emerges. Making a change to a feature requires that change be compatible with all of the features that follow it. If not, the model can fail. Trying to understand why a model failed can lead to a long and complicated trail of complex interdependencies.
2. Changes are constrained by feature definitions. Once a model is built, it cannot be changed in any ad-hoc or freeform way. It must be changed within the constraints of the original feature definitions or rebuilt. Overall, this limits the freedom the user has to make significant changes.

While these present serious challenges to design organizations, let us not forget how another key capability enables quick iterations in addition to engineering automation. Parameters allow users to make numerically based modifications to designs. This allows them fine tuned controls over the geometry, a key capability in today's quality driven manufacturing environment. Furthermore, these parameters can be driven using extensive configuration logic. For assemble- and configure-to-order manufacturers, this is a powerful boon to shortening the time between taking an order and delivering a product.

Does Direct or Dynamic Modeling Provide a Solution?

Synchronous technology is a significant advancement in the industry, especially in the light of the challenges many design organizations face. How does it address the challenges that design organizations face with feature-based modeling solutions? At first glance, one would think it is how you can push and pull geometry to make changes. However, many feature-based CAD applications have now adopted push and pull interactions. Instead, the key enabling capability is to make changes outside the original definitions of features. Users have the ability to quickly make modifications that would require feature redefinition if not recreation. This capability directly addresses many of the root causes driving the challenges of a design organization.

However, direct or dynamic modeling isn't without its detriments. Many of the solutions employing this technology are lacking in the ability to control geometry through parameters. Without this key ability, users cannot fine tune models or deploy engineering automation or knowledge based configuration.

How is Synchronous Technology Unique?

When considering feature-based modeling and direct or dynamic modeling, each technology has advantages and disadvantages:

- Feature-based modeling parameters provide users with great fine tuned control of geometry and enable engineering automation. However, the inherent complexity of feature interdependencies and the constraint of changes within feature definitions lead to many of the challenges faced by engineering organizations.
- Direct or dynamic modeling allows users to change geometry outside of the feature definitions originally used to create the geometry. But the lack of parametric control over geometry takes away the fine tuned control and engineering automation many users of feature-based tools have come to expect.

Interestingly, synchronous technology seems to have merged together the advantages of both systems without the disadvantages of either. It allows users to create geometry through features. It then allows users to modify the geometry outside the definition of those features. Furthermore, it allows users to constrain and parametrically control geometry to enable engineering automation. In addition to these two options, synchronous technology also offers the flexibility to remove the history of a feature-based model which in essence "switches" it to a history-free model. This allows the ability to leverage the benefits of feature-based, parametrically driven modeling, but then if this gets in the way of major changes, the history can just be removed without inhibiting progress. All in all, it seems to hold great promise in solving the challenges faced by design organizations without taking away the benefits of traditional feature-based modelers.

Not only does synchronous technology offer so many benefits, but the technology can even be applied to imported geometry. Typically, when geometry is imported, it can be used as a reference for building new geometry, but it does not have any of the intelligence that would be associated with "native" features created in the CAD program. Synchronous technology handles imported geometry differently. It recognizes features such as holes as well as intended design constraints such as symmetry. This allows the user to modify imported geometry while accessing much of the functionality that previously was only available with new features created in the native CAD tool.

Solution Provider Landscape

While understanding the minute yet differentiating capabilities of different modeling technologies is difficult, sorting through which solutions use the different technologies can be even more difficult. In general, however, there

are three categories: pureplay direct modelers, feature-based solutions with direct or dynamic modeling capabilities and synchronous technology modelers.

Pureplay Direct Modelers

There are three applications that focus specifically on direct modeling: PTC's CoCreate, Spaceclaim's offering and Kubotek's Keycreator. Each comes from a unique background but offers similar capabilities.

CoCreate, with roots in Hewlett Packard's Mechanical Design Division (MDD), was acquired in December 2007 by PTC. Aberdeen's November 2007 Market Alert, *PTC Acquires CoCreate: Building with Blocks or Molding with Clay?* observed that this acquisition marked the first time both parametric and explicit modeling applications were available from the same solution provider, albeit in two separate applications. Spaceclaim is a relatively recent startup led by Mike Payne, a co-founder of both PTC and Solidworks that offers a subscription based direct modeling CAD application. Kubotek offers KeyCreator, a tool explicitly positioned for design, validation and multi-CAD environments.

What is most interesting about these three offerings is none of them are explicitly positioned as a solution for mass market core engineering and design work. PTC has targeted CoCreate at short lifecycle and highly dynamic industries where parametric feature-based approaches could get in the way of rapid and radical design changes. Spaceclaim positions their solution to the broader set of stakeholders to engage in the design feedback process. Kubotek has positioned KeyCreator to support validation and multi-CAD environments.

Feature-based Modelers with Direct Modeling Capabilities

While many of the pureplay direct modelers offer a new solution to the market, there are five longstanding CAD solutions that have evolved to adopt direct modeling capabilities including: Dassault Systemes CATIA and Solidworks, PTC's Pro/ENGINEER Wildfire, and Siemen's NX and Solid Edge. All of these solutions have included direct modeling capabilities within the last 18 months with the exception of Pro/ENGINEER Wildfire. PTC acquired CDRS back in 1995 and integrated some of that technology into Pro/ENGINEER several years later.

While this has enabled users to make push and pull changes to a model, these tools are fundamentally still feature-based modelers that allow for freeform manipulation. As a result, the same level of feature interdependency and complexity exists.

Synchronous Technology Modelers

Currently, there are no released products that utilize synchronous technology. However, Siemens PLM Software's next releases of NX and Solid Edge will both leverage the technology. Both tools will offer the options to design using the feature based parametric modeler and the flexibility to switch individual features between the two modes.

Another software vendor that offers this flexible modeling environment that combines the three options to model parametrically, use direct modeling, or convert individual features between the two is IronCAD. However, Aberdeen research has found that IronCAD has a much lower adoption rate than many of the other CAD vendors. In both the September 2006 *The Transition from 2D Drafting to 3D Modeling Benchmark Report*, and May 2008 Best Practices for Migrating from 2D to 3D CAD report, less than 1% of survey respondents currently use IronCAD.

Key Insights

Synchronous technology appears to offer all the benefits of working in 3D while solving many of the inherent challenges. It provides an answer to many of the problems that have prevented engineers from transitioning from 2D to 3D. In addition, it also allows engineers to work in the environment they feel most comfortable in, without forcing them to change the way the work. Finally, it offers a solution that enables engineers who work in a multi-CAD environment to more easily manipulate CAD data created in third party packages.

For more information on this or other research topics, please visit www.aberdeen.com.

Related Research	
PTC Acquires CoCreate: Building with Blocks or Molding with Clay?; November 2007 *The Design Reuse Benchmark Report*; February 2007	*The Multi-CAD Design Chain Benchmark Report*; December 2006 *The Transition from 2D Drafting to 3D Modeling Benchmark Report*: September 2006

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