The Maple Reporter

The Newsletter from Waterloo Maple Inc. Summer 1998

Welcome

to the new Maple Reporter!

We aim to keep you up to date on what's new in the Maple world, with articles about how Maple V is being used, and to provide you with ways of getting the most out of the package to help you do your job more effectively.

Symbolic computation is being increasingly used within the commercial technical world as a valuable resource for numeric computation and even as a viable alternative. This is reflected in the dramatic increase in the use of Maple within, for example, Electronics, Control Engineering, Telecommunications and Financial Modeling. Also, because Maple V is so commonly used, and highly regarded, within the academic world, it is being used increasingly for transmitting technical knowledge from one world to the other without losing mathematical meaning or accuracy.

This can be witnessed in the Maple User Group mail list where we have groups of technical professionals from all over the world, collaborating together to produce innovative solutions to real problems. An excellent example of this collaboration is featured on page 6.

We hope you enjoy **The Maple Reporter** and we look forward to your feedback and contributions for future editions.

Paul Goossens
Manager, Product Marketing
Waterloo Maple Inc.

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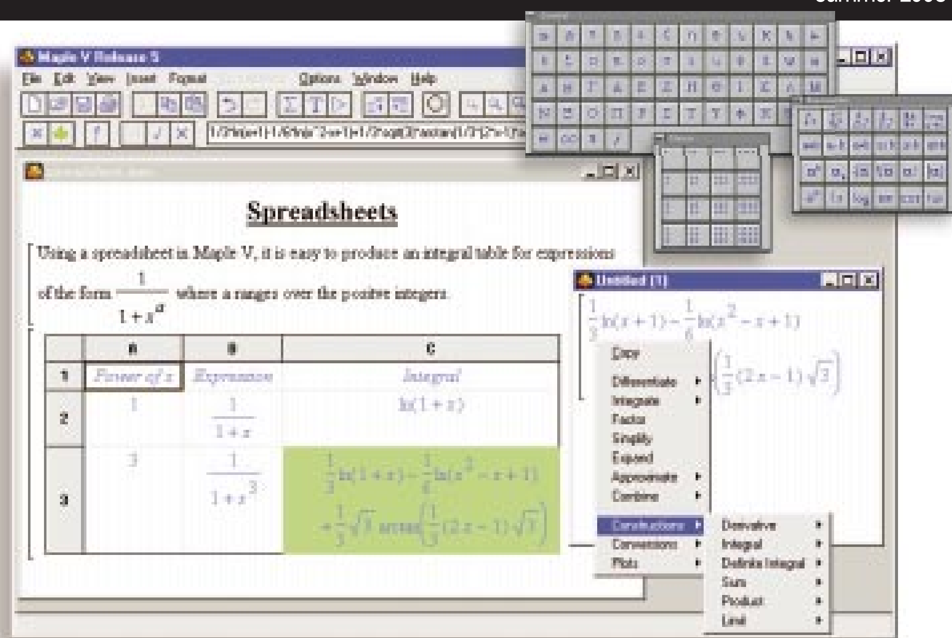

Maple V Release 5!

Maple V Release 5 has been shipping since the beginning of the year and is already getting a favorable response from reviewers, educators and technical professionals from all over the world. If you're considering upgrading your version of Maple V, here is a summary of the main new features to help you make up your mind.

Usability Enhancements with Palettes, Expression Editor and Context-Sensitive Menus

The first thing you'll notice about Release 5 is that you don't need to type Maple commands to enter your expressions (although you can if you still wish to). You can enter and edit expressions as if you're writing them down, using standard math notation, with palettes that contain mathematical constructs, such as integrals, summations, roots, powers, matrices and Greek symbols. Then you can navigate around your expressions by clicking on part or all of the expression and modify it in the new editing field, just like a spreadsheet. You can even use the expression editor to easily substitute for one or all occurrences of a variable. And when Maple V processes your problem and returns the resulting expression, you don't have to remember the command syntax to continue your analysis. Using your right mouse button (or option click on a Mac), just click on the symbolic result and Maple V will examine it, gather operations you can perform on it and display them in a menu! Simply click on the operation you want and Maple V constructs the right command, then processes it.

Amazing Graphing and Visualization!

The graphing and visualization power of Maple V Release 5 has been extended with new and enhanced plotting functions. Most notable of these is the new Smartplot function, which allows you to 'Drag and Drop' expressions from the input editor straight onto a plot to very quickly build up multiple-curve and surface plots. And now with the OpenGL* graphics drivers you get near-graphical workstation performance out of a standard PC running Windows 95 or NT. It's pretty

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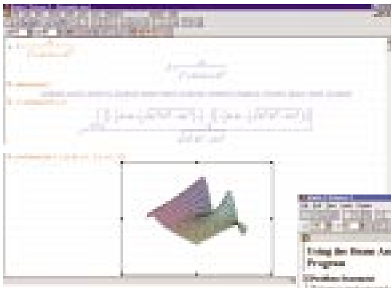

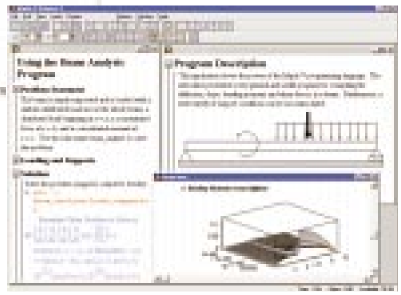

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amazing to see real time rotation of complex three-dimensional plots on a standard PC!

With Maple V Release 5, you can now take your 3-D plots even further by converting them into VRML 1.0 (Virtual Reality Mark-up Language). This is a standard format that allows three-dimensional data structures to be published on the Internet in an interactive form. Simply download a VRML plug-in for your WWW browser and you can 'wander' through your Maple V generated plots to gain a greater understanding of the mathematics you're exploring. It's great fun too!!

More Mathematical Functionality!

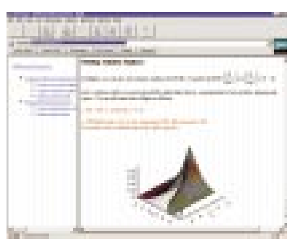
Many of the 2,700+ functions have been extensively reviewed. This has resulted in Maple V Release 5 giving you more robust mathematics, new algorithms and increased functionality, especially in the areas of ODE and PDE solving, 3-D Euclidean Geometry, Groebner Bases, Ore, Differential Algebras, Pattern Matching and C and FORTRAN Code Generation. Even to briefly summarize these new mathematical enhancements would require a whole article in itself. In fact, there is one! If you'd like to find out more, contact our representative and ask for a copy of the New Mathematical Functionality Application Brief, or check out **http://www.maplesoft.com**.

World Premiere – The Symbolic Spreadsheet!*

For the first time ever, you can now carry out symbolic calculations using a familiar spreadsheet user interface. With Maple V Release 5 you can create and work with a symbolic spreadsheet, which allows you to enter expressions into spreadsheet cells and link cells in the way you would expect. The difference is that the entered expressions and results maintain their mathematical structure throughout! Make a change in one expression and see the effect on the results in other cells immediately. This means you can explore and instantly see the results of your ideas in a familiar working environment.

