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**Power is Everything**

When called upon to redesign the design process, sophisticated C makes the difference between freedom to be creative and worry al constraints.

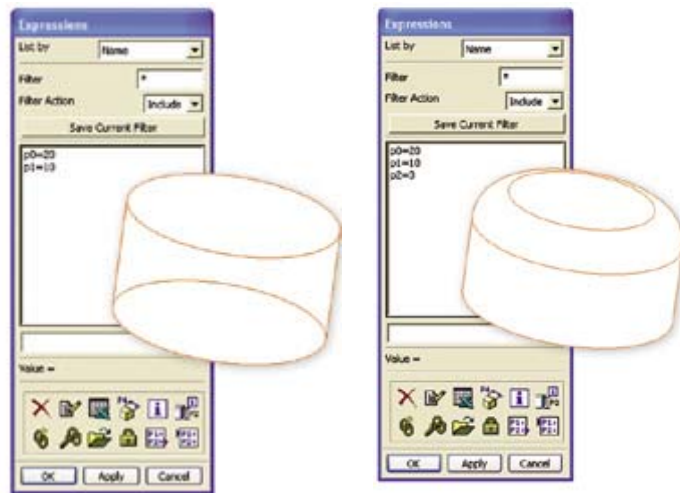
Stephen Samuel

As a company devoted to helping other design firms do what they cheaper, and better, Design Visionaries is often asked to redesign design process. More often than not, we get that job done most eff by using the capabilities of high-end software. We have found that functionality of a sophisticated CAD package like Unigraphics NX2 ProEngineer Wildfire, or even SolidWorks, gives us the flexibility to creative and generate a great variety of designs. While some user high-end CAD overly complicated, flexibility is the key to greater ci and you just don't get that with low-end CAD packages.

The optimum design process is one that is customized to your app you are designing something like a valve body, which follows long-established rules, you'll be best served by a straightforward proces Chances are you won't need to create numerous iterations and we aided greatly by parametric start parts and programs that calculate geometric dimensions. On the opposite end of the scale, for exam toy robot with a lot of moving parts. The actual geometry might be completely different than the toys you have designed in the past. In case, a meandering design process might be best, as the toy robo involve many changes in design. The process must allow you to ite easily as the toy may not have a prescribed shape. You might nee change the design radically after marketing reviews, child safety re manufacturing cost reductions, etc.

Whether your design process is straightforward or meandering, the system needs to enable you in many ways. It has to have a good i interface, powerful mathematical algorithms that don't trip up, easy

features, and a huge variety of other competitive attributes. On a rudimentary level, however, the optimum CAD system must free your mind so you can concentrate on the actual design. You shouldn't waste time thinking about how the software will work or how it will let you do certain things. Flexible CAD software allows you to create the same geometry in a variety of ways and ought to get out of your way and do what's important: be creative. For example, Unigraphics NX2 lets you create a hole on a face with the hole option, an extruded sketch, a fillet, trimming, an extruded solid edge, an extruded curve, a subtracted sketch, and a host of other options. ProEngineer allows you to simultaneously create a hole on a face and a symbolic thread.



Figures 1 and 2: Shows changes to a design created using Unigraphics NX2. The software's Expressions List captures parametric data and makes it accessible to the user throughout the design process.

But the real gem in the NX2 package is its ability to let you customize the design process, whether it meanders or is straightforward. Out of the end CAD packages, Unigraphics NX2 has one of the best ways of capturing and relating parametric data with its Expressions List. As you create features, holes, blends, extrudes, and the like, NX2 places all pertinent numerical data into a sequential list, and the list remains accessible throughout the design process. For example, if you specify a cylinder 10mm high by 20mm dia., you will find that expressions $p0=20$ and $p1=10$ are automatically added to the expression list for that part (see Figure 1 above, left). Should you then place a 3mm blend on the edges, $p2$ shows up (Figure 2; above, right).

Certainly, every good CAD system has something similar, but Unigraphics is unique in that you get access to the entire list of expressions at any time with one menu pick. You're also afforded the opportunity to relate expressions at any time, then rebuild the model with the new mathematical assumptions. For example, if your application called for a cylinder whose height is twice its diameter, you can edit the expressions to $p0=2*p1$. In doing so, you will have created an independent/dependent relationship between the two attributes of the cylinder and, in essence,

it design intelligence. So, when you make design changes down the line you will only have to think about one variable, because you have built the intelligence into the model.

To go a step further, you can easily change the names of the expressions. For example, instead of $p0=2*p1$ you can replace the variable name with "cyl_height." It's easy to do and very important because an expression for a complex model may have thousands of expressions that will be confusing to constantly read through.

On a higher level, the ability to incorporate complex mathematics provides a tremendous help. For example, it makes the design of a paraboloid dish easy to execute. The equation for the shape can be easily entered before you create your first geometric feature. You can pre-create expressions for attributes, such as focal distance, surface area, and thickness. Next, you create a profile that will be linked to those equations and revolve the profile into a parabolic surface. If you want to characterize the design later, all you have to do is change the values in the expressions. In essence, you write a mini program that creates the geometry.

On an even higher level, the ability to capture the logic of your design. The logic of certain design attributes enables more complex customizations.

Another example is the design of a machine that has two components together. To achieve high accuracy, it is commonplace to include precision locating pins to guarantee position. As you design the holes for the bolts, it is important to take into account tolerance data. The holes for the pins might require a tight fit, but the bolt holes should be loose enough so that tolerances aren't problematic when it's time to assemble the machine. To capture all this design intelligence, you need to have access to appropriate what-if statements:

Let "d" represent the diameter of the pin hole;

```
d=if(pin_diameter)<=(4.0127)else(d2)// values for a  
tight fit 4mm pin
```

```
d2=if(pin_diameter)<=(6.0127)else(d3)// values for a  
tight fit 6mm pin
```

```
d3=if(pin_diameter)<=(7.0127)else(d4)// values for a  
tight fit 7mm pin
```

```
d4=8.0127 // values for a tight fit 8mm pin
```

This small piece of code allows you to automatically select the right size of your pins. If you set the model up as shown above, you will be able to get the correct fits on the fly, without having to stop and look them up.



Yet another innovation contained in the program is the ability to assign an expression value to the length, angle, or distance between two features. This enables you to create models whose geometry changes based on the positions and shapes of other components. In NX2 it's called a "geometric expression".

An example might be the calculation of the stroke and angles necessary for the smooth operation of a gas shock/spring device mounted to a door. As the door is opened and closed, the angles of the spring relative to the door frame are automatically returned to the expressions list for design (see Figure 3).

When it is fully closed, the angle of the door is captured by geometric expressions, and when it is fully open, the geometric expressions are updated with different values (see Figure 4, at right).



The entire range of such advanced design methods found in the Unigraphics NX2 package are too numerous to describe in a single article. Nevertheless, they comprise a tremendous opportunity to streamline design procedures, giving engineers the time to be more creative. As always, it is difficult to find the one best way to design a given component. But it is certain, as these methods are understood and used more frequently, design engineers become increasingly capable of accomplishing their tasks. There can be no doubt that the more conversant engineers with advanced techniques of high-end CAD software, the more competent they will become.

*A mechanical engineer with 10 years' experience designing jet engine components for Pratt & Whitney, **Stephen Samuel** is the founder and president of **Design Visionaries** (San Jose CA; designviz.com), which has been helping clients design new products. You can contact him about this article at de-feedback@helters.com.*

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