EDITOR'S NOTES

Greetings from West Point!

This is a special time at the Academies, as the new cadets (Class of 1999) have arrived, preparing for the beginning of their four-year education. They will receive some of the best technology available to help them, including programmable graphing calculators and personal computers loaded with high-technology software.

Here at the United States Military Academy, new cadets will soon sign for their PCs with Pentium processors and several mathematics packages. The focus of this issue, therefore, will be "Technology in the Classroom". At all of the academies, instructors are blending the latest in computer algebra systems and computer training with mathematics. It's an exciting topic and one sure to continue in the future.

Thanks to all for interest in this magazine. Our subscription list is growing almost as fast as the technology!

All the best from West Point!

Mike Huber
Michael Jones

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SUBSCRIPTIONS TO *MATHEMATICA MILITARIS*:

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Math Awareness Day

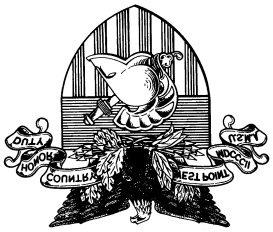
LTC Thomas Riddle, USMA

Seventy Pre Calculus and Calculus students from James I O'Neil High School attended Math Awareness day with the USMA Math Department. The Joint Policy Board for Mathematics designated 23 - 29 April 1995 as math awareness week. The USMA Department of Mathematical Sciences in turn designated Mathematics Awareness Day for USMA as 25 April.

The days' activities began with a breakfast and welcome by COL Arney at the Thayer Hotel. This was followed by a bus ride to Thayer Hall and presentations by three faculty members and two cadets. The theme for their many presentations was symmetry and mathematics.

LTC Jensen discussed "Escher and Symmetry" with the students. His presentation included several interesting slides that demonstrated different forms of symmetry.

Dr. Cindy Wyels discussed combinatorial thinking. She provided the students with a problem of stacking multicolored blocks such that no color repeated on any side of the stack. After the students had tried to solve the problem by trial and error for ten minutes Dr. Wyels showed a strategy for quickly solving the problem.



CDT Vine was unable to make his presentation on fractal geometry, but later traveled to O'Neil High School and lectured on Chaos and Fractals to the Calculus class.

CDT Hair divided the group in two and challenged them to optimize the design parameters for a trebuchet catapult. By trial and error the students managed a best throw of about 1100 meters. CDT Hair then showed how he used multivariate numerical optimization to design a catapult capable of a theoretical 6000 meters plus range.

Dr. Mike Jones completed the presentations with an interesting talk on symmetry and the arts that concentrated on translational symmetry in music. He combined visual and audible demonstrations using a computer controlled keyboard.

The program strengthened ties between the High School and the USMA Math department. The department designed it to motivate students to pursue careers in mathematics and mathematics related fields. The program emphasized the practicality and pervasive nature of mathematics in real world problems. The presentations by cadets aptly demonstrated the ability to greatly profit from a mathematics education at the undergraduate level.

USMA hosts West Point Core Curriculum Conference in Mathematics

MAJ Don Engen, USMA

Senior faculty members from seven college and university math, science and engineering departments gathered at West Point for a Core Curriculum Conference in mathematics from 27-30 April 1995, under the direction of Professor Don Small, the senior civilian faculty member in USMA's Department of Mathematical Sciences. The focus of the "7-into-4" conference was an examination of: (a) the role played by a set of fundamental core courses in launching the study of mathematics for students majoring in the mathematical sciences or fields of study which are highly mathematics dependent, and (b) how to most effectively integrate the critical content of:

1) Discrete Mathematics,
2) Calculus I,
3) Calculus II,
4) Calculus III,
5) Linear Algebra,
6) Differential Equations, and
7) Introductory Probability and Statistics

into a four course sequence. The phrase "7-into-4" has been coined, which denotes offering seven sequential mathematics courses in four semesters.

