

Why you may need parametric and direct 3D CAD

FIVE AREAS WHERE PARAMETRIC MODELING COMPLEMENTS DIRECT

Introduction

For too long, product design teams have been forced to compromise when it comes to using MCAD software. 3D users have been limited to a single modeling paradigm for all jobs—parametric or direct modeling.

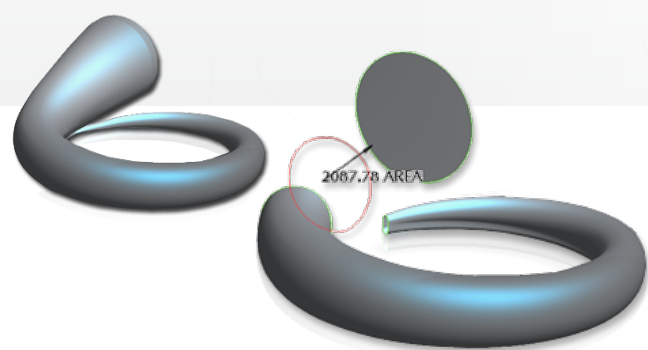
But now, you're free to choose the right tool for the design task at hand: 2D or 3D, parametric or direct, whether you're creating designs or viewing them. With the Creo™ Elements suite of design solutions, you have interoperability as never before. Freedom, instead of limitations.

Here are five reasons why complementing direct modeling environments with parametric modeling offer 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, enabling designers to quickly define and capture geometry. With the direct modeling approach, users focus on creating geometry rather than features, constraints and design intent. The parametric modeling paradigm, on the other hand, provides an “engineer it” approach that requires the user to anticipate and define feature constraints, relations and dependencies to ensure that any design modification will update all related geometry in a predefined manner.

The “just do it” direct modeling approach is about speed and responsiveness-to-change, making it the best strategy for design tasks where speed and flexibility are key. The parametric approach, on the other hand, is better suited for those design tasks where the designer is given strict criteria to meet design aesthetics, performance and manufacturing criteria; the added effort and upfront planning is justified to deliver the downstream benefits.



Highly engineered designs are mostly a result of driving geometry from engineering relations, formulas, and graphs. The turbo charger compressor above is defined using advanced surface functionality driven by a graph and mathematic equation.

Let’s look at five areas of product development where parametric modeling can complement a direct modeling environment.

1 Improve the control of highly engineered and complex geometry

Team goals:

- Control any geometry regardless of shape or complexity
- Support the control of precise engineering geometry; derive geometry from engineering relations, formulas, external calculations, etc.

Direct modeling challenges:

- Direct 3D CAD solutions are able to create any type of complex geometry, but have limited capabilities to control geometry
- The control of precise, highly engineered and complex geometry requires the ability to define and drive intelligent geometry – via feature constraints, dimensions, variables, etc.

Solution requirements:

- Implement comprehensive geometry control capabilities
- Speed the creation and editing of controlled geometry
- Enable iterative design and reuse of CAD geometry

To support engineering and control of highly engineered and complex geometry, the CAD solution must provide the ability to control any geometry regardless of shape or complexity. The CAD solution must enable the user to create control of complex, precise engineering geometry, with the ability to derive geometry from engineering relations, formulas, graphs, and external calculations.

The CAD solution must enable users to capture, reuse and repurpose design intent to solve for current and future requirements. Rather than redesigning the part, engineers want to add control in editing design objectives, calculations and driving dimensions to iterate the original design.

A parametric-based 3D CAD is best suited to define control for highly engineered, complex geometry.

