

THE CALCULATION-AND-GRAPHING-SOFTWARE MARKET'S 800-LB GORILLA ACHIEVED DOMINANCE FOR GOOD REASON. STILL, OTHER TOOLS CAN BOOST YOUR PRODUCTIVITY. AMONG A WEALTH OF EXCEL ALTERNATIVES AND ENHANCEMENTS, SEVERAL COULD PROVE WORTHY OF INVESTIGATION.

When EXCEL isn't enough

ENGINEERING USERS OF MATH SOFTWARE are a diverse lot. The publishers of some of the more powerful math packages believe that most engineers who need to perform calculations and create graphical displays based on experimental data are more than happy to write programs in specialized languages to perform these tasks. But even these companies (several of them, anyway) acknowledge that

they can't overlook many technical users' affinity for the calculation-and-graphing-software market's 800-lb gorilla: Microsoft's Excel spreadsheet package. Excel is ubiquitous; you'll find it on nearly every PC user's desktop because it is part of the Microsoft Office suites that many PC manufacturers preload into

every PC they sell. And Excel is inviting. Though perhaps not the most capable spreadsheet program ever published, it has a wide array of capabilities and is relatively easy to learn and use. Unlike the other Office applications (most notably, the bloated, needlessly complex Outlook), Excel actually appears to have been designed by people who use programs of its genre. (Note to Microsoft: You might try making your other applications behave as if knowledgeable users had been involved in their development; if Excel is any example, doing so could cut down on

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grumbling by users who feel that they have no practical alternative to your software, no matter how horrendous it is. On the other hand, when you own 95% of the market...)

Microsoft recognizes that a general-audience package can't profitably include capabilities that only small user communities need, so the company encourages an Excel-based cottage industry. The spreadsheet package includes an add-in facility, which enables users to easily install programs that enhance its basic capabilities. For example, users of data-acquisition hardware can choose among approximately half a dozen low-cost dedicated add-ins that allow acquiring data directly into Excel worksheets and producing plots and displays that are often more appropriate for presenting experimental data than are Excel's native graphics. Vendors of such packages include Dataq, IOtech, Keithley, Measurement Computing, and National Instruments.

IMPORTED OBJECTS

Several high-performance math-software packages, such as Matlab, Mathcad, and TK Solver can import Excel worksheets and use them as objects in their own worksheets. Meanwhile,



with the aid of the Excel add-in facility, you can create Excel worksheets that take advantage of the math packages' advanced capabilities. You might say that such Excel worksheets perform as front ends for custom applications created with the high-powered packages. Users of these front-end worksheets often need not even know that a math package with greater power than Excel underlies the experimental results they see on their PC screens. In contrast, the developers of the math-intensive applications on which the front-end worksheets depend must actively work with the math package. (To a lesser extent, so must the creators of the front-end worksheets.)

Although their installation routines may place DLLs (dynamic-link libraries) and OCXs (Object Linking and Embedding Custom Controls) on users' hard drives, dedicated, low-cost add-ins, such as the previously mentioned data-acquisition packages, generally don't require installing other software. Conversely, add-ins that turn Excel into a front-end for high-powered math packages usually require the target package's presence on the user's PC.

If you don't normally use a high-performance math package and you need one only to add a few advanced functions to Excel (for example, to perform matrix operations that are more complex than Excel's array functions), the addition may appear to be a case of the tail wagging the dog. After all, most high-powered math packages cost significantly more than a separately purchased copy of Excel. Moreover, because Excel probably came

AT A GLANCE

▶ For many engineers who need to analyze experimental data and display it graphically, Excel is the appropriate tool, combining ease of use with capabilities that are just right—neither inadequate nor excessive.

▶ Third-party add-ins, which Excel accepts, add numerous capabilities that aren't present in the basic package.

▶ Some add-ins turn Excel into a friendly front end for high-powered math packages. Excel worksheets can also become objects within some of these packages' own worksheets.