The conference featured nationally known speakers and discussants detailing the essential content that would have to be included in such a program, an examination of the 7-into-4 program used at USMA, small group sessions that worked on questions dealing with both organizing the content into workable models and articulating with secondary schools and community colleges, and new methods to implement instruction into the program.
Participants included members from Harvey Mudd College, Fairfield University, Carroll College, Texas Southern University, the University of Redlands, Oklahoma State University, and the Military Academy. COL Frank Giordano, COL Chris Arney, LtCol Doyle Daughtry, LTC Bill Fox, LTC Gary Krahn, LTC Kelley Mohrmann, LTC Rich West, Prof Don Small, Prof Jim Tattersall, and MAJ Kathi Snook from USMA's Department of Mathematical Sciences served as group facilitators.

As a result of the conference, each participating school submitted a report which was included in the Proceedings of the April 1994 West Point Curriculum Conference on Integrated Curriculums. The Proceedings, which will be published in the MAA Notes series, include:
-- a description of each school and student audience,
-- a description of the current (mathematics curriculum) status and why reform is desired,
-- a model of the goals, Student Growth Model, Threads, and actual proposed curriculum reforms,
-- reception of the reform model by the implementing department, partner disciplines, and school administration, and
-- timeline for implementation.

We all look forward to reports from the participating schools regarding the success of their Mathematics Programs' Curriculum Reform, and any lessons learned that they might be willing to share for other schools that have similar interests or agendas.

The USMA Department of Mathematical Sciences wishes to formally and publicly thank each of the 7-into-4 conference attendees for making the conference such a success -- Well Done!

(Editors note: For a complete listing of conference attendees from each participating school, please contact MAJ Engen at ad9283@usma2.usma.edu).

Calculus & Mathematica at the US Air Force Academy

Dr. Judy A. Holdener, USAFA

Why teach Calculus the reformed way?

Our math department has been asking the following question (especially at the core level): What does a student gain from a mathematics lecture?

My own response to the question is:

The largest gain occurs when the student watches what the lecturer does, understands it, repeats it, and explores it. Unfortunately, it is rare (particularly in a beginning math class) that a student "explores it." A more realistic goal is that the students watch, understand, and repeat. Of course, the reality is that most students watch and repeat only. Some watch only without repeating (that is, they don't do their homework), and unfortunately, there are those who don't even watch. Hence, it becomes clear that the lecture that results in the most gain is the one that results in the students' ability to repeat what the lecturer does.

Is this really a *gain*?...Are the students *really* learning?...Are these students going to be able to leave this lecture-based course able to use the material in their other courses or in their own fields of interest? I have come to believe that the answer is no to all three of these questions. In fact, I would go as far to say that teaching a student to "do as I do" is generally a huge waste of time.

Let's consider now a question that is being asked by mathematicians worldwide:
What does a student gain from a traditional calculus text?

My response follows (after a lot of copying and pasting):

The largest gain occurs when the student reads what the traditional book does, understands it, repeats it, and explores it. Unfortunately, it is rare (particularly in a beginning math class) that a student "explores it." A more realistic goal is that the students read the book, understand it, and repeat it. Of course, the reality is that most students "read" just enough (i.e., the contents of the little blue boxes and perhaps an example) to repeat only. Unfortunately, many don't read or repeat at all. Hence, it becomes clear that the traditional book that results in the most gain is the one that results in the students' ability to repeat what the examples do.

Again, I ask...Is this really a *gain*?...Are the students *really* learning?...Are these students going to be able to leave this traditional course able to use the material in their other courses or in their own fields of interest?

Is the traditional calculus course a waste of time?

This semester, the cadets in my multivariate calculus course are learning mathematics without any lectures and without the aid of the little blue boxes. Instead they are learning mathematics by working through a series of interactive electronic notebooks which introduce the concepts of calculus in the context of real life applications (e.g., the cadets have already faced applications which involve heat seeking missiles and stealth bombers.) Every lesson includes both a computer assignment and a written assignment which are collected and graded. All exams, including the final, are written. All cadets in the classes are freshmen who volunteered to participate.