MATLAB link for Maximum Numeric Flexibility*

If you are a MATLAB user, you will find Maple V Release 5 even more indispensable. Use Maple V to break down complex problems into components, process them symbolically and then use the power of MATLAB's numeric processing directly from within Maple V! In effect, the MATLAB link turns MATLAB into a numeric toolbox for Maple V, giving you the best of both numeric and symbolic worlds!



Publish your work on the Internet with HTML export!

Finally, when you've completed your project, you can now publish your work on the Internet, or your organization's Intranet. If you have tried creating HTML documents with mathematics in it, you'll know what a time-consuming and laborious task this can be! Maple V Release 5 is the first mathematics software that allows you to create technical web pages instantly. No special software to buy, no plug-ins to download – your Maple V document, with your mathematics, text, graphs, even animations can be published and viewed by any standard HTML browser with a simple menu pick.

This is just a short summary of the new features in Maple V Release 5. If you would like to get more detailed information on any of these, please contact your local representative.

**Available on some platforms. Please ask about availability*

HTML? Now there's MathML too!

Few categories of people make as much use of the Internet as mathematicians, and there are extensive - and growing - math resources all over the World Web Web. Now the World Wide Web Consortium (W3C), the organisation set up to develop common protocols for the Web, has released a mathematical markup language for the communication of mathematics across the Web.

MathML 1.0 is proposed as an industry-wide standard for authors, researchers, scientists, engineers, teachers and students to publish mathematical expressions in their Web documents.

MathML is a mathematical syntax for machine-to-machine communication over the Web. It provides two sets of markup tags: one presents the notation of mathematical data, the other relays the semantic meaning of mathematical expressions, so that complex mathematical and scientific notation can be encoded in an explicit way.

Waterloo Maple Inc. has played a leading role in the W3C Math Working Group, alongside such organisations as Adobe, Hewlett-Packard, IBM, INRIA, the American Mathematical Society and the University of Western Ontario. According to the company's President and CEO, **Dieter Hensler**, "Waterloo Maple Inc. is committed to accurate, standards-based communication of technical information on the Web. As an integral partner in W3C's development of MathML, we are dedicated to further development and adoption of this revolutionary specification."

Adds W3C Director **Tim Berners-Lee** *(the man widely recognised as the creator of the World Wide Web)*, "MathML will make the Web even better for educational, scientific and technical materials. It also has the potential to make mathematics accessible to those with visual disabilities. It will allow mathematical content to be reused and exchanged with technical computing systems for further manipulation."

NORTEL
NORTHERN TELECOM

This case study describes a project undertaken by Nortel, which used Maple to develop a generic capacity model for their radio products, specifically designed to model the effect of the introduction of higher bandwidth services to traditional Public System Telephony Services (PSTN) radio systems.

Nortel is one of the worlds leading telecoms products manufacturers and has its principal European research and development facility at Harlow in England where over 1200 research engineers work on the design and development of telecoms systems. **Boris Sedacca** talks to **Ben Freeman** at Nortel, about the development of the model and the choice of Maple V as a platform.

Currently there are many different systems, in the world, which offer PSTN services via radio systems. Some are Fixed Wireless Access, which offer PSTN services to homes via a radio link; other are mobile e.g. GSM, the European digital mobile radio standard. The vast majority of the established systems were originally designed for voice only (PSTN) and at the time of their design the demand for higher bandwidth services e.g. World Wide Web access was not envisaged. One such standard for higher data rate services is ISDN and demand for such a service has driven designers of fixed wireless access and mobile personal communications systems to look for means of offering higher bandwidth services in addition to PSTN on existing radio systems.

ISDN (Integrated Service Digital Network) was designed by the United Nations with the ultimate goal of allowing any communications equipment to plug into any phone jack anywhere in the world. While this goal is still many years from realisation, ISDN service is proving to be an extremely reliable and fast means of transmitting digital voice and data over existing copper wires, fibre optics, radio and satellite channels.

Improved capacity

Many radio systems, such as GSM, operate on a frequency and time slot air interface structure. Any one user making a call is assigned a timeslot and a frequency, which may be fixed for the duration of the call. The radio interface protocols were designed to have a flexible timeslot structure to be able to cope with the provision of different types of service (e.g. voice, data, etc) although, as the majority of calls were expected to be PSTN, the single timeslot capacity was optimised for voice traffic. Data traffic therefore needs to occupy multiple timeslots and/or frequencies. E.g. if each individual time slot has enough capacity for a PSTN voice call, say 32 kb/s, then a higher bandwidth services such as ISDN would require multiple time slots to meet its capacity demand, e.g. 64 kb/s for ISDN basic rate interface.

Nortel needed an improved capacity model which could be used to analyse the effects that mixtures of traffic types would have on their systems, especially how higher bandwidth traffic would affect the service offered to existing PSTN users. The study of traffic modeling is a well-established discipline in telephone engineering. The basic factors involved are the nature of the demand from users on the system i.e. call attempt rate, call holding time or duration, and various system parameters e.g. number of channels available in the system and minimum acceptable grade of service (GOS). GOS is often defined as the probability that a user attempting a call will be blocked or delayed due to the system running at full capacity. It is commonly expressed as the fraction of calls failing to receive immediate service (blocked calls), or the fraction of calls waiting longer than a given service time (delayed calls).

As Nortel design and manufacture a wide range of radio systems, involving many different standards and protocols, a generic model was required; one which could be easily adapted to different systems offering different services. This generic structure would allow the blocking, or GOS, to be broken down by type of service request e.g. PSTN voice, PSTN fax, ISDN data, etc; as well as being adapted to take account of specific channel selection algorithms implemented in the radio hardware as well as the different call demand statistics for each of the service types.

Ben Freeman of Nortel has developed just such a universal analytic blocking model that takes advantage of Maple's symbolic computational features. The model builds symbolic multi-dimensional Markov finite state models [1], which are used to model the traffic on the radio system.

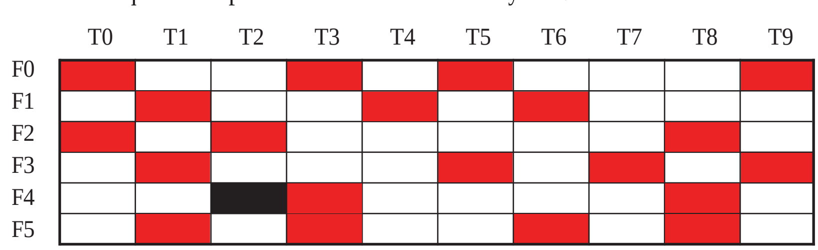


Figure 1

As an example of some of the more subtle complications of offering higher bandwidth services to a primarily PSTN only system: take the case of a six frequency by 10 time slot system, which can maintain up to 60 simultaneous single time slot calls.

Simulation title: "Example", current cell population is

index	*number*	*user type*
1	1000	*phone_only*
2	200	*phone_and_fax*
3	10	*medium_business_ISDN*
4	50	*distance_learner_ISDN*

Enter command in lower case only (or type "help") :

>sim

Starting convolution of foreground & background models.

Running background model.

Running foreground model for user profile 1 out of 4.

Running foreground model for user profile 2 out of 4.

Running foreground model for user profile 3 out of 4.

