Parametric Modeling:
The New CAD Paradigm for Mechanical Designs

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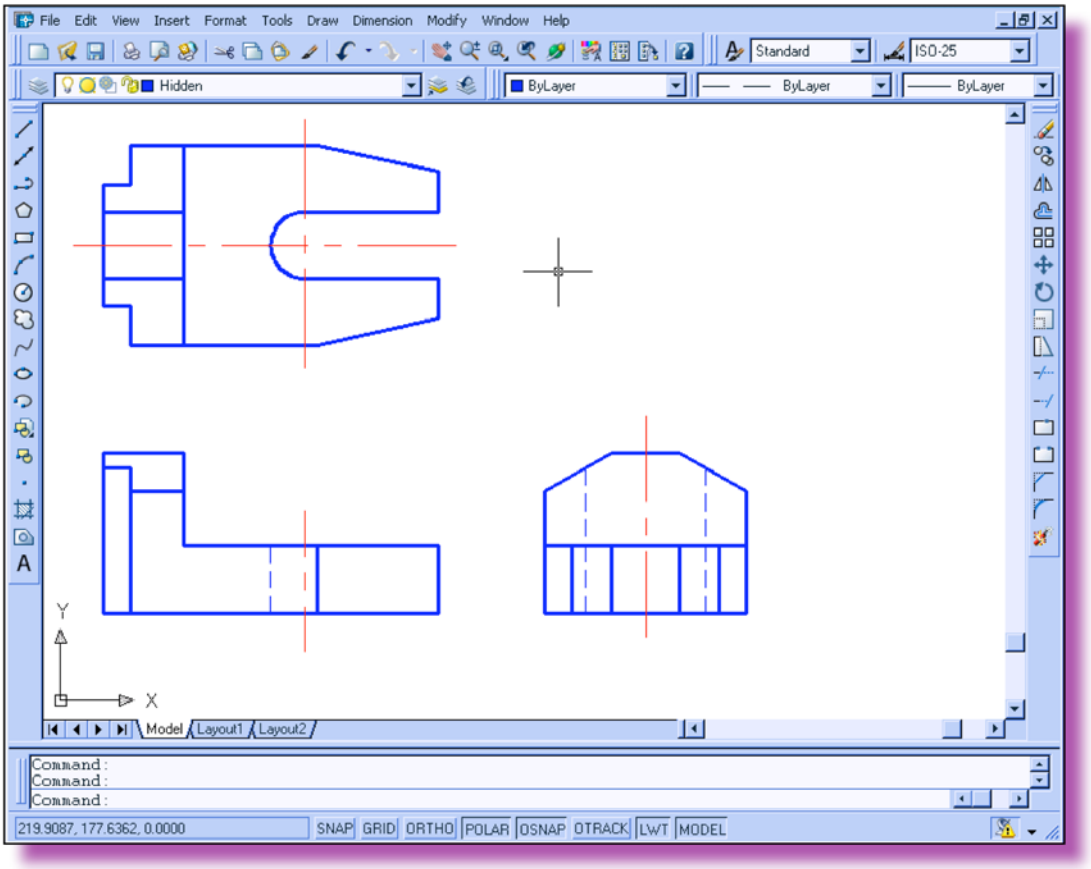
There is a new kid on the block in the arena of mechanical CAD technology, and that new kid has already formed a new paradigm of creating designs as well as 2D drawings. That new kid is *parametric modeling*.

Mechanical CAD is a relatively new technology. In parallel with the development of the computer hardware technology, mechanical CAD development has happened in the last 40+ years. The first generation CAD systems were 2D only, basically a replacement of pencil and paper. The very popular AutoCAD, first released in 1981, gained its popularity as one of the best first-generation 2D CAD systems. Even today, many companies still use these 2D CAD systems to create designs and 2D drawings.

