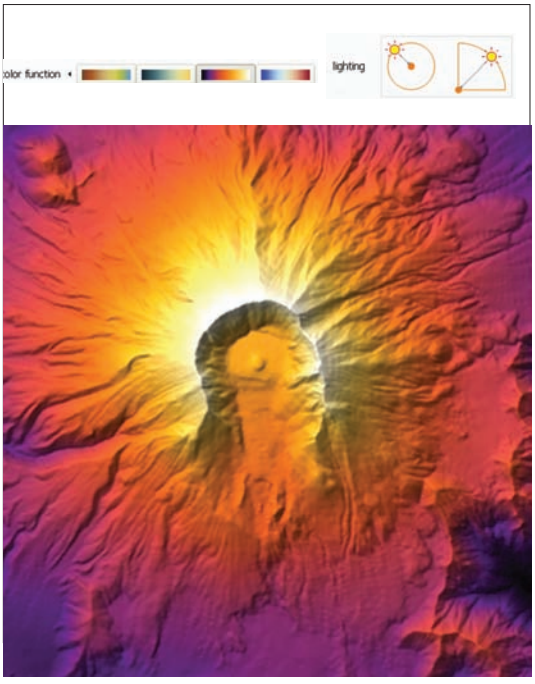
# Mathematica 6: A new revolution?

Software that helps engineers and scientists do mathematics has been around for over 45 years, since the beginning of scientific computers. Back then, of course, it probably used a programming language such as FORTRAN, which required the user to write a software program or algorithm to perform the operations. But engineers and scientists did not necessarily want to learn a programming language—they just wanted tools that could help them do their work.

Fast-forward a generation after the initial use of FORTAN and you get the first version of a math package from a company called Wolfram Research in Champaign, Ill. [http://www.wolfram.com]. At first this package, called Mathematica, was considered a programming language and an application as well as a communication and computation system. Mathematica provided key math algorithms that could be used standalone (adding 2+2 and getting 4), or as a programming language (by piecing a variety of mathematic expressions together to solve an engineering problem). Its other big advantage was that it graphically expressed the results of the work performed.

In early May of this year, Wolfram Research announced the newest version of this package, Mathematica 6. This release, according to the company, takes technical computing to a new level: more tightly bound, more natural, and more automated, applicable to a far wider range of areas than ever before. Central to this achievement is "instant interactivity"—taking models, simulations, computations, or just about any concepts and turning them into fully interactive applications, sometimes within seconds. Let's investigate some of these new capabilities.




*The software enables the presentation of highly detailed objects, as seen in this relief shaded elevation map.*

## Dynamic interactivity

Dynamic interactivity is Wolfram's way of describing the ability to manipulate and visualize graphical information in a fluid or dynamic manner. With this capability, engineers can animate their graphs. These graphs can then be visualized either automatically or by moving a slide bar with appropriate values. Another way of looking at this capability is to consider a set of what-if scenarios with certain key variables. With dynamic interactivity, a user can easily view the graphical results by changing the variables on a slide bar.

Another example the company uses to describe some aspects of this capability is the analysis of a mechanical cog. In this case, cog position, number of teeth, tooth contact angle, and tooth deport are all variables. Each of these variables has a separate slide bar. One can easily see the effects of changing the quantity of any (or all) of these variables. The visualization of this is quite effective.

This dynamic interactivity is not limited to graphics. Tables, text, or algebraic text also can be manipulated. One can view a matrix with $n$ rows and $m$ columns. The matrix itself can be displayed dynamically, with the number of rows and columns specified, or by setting up a slider that can increment the number of rows or columns independently. This is also available for algebraic text.

This capability provides a novel way to view a variety of data, graphs, expressions, or objects. The ability to combine dynamic interactivity into the Mathematica programming language gives engineers an effective tool for conducting their analyses.

## Unification of graphics

Mathematica achieves a unification that integrates fully editable and active graphics, text, math, tables, controls, and user interfaces in every aspect of both input and output. By building on its symbolic architecture and notebook document paradigm, the software allows all these elements to be mixed and connected. In any document it produces, the graphics can contain arbitrary active elements, controls, and other features. This allows the user to generate an interactive report. In addition, the graphical control can be viewed as a label or as a value. These elements can be nested in various ways.

Another key component is the context-sensitive size feature. This is the ability of the graphic to size itself automatically, depending on the output formats (interactive document, presentation, or printed).

## Computational aesthetics

A key strategic initiative of Wolfram Research is to enable users not only to perform mathematical computations, but also to present them in a manner that is compelling and accurate. This documentation capability also should be part of the process, not something that must be completed after the computation and analysis are finished. To this end, Mathematica offers immediate, automatic creation of publication-quality visual material.