Running foreground model for user profile 4 out of 4.

Summary of results: (call failure rates):

==

index	*number*	*user type*	*POTS voice*	*POTS data*	*ISDN voice*	*ISDN data*
1	1000	*phone_only*	.0000454	0	0	0
2	200	*phone_and_fax*	.0000874	.000280	0	0
3	10	*medium_business_ISDN*	.0000804	0	.000284	.000156
4	50	*distance_learner_ISDN*	.0000597	0	.000194	.000156

Call set up rate is .444187 calls per unit time

Do you wish to save these results (and the current settings) yes / no :

>no

Example of using the text based blocking model in Maple V

In this example each time slot has a data capacity of 32 kb/s, which is adequate for digital PSTN voice. Figure 1 shows such a system with 20 active PSTN voice calls, shown as red cells. An ISDN call, requiring 64 kb/s, needs two time slots to obtain this data capacity. However, the choice of timeslots has restrictions because of the design of the radio system. For example cost constraints on mobile-type equipment prevent either receiving or transmitting on multiple frequencies at the same time, so for example, if the first timeslot were (T2,F4) then the second timeslot could not be (T2,F3).

"If you need two time slots for ISDN you cannot just pick any two free timeslots because of the system constraints. If somebody wants to make an ISDN connection, it is not sufficient just to have two time-slots free. They have to be at an appropriate separation." The type of blocking which occurs when there is free capacity, but not in the right place, is called 'soft blocking' to distinguish it from 'hard blocking' when there is no free capacity and the system is working at full capacity. Soft blocking can only affect multi-time slot calls and the probability of its occurrence gets progressively higher as the system nears capacity, i.e. as the airside capacity 'fills up'. Designers of a radio system need to accurately quantify this affect and ensure that the radio system intelligently allocates capacity to minimise 'soft blocking', which will be experienced by the user as a refused call attempt by their ISDN radio modem.

Another complication in traffic modeling is that different types of users have different call profiles so any model must be adaptable to allow the population to be defined in terms of user profiles, each with their own call statistics e.g. a home Internet user will typically make longer calls than a home phone user.

"We wanted a model that would allow us to look at the performance of these systems by specifying the total capacity in a cell and running a model which would indicate what the GOS is likely to be" says Ben Freeman, "The model we have developed allows the user to plan capacity before installing any equipment and hence to optimise their revenue for their system, whilst ensuring that all users experience a good GOS."

Accurate Results

Traditional methods of calculating GOS relied on Monte-Carlo simulation techniques, but the problem with this technique on traffic modeling problems is that over 100,000 iterations would be needed to approach realistic results, because of the burst nature of the traffic blocking. Therefore, Nortel's model was designed to be analytic, providing accurate results within a few seconds running on modern PC platforms. Another advantage of analytic models is that the computation time is the same, regardless of the probabilities of the events being modeled. "With an analytical model, you need to put in a little more effort into understanding the problem, but once you have worked out your method, it is easier to compute," adds Ben Freeman

One of the key advantages of using symbolic mathematics is that the programmer does not need to specify the solution exactly in terms of all parameters but by a set of equations, each relating one part of the system to another. There is no rigid structure for specifying the problem. There are also advantages of reduced coding time over lower-level languages like C or Modula-2, e.g. built in support for complex variable types like sets, tables and matrices. Debugging and testing also takes less time, with the effort applied to checking algorithms rather than the code syntax.

Ben Freeman argues that with Maple V, any mathematical concept can be tackled directly without having to write tools to deal with them. The price of an interpretive system's slower run times, compared with a compiled C program, is more than outweighed by the savings in development time.

[1] For an introduction to blocking analysis and Markov finite state models: Queueing Modelling Fundamentals, NG Chee Hock, J Wiley & Sons.

Applied Maple for Engineers and Scientists

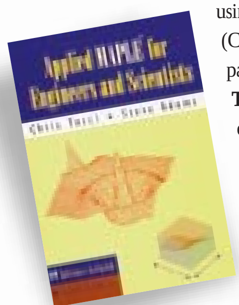
Authors: Chris Tocci and Steve Adams

Published by Artech House Publishers

ISBN 0-890-06853-4

Aimed at engineers and scientists, this book is a gold mine for electrical and control engineers in particular. The authors have made an effort to minimise exotic coding to keep the reader on track with the fundamental usage of the Maple language.

A chapter on **active filter design** provides a detailed analysis and design for an active Butterworth low pass filter and for a switching or sampled data approach to bandpass filtering using charge-coupled device (CCD) technology. What I particularly like is the way **Tocci** highlights the strength of Maple V's symbolic computation facilities.



He does this by expressing equations in terms of capacitors and resistors throughout without having to provide specific values for the components - these would normally be required when running under a numeric computation engine. Constituent relationships are then derived using the Laplace transform from the time domain to the frequency domain and then rewriting the equations in matrix formulation. Having specified an 'A' matrix in terms of resistors and capacitor and a 'y' matrix in terms of a resistor and an input voltage, the transfer function VOUT/VIN is easily evaluated.

From there, the zero, first and second order coefficients are extracted to compute the natural frequency and damping factor of the filter. It is then simply a matter of entering specified numerical values for natural frequency and damping factor in order to calculate the required resistor and capacitor values.

Another chapter emphasises the strength of Maple V's **curve fitting of raw experimental data**, including an example derived from a real world situation of peak detection associated with a spectrophotometer.

The chapter on **ordinary differential equations** gives several basic template applications on Maple V's ability to analyse the dynamic behaviour of real rotational and translational mechanical systems.

The authors then describe the basic applied principles of Maple V in continuous control systems using frequency (Laplace) and time (state-space) domains. For purposes of comparison, a real world third order template controller problem is solved using both approaches. The book then delves into template applications associated with both the **pulse** and **Z-transform methods** and comparatively with the

discrete time state-space techniques for discrete control design and analysis.

It then describes some **basic digital signal processing** associated with 1-D and 2-D information. The concept of image conversion is described and exemplified, as are several approaches using classical linear digital FIR and IIR filters.

The final chapter shows the reader how Maple V can solve rather **complex boundary problems** associated with periodic signals. One of the most common applications of this analysis is used on a buck-type switching power supply. An associated template application depicts how Maple V is used in solving and describing the dynamics involved in a pulse-width modulator (PWM) used for signal acquisition.

The book includes a diskette with several Maple V worksheets, for example, a worksheet for modelling a double mass-spring arrangement.

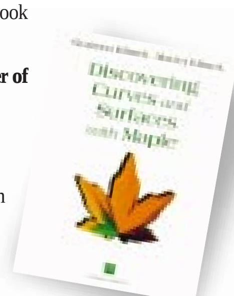
Discovering Curves and Surfaces with Maple

Authors: Grazina Klimek and Maciej Klimek

Published by Springer-Verlag

ISBN 0-387-94890-2

The main objective of this book is to show the reader how to **unleash the graphical power of Maple V**.



The diskette that comes with the book contains Maple V worksheets for each chapter – these are better connected to the text than was the case with the previous book review.

The book explains in detail the basic types of **two-dimensional plots** that can be executed in Maple V. In contrast to the three-dimensional case, most choices are straight-forward and can be mastered quickly.