▶ Thanks to add-ins that turn Excel into a front end for high-powered packages, you can quickly become productive as you learn to use complex new software. But, because you usually must purchase both the high-performance package and the add-in, the cost can at first seem too great.

preinstalled on your PC, you might easily have gotten the erroneous impression that the spreadsheet package cost you or your employer nothing.

Nevertheless, math-package publishers have good reasons for designing their Excel add-ins as links from Excel to their packages and not as dedicated programs. Creating a link to a package is easier and less costly than creating a less capable dedicated add-in. As a result, add-ins that link to established packages often cost less and do more than dedicated add-ins. Of course, a user who purchases an expensive high-powered package and uses it only to enhance Excel never realizes these cost benefits. Moreover, the high-performance package almost surely requires PC resources greater than those needed to run the dedicated add-in. However, in this era of 80-Gbyte hard drives that sell for \$129, few architects of high-powered math software worry much about resource constraints.

FROM USER TO EVANGELIST

Perhaps more important, publishers of the high-performance software also hope that, once you gain some experience with their packages, you will delve further into them and start using them extensively in

their stand-alone form. Users often become unpaid evangelists for these packages. However, if you've been using Excel intensively and you become particularly fond of a new math package, you should think about whether you had been using Excel inappropriately. Publishers of high-powered packages stress that a major hazard of Excel is users' tendency to apply it where a different program could more quickly and easily provide the needed answers.

Excel has bred a generation of spreadsheet jockeys—largely in finance and nontechnical functions—not in engineering. Most engineers regard any software package as merely a tool for doing a job; if a familiar tool appears adequate, engineers rarely see much reason to find a replacement. But the math-software publishers maintain that hard-pressed engineers who have become familiar with Excel often use it in place of other, more appropriate programs. These publishers say that fear of having to spend significant time and effort learning a new program often motivates these engineers to use Excel and to fail to recognize the symptoms of using the wrong tool. The most pronounced symptom is spending too much time on the job—not on the technical aspects, but on finding creative ways to make an inappropriate tool perform functions that its creators clearly never intended. In such cases, a new tool could increase productivity so much that the time savings would dwarf the time spent learning its use.

The beauty of using an Excel add-in as your introduction to a more powerful program is that you can follow a familiar path as you learn to use the new tool. This tactic often represents the best of both worlds; it can take some of the pain out of climbing the learning curve, and it does minimal (and only temporary) damage to your productivity as you learn.

A LIFETIME JOB

Anyone who wanted to make a career of evaluating math software might just be able to turn the activity into an entire life's work. A directory at <http://directory.google.com/Top/Science/Math/Software/> lists more than 300 suppliers and packages, but even that voluminous listing probably isn't comprehensive. If the evaluations took an average of two weeks per package, the job could easily stretch

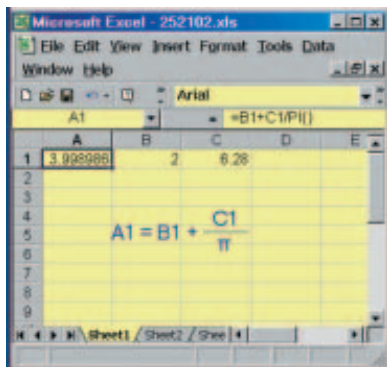


Figure 1 MathLook for Excel transforms the formula in cell a1 (you can see the formula in ordinary text in Excel's data-entry window) to the mathematical notation that appears in cells b4 through c6.

out over more than a dozen years. And by then, it would be well past the time to start all over again.

Clearly, some of the packages in the Web-based directory are of only margin-

al interest to electronic engineers. Nevertheless, finding the best package for an application is a job of such magnitude that few people would find it worthwhile. It seems more appropriate to adopt a

more pragmatic approach: Find a tool that works, and look further only when you start to wonder whether another tool might overcome annoyances and problems you've encountered.

