Parametric or Direct Modeling: why you may need both

SEE 10 AREAS WHERE DIRECT MODELING COMPLEMENTS PARAMETRIC

Introduction

For far too long, product design teams have been forced to compromise when it comes to using MCAD software. 3D users have been limited to one modeling paradigm – either parametric or direct – for all jobs. And for those using 2D, being able to easily access and leverage their data in 3D has been complex and challenging.

But now, with Creo™ Elements, you're free to choose the right tool for the design task at hand: 2D or 3D, parametric or direct. Now you can have the ideal tool whether you're creating designs or just viewing them. With the Creo Elements suite of design solutions, you have interoperability like never before. Freedom, instead of limitations.

Here are 10 compelling reasons why combining Parametric and Direct CAD with Creo Elements offers benefits to you, your team and the products you create.

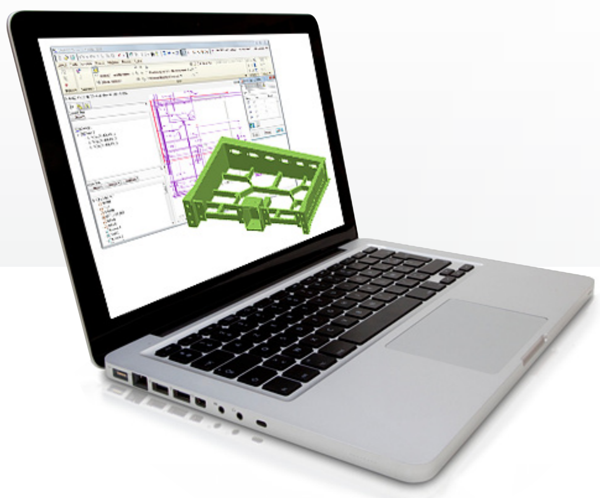
What are the main differences between the two approaches?

The direct modeling paradigm provides a "just do it" modeling strategy that gives users the power to quickly define and capture geometry. With direct modeling, designers can focus on creating geometry rather than building features, constraints and design intent into their models.

The parametric modeling paradigm, on the other hand, provides an "engineer it" approach to design, which requires the user to anticipate and define feature constraints, relations and dependencies, ensuring that any design modification will update all related downstream geometry in a predefined manner.

The "just do it" direct modeling approach is all about quickness and responsiveness-to-change, making it an ideal strategy for design tasks where speed and flexibility are key. The parametric approach, on the other hand, is better suited to those design tasks where the designer is given strict criteria to meet exacting design aesthetics, performance metrics and manufacturing criteria. With parametric modeling, the added effort and upfront planning is justified in order to deliver these downstream benefits.

No doubt, each style of modeling has its benefits, depending on the task at hand and the type of product being designed. In many cases today, companies are applying both approaches in order to achieve the speed, quality and innovation they need to stay on top. Read on and you'll see why.



Concept design requires speed and flexibility in order to enable creativity and innovation.

Let's take a look at 10 areas of product development where direct modeling can complement a parametric modeling environment.

1 CONCEPT DESIGN

Team Goals:

- Convey a visual representation of the idea or concept
- Create as many design concepts as possible
- Evaluate the concept that best captures specified criteria and aesthetic requirements

Parametric CAD Challenges:

- Conceptual designers are not engineering the product, thus parametric 3D CAD is overkill for their needs
- Conceptual design is a creative process that requires a 3D modeler with speed, flexibility and ease of use

Industrial designers are often involved in this phase of product development. However, they don't need the powerful parametric tools of 3D CAD experts who need to define design intent and deal with parameters or feature trees. Instead, industrial designers must quickly produce multiple concept designs of the future product, and discuss these concepts with internal stakeholders and customers.

The optimal CAD solution required at this stage must support the rapid creation and ideation of geometry. If the user is forced to think about how to use the 3D CAD tool, creativity slows down and innovation suffers.

Direct modeling is the ideal complement to parametric modeling in this scenario because it delivers the speed, flexibility and ease of use for concept design.