It presents a number of geometric mappings useful in computer graphics, including **affine transformations in two and three dimensions**. The use of matrix notation in Maple V programs involving affine transformations is purely optional, but it can dramatically increase the clarity of such programs.

The book also prepares the geometric background for executing **three-dimensional graphics in Maple V** and includes some examples (with program listings) involving three-dimensional graphics commands. The reader is then encouraged to put to use knowledge of how to control the perspective projection and how to specify the position of directional lighting.

Some sections are devoted specifically to colour and lighting. The data structures generated by plotting commands and various ways of modifying such structures are also examined. Careful use of colour and light in three-dimensional graphics can radically improve the appearance of a plotted object. Conversely, clumsy colour editing can prevent the viewer from deriving information from a picture.

The authors then delve into **functions and procedures**. Much of this book is designed in such a way that it can be understood with a limited knowledge of functions. In several instances, however, some familiarity with functions defined via procedures is indispensable. Spline interpolation is described, which provides an important tool for graphics, and shows how to use iteration of functions to plot some fractal sets.

Maple V's **animation facilities** are also explored. By adding time as an extra variable, one dramatically increases the scope for visualising various mathematical and non-mathematical processes. Animations require more computational power than static images, so the capabilities of the hardware are significant.

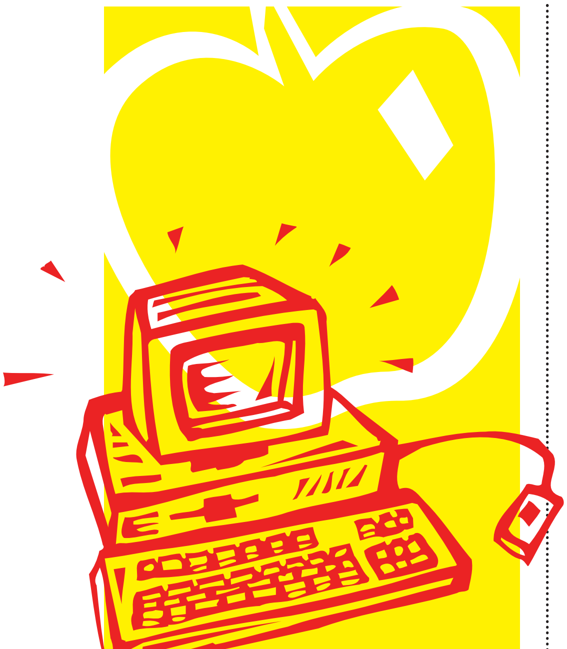
The authors investigate Maple V's plottools package, one of the most significant changes implemented in the area of graphics in Maple V Release 4.

The package contains a selection of commands that produce two-dimensional and three-dimensional graphical objects, as well as several commands that allow easy transformations of these and other graphical objects. They also contemplate the use of specialised graphics for specific visualisation tasks. Several commands in Maple V allow the user to plot complex valued functions. The first of these commands is called complexplot for drawing curves in the complex plane.

Finally, the book deals with **saving and exporting Maple V graphics**. This chapter is divided into two sections. The first explains straightforward methods of saving, editing and printing images created within Maple V. The second show how to export numerical data related to surfaces generated in Maple V to an external renderer to provide smooth surfaces with a photo-realistic finish.

Book reviews by Boris Sedacca

For a full listing of the available books about Maple V see **http://www.maplesoft.com**. or contact your local distributor.



Waterloo Maple Inc. supports Macintosh with Maple V Release 5

We are proud to announce that Waterloo Maple Inc. will continue to support the **Macintosh platform** with the latest version of Maple V Release 5.

The Macintosh version of Maple V Release 5 will be available from April 1st, 1998. With Release 5, the addition of new features allows users to enter data and solve problems in an easy-to-use and familiar environment. The context-sensitive menus and data entry palettes create a “click & solve” environment that significantly enhances the usability of the product.

“Macintosh has been and continues to be a driving force in education and business and Waterloo Maple Inc. is proud to support this platform.” states **Dieter Hensler**, President and CEO of Waterloo Maple Inc.

Unlike many technical software producers that have made a conscious decision to discontinue Macintosh support or the development of future releases, WMI is committed to its Macintosh customers in both the academic and commercial markets.

Fit for Anything?

Regression of data to a non-linear function does not have to be as difficult as it first appears to be – especially when you can rely upon the help of your fellow Maple users!

For many technical professionals, performing a curve fit to experimental data isn’t just about producing nice looking curves on their graphs. It is about the much more serious business of being able to take experimental data and analyse how well the experiment demonstrates a hypothesis, in the form of a mathematical function, by fitting the data to that function using regression techniques.

For many years, the method of least squares has been used as the standard for this type of analysis but this only works well for linear functions, that is, functions that are a linear summation of expressions of the independent variable(s) and coefficients. That is,

$$f(x) = a*f1(x)+b*f2(x)+c*f3(x)..$$

where a, b, c, are the coefficients of each expression to be found by the least squares method. However, the real world is not so ordered and many people need to fit data to non-linear functions. Let’s say. For example, you wish to fit your data to the logistic function:-

$$f(x)=\frac{c}{1+e^{(a-b\,x)}}$$

The function doesn’t follow the linear form and becomes much more difficult to regress. On first inspection of this ‘simple’ model, it may be possible to ‘linearize’ the problem by taking logs of each side and then use least squares on the linear function.

$$\ln\left(\frac{f}{c-f}\right)=b\,x-\ln(a)$$

However, since the residuals will be logged also, this may not give a sufficiently accurate result. And we get into deeper trouble if the function gets more complex and doesn’t lend itself to linearization using logs. Fortunately for Maple V users there is always a place to go to find solutions to any problem of a mathematical nature – the **Maple User Group (MUG)** mail list. Simply send up your request, as user **Bob Jantzen** of Villanova University did recently, and you’ll find no shortage of highly capable people to help you out.

Out of the ensuing discussions around Bob’s request came an amazing collaborative effort, resulting in a worksheet that uses contributions from all over the world.

His problem was fitting data to a logistic function, obtained from a problem in a business calculus course. They had been trying to use a spreadsheet to do this but not very successfully. For him, Maple V was the ideal platform on which to, not only solve the problem, but to give students insight into the mathematics used to solve it. Having tried the linearization approach, suggested through MUG, he was still unconvinced of the accuracy of the results. Then **Preben Alsholm** at the Technical University of Denmark submitted a worksheet he had been working on, which was also taken up by **Les Wright** at Queens University, Kingston, Ontario.

Preben’s approach uses a successive linearisation and least squares method to arrive at a closer fit which worked well, as can be seen from the resulting graphs and least squares error. Les took this method and turned it into a function that can be used by anybody for any non-linear function, defined by the user.