ONLINE PRODUCT SELECTION: SAY GOODBYE TO CUT AND TRY

By Todd Piefer, UTS

Reference A discusses the growing popularity of 100W (or greater) isolated-output dc/dc converters—and the complexity of determining the permissible output current at different input voltages, operating temperatures, and airflows. In response to questions about TK Solver for this article, UTS found an opportunity to demonstrate how to apply some of its package's capabilities to help users select the correct dc/dc-converter via interactive, Web-based catalog pages.

Typically, selecting a converter involves calculations based on a series of graphs: efficiency versus output current, mounting-surface temperature rise, and the hottest junction's temperature rise above the mounting-surface temperature. If the junction temperature is too high, you must start over and keep repeating the process until you determine how much current you can safely draw.

Online catalogs have improved converter selection, but so far, not by much. You can now go to a supplier's Web site and pick a converter of the desired dimensions that provides the desired output voltage and maximum output current. But the module may not meet your requirements, and determining whether it does requires a step backward—printing graphs and tables and doing manual calculations. You must go back and forth between the printed page and the Web site until finally—maybe—you find a converter that fills the bill.

An interactive Web-based calculator could take your tentative

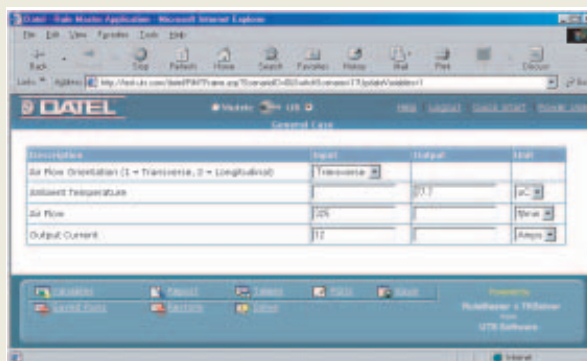


Figure A The selected dc/dc converter operates reliably in air as hot as 77.7°C if you cool the converter with air traveling longitudinally at 325 ft/min and draw 12A from its output.

Follow these steps to try out the Datel and CGI applications:

1. Go to www.uts.com;
2. Click on Development Services;
3. Select Sizing and Sales Configurators; and
4. Click on Examples.

To access the Datel application, log in as *EDN* and enter the password *tksolver*. The CGI application requires no registration.

converter selection and, in real time, plot its output current as a function of air temperature and velocity. To construct a demonstration of TK's Web-based capabilities, UTS enlisted the help of Datel Inc, one of the companies listed in the reference.

The result of this brief effort is an interactive Web-based demonstration application using a 5V-output isolated converter with a maximum output current of 20A (Figure A). The application accepts user inputs for ambient temperature, airflow, and the converter's orientation (transverse or longitudinal) with respect to the airflow. From these parameters, the application calculates the permissible output current. Optionally, you can input a desired output current—say, a minimum allowable—and

the application automatically back-calculates the maximum allowable ambient temperature and airflow. The application includes prepackaged data of current versus temperature at various airflow rates.

A more finished version would integrate the calculation capability with product selection. The application would pick up the specifications of the converter that you (tentatively) select and use them to precisely calculate the maximum permissible output current.

UTS has deployed other such Web-based interactive component-design and selection systems—including an interactive chemical-plant-design guide for DuPont and a product configurator for gearbox manufacturer CGI Inc.

The gearbox selector should particularly interest *EDN* readers who work in motion control.

Electric motors, of course, drive the gearboxes. You first select a motion profile: continuous, trapezoidal, or triangular. Next, you pick the type of gearhead and drive and the mounting orientation, rotation direction, and shock load. Then, depending on the motion profile you've chosen, you can set as many as a dozen minimum and maximum input speeds and other numeric parameters. The application returns a complete performance profile of the smallest suitable gearbox, along with a selection of products in the inventory database that match the specifications.