The text for the course is an electronic text (though cadets also get a hard copy) called *Calculus & Mathematica*. It was developed under funding from the National Science Foundation by Professors J. Jerry Uhl (who was once a captain in the Army himself!) and Horacio Porta of the University of Illinois, together with Bill Davis of Ohio State University. Of all the new calculus reform projects, *Calculus & Mathematica* is considered to be one of the more radical courses in that it leans on technology the most.

Commonly asked questions (from both students and instructors):

Does the course content differ from that of a traditional course? Is there too much time devoted to the computer part of the course at the expense of calculus? Can the students still do the hand calculations that are necessary for later courses? These are important questions to ask (and in fact, if students and instructors didn't worry about these issues, I would worry about them!).

The content of *Calculus & Mathematica* is the same as that of a traditional course; although the emphasis is quite different. For example, in multivariate calculus, less time is spent on the algebra of vectors, whereas more time is spent on the geometry of them. Less time is spent on the computation of triple integrals, and more time is spent on the line integral and its applications. More generally, the concepts of calculus in this course tend to be introduced in the context of an application rather than as an abstract theory. Students in *Calculus & Mathematica* rarely ask the question, "What is this stuff used for?".

Regarding the extra time needed to master the technology aspect of the course...this is definitely a problem early in the semester. I've found that I have to lessen the amount of calculus introduced in the first couple of weeks to get the students up to speed on *Mathematica*. I do, however, feel that this is time well spent and that the rewards gained from the power of technology far outweigh the "extra" amount of calculus they might have learned. I argue that the use of the computer and, in particular its visual capabilities, allow for the students to learn more quickly later, so that there is no net loss (more likely it's a gain). Nonetheless, getting through the first two or three weeks of the course is difficult. I warn the students at our first meeting of the course that the early lessons will be painful; they are more willing to endure the added pain when forewarned. This semester, my two sections of freshmen claimed that I was training them (they even asked me when I was going to "recognize" them in the class). Both

sections have since become quite proficient with *Mathematica*.

The hand skills are not ignored in *Calculus & Mathematica*. Although the heart of the course consists of the computer assignments where new concepts are introduced visually, each lesson is completed with a written assignment. These written assignments reflect the same emphasis as the computer assignments do, and they include many of the same types of problems that one would find in a traditional course. The problems are different in that they often require an explanation together with a computation. This forces the students to think about the numbers they get. Most importantly, the written problems show up on the exams, and as a result, the written assignments are significant.

How are cadets responding to this new way of learning?

The cadets in *Calculus & Mathematica* had a rocky start. Computer memory problems plagued the class for the first month. One morning I turned on my computer to find nineteen email messages, each describing a different computer catastrophe that had occurred. Learning *Mathematica* and encountering its syntax errors was frustrating for the cadets. The realization that they would have to do much of the learning on their own without the aid of my lectures was also rough on them. A couple of the cadets wanted to get out of the course by the second week. One cadet even nicknamed me Dr. Hardener!

As time progressed however, the cadets began to rise to the challenge. After the first month they had developed a network among them and I began to find that explanations I had given to one student found their way to the others. Students met together at night to work on the computer assignments (I encouraged them to work together). They became more and more comfortable with *Mathematica*, and even started asking if they could use *Mathematica* for the written assignments. Most importantly, the students developed a change in attitude towards the learning of mathematics. They stopped asking me how to do everything, and started to do it themselves!!! They began asking me different types of questions; they now ask me more *why* questions, and fewer *how* questions.

In short, I would say that over the past few months, I have seen a distinct improvement in the level of intellectual maturity in my students. They are more confident to explain mathematical concepts to one another and to me. They aren't afraid to say what they believe is right and why. They even argue with one another about who is right. The class as a whole, now seems to be proud to be in the course, and proud with what they have achieved.