Logistic Regression with nonlinfit
The General Form of the Curve

```
> logistic:=(x,a,b,c)>c/(1+exp
  (a-b*x)):
> u:=logistic(x,a,b,c);
```

$$u := \frac{c}{1+e^{(a-b\,x)}}$$

Sample Data Input

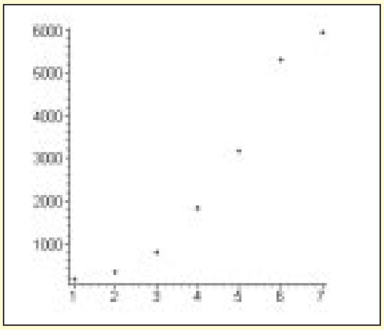
Now input the lists of x and y data from the second example in your worksheet:

```
> Lx:=[1,2,3,4,5,6,7];
> Ly:=[158,317,793,1823,3170,5310,
  5944];
```

Scatter Plot of Data

Now plot the points to get a sense of the shape of the curve:

```
> points:=zip((s,t)>[s,t],Lx,Ly):
> plot(points,style=point,symbol=cross,color=black);ptplt:=%:
```



The familiar sigmoidal shape indicates that a logistic fit is indeed appropriate - but we knew that already!

Initial Parameter Estimates

Now we specify some starting values for the parameters. Note that a and c are approximately equal to the values given by your least squares solution of the linearized problem. If anything, they are somewhat larger. Through trial and error, I have learned that, in order for nonlinfit to converge, these two parameters may need to be slightly overestimated and b needs to be calculated in relation to them so that the initial curve passes through one reasonably placed point. (I ask you to examine this property of the algorithm to see if my intuition is correct.) Therefore, I use a=5 and c=7000, and fsolve for b in order for the initial curve to pass through a data point in the middle of the plot (the 4th one in this case):

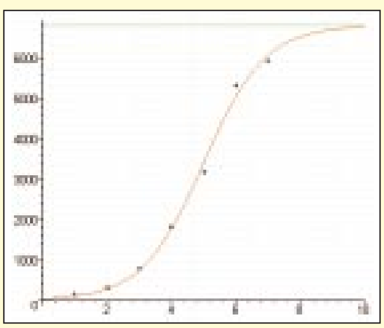
```
> fixed:={a=5,c=7000}:
> fsolve(subs(x=Lx[4],fixed,u)=Ly[4],{b});
> start:= % union fixed;

{b = .9890644394}
start:= {b =.9890644394,a = 5, c = 7000}
```

The Fit

Now run Alsholm's procedure.

```
> ans:=nonlinfit(Lx,Ly,y=u,x,start,iter=50,hist):ans;
```



$$y = 6802.889626 \frac{1}{1 + e^{(5.249591086 - 1.050186859\,x)}}$$

Now let's plot the curve along with the data points to see how things look. I include the asymptote as well:

```
> plot({rhs(ans),6802.89},x=0..10):crvplt:=%:
> plots[display](ptplt,crvplt);
```

The sum-of-squares of the deviations of the points from the fit calculated in this worksheet is:

```
> sum((unapply(rhs(ans),x)(Lx[i])
  Ly[i])^2,i=1..nops(Ly));
  151229.7857
```

> **"I have really been inspired by this MUG generated cooperative result."**
>
> Bob Jantzen, Villanova University

However, nobody claims that this will be suitable for all non-linear functions. There will always be problems that will not be solved by this method and others may be more appropriate. Other techniques offered through MUG have been a generalized Levenberg-Marquardt worksheet by **David Holmgren** at the Czech Academy of Science and a downhill simplex minimization method in multidimensions (based on a method outlined in Numerical Recipes) by **Francis Wright** at the Queen Mary and Westfield College, London, UK. A truly international effort!

Watch out for an article in the MapleTech Journal (Vol 4 No 3) titled "Fitting Logistics to the US Population", by Bill Bauldry, Appalachian State University.

You can find all these worksheets at:

Bob Jantzen: **http://renoir.vill.edu/math/archives/maple/misc/**
Francis Wright: **http://www.maths.qmw.ac.uk/~fjw/public_maple/**
MUG Archive: **http://samuel.math.rwth-aachen.de/ MapleAnswers/**
Bill Bauldry: **http://cs.appstate.edu/~wmcb/AtlantaMAA/**

How to Subscribe to the Maple User Group (MUG)

The Maple User Group is a moderated mailing list devoted to the discussion of research-related topics involving Maple V. To subscribe to the list, send an e-mail to `majordomo@daisy.uwaterloo.ca` *with the subject* `subscribe`.

1998 Shows and Conferences Featuring Maple V

T3 Conference
March 13-15 • Nashville, TN, USA

Twenty-Fourth Annual UW Computer Fair
March 18-19
• University of Washington, Seattle, Washington USA

Scientific Computing with Maple V and MATLAB
March 19-20
• Simon Fraser University, Burnaby, British Columbia USA

NCTM - National Council of Teachers of Mathematics
76th Annual Meeting April 2-5 • Washington, DC USA

ECCAD '98 - East Coast Computer Algebra Day
April 15 • US Naval Academy, Annapolis, MD USA

Conference on Algebraic Combinatorics & Applications
May 1-3 • Oakland University, Rochester, Michigan USA

CCCF - Technology in Education
May 3-6 • Santa Clara, California USA

CCECE '98 - Canadian Conference on Electrical & Computer Engineering
May 24-28 • Waterloo, Ontario USA

ASEE - American Society of Engineering Education
June 28 - July 1 • University of Toronto, Toronto, ON USA

39th International Mathematical Olympiad (IMO)
July • Taipei, Taiwan

ICTM
July 3-6 • Samos, Greece

1998 SIAM Annual Meeting
July 12-15 • University of Toronto, Toronto, ON USA

MathFest '98 - The Mathematical Association of America
July 15-18 • Ryerson Poly. University, Toronto, ON USA

MathCamp '98 - Mathematics Foundation of America
July 5- August 9
• University of Toronto, The Fields for Research in Mathematical Sciences, Toronto, ON USA
Waterloo Maple is proud to be a major financial sponsor of this project!

ATCM
August 24-28 • Tsukuba, Japan

NSBA - Technology & Learning Conference
October 29-31 • Nashville, TN USA

AMATYC 1998
American Mathematical Association of Two Year Colleges
November 5-8 • Portland, Oregon USA

ICTCM - 11th Annual International Conference on Technology in Collegiate Mathematics
November 19-22 • New Orleans, LA USA

University of Mining & Metallurgy Exhibition
November 25-26 • Krakow, Poland

Polish your Maple V 3D Plots

Maple V has always been well known for its highly sophisticated three dimensional plots, either mathematically generated or from discrete data. With its vast array of built plotting functions for producing rectangular, spherical, cylindrical and three-dimensional geometrical shapes, you can produce combinations very easily, simply by 'stacking' plot commands. This gives the Maple V language enormous flexibility and allows users to define their own libraries of plotting functions to add to the built in functionality.

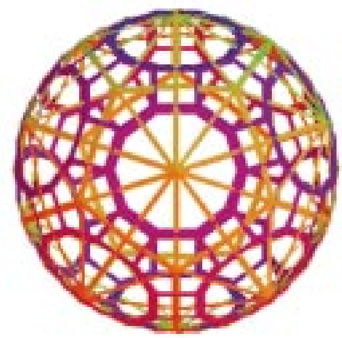
Release 5 of Maple V now uses the **OpenGL graphics drivers** which gives you near-graphical workstation performance out of a standard PC running Windows 95 or NT. It's pretty amazing to see real time rotation of combined plots on a 133Mhz Pentium!