Along with this publication quality, the software also provides an option for both high-level and detailed control of aesthetic criteria. Interesting components of this documentation provide these automatic functions:

- Meshing, lighting, and labeling in 2D and 3D graphics.
- Coloring, transparency, and markers for multiple curves, regions, or data sets.
- Context-sensitive sizing and proportioning of the graphics.
- Scalability of large data sets and complex graphics.

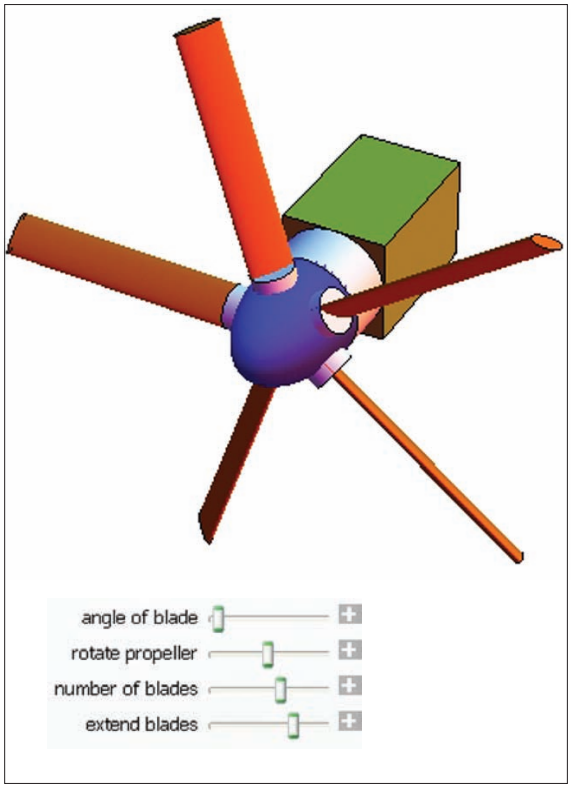
Another key set of features that I especially like provides help with the aesthetics (an area where I am not strong at all). These include highlighting segments and choosing color schemes for both artistic and scientific areas.

The bottom line here is that all of this capability is not useful unless the results can be presented to others effectively. A helpful feature in this regard is Mathematica's high-resolution printing capability, which is fully supported for all output.

## Symbolic interface construction

One key advantage that Mathematica has over other products is its programming language capabilities. With this new version, Wolfram has improved the user interface, making it easier for nonprogrammers to program algorithms. Mathematica provides a library of elements that can create sophisticated programs. These include 2D and 3D sliders for graphical representation, the use of checkboxes, radio buttons, toggles, pop-up menus, input fields, mouse positioning, panes, and many more. Being able to add these elements with little additional programming is vital for making professional programs quickly and effectively.

Mathematica also lets users check and test the algorithm or the program that is being created. This version supports the ability to build the program incrementally. Using this approach, the user can test these subparts of the program without any compiling. In addition, the interfaces can be reconfigured dynamically and in real time.




*An aircraft propeller is modeled with the use of distorted cylinders, a sphere, and a cuboid. The controls enable a user to vary the angle, length, and number of blades, and to rotate the propeller.*

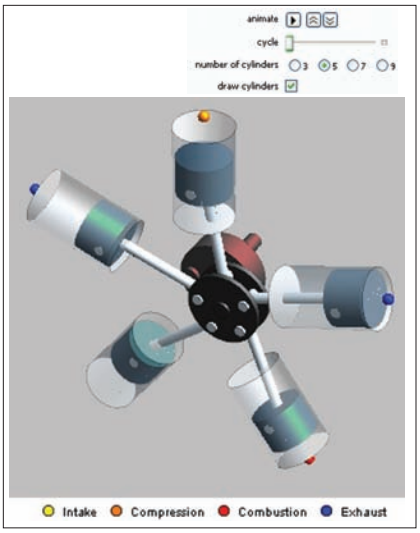
## Load-on-demand curated data

The load-on-demand module provides a mechanism that makes hundreds of gigabytes of carefully curated and continually updated data immediately available inside Mathematica for use in computations. This version introduces major collections of data in mathematics, physics, chemistry, astronomy, geography, linguistics, and finance—all organized and aggregated for the first time by Wolfram Research for direct use in computations. This is basically a set of available math and science information that is well catalogued right on your computer. No Google, Ask, Yahoo, Lycos...no Web searches required.

In this model there are properties of all the chemical elements and data on all known subatomic particles. There is extensive information on molecular, physical, and chemical properties of common compounds, and on the planets, moons, and over 100,000 stars and galaxies. Combining all this with the ability to plot, graph, or visualize the data in unique and interesting ways gives users a degree of functionality available in few other products.