Such a system takes the state of component-selection technology to the next step. Indeed, this system can serve as a prototype not only for component selection, but also for collaborative engineering. The technology allows, for example, for posting a component model that a team of design engineers around the world can take turns at tweaking by way of their Web browsers.

AUTHOR'S BIOGRAPHY

Todd Piefer is the product manager responsible for TK Solver software-application development and customer training at UTS (Rockford, IL).

REFERENCE

A. Strassberg, Dan, "Tiny titans: Choose 'em and use 'em with care," *EDN*, May 2, 2002, pg 41.

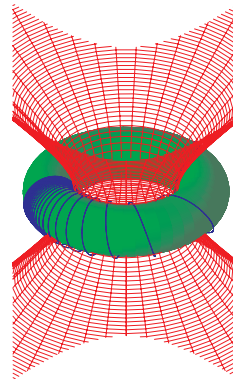
Instead of trying to present any sort of comprehensive listing, the paragraphs that follow discuss a few products that attracted my attention during research on this topic.

SYMBOLIC MATH

A low-cost, easy-to-use package that does symbolic math is Derive, currently in Version 5. Derive has been around for many years, but Texas Instruments acquired it several years ago as an adjunct to its scientific-calculator business. Symbolic math is the ability to manipulate formulas that contain multiple unknowns represented by variable names or symbols rather than by numeric values. Spreadsheet programs such as Excel as well as most math packages, do not perform symbolic operations. Derive also

creates attractive color surface plots, which Excel cannot create. Derive costs \$199 for a single-user US commercial license. (All software prices in this article are for licenses of this type.) Of course, you can't expect a \$199 package to do everything that a truly high-performance \$2000 package can do, but within its limitations, Derive is a useful adjunct to a spreadsheet package.

UTS (Universal Technical Systems) offers several interesting tools, the best known of which is TK Solver (see sidebar "Online product selection: Say goodbye to cut and try"). TK Solver, current-



Several high-powered math packages enable you to mathematically describe and display 3-D surfaces, such as this mesh, which represents the fringing field from a toroidal inductor. This color presentation was created in Waterloo Maple's Maple 8.

ly at Version 4.0 (\$399) incorporates the unusual ability to back-solve. That is, if you have found one acceptable solution to a problem in which there are several unknowns, you can impose constraints on variables—including ones for which you might already have solved—and find new and possibly more desirable

FOR MORE INFORMATION...

For more information on and alternatives to Excel and products that complement Excel, go to www.edn.com/info and enter the reader service number. Following each company name in this box you will find in *italics* the name or names of company products that are most likely to interest readers of this article. When you make direct contact with any company listed here, please tell the representative that you read about the company's products in *EDN*.

Aptech Systems Inc

Gauss 4.0
1-425-432-7855
www.aptech.com
Enter No. 301

Comsol Inc

FemLab
1-781-273-3322
www.comsol.com
Enter No. 302

Dataq Instruments Inc

WinDaqXL
1-800-553-9006,
1-330-668-1444
www.dataq.com
Enter No. 303

Data Translation

DT Measure Foundry 3.0, Formula Evaluator
1-508-481-3700
www.datatranslation.com
Enter No. 304

DSP Development Corp

DADiSP
1-800-424-3131,
1-617-969-0185
www.dadisp.com
Enter No. 305

Harmonic Software Inc

Omatrix
1-206-706-3046
www.omatrix.com
Enter No. 306

Infragistics Corp

UltraWinChart, UltraWebChart
800-231-8588,
1-609-448-2000
www.infragistics.com
Enter No. 307

IOtech Inc

DaqViewXL
1-888-714-3272,
1-440-439-4091
www.iotech.com
Enter No. 308

Keithley Instruments Inc

ExcelInx
1-800-552-1115,
1-440-248-0400
www.keithley.com
Enter No. 309

Mackichan Software

MuPad
1-877-724-9673,
1-206-780-2799
www.mackichan.com
Enter No. 310

MathSoft Engineering and Education Inc

Mathcad, Axum, StudyWorks
1-800-628-4223,
1-617-444-8000
www.mathsoft.com
Enter No. 311