The 3D plot functions in Maple V allow a certain amount of customization of the displayed plot, such as surface colouring, gridding and lighting. But what if you wanted to take the generated plots and produce 'polished' rendered images for visualizing the shapes more realistically? No problem, here are two options, both freely available to Maple V users.

The first is **VRML** *(Virtual Reality Markup Language)*; a means by which 3D data structures may be viewed interactively on the Internet. Release 5 now allows you to take any 3D plot you create in Maple V and directly generate a VRML file.

Take an example from the Maple V Help (?vrml):

```
> with(plottools):
  # 3D geometry objects are particularly
  interesting viewed from VRML
> geom3d[point](o,0,0,0): r := 1.:
> geom3d[GreatRhombiicosido
  decahedron] (p1,o,r):
> geom3d[duality](dp1,p1,geom3d
  [sphere](s1,[o,geom3d[MidRadius]
  (p1)]));
> c1 := COLOR(RGB,1.00,0.50,0.50):
  c2 := COLOR(RGB,0.50,0.00,0.05):
> pic :=
  geom3d[draw]([p1(color=c1),
  dp1(color=c2)],cutout=7/8,
  lightmodel=light2,
  orientation=[0,31]):pic;
```

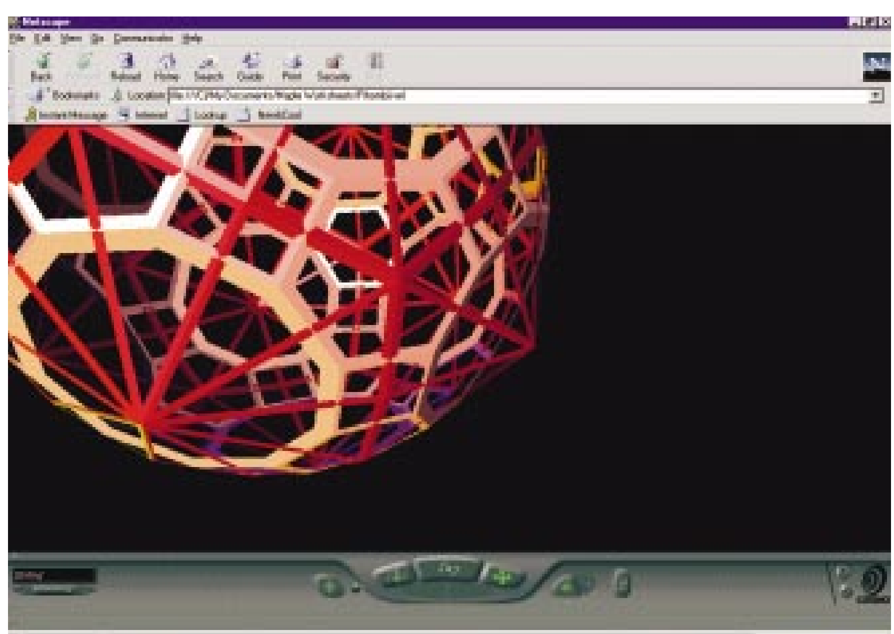


```
> vrml( pic, `Rhombii.wrl`,
  shininess=0.5,  specular_color=
  COLOR (RGB,1,1,1)):
```

The complete data structure that defines the plot is assigned to the variable, pic. The vrml function then generates a file, called **Rhombii.wrl** in the default directory, which defines the data structure in VRML. This may be viewed using any VRML viewer. This example was tested using Silicon Graphics' own viewer, **Cosmo Player 2.0** *(available for download from* **http://cosmo.sgi.com/***)*. The advantage of this is it allows you to visualize and explore the plot interactively, using navigation tools almost like a flight simulator, in real time within your own virtual world. Even if you can't think of a reason to use this, it's well worth trying it out just for the experience. I guarantee you'll be hooked and trying out your own functions within half an hour of your downloading the viewer!

Another freely available technology for rendering 3D surfaces into your own virtual world is **POV-Ray**. This was brought to our attention when we visited the web site of Maple V user, **Bjørn Konestabo** at the University of Oslo **(http:// http://www.math.uio.no/m2p/)**. POV-Ray is essentially a scene description language that allows users to define shapes, their size and position in space, surface colour and texture, lighting etc, to produce stunning looking images.

Bjørn and his colleague, **Bjørn-Helge Mevik** developed two utilities for Maple V Release 3; **povtrace** which is a library function that takes a 3D plot data structure, saves it to a file then calls the second utility, m2p which converts the Maple V data into the **POV-Ray scene description language**. This allows you to load it into the POV-Ray editor *(downloadable from* **http://www.pov.org/***)*. Embellishments to the original plot can then be added to the text, using its own language (partially but sufficiently documented in the on-line help), set

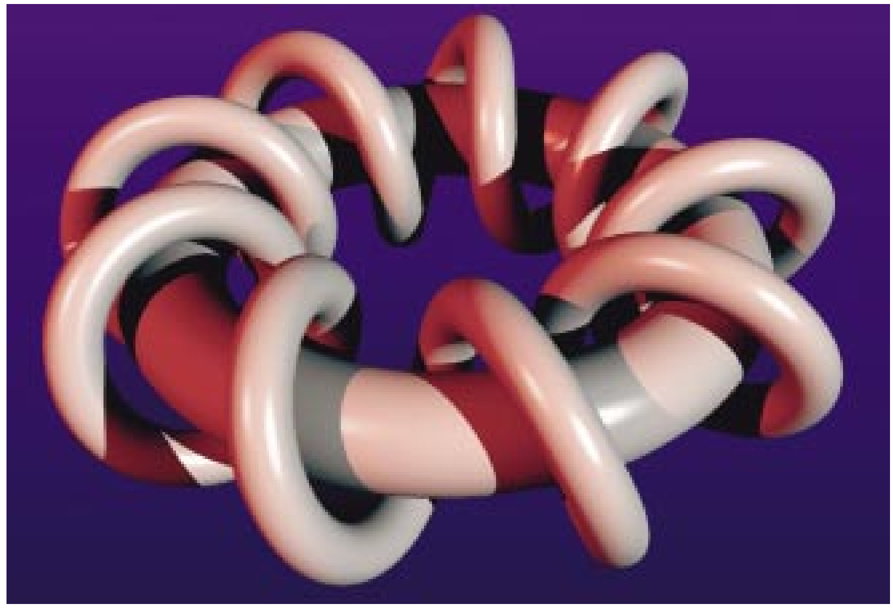


Using a VRML browser you can 'fly' through your Maple V plots to explore them!

lighting levels and angles, transparency, specularity, reflectiveness and so on.