A New Challenge

The cadets in *Calculus & Mathematica* have made me rethink the previous sections of calculus I have taught. In particular, I don't think I was successful in the past. Most of my students left my classes with the same level of intellectual maturity that they had when they started. Even many of my "A" students gained nothing more than a temporary knowledge of how to do certain computations. I did my students a disservice by giving them all the facts and procedures they needed for the homework. I didn't teach those students how to solve problems. I didn't prepare those students for the future.

The change I experienced in my students this semester has given me a new challenge in teaching. In the future, I will consider myself successful when my students are able and willing to attack problems they have never seen before. Success will be a class that is able to explain their ideas (preferably good ideas!) with confidence. I will strive to teach students to not depend on me to give them the answers. I will work to produce students who take charge of their own education, students who are independent thinkers. My new goal for future classes is to be able to say at the end of each semester that my students have reached a higher level of intellectual maturity, even if this does mean that the first month of the course is painful.

I ask others to take this challenge too. It's time we stop teaching canned computations courses.

An Overview of Computer Technology in the Classroom

Professor Michael W. Chamberlain, Department Chairman, USNA

The USNA Mathematics Department continues to increase the use of technology in educating midshipmen. Almost every classroom has a large color monitor and computer connected to a LAN to run software such as the USNA produced MPP and MDEP as well as commercially purchased spreadsheets, simulation packages, and computer algebra systems (CAS). Midshipmen have access to the computer labs to work on PCs or Sun workstations. They can remotely connect from their own PCs in their rooms to the LAN or they may use software issued or loaned for specific course use.

Here is a quick overview of how this technology is put to use in some USNA mathematics courses. Precalculus uses commercial tutorial software to generate questions and provide detailed solutions. The calculus sequence is now based on the Harvard Consortium version of reform calculus. Hand graphing calculators are used by the students to perform the same kinds of graphical and numerical work demonstrated with MPP by the instructor on the classroom computer system. In addition, course projects for calculus are being produced this summer. This will encourage midshipmen to work together to solve problems in naval applications using the reform approach along with sophisticated and powerful software.

Differential Equations continues to use MDEP to solve problems beyond the scope of hand solution. In addition, a new version of D.E. has been offered this year for midshipmen majoring in Mechanical Engineering or Oceanography. Based on *Mathematica*, it introduces students to a CAS as a problem solver that they will use in their major courses. Indeed, the Oceanography majors go on to take from us Engineering Mathematics with *Mathematica* to gain more familiarity with a CAS and to better learn about the mathematics (e.g., fluid flow) appropriate for their education.

This year Mathematics majors in one section each of E.E., Probability, and Linear Algebra were loaned copies of *Maple* to get an idea of how such a CAS can be integrated into standard course work to gain power without much loss of time due to the learning time overhead. Looking to the future when a CAS such as *Maple* or *Matlab* is a standard issue with the midshipman computer, an effort is underway to install software so that PCs can easily access the Mathematics Department LAN through a DOS or UNIX windowing system.

Specialized use of technology in the mathematics education of midshipmen is sketched out in the adjoining articles.

Application of Computer Software in the Classroom

Professor John C. Turner, USNA

SM230, Probability with Naval Applications, uses Quattro Pro for all its computer work. Some of the assignments use the computer to verify assertions made in the text. For example, the student is to verify that the binomial distribution is a good approximation to the hypergeometric distribution by calculating probabilities from both distributions and comparing them.

There are several novel assignments in the course. The first is an exercise in calculating binomial coefficients and generally reviewing the operation of Quattro Pro. It is the "tag and recapture" problem. We tag 10 deer and release them into the woods. Later, we capture 30 deer from the woods and discover that 6 of them are tagged. How many deer (tagged and untagged) are in the woods? Although the students haven't seen the hypergeometric distribution by name, they have seen this type of probability calculation in the text. (The problem is actually posed as a confidence interval for the total number of deer, but the students don't know that.)