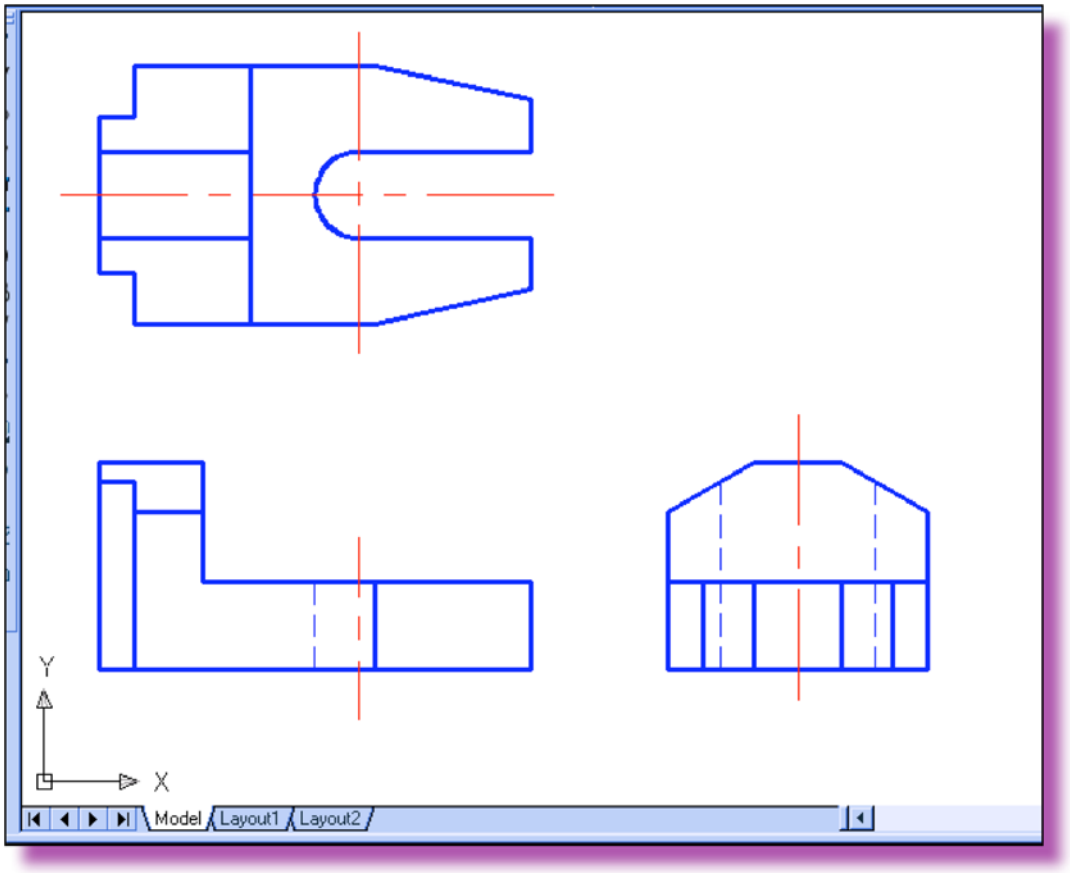
There is nothing wrong with using the first-generation CAD approach to create engineering designs and 2D engineering drawings, as many engineers still do. Parametric modeling provides a more flexible and powerful approach, and in most cases, this approach is faster and more effective for design and production processes.

First-Generation CAD

Generally speaking, using the first-generation CAD approach requires knowing the actual dimensions of the design. Therefore, this approach is less flexible than parametric modeling. For example, the figure below shows a 2D mechanical design created in AutoCAD.



Note that (1) the creation of these views requires knowing the dimensions and (2) each of the three views is created and edited independently of the others, as shown in the figure below. Changes in one view are not automatically reflected in the other views. Each view has to be updated manually.