In Release 5, it is now a relatively straightforward matter to store any data structure in a file, which can go straight into m2p. Let's try the following example.

```
> restart:with(plots):
> fn := proc (expr)
    Digits := 6;
    if type(expr,function) then
     if member(op(0,expr),
       {TEXT, CURVES,
        ISOSURFACE, POLYGONS,
        GRID, MESH, POINTS})
       then map(evalf,expr)
       else map(fn,expr)
     fi
    else expr
    fi
  end:
```



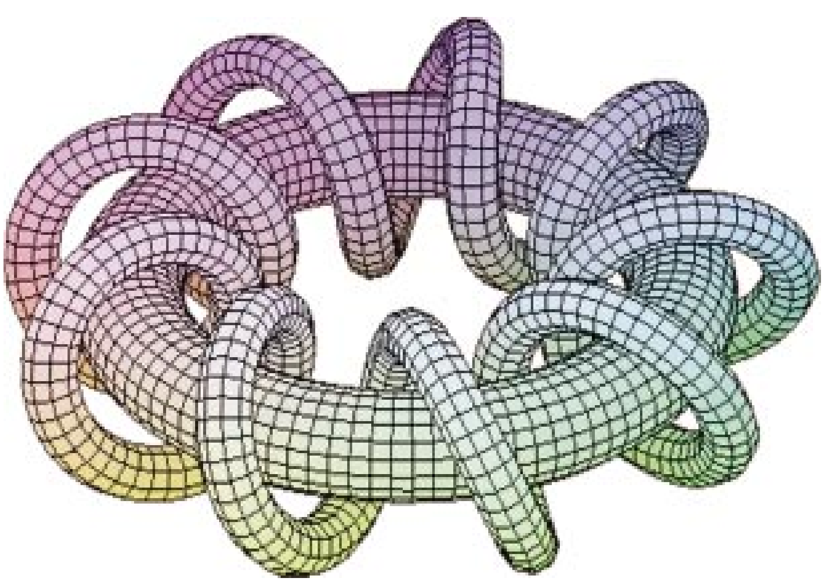
Screen shows the final rendered image of the Maple V plot from POV-Ray

```
Spiral Tube Around a Torus
>N :=10:
>tortube := tubeplot({[10*cos(t),
  10*sin(t),0,
>t=0..2*Pi,radius=2,numpoints=10*N,
  tubepoints=2*N]
>,[cos(t)*(10+4*sin(9*t)),sin(t)*(10+4
  sin(9*t)),4*cos(9*t),
>t=0..2*Pi,redius=1,numpoints=
  trunc(37.5*N),tubepoints=N]},
>scaling=CONSTRAINED,
  orientation=[7640]):
>
>tortube;
```

```
#Save data structure to file
>writeto(`c:/My Documents/Maple
  Worksheets/toroid`):lprint(fn
 (tortube)):writeto(terminal);
>system(`m2p c:/My Documents/Maple
  Worksheets/toroid`);
```

This creates a file called **TOROID.POV** which can then be used in POV-Ray. POV-Ray is essentially a text language that describes every element in the 'scene'. The description generated by m2p depends on the command line settings you use when you perform the conversion but it is very basic. However, it does give you a very good starting point from which you can add your own descriptions to produce something that looks astonishingly lifelike.

Above is a perfect example of how Maple V's open architecture allows other developers to use third-party technology with astounding results. And the images you create don't need to be theoretical mathematical models. The use of VRML or POV-Ray would be ideal for visualizing mathematically generated shapes for, say, engineering. For example, pump impeller vanes, turbine blade profiles and airfoils could be produced in Maple V, using the appropriate fluid dynamic calculations and then rendered for inspection. By reducing the need for expensive early prototyping, this would reduce the costs of the design process enormously.



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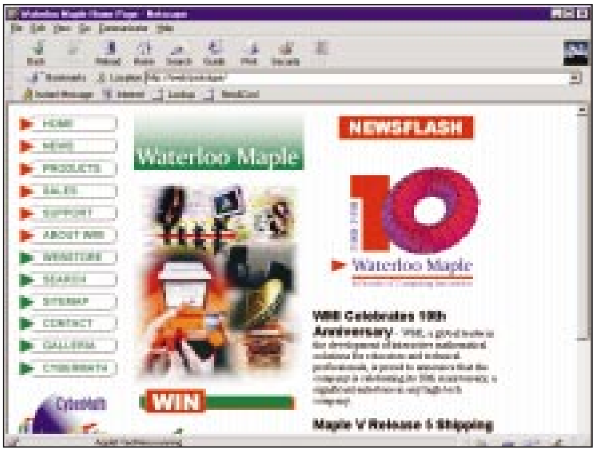
Also see '*Discovering Curves and Surfaces with Maple*', Klimek and Klimek, Springer, ISBN 0-387-94890-2



Maple V on the World Wide Web

Key Maple V Worldwide Web Sites:

The Home of Waterloo Maple Inc.: • **http://www.maplesoft.com/**
The Symbolic Computation Group, University of Waterloo:
• **http://daisy.uwaterloo.ca/**

Comprehensive Lists of Links to other Maple V Sites:

- **http://www.df.uba.ar/~jakubi/maple.html**
- **http://www.indiana.edu:80/~statmath/math/maple/**
- **http://SunSite.informatik.rwth-aachen.de/maple/**
- **http://www.maplesoft.com/websites.html**

Some Math Courses using Maple V:

Calculus:
- **http://www2.ncsu.edu/eos/info/math/maple_info/www/ma141_maple/** (Maple V Worksheets)
- **http://www.math.montana.edu/~frankw/ccp/calculus/topic.htm**

Differential Equations:
- **http://calclab.math.tamu.edu/docs/math308/topics.html** (text files)
- **http://www.math.scarolina.edu/~meade/math242**
- **http://www.math.hmc.edu/mellon-de/categ_de.html** (text and Maple V Worksheets)
- **http://www.cms.uncwil.edu /~herman/m361.htm**

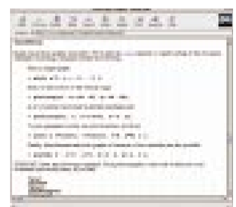
Linear Algebra:
- **http://www.math.duke.edu/modules/materials/linalg/** (html pages and Maple V Worksheets)
- **http://www.laurentian.ca/www/math/badams/numeric/linalg/contents.html**
- **http://www.indiana.edu/~statmath/smdoc/maple_linalg.html**

Multivariable Calculus:
- **http://omega.albany.edu:8008/mat214.html**
- **http://www.math.montana.edu/~frankw/ccp/multiworld/topic.htm**

Numerical Analysis:
http://www.laurentian.ca/www/math/badams/numeric/intro/intro.html

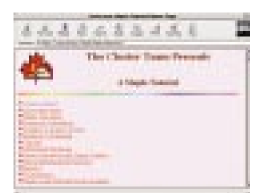
Modeling:
- **http://www.math.montana.edu/~frankw/ccp/modeling/topic.htm**

Examples! Example! Examples!:
- **http://www.ms.uky.edu/~carl/** (postscript files and Maple V Worksheets)
- **http://www.math.tamu.edu/~david.barrow/labs.html** (postscript files)
- **http://userwst1.fh-reutlingen.de/~komma/embuch.html** (lots of physics examples)
- **ftp://ftp.inf.ethz.ch/pub/SolvingProblems/** (From the book *'Solving Problems with Maple and Matlab'* Edited by W. Gander and J. Hrebicek)
- **http://www.math.sc.edu/~murphy/reno96/** (Links & examples)
- **http://webby.cc.denison.edu/fipse/** (Applications of Maple V)



Maple V Courses:

