

# A Review of *Mathematica 6*

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*Mathematica 6* was released on May 1<sup>st</sup>, 2007. It is the latest version of the computer algebra system developed by Wolfram Research. Version 6 is the first major upgrade since version 5 was released four years ago. The new version includes improved graphics handling, dynamic interactivity, expanded symbolic capabilities, and thousands of other new features and options.

This review assumes some knowledge of *Mathematica* syntax and is not meant to provide an introduction to *Mathematica*. Those looking for an introduction should read the tutorial entitled “First Five Minutes with *Mathematica*” located in *Mathematica*’s Documentation Center (under Help in the menu bar). Further introductory materials can be found on Wolfram Research’s website and in [1, 2, 3].

As *Mathematica* is an enormous software package with extensive capabilities, it is impossible to include a complete review of the new version here. Therefore, this review will focus on a handful of the major improvements and additions included in version 6.

## Graphics

The family of plotting commands has been dramatically improved. Most notably, *Mathematica 6* allows for the immediate real-time rotation of three-dimensional surfaces and plots. This adds an ability that the *Maple* and *MATLAB* software packages have had for years.

For two-dimensional plots in version 6, the default curve color is blue while the axes are black. (In previous versions, all curves and axes were colored black by default.) If multiple functions are plotted on the same set of axes, then each curve has a unique color. These color differences allow the curves to be easily distinguished from the axes and from one another. Further, all plots simply appear sharper in *Mathematica 6*.

All of the functions in the Graphics ‘FilledPlot’ package have been rolled into options of the Plot command in a very logical and systematic manner. In version 6, the command

```
Plot[{Sin[x], Cos[x]}, {x, 0, 2*Pi}, Filling->{1->{2}}]
```

creates a plot of the functions  $\sin(x)$  and  $\cos(x)$  on the interval  $x \in [0, 2\pi]$  in which the area between the curves is shaded light blue. Creating the same plot in previous versions was not as straightforward.

In *Mathematica 6*, all graphics can be edited directly. Using the 2D Drawing Tools and the Graphics Inspector Tool, the user can add text and equations, modify graph properties (colors, marker symbols, etc.), and add hand-drawn items. An especially useful addition is the flexibility with the new plot markers used in ListPlot-type commands.

## Dynamic Interactivity

*Mathematica 6*’s “dynamic interactivity” is a new addition that greatly enhances *Mathematica*’s ability as a demonstration tool. This interactivity will be used to improve presentations at all levels from classrooms to research conferences. The Manipulate command can be used to create a dynamic interface for a number of objects. The command

```
Manipulate[Plot[Sin[k*x], {x, 0, 2*Pi}], {k, 1, 5}]
```

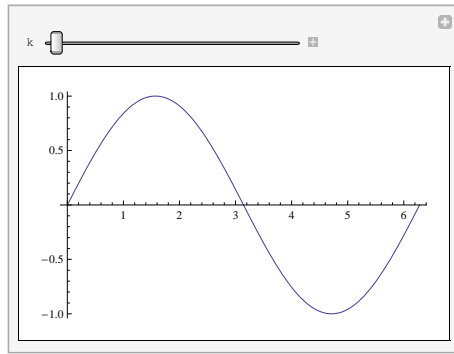


Figure 1: A graphic obtained using the `Manipulate` command in conjunction with a `Plot` command.

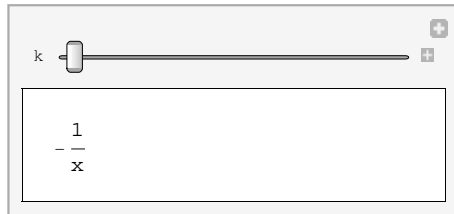


Figure 2: A graphic obtained using the `Manipulate` command in conjunction with an `Integrate` command.

creates the graphic included in Figure 1. This command creates a plot of the function  $\sin(kx)$  on the interval  $x \in [0, 2\pi]$ . The slider bar allows the parameter  $k$  to be varied between 1 and 5. As the slider is moved, the value of  $k$  is changed and the graph is modified in real time while the  $x$ -axis is held fixed. The expanded slider bar (not shown) allows the user to create plots corresponding to specific values of  $k$  and animations corresponding to ranges of  $k$  values.