The Mathworks Inc

Matlab, Excel Link
1-508-647-7000
www.mathworks.com
Enter No. 312

Measurement Computing Corp

DAS Wizard
1-508-946-5100
www.measurementcomputing.com
Enter No. 313

National Instruments

Measure, Dtdem
1-800-258-7022
www.ni.com
Enter No. 314

Numerica

PDEsol
1-972-991-2860
www.pdesol.com
Enter No. 315

OriginLab Corp

Origin 7.0
1-800-969-7720,
1-413-586-2013
www.originlab.com
Enter No. 316

Poly Software International

PSI-Plot V7
1-845-735-9301
www.polysoftware.com
Enter No. 317

SPSS Inc

SigmaPlot 8.0
1-312-651-3000
www.spss.com
Enter No. 318

Texas Instruments

Derive
1-800-842-2737
www.ti.com
Enter No. 319

Universal Technical Systems Inc

TK Solver, Mathlook for Excel, TK Solver Excel Toolkit
1-800-435-7887,
1-815-963-2220
www.uts.com
Enter No. 320

Visual Numerics

PV-Wave, TS-Wave
1-925-807-0138
www.vni.com
Enter No. 321

Waterloo Maple Inc

Maple 8
1-800-267-6583,
1-519-747-2373
www.maplesoft.com
Enter No. 322

WaveMetrics Inc

Igor Pro V4
Fax: (503) 620-6754
www.wavemetrics.com
Enter No. 323

Wolfram Research Inc

Mathematica 4.1
1-800-965-3726,
1-800-441-6284,
1-217-398-0700
www.wolfram.com
Enter No. 324

OTHER COMPANIES MENTIONED IN THIS ARTICLE

CGI Inc
www.cgimotion.com

Datel Inc
www.datel.com

DuPont
www.dupont.com

Microsoft Corp
www.microsoft.com

SUPER INFO NUMBER

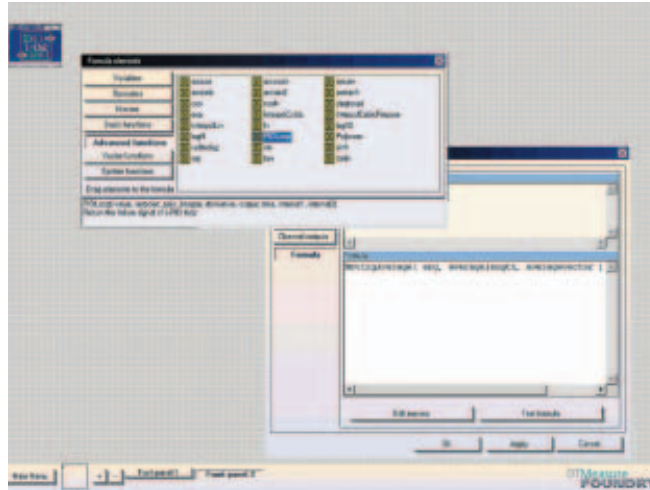
For more information on the products available from all of the vendors listed in this box, enter no. 325 at www.edn.com/info.

input values than those you started with. The example that the sidebar describes uses TK's back-solving capabilities.