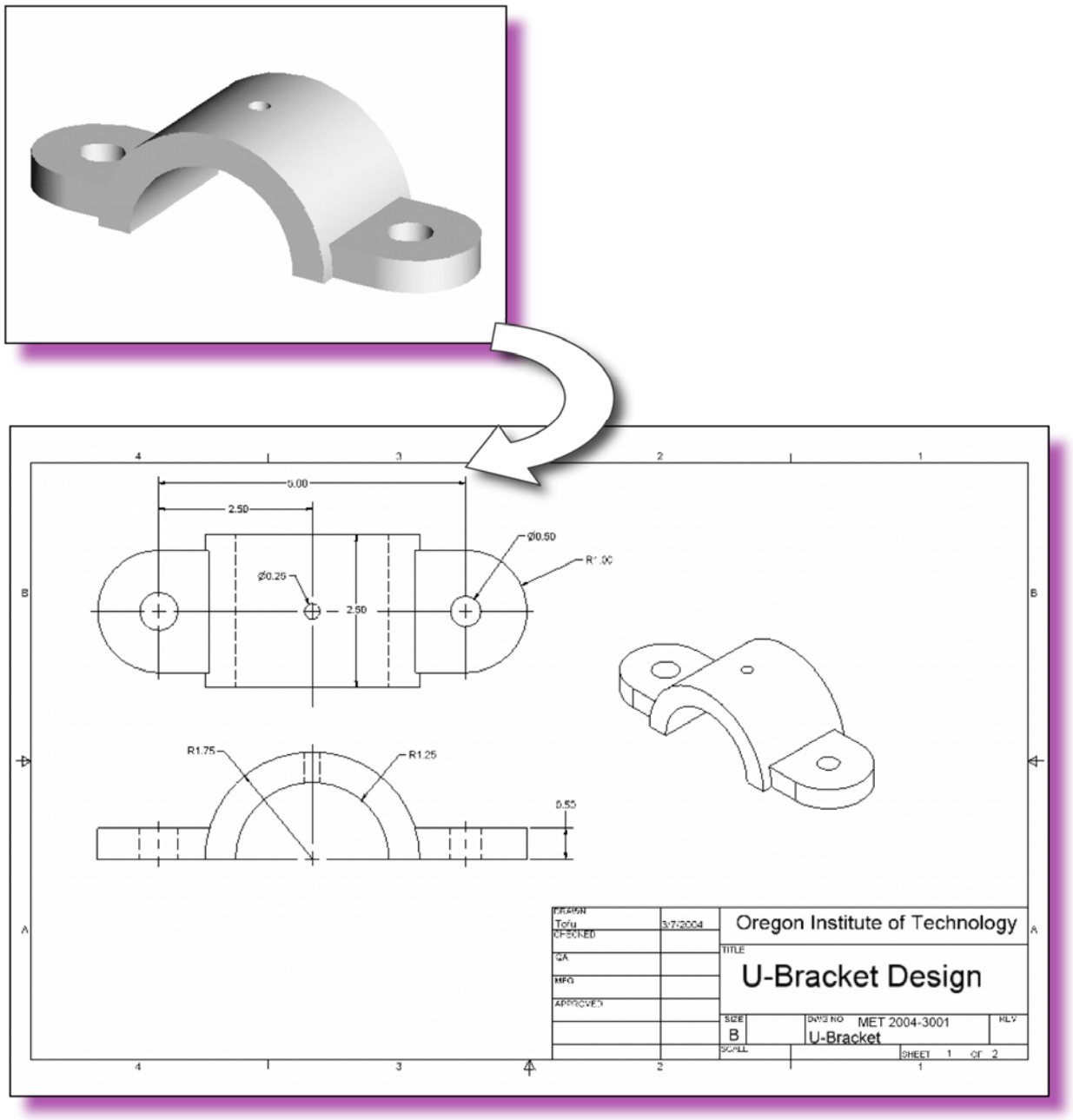
Parametric Modeling

Parametric modeling was first introduced at the end of the 1980s, and it has recently become the new paradigm for Mechanical CAD designs. The parametric modeling approach has elevated computer-aided design technology to the level of a very powerful design tool. Parametric modeling automates the design and revision procedures by the use of parametric features.

Parametric features control the model geometry by the use of design variables. The word *parametric* means that the geometric definitions of the design, such as dimensions, can be varied at any time in the design process. *Features* are predefined parts or construction tools in which users define the key parameters. A *part* is a sequence of features, which can be modified at any time. The concept of parametric features makes modeling more closely match the actual design and manufacturing processes. In parametric modeling, every aspect, view, and assembly associated with the models and drawings are updated automatically as the design is refined.

The Basic Scheme of Parametric Modeling

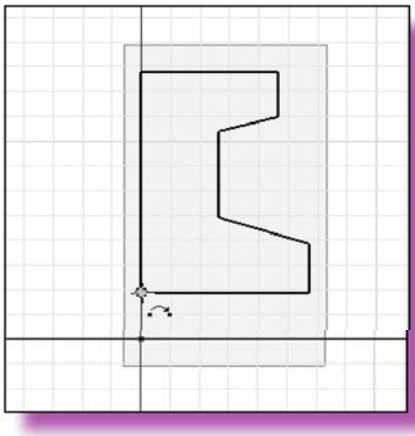
The solid model is created first and is used as the basis for all other applications, such as 2D drawing, assembly modeling, and stress analysis.