2 Maintain designs with tightly associated engineering deliverables

Team goals:

- Create engineering deliverables, tightly associated to the design to improve efficiency and productivity throughout the lifecycle
- Reduce the time required to create associated engineering deliverables
- Streamline the ability to implement change; leverage design associativity to push automatic updates

Direct modeling challenges:

- Direct 3D CAD solutions provide complete flexibility to change any design and engineering deliverables, but often lack the ability to define or maintain associativity between them to push associative design changes through
- Third-party applications are required to create engineering deliverables; non-integral capabilities make it difficult to drive associative changes

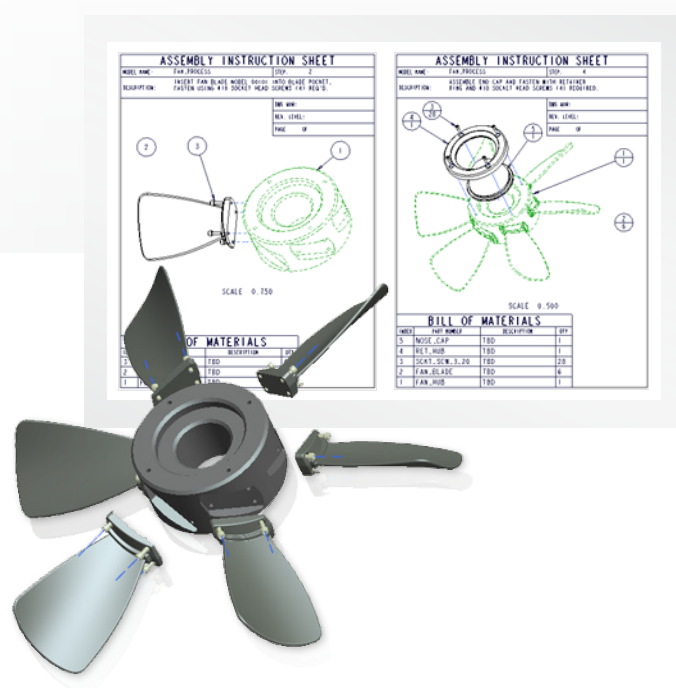
Solution requirements:

- Define and maintain associativity by adding comprehensive parametric 3D capabilities
- Speed the creation and editing of engineering deliverables associated to the geometry
- Enable iterative design and automatic update of associated downstream deliverables

Engineering deliverables are created throughout the product development process to support production and manufacturing requirements. Typical deliverables include 2D detailed drawings, assembly and disassembly procedures, production mold geometry and manufacturing tool paths. The common variable is that all these deliverables directly reference the engineering design geometry and must be up-to-date with the current status or model revision.

Direct 3D CAD solutions provide tools to create and maintain designs and engineering deliverables, but typically lack design associativity and model history. Rather than reference the design geometry and maintain an associative link back to the information, history-free modelers maintain the benefits of design freedom, but have less focus on a complete associative process for design and engineering deliverables. Additional challenges result from the use of third-party application to create downstream deliverables such as manufacturing tool paths or mold base designs. The third-party applications, although capable, require CAD data translation, and break associativity, thereby limiting the ability to drive associative change.

Parametric modeling best streamlines and automates the associativity and update of downstream engineering deliverables.



Time and cost savings can easily be achieved when associated engineering deliverables are automatically updated with design changes.

3 Speed the creation of family-table and configurable products

Team goals:

- Accelerate the design of family-table and configurable products to improve engineering productivity and efficiency
- Create intelligent geometry that can be reused and repurposed as variants in the product family or for the same platform
- Automate the creation of family-table and configurable products

Direct modeling challenges:

- Direct modeling does not capture design history; family-table product definition requires access to design variables, parameters, features, etc.
- Direct modeling only allows designers to represent one product configuration at a time—instead of representing all required parts of a product family

Solution requirements:

- Define robust parametric geometry
- Create comprehensive family-tables
- Reuse design intent

Family-table functionality allows designers to drive component instances using variables specified in the family-table, rather than having to model every variation of a component. To understand family-table geometry, envision a simple bolt or fastener. Family-table instances of the design may vary the screw thread, shaft length, diameter, and bolt head configuration. The single generic part can support an unlimited number of product configurations.

In addition to defining variables, the CAD solution must also understand feature relations and dependencies to ensure geometry can be defined to update in a predictable, pre-defined manner. The overall goal is to automate the creation of family-table and configurable products, thus leveraging the intelligent creation and capture of geometry.