Introductory:
- **http://www.indiana.edu/~statmath/smdoc/Maple.html** (Getting Started html page)
- **http://www.ms.uky.edu/~carl/handf97.html** (Maple V Worksheets)
- **http://www.mcs.dundee.ac.uk:8080/~dfg/MapleExternal.html** (postscript)
- **http://www2.ncsu.edu/math/MapleInfo/MapleArchive/info/MapleInAction.html** (Learning from 'Maple in Action')
- **http://saaz.lanl.gov/Maple/Maple_Home.html** (html pages)



Accomplished:
- **http://SunSite.informatik.rwthaachen.de/maple/mplardoc.htm#advanced**
- **http://www.cs.utah.edu/~zachary/isp/resources.html** (*'Intro. to Scientific Programming'* book)

Maple V Tools:

- **http://www.df.uba.ar/~jakubi/maple2.html#packages** (Some Maple V Tools for Applied Math)
- **http://www.mech.kth.se/~mlesser/html_lib/sophia.html** (A Toolkit For Doing Mechanics With Maple)
- **http://SunSite.informatik.rwth-aachen.de/maple/mplarpac.htm** (Syrup, A Symbolic Circuit Analyzer)

Graphics Galleries:

- **http://www2.ncsu.edu/math/Projects/MapleArchive/Gallery/Gallery.html http://www.cybermath.com/**
- **http://dept.physics.upenn.edu/courses/gladney/mathphys/gallery.html**
- **http://www.cybermath.com/gallery**

Miscellaneous:

- **http://archives.math.utk.edu/topics** (Search for bibliography of Maple V related material)
- **http://www-math.math.rwth-aachen.de/MapleAnswers/** (Compiled list of MUG answers)

Have we missed you? *If you have an interesting Maple V Web site and would like to have it publicized, please send your URL to* ***reporter@maplesoft.com****.*

How can I do numerical integration using Maple V?

Let's say I want to integrate **exp(cos(x)^2)** symbolically, Maple V will not return anything. In this case what you need to do is, integrate it numerically as in the example below.

```
> int1:=int(exp(cos(x)^2), x); # cannot be evaluated symbolically
```

$$int1 := \int e^{(\cos(x)^2)}\, dx$$

Use the function **evalf(int(f(x),x=a..b) ,n)**, or **evalf(Int(f(x), x=a..b),n)** where **a** and **b** are the range over which to integrate **f(x)**, and **n** is the number of significant figures.

```
> evalf(int(exp(cos(x))^2, x=0..1),20);#Evaluating
      the integral to 20 significant figures
                 5.5799440848486685663
> evalf(Int(exp(cos(x))^2, x=0..1),20);
                 5.5799440848486685663
```

How can I simplify an expression of the form ln(x*y) to give ln(x)+ln(y)?

Using Maple V to simplify expressions such as the one above, you will need to give more information about x and y, whether they are positive, negative and so on. For more information on simplify type **?simplify,ln** and press enter.

```
> interface(showassumed =0);
> restart:
> simplify(ln(x*y));
                 ln(x y)
> assume(x>0, y>0);
> simplify(ln(x*y));
                 ln(x) + ln(y)
> assume(x<0, y<0);
> simplify(ln(x*y));
                 ln(-x) + ln(-y)
```

How can I import experimental data to a Maple V Release 5 spreadsheet?

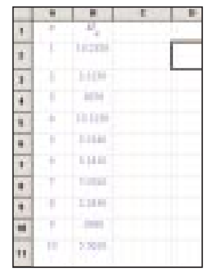
To import data to a Maple V R5 spreadsheet follow the instructions below:

- Use the **readdata** function to read the data (data should be a text file).
- Convert the list returned by the readdata function to an array **M** using the convert function.
- Define a function which takes an integer value **n** as its independent variable, and returns the elements of the array M[n] using n as the index.
- Insert a spreadsheet, click on the first cell (~A1) and type **n** then click on cell (~A2) and type 1, press the left mouse button and drag it until you reach cell (~A11), do a right click and select **Fill..Detailed**, type 1 for step size and 10 for stop value, then click ok.
- Click on cell (~B1) and type M[~A1], press enter then press the left mouse button and drag it all the way until cell (~B11) is reached, do a right click, select **Fill..Down**, and the data file will be copied to the spreadsheet.

```
> restart:
> L:=readdata("a:/MAPLE.txt",1);
        L := [10.235, 2.123, .987, 15.123, 5.314, 3.141,
              7.052, 2.243, .098,5.562]
> M:=convert(L,array);
        M := [10.235, 2.123, .987, 15.123, 5.314, 3.141, 7.052,
              2.243, .098,  5.562]
> f:=n->M[n];
                 f := n -> M[n]
```

Insert a spreadsheet from the insert menu.

```
>
>
```



How can I write my own package in Maple V?

Maple V has a high-level programming language for developing highly-efficient mathematical programs for technical applications. Its syntax and procedural programming style is similar to FORTRAN, C, BASIC and Pascal, making it easy to learn by anyone with some programming experience.

Users can rapidly convert their working Maple V session into a Maple procedure and use the powerful interactive debugger to quickly track down any problems. They can extend the functionality of Maple V by saving custom code either as Maple V **'.m'** files.

A Maple procedure has the form:

```
procedure_name:=proc(sequence_of_variable_names)
  local/global_declarations
    options
      body_of_procedure
end:
```

Where the body of the procedure consists of Maple V statements and can include loops, branching etc. An example of a very simple Maple V procedure is:

```
>sampleproc:=proc(x,y) x^2+2*y end:
```

`>sampleproc(3,4)` returns 17

`>sampleproc(a,b)` returns a^2+2*b.

Examples of more complex procedures can be found by examining the source code of the Maple V library functions. This is done by typing `interface(verboseproc=2);` `print(library_procedure_name);` at the Maple prompt.

How can I use procedures I have written in Maple V in my C program?

Maple V has very powerful routines for creating optimized FORTRAN and C code from Maple V procedures, that can then be used as part of or in conjunction with your own programs or packages that support user libraries.

In fact many of our users tell us that this is the major benefit of using Maple V for their problems. They use the Maple V worksheet to test ideas and manipulate or solve their mathematics, convert their interactive session into a procedure which can apply the same solution methods to other input conditions and then use the **"C"** or **"fortran"** commands in Maple V Release 5's **"codegen"** package to convert this to optimised numerical code which they can use outside Maple V.

Check out our web site: **www.maplesoft.com** for more FAQs or email us at: **reporter@maplesoft.com** with your questions.

FREE Maple V White Papers

The following white papers are available free of charge!

1. What Makes Maple V Essential to Today's Math Classroom?
2. Maple V in Engineering Education: From Theory to Practice
3. Computer Algebra Methods for Feedback Linearization using an Exterior Calculus Framework
4. Vibration Analysis using Symbolic Computation Software
5. Modelling a Thermal System
6. The Use of Symbolic Computation in Statistics
7. Using Maple to Solve Multivariable Control Analysis and Design Problems for Systems Represented by Polynomial Matrices
8. The Latest Important Discovery in Physics – Maple V
9. Maple V and Electronics
10. Symbolic Circuit Analysis and Design Using Maple V

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The Maple Reporter

Please email any enquiries or suggestions about this newsletter to the editor at: ***reporter@maplesoft.com*** *.*

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