The second novel application involves the sum of random variables. For discrete random variables, it is fairly easy to derive the convolution rule for the sum. Quattro Pro has a built-in function to calculate dot products (@SUMPRODUCT()). If the two probability distributions are cleverly laid out on the page, you can use the dot product to form their

convolution. Further, by copying the result over one of the inputs, you can form three-fold (and hence many-fold) convolutions. This is used to verify the standard theorems on the sums of random variables, *e.g*., the sums of binomials are binomial, sums of Poisson are Poisson, *etc*. Also, by discretizing continuous random variables, it is possible to indicate the corresponding results for the continuous case. This avoids the convolution integral and another pesky occurrence of the density function.

The third novel application applies directly to naval tactics. This is Bayesian searching. An object is known to be in one of several locations with given probabilities for each location. Our search effort has different probabilities of success in each location. The first variation is the "simple search." In this case, we search all the locations. If we do not find the object, we use Bayes' Theorem to update the probabilities assigned to each location. The student is to investigate the asymptotic effect on the location probabilities when the initial conditions are varied. The second variation is the "single sector search." In this case, we do not search all locations, but rather the single location that has the highest probability of success. Again, the student is to examine to effect of changing the input parameters.

Quattro Pro has generally been well accepted by the students. Student Opinion Forms show a positive attitude. Students often say that it has helped them understand some concepts by relieving them of the computational burden. It has also allowed us to explore some topics that are of interest, but that otherwise would have taken too much effort to compute.

Scientific Computing

Professor Peter R. Turner, USNA

The Computer Calculus sequence (SM161-162) is a 5-hour version of the plebe calculus sequence which covers the usual mathematical topics together with computer programming and use of Maple. The programming is in Turbo Pascal and is aimed at enhancing the students' understanding of the mathematical topics under discussion. This leads, for example, to a much more detailed treatment of limits of sequences and of integration including a careful development of computer routines and their error bounds. A substantial additional benefit is the improved problem-solving skills that are acquired as a result of the unforgiving nature of programming.

During the academic year 1994-5, this course was further modified to incorporate Maple as a symbolic manipulation and graphics package. This was our first venture into symbolic packages at the plebe level. We learned much about its usefulness as a demonstration tool often turning to Maple in unplanned ways in response to questions. These included, for example, the notion of "higher-order tangency" as a way of illustrating and explaining improved polynomial approximations to the sine function several weeks before any formal treatment of Taylor's theorem. The success of Maple in this sequence has resulted in the revival of a special Calculus III with Computers this Fall. Approximately 50% of the Computer Calculus students elected to take this version.

The Introduction to Scientific Computing (SM365) course is our first numerical course and is a requirement of the Mathematics Major. This is the first time that students make extensive use of their computers for "number crunching." As well as the usual numerical methods, they are instructed in programming. This has been in Turbo Pascal. In the Fall of 1995, we are switching to the student version of Matlab. This should make the programming tasks easier for those who have no previous experience. Also, by allowing the use of Matlab's library of routines *after* the basic methods have been mastered, it should be possible to use numerical techniques to solve more practical problems. One major advantage will be the removal of the

need for students to write their own "graphics engine" to display results.
A major innovation in the last year has been the introduction of parallel computing into the curriculum. In the summer of 1994, our DEC/MasPar massively parallel computer system was installed. This system has 4096 processor arranged in a 64x64 array. Last year it was used first in a special "reading course" for three Honors students in the Fall and then in the SM426 Numerical Solution of Differential Equations course in the Spring. This course developed into a group project on parallel numerical integration, the computation of wavelet transforms, and the reconstruction of the original function/data. For the Fall of 1995, a course in Parallel Scientific Computing is being offered and has been chosen by Midshipmen from four different majors, and by two faculty members!

For further information on any of these, please contact Prof. Peter Turner by *e*-mail (prt@sma.usna.navy.mil) or phone (410) 293-6732.