## Wolfram

Wolfram Research is the brainchild of company founder and CEO Stephen Wolfram. He is also the creator of Mathematica and the author of *A New Kind of Science*. Wolfram began developing Mathematica in late 1986, and the first version was released on June 23, 1988. What made this product different from others




*Radial engine can be examined from any angle.*

in the field was that it provided a mechanism for direct computation of advanced mathematical concepts and symbols.

Born in London in 1959, Wolfram was educated at Eton, Oxford, and Caltech. He published his first scientific paper at age 15 and had received his Ph.D. in theoretical physics from Caltech by age 20. His early scientific work was mainly in high-energy physics, quantum field theory, and cosmology. Wolfram is well known as an innovative scientist, author, and businessman.

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A basic question might be asked about this latest release: Is this a new Mathematica? Is it a new invention, a truly innovative technology? I personally am not sure this claim is correct. Mathematica is a wonderful product; I really enjoyed the new user interface, the dynamic graphics, and all the extra features. I particularly liked the integrated geometric computing area. But the hyperbole the company has created regarding the new Mathematica is a bit overblown.

This does not mean that Mathematica is not worth all the effort that went into it. It certainly is. All the features, the ease of use, the new user interface are indeed worth it. However, it is not all brand new. Mathematica certainly is a valuable and effective product. If any fault can be found, it is only with its advertising hype, not with its capabilities.

**John D. Binder**
jbinderaero@rcn.com

## NOTED IN BRIEF

**Dassault Systèmes** (Charlotte, N.C.) [http://www.3ds.com] announced the availability of **ENOVIA MatrixOne 10.7.1**. This solution supports Dassault's strategy of targeting and supporting vertical industries, in line with the delivery of 3DLive, the company's solution for online collaborative intelligence. NOVIA PLM SOA middleware enables its customers to integrate collaborative business processes into other SOA environments. Less than a year after Dassault's acquisition of MatrixOne, it is delivering a solution that combines the product knowledge of CATIA/ENOVIA VPLM with the enterprise visibility and collaborative business process management capabilities of ENOVIA MatrixOne. Direct access from ENOVIA MatrixOne to the ENOVIA VPLM engineering work-in-progress environment gives project managers real-time visibility into engineering activity and project status, allowing them to identify potential issues early in the product development process. An added benefit is a new ENOVIA solution that combines management of design work-in-process and X-BOM views, seamlessly integrating design and engineering communities with the rest of the enterprise.

**IntelliCAD Technology Consortium (ITC)** (Portland, Ore.), the developer of IntelliCAD core technology, today announced the **New IntelliCAD**. This is a complete redesign of the widely used IntelliCAD engine, an open platform on which hundreds of engineering applications have been based. The new product, which will offer greater speed and wider functionality, is based on DWGdirect, a nonproprietary design format compatible with ARX and Autodesk-related systems available from the Open Design Alliance. ITC welcomes all developers who have ARX applications, and all application developers closely reliant on IntelliCAD technology, to learn more about the New IntelliCAD. Interested parties may register at http://www.intellicad.org/register/. Registrants will receive invitations for webinars, newsletters, and beta testing opportunities, as well as status updates on the New IntelliCAD's development and availability. ITC anticipates the alpha test release this month and the full release at the start of 2008.

**Pinion Software** (Austin, Texas)[http://www.pinionsoftware.com] launched **ShareSafe Desktop-Enterprise Edition** for engineers, manufacturers, and purchasing professionals working inteams. This version introduces several major enhancements, including an embeddable security-packaging engine, new recipient authentication module and access control features, and serialized watermarking for PDF files. ShareSafe provides comprehensive file security (including data destruction when permissions expire) for dozens of mechanical CAD files, engineering data, and files generated from popular business applications. Users can create and share files in their native application format while retaining continuous control over how the information is used by recipients, both inside and outside the corporate firewall. Users can also implement time-based access to files and impose an automatic shred date to self-destruct files on remote computers.

**Leica Geosystems** (Norcross, Ga.) [http://www.leica-geosystems.us] has developed **IPAS PPP Post Processing Software**. This new package within the IPAS (Inertial Position & Attitude System) product family reduces the need for reference station data. IPAS PPP software determines high-accuracy position and velocity data from a single Global Navigation Satellite System receiver. It then uses PPP (precise point positioning) technology to take advantage of precise satellite orbit and satellite clock corrections while postprocessing the trajectory of the sensor flight mission. The automatic download of precise satellite orbit and clock correction data ensures intelligent correction selection that corresponds to the flight mission time and data provided by multiple analysis centers. IPAS PPP typically provides position information accurate to 15 cm (horizontal) and a height of 20 cm.