Direct modeling typically allows designers to create simple design variants using geometry and part relations. However, since it does not retain model history or feature-level information, family-tables consisting of multiple variants at a time cannot be created due to the lack of design variables. 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.

To speed the creation of family-table and configurable products, it is essential to leverage the parametric modeling paradigm to capture model history, design intent, and dimensional constraints.



Family-table functionality allows component instances to be driven via variables specified in the family-table.

4 Improve product performance, quality and durability with design automation

Team goals:

- Capture market share and competitive edge
- Enable engineers to create the optimal design, by solving for engineering criteria and design goals
- Create robust engineering geometry that can be rapidly iterated, leveraging design variables and design intent

Direct modeling challenges:

- Slow, tedious process to automate the optimization of non-intelligent geometry; cyclic process of designing, analyzing and refining geometry
- Direct modeling paradigm cannot automate design optimization; process must be automated to achieve design goals and objectives for optimized designs

Solution requirements:

- Support the automation of optimizing intelligent geometry
- Enable iterative design and reuse of CAD geometry

To gain competitive edge, companies must strive to create products that offer enhanced performance, durability and quality. The optimization for any product that has a measurable design goal or criteria can be automated by leveraging the capabilities of automated design optimization.

Design optimization is based on a cyclic process of designing, analyzing and refining geometry. High-quality parametric CAD solutions allow creating a design optimization study that defines the design goal and variables that can be used to satisfy the condition. Once defined, the system automatically iterates the design variables, rebuilds geometry, and compares the results against the design goal. The process is repeated until the design goal is achieved and geometry is optimized. What could typically take hours, days or months is completed in minutes.

The challenge is to support intelligent geometry creation and design optimization driven by engineering equations and design objectives. Given design deadlines and reduced budgets, companies are challenged to support the iterative design process and often settle for less-than-optimal design conditions. The direct modeling paradigm cannot automate design optimization due to the inability to drive intelligent geometry via measurable design criteria.

To effectively solve for complex design goals, the process must be automated to remove reliance on manual interaction and to support system automation. Parametric modeling is best suited to support this goal.



A design optimization example: To properly balance a golf club, the design must be created so that the shaft axis passes through the axis that is defined through the club's center of gravity and perpendicular to the club face. (Graphic courtesy of PING, Inc.)

5 Improve assembly variant design processes

Goals:

- Optimize variant design of assemblies to improve engineering productivity and time-to-market
- Streamline assembly variant design and support top-down processes
- Accelerate the creation of variant designs and configurable products
- Enhance assembly performance when working with variant assemblies

Challenges:

- Direct modeling does not optimally support top-down design processes or the creation of configurable products

Requirements:

- Support variant design and configurable products
- Streamline assembly design and improve system performance

For manufacturers who offer configurable or customized products, the assembly design process is highly complex due to the need to design and validate multiple product configurations and variants. To model variant and configurable geometry, the CAD solutions should address the ability to work with interchangeable components and automate the creation of assembly configurations.



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

To improve assembly design for configurable or customized products, the CAD solution must streamline assembly creation. It also needs to provide support for advanced methodologies such as top-down design to manage and control assembly dependencies. The top-down design methodology places an emphasis on planning and communicating the complete understanding of the system, leveraging a simplified representation or “skeleton model” to define the assembly structure.

The ability to support the top-down design process of variants and configurable designs is best supported by the parametric modeling paradigm due to the reliance on intelligent geometry and CAD data associativity.

Variant and configurable products require a level of design intelligence that cannot be captured leveraging direct modeling capabilities.

Parametric modeling supports parameter-driven geometry and offers programming capabilities to modify system parameters and specify alternate design configurations.

Learn More

PTC.com is your best source to learn about parametric and direct modeling, as PTC is the only vendor on the market that offers a complete range of modeling paradigms, including 2D, 3D direct, and 3D parametric. To learn more about PTC design solutions, visit <http://creo.ptc.com>

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