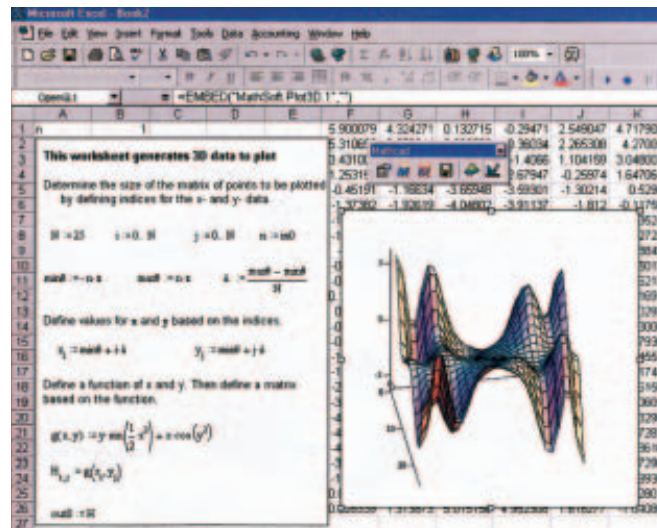
A TK feature of special interest is MathLook, which displays and lets you manipulate equations in notation that resembles what you would produce by hand, rather than as confusing strings of nested parentheses and superscripts preceded by carets, which you must use with all spreadsheets and many math programs. UTS also offers a package called MathLook for Excel, an Excel add-in that lets worksheets display formulas in this more convenient manner (Figure 1) and simplifies referring to variables by name instead of by references to spreadsheet cells. UTS hopes that, by the time you read this, it will have a new version of MathLook for Excel that you can install without installing TK Solver and the Excel Toolkit that comes bundled with it. Naturally, though, the company hopes that you'll become intrigued enough by MathLook for Excel to want TK itself. Pricing for the new version of MathLook for Excel was not available at press time, but the earlier version cost \$99.

DO THE MATH

Although Data Translation's Measure Foundry isn't an Excel plug-in, and few people are likely to think of it as a math package (it's a data-acquisition package), the newly announced Version 3.0 (\$249) includes "the formula evaluator," a feature that combines data acquisition with math. A perfect application is linearization of inherently nonlinear transducer outputs. Suppose that you use one of the company's analog-input boards or data-acquisition peripherals to monitor the output of a group of strain gauges during a vibration test. As long as you can construct a formula to translate the acquired signal from millivolts to micros-



The formula-evaluator feature of Data Translation's Measure Foundry 3.0 lets you drag icons that represent mathematical operations into a work space. The software then converts these icons into text such as the text that the lower-right-hand window displays.



With tools from MathSoft, you can embed Mathcad worksheets and graphs, such as this color surface plot, in your Excel worksheet.

train, you can enter the formula and produce a real-time display of microstrain versus time. With a wideband stimulus, such as a shake table applying dynamic forces, such as white noise, impulses, or step functions to the structure under test, Measure Foundry could do FFT calculations and display microstrain versus frequency. You enter formulas by dragging tools from a graphical palette to a work space. Jobs that involve wideband signals should be right up Measure Foundry's alley because of its patent-applied-for architecture, which avoids unpredictable delays by bypassing Windows' message queue.

A recent major announcement in the

close to solving all such problems for everybody. Even with the dozens of available add-ins, it's questionable whether Excel serves the needs of 80% of math-software users. The enormous number of other packages demonstrates that it doesn't. In Excel, Microsoft has restrained its usual propensity for adding a plethora of arcane and needless features. Excel owes much of its success to that admirable restraint. □

math-software market was the arrival of Waterloo Maple Inc's Maple 8 (\$1695). Maple is one of the best known and most comprehensive of the high-performance math packages. Some of Maple's competitors have even struck deals with Waterloo Maple to use parts of Maple's symbolic-math capability. Among the new capabilities in Maple 8 are what the publisher calls a reinvented user interface, an interactive plot builder, and facilities for guiding novice users and students through calculus computations. Additional new capabilities include a database of more than 13,000 scientific constants; a numeric solver for partial differential equations; a code generator for the Java language; the ability to call external Java static methods from Maple applications; and a variety of calculus tools, including vector- and variational-calculus functions.

Regardless of the type of software that handles your math needs, one fact should stand out: This market is about as far as markets get from a one-size-fits-all tool. Excel seems to solve more computation and graphing problems for more people than any other software package, but it doesn't come

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