2 BID AND PROPOSAL PROCESS

Team Goals:

- Minimize the time and costs required to create the bid geometry
- Submit models and geometry to support a proposed customer price
- Accurately convey and communicate proposal requirements and costs
- Improve accuracy of the proposal to meet budget and schedule commitments

Parametric CAD Challenges:

- Creation of bid geometry requires CAD expertise – often not available from technical sales staff
- Many parametric CAD tools lack the ease-of-use, speed and modeling flexibility necessary in the bid process

In the bid and proposal process, a customer is offering the opportunity to win business. The competitive bid process requires each supplier to submit their proposal within the specified period – thus the process is time-sensitive. Once submitted, the competitive bids are reviewed, and the supplier is eventually selected based on their overall price point and their ability to communicate and demonstrate value. The better or more accurate the geometry, the better the chance of securing the new business.

Here, the ideal CAD solution will support the bid process by allowing geometry to be quickly created in order to minimize the time and costs required to create the bid geometry. The proposals are also a proof point for the supplier to verify feasibility.

Generally, parametric CAD tools lack the ease-of-use, speed and modeling flexibility required to define throw-away bid geometry, which makes direct modeling the perfect complement for the bid and proposal process.

3 DIGITAL PROTOTYPING

Team Goals:

- Design, iterate, optimize, validate and visualize products before they are built
- Rapidly create and explore design geometry
- Enable fast changes to legacy and heterogeneous data

Parametric CAD Challenges:

- The parametric 3D design process is often too slow for rapid prototyping
- Difficulty in working with and editing legacy data or data from multiple CAD tools

Digital prototypes are frequently created to support the detailed design phase of product development to demonstrate and evaluate design alternatives. The objective is typically to assess design feasibility.

Digital prototyping is best supported by a CAD tool that is easy to use, intuitive and interactive enough to support innovation and the brainstorming process.

With digital prototyping, the ideal CAD solution should make it easy to reuse and repurpose existing geometry. Rather than re-creating digital prototypes from scratch, it is more advantageous to use carry-over or legacy data as the base geometry to quickly create digital prototypes.

The direct modeling paradigm is better suited to meeting digital prototyping requirements by providing history-free, geometry-based creation and editing.

Digital Prototyping

When validating and optimizing designs, digital prototyping is an ideal cost-saving process, but it should be done frequently and the design tools need to support rapid prototyping cycles.

4 2D DESIGN AND CONVERSION TO 3D

Team Goals:

- Support quick 2D concept design and the creation of 2D engineering deliverables
- Accelerate the 2D-to-3D conversion process to evolve 2D drawings into 3D models

Parametric CAD Challenges:

- Often, 3D parametric CAD tools lack powerful, easy-to-use, associative 2D design capabilities
- 2D-to-3D model conversion is slow and tedious, requiring significant effort to re-create 2D profiles in 3D CAD

2D design capabilities are often required to support concept design and the creation of engineering deliverables. The simplicity of 2D design supports fast conceptual design and layout detailing.

The ideal 2D CAD solution must provide comprehensive 2D design capabilities and support the 2D-to-3D model conversion process. To support downstream deliverables, the optimal 2D CAD solution should be integrated with the 3D CAD solution to accelerate the 2D-to-3D conversion process, thus leveraging the ability to directly utilize 2D information to create 3D models.

Here, the direct modeling approach is a perfect complement to parametric modeling because it provides integral 2D and 3D capabilities to support fast 2D design and 2D-to-3D model conversion.

5 REUSE LEGACY DATA

Team Goals:

- Reuse and maintain legacy 2D & 3D data to support current and future programs

Parametric CAD Challenges:

- Traditional CAD solutions do not provide the ability to make changes to non-native CAD data
- Legacy 2D & 3D CAD data is often treated as "dumb" information that's difficult to maintain, edit and repurpose

For many organizations, the need to support legacy data is an ongoing effort that presents a variety of challenges resulting from the need to maintain and carry over legacy information to support current and future programs.