What a Site

Prof C. Ara Pehlivanian, USMA

The World Wide Web (WWW) has its genesis in an effort by the particle physicists at CERN (the European Particle Physics Laboratory) to provide a forum for efficient exchange of ideas within their field. Despite this modest beginning, "the web" has grown at an astounding rate, (the protocols are now a recognized piece of the internet) and can be a valuable source of mathematics-related material, if one knows where to look. I will give a very brief tour of some of the more interesting mathematics-related sites, and hopefully uncover areas ripe for exploration.

I will assume that you are somewhat familiar with navigating in the WWW - let's say, that you've successfully visited a site or two on your own browser. First, perhaps, some terminology: a browser is the software you use which understands the web protocols and allows you to navigate, and a site is a server, or location, that can be accessed by your browser. Each site is marked by its own URL (Uniform Resource Locator), or address, beginning with one of the prefixes: "http", "ftp", "gopher", or "news". A link is any highlighted text on a web page which provides access to a different site or page.
Onward! Two good starting points are:

http://www.yahoo.com
http://www.w3.org/hypertext/DataSources/bySubject/Overview.html

The first site, known as the "yahoo" site, contains, at last count, 44 links to math-related sites. Some are for specialists only ("the "semigroups" link), while others seem to be recreational (the "WWW spirograph" link). To access this master list, click on "Science", then "Mathematics" from the yahoo main page. The second site above, known as the "WWW virtual library" page, provides access to a main menu providing links to electronic journals, addresses, preprints, information on specialized fields, etc. All in all, there are more links here than on the yahoo page, and they represent more technical, or specialized interests.

Some of the highlights include the essential American Mathematical Society page at http://e-math.ams.org. This page is relatively new and very comprehensive. I found Math Reviews information, addresses, conference announcements, even that Math Awareness Week this year, it turns out, was officially April 23-29. For a list of famous problems, consult http://daisy.uwaterloo.ca/~alopez-o/math-faq/tableofcontents3_1.html. There is a list of on-line courses, or interactive texts, at http://www.shu.edu/html/teaching/math/. Almost all of these are very well-done, as is evidenced by the "interactive real analysis" page. This site is set up as a kind of beginning "course" in real analysis, in hypertext format. So there are problems with links to solutions, theorems with links to the proofs, etc. The material is subdivided into several chapters, so that I could easily access very specific information (say, the ratio test) by simply pointing and clicking a few times. All in all, this is a promising trend in mathematics pedagogy, although it seems to be still in an experimental stage, and many of the "courses" offered are still under construction.

Finally, I would have to include the "geometry center" page, http:/www.geom.umn.edu/, the

"mathematician biographies" page, http://www-groups.dcs.st-and.ac.uk/~history/, and the "math history" page, http://aleph0.clarku.edu/~djoyce/mathhist/mathhist.html, on any "must-see" list.
As a final experiment, I tested the premise stated at the beginning of this article; that is, I chose beforehand two topics chosen more or less at random, to see if I could find the information on the web. The topics I chose were: Hilbert's 23 problems of 1900, and a biography of Georg Cantor. The findings surpassed my expectations: I found not a list, but extensive references to Hilbert's problems at http://daisy.uwaterloo.ca/~alopez-o/math-faq, and a very comprehensive list of short biographies of mathematicians at http://www-groups.dcs.st-and.ac.uk:80/~history/ (who is Lexis?).
As always, the best way to find out what is offered on the web is to try a test drive! You should be pleasantly surprised.

Scientific Workplace, by TCI Software Research, Las Cruces, New Mexico

Dr. Michael D. Marcozzi, USMA

Scientific Workplace is a windows based, menu driven, Latex word processor with an integrated Maple symbolic processor. Competing products are PC Tex, by Personal TeX, Inc., Waterloo Math Software Math Office which couples Microsoft's Word for Windows with the Maple engine, and waterloo's MathCad application.