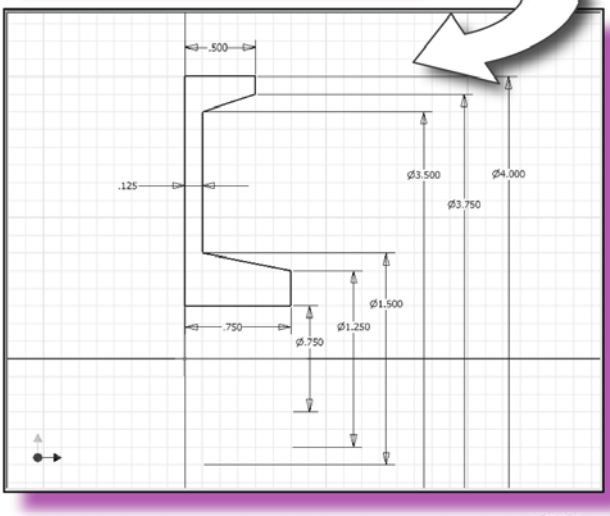
The 2D drawing is generated from the 3D model. Any modifications made to the 3D model at any time are automatically reflected on the 2D drawing.

2D Parametric Sections

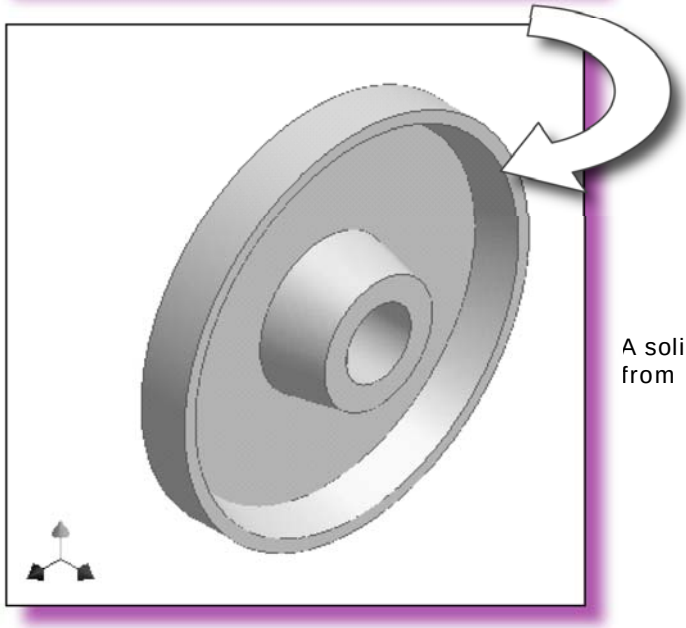
In parametric modeling, 2D sketches are still used; they are known as *parametric sections*. Parametric sections typically start out as sketched individual entities (lines, arcs, etc.), but the geometric properties and dimensions are parametrically controlled so that geometry can be modified quickly, as illustrated in the following figure.



Note that the initial sketch can be done without knowing the actual dimensions. This conforms to the design philosophy of *shape before size.*



Dimensions are added and used as control variables. The sketch is adjusted by changing the dimensions.



A solid model is constructed from the parametric section.

Benefits of Parametric Modeling

Parametric modeling offers many benefits:

- We begin with simple, conceptual models with minimal detail; this approach conforms to the shape-before-size design philosophy.
- Geometric constraints, dimensional constraints, and relational parametric equations can be used to capture design intent.
- The entire system, including parts, assemblies and drawings, can be changed simply by changing one parameter of a complex design.
- We can quickly explore and evaluate different design variations and alternatives to determine the best design.
- Existing design data can be reused to create new designs.
- Parametric modeling provides quick design turnaround.

Today, the benefits of using parametric modeling are realized and gladly accepted by industries. Parametric modeling is the new kid on the block, but this new kid has revolutionized the mechanical CAD arena, and it is here to stay.

Credits:

Illustrations used in this article were created with AutoCAD® and Autodesk Inventor®.

For more on parametric 3D modeling, see Glencoe's Designing with Inventor 10