Here, the ideal CAD solution must provide the capabilities to leverage, maintain, edit, reuse and repurpose legacy data to support current and future programs.

The challenges in reusing legacy data usually result from using multiple parametric CAD solutions and their inability to work with native and non-native legacy data. Also, with parametric modeling, the geometry is generally imported as a "dumb" entity, which means the user has few options to edit the data.

Direct modeling enables designers to leverage legacy data, and repurpose and modify it just as if it had been created inside the direct modeling CAD application.

Direct modeling makes it easy to design concepts in 2D and quickly leverage and transform them into 3D designs.

6 INTEROPERABILITY AND DATA EXCHANGE

Team Goals:

- Enable CAD data-interoperability to support not only dispersed product development teams, but also communication and collaboration of engineering deliverables
- Improve the ability to communicate and share information with suppliers, vendors, partners, et al
- Manipulate and integrate non-native data into the design process

Parametric CAD Challenges:

- Imported CAD data is often treated as "dumb" information
- Traditional parametric CAD solutions often lack the ability to make changes to non-native CAD data

Interoperability and data exchange are critical to ensuring that organizations can leverage the extended enterprise and communicate and share the complete range of engineering deliverables with suppliers, vendors and partners. The CAD solution should make it easy to integrate non-native data into the design process, thereby providing opportunities to reduce duplication of effort.

The challenges surrounding data reuse and interoperability are often the result of designers working with multiple parametric CAD solutions, which are unable to work with native and non-native legacy data. Too often, geometry is imported as a "dumb" entity and the user has few options to edit the data.

Direct modeling allows designers to leverage legacy data, so they can repurpose and modify the data just as if it had been created inside the direct modeling CAD application.

7 LATE-STAGE DESIGN CHANGES

Team Goals:

- Accommodate late-stage design changes to support product development and promote design innovation
- Enable radical and unexpected design changes to be rapidly implemented throughout the product development process

Parametric CAD Challenges:

- Inability to implement late-stage design changes; design intent limits the ability to implement unexpected design changes
- Slow and tedious process to understand and rework design intent, so that models must be re-created

In many industries, late-stage design changes are common and unpredictable, and yet they must be addressed in a timely and efficient manner.

The goal of the 3D solution is to promote creativity and innovation, while leveraging the ability to react and implement change at all stages of the product development process.

The optimal CAD solution must also support fast creation and editing of geometry. The inability to address rapid turnaround, late in the process, can severely impact production schedules and product success.

Unlike the parametric modeling paradigm that supports prescriptive and predefined changes as defined by the design intent, the direct modeling paradigm supports the ability to implement radical and unexpected changes.

8 CAE & FEA WORKFLOW

Team Goals:

- Accelerate the CAE & FEA workflows; enable and support digital simulation and analysis, to enhance product quality and performance
- Support the ease-of-use requirements of casual and non-CAD users
- Decrease the time required to create, prepare and optimize CAD data for analysis

Parametric CAD Challenges:

- Analysts, who are not expert CAD users, struggle to modify parametric CAD geometry, thus they must rely on CAD experts to de-feature and prepare models for analysis
- Model history and design intent limit the ability to make changes to designs

Computer-aided engineering (CAE) is leveraged early in the design and development process to validate and improve the structural integrity and performance of engineering designs. The objective here is to speed the time it takes to analyze CAD geometry and provide engineering feedback.

Analysts will often prepare the CAD geometry for analysis to improve the speed and accuracy of results. Initially, analysts will assess the overall geometry and de-feature CAD models to remove unnecessary features.

As a rule, analysts are not CAD experts, and do not spend their time performing CAD or design work.

Direct modeling tools enable CAE & FEA experts to quickly prepare their 3D models for analysis and optimization.

The direct modeling paradigm is best suited to the needs of analysts working with legacy and heterogeneous CAD data. The geometry-based approach of direct modeling eliminates the need to access feature-level information to implement design changes. Analysts can easily edit, modify and repurpose data from any CAD source.