The `Manipulate` command can also be used in conjunction with symbolic calculations. For example, the command

```
Manipulate[Integrate[x^k,x],{k,-2,2}]
```

returns the graphic included in Figure 2. As the slider is moved, the value of  $k$  and the resulting antiderivative change. Using the expanded slider bar (not shown) the user can have *Mathematica* display the result corresponding to a specific value of  $k$  or a sequence of  $k$  values.

### The `DSolve` Command

The `DSolve` command has been generalized to solve first-order initial-value partial differential equations. The quasi-linear initial-value problem

$$\begin{aligned} u_t + 9u_x &= u^2, \\ u(x, 0) &= \sin(x), \end{aligned}$$

can be solved symbolically using the following command

```
DSolve[{D[u[x,t],t]+9D[u[x,t],x]==u[x,t]^2,u[x,0]==Sin[x]},u[x,t],{x,t}]
```

This command returns the analytic solution of the initial-value problem

$$\{u[x,t] \rightarrow 9/(-9t - 9\text{Csc}[9t-x])\}$$

Just as in previous versions, the solution can be simplified by using either the `Simplify` or the `FullSimplify` command. The `DSolve` command can also find some special solutions to some nonlinear partial differential equations. Consider the following nonlinear PDE

$$u_t u_x = u^2.$$

The command

```
DSolve[D[u[x,t],t]D[u[x,t],x]==u[x,t]^2,u[x,t],{x,t}]
```

returns a solution

```
{u[x,t]->E^(-t/Sqrt[C[1]]-xSqrt[C[1]]-C[2]/Sqrt[C[1]])}
```

along with a warning message stating that *Mathematica* has only found a special solution and not some sort of general solution.

## Help Menus and Obsolete Functions

*Mathematica 6* includes a completely redesigned help menu. Wolfram Research calls this new help menu the Documentation Center. Although searching for help on a certain topic in the Documentation Center is slower than using the Master Index in version 5, the results are better organized. In version 6, it is possible to have multiple Documentation Center windows open simultaneously. This is advantageous when learning about families of new commands.

Many functions in *Mathematica 5* have been replaced by new functions and are obsolete in *Mathematica 6*. One such command is the `PlotVectorField` command, which is part of the `Graphics`PlotField`` package. This command has been replaced with the command `VectorFieldPlot`. This replacement (along with others) removes the need for the `Graphics`PlotField`` package. *Mathematica 6* is able to load and run the obsolete functions and packages, but it seems to do so in a kludgy way. Updating old notebooks to the version 6 standard makes for much better (and faster) functionality. The Documentation Center in *Mathematica 6* does not include compatibility information or any sort of documentation on many of these obsolete commands. However, version 6.0.1 contains help menu information on all of the obsolete packages and functions.

Some brief comments on other new additions:

- *Mathematica 6* notebooks can be saved as .pdf files.
- The commands `Import` and `Export` have been enhanced to handle a wider range of file types.
- Text is color coded.
- Unlike previous versions, output from `Plot` commands can be suppressed by using a semicolon.

Some quibbles:

- All notebooks created with previous versions of *Mathematica* must be “scanned for possible compatibility issues.” This is a pain, but pays off once all necessary changes (if there are any) are made.
- The cursor gets stuck when using the down arrow to move through large notebooks.
- A single equals sign should not act as an assigning operator inside a `DSolve` command.
- There is no print preview.

## Summary

*Mathematica 6* is a major upgrade from previous versions. Its added graphical abilities and dynamic interactivity combined with new features not discussed here make upgrading very worthwhile.

The suggested retail price for *Mathematica 6* is \$2,495. The academic and student versions list for \$1,095 and \$140 respectively. Both of these versions have the same functionality as the professional version. *Mathematica 6* can be purchased directly from [www.wolfram.com](http://www.wolfram.com).

## References

- [1] M.L. Abell and J.P. Braselton, *Mathematica by Example, Third Edition*. Academic Press, 2003.
- [2] C-K. Cheung, G.E. Keough, C. Landraitis, and R. Gross. *Getting Started with Mathematica*. Wiley, 2005.
- [3] P.R. Wellin, R.J. Gaylord, and S.N. Kamin. *An Introduction to Programming with Mathematica, Third Edition*. Cambridge University Press, 2005.