The obvious advantage of the TCI product is it's integration as a package. It is possible to produce documents in the scientific standard latex while seamlessly integrating calculations and quality graphics associated with Maple. This particular combination offers exciting possibilities when interaction is desired, either in terms of the authors exploration of results or presentation, or through a document meant to entice student participation through the exploration of results. Evaluating expression and graphics is relatively simple and "hot" in this setting as is the options to simply write "mathematics".
Disadvantages center mainly on the difficulty of the format for the latex language, which was not developed with such an application in mind. The consequences are that for simple document styles the system works easily and efficiently, However, to deviate from given formats can greatly increase the need for software skills and knowledge of latex. Compounding this problem is a manual that is behind the software's development. The manual is excellent in terms of working within the well thought out abilities of the package, but is entirely inadequate when "trying to go your own way". Simple formatting changes that may be affected simply in latex can be tremendously complicated and require a call to technical support for resolution, if at all possible. However, TCI seems aware of these problems and appears to be continuing their development of Scientific Workplace. In particular, I have found the technical support staff immanently helpful when needed. Moreover, the direction TCI is headed no doubt portends the future in latex processing; quality word processing with accessible "hot" links to Maple.

A brief review of the other competitor's to Scientific Workplace may well stand to put the achievements of TCI into perspective, pro and con. In terms of a latex editor for the PC, PC Tex represents a system more true to a windows based implementation of straight Tex. While there are menus available for many auxiliary functions, one still programs in Tex, or latex. Hence, this system offers all the power of Tex and arguably represents the system of preference when simply scientific word processing is desired. As such, interactive documents of the type suggested by Scientific Workplace appear to be out of the questions.

Similarly with an integration of Maple with Word for windows through Math Office. Here, word processing is as easy as "what you see is what you get" and the maple system appears to be able to be called into play easily. However, it is not as easy to write "mathematically" in Word owing to the need to call the "equation editor". From a technical writing perspective, quality suffers by comparison to a Tex based system. Also, while graphics are good quality, three-dimensional graphics at this point are not possible. This however, is an interesting system that holds much potential.

Finally, MathCad maintains excellent interaction between symbolic and numerical engines, it simply was not designed as a word processor. Similarly, graphics can be somewhat weaker and

there appears to be a degree of difficulty in modifying the presentation of materials. This may well be the application of choice for provided interactive examples for analysis, however.

In effect, Scientific Workplace offers a seamless integration of the power of Tex, full menu integration and maple compatibility. For the development of standard formatted documents, this system offers seamless performance as well as obvious potential. For use by undergraduates, this system warrants a closer look.

Who's Who at the Academies

Joseph Arkin Retires

The retirement of Dr. Joseph Arkin, Senior Lecturer, Department of Mathematical Sciences, United States Military Academy, is announced with the deepest regret but with great appreciation for his distinguished service to the Department and Academy for eight years.

Joseph Arkin was born on 25 May 1923, at Brooklyn, New York. He faithfully served his country in the Army during World War II and was retired as a disabled American Veteran. Without any formal education beyond his high school training at Boy's High in Brooklyn, he managed to study on his own and learn the advanced mathematical concepts and theoretical foundations of number theory. He helped others learn about the beauty of mathematics by serving as a part-time instructor at Ramapo Public Schools (1962-67) and as a Visiting Lecturer at Orange County Community College (1962-67). He has been a member of the American Mathematical Society and the Mathematics Association of America since 1967 and became a charter member of the Fibonacci Society in 1965.

Joseph Arkin began working informally with Academy faculty in 1986 and was formally appointed a Lecturer in the Department of Mathematical Sciences in 1988. In 1990 he was promoted to Senior Lecturer. His vast knowledge, intuitive understanding of the properties and relationships of numbers, and his drive to solve the deepest mysteries of number theory, gave him the skills and motivation to perform state-of-the-art research and solve some of the most challenging problems in this field.

Joseph Arkin's first published work appeared in the American Mathematical Monthly in 1964. Since then he has written over 50 articles which have appeared in numerous publications such as the *Mathematics Magazine, Fibonacci Quarterly, SIAM Review, Duke Mathematical Journal, Journal of Recreational Mathematics, Notices of the American Mathematical Society, Canadian Journal of Mathematics, Pacific Journal of Mathematics