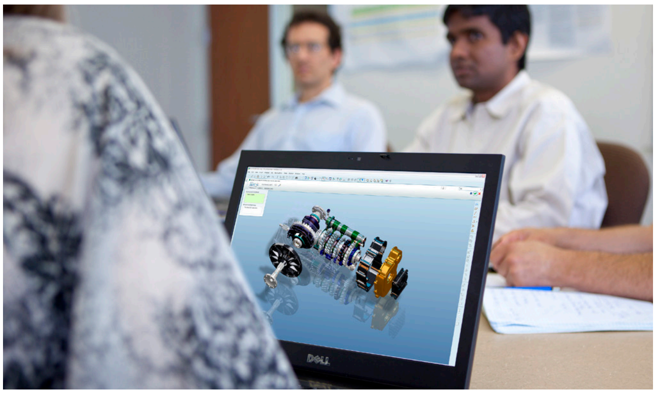
9 CREATING DOWNSTREAM DELIVERABLES

Team Goals:

- Speed the creation of downstream deliverables to improve product-development efficiency and productivity
- Support the ease-of-use requirements of casual and non-CAD users
- Enable downstream users to work with and leverage heterogeneous CAD data

Parametric CAD Challenges:

- Downstream users are not expert CAD users, thus they must rely on engineers to prepare geometry to support downstream deliverables
- Inability to provide the flexibility and freedom to work with data from any CAD source



With direct modeling, downstream teams can easily leverage designs for their specific needs.

There is a wide range of downstream deliverables that must be created to support product development and the product lifecycle. These deliverables ensure that the product can be properly manufactured, supported and serviced. Typical deliverables include CAD illustrations required for service manuals and spare-parts catalogs. As well, fixtures and jigs must be created to support inspection and machining processes. Fortunately, the majority of end-deliverables do not require the downstream user to create complex CAD geometry, but only to reference and utilize the CAD information.

The ideal CAD solution for creating downstream deliverables is one that provides the proper level of usability to allow casual and non-CAD users to create their end-deliverables. In addition to ease-of-use, the appropriate CAD solution must make it easy to work with data from any CAD source.

The direct modeling paradigm provides the ease-of-use and modeling flexibility required to define the complete range of end-deliverables. Its history-free, geometry-based modeling supports heterogeneous data and the need to implement unexpected and radical changes. Users can leverage a geometry-based approach to edit, modify and repurpose heterogeneous CAD geometry with ease.

10 DESIGN REVIEWS

Team Goals:

- Accelerate design reviews to improve product-development efficiency and productivity
- Eliminate/reduce the need to schedule follow-up meetings

Parametric CAD Challenges:

- Inability to demonstrate and assess "what-if" scenarios during the design review process
- Inability to make unexpected and radical edits to CAD geometry

Design reviews are required so that cross-functional team members can get together and review the status of key engineering deliverables and program milestones. In addition to reviewing design activities and the team's progress, the design review process is an opportunity to leverage the collective knowledge and expertise of the team in troubleshooting and solving engineering challenges.

To improve the efficiency and effectiveness of the design review, the CAD solution must offer designers the speed and flexibility to create and manipulate geometry on-the-fly. By leveraging the proper CAD solution, users can eliminate or reduce the need to schedule follow-up meetings, saving time, effort and cost.

To speed the design review process, it is often necessary to edit, reuse and repurpose CAD geometry to demonstrate design alternatives.

The capabilities of direct modeling provide the maximum flexibility by ensuring that any data can be edited, reused or repurposed to quickly mock up geometry that represents a new product configuration or an alternative to be evaluated.

LEARN MORE

No doubt there are many ways that direct modeling can complement parametric modeling within the product development spectrum. That's why many organizations are choosing to implement both styles of modeling within their operations.

If you're considering adding direct modeling to your design strategy, keep in mind that PTC is the only vendor on the market that offers a complete range of fully integrated modeling paradigms, including 2D, 3D direct, and 3D parametric.

To learn more about PTC design solutions, visit PTC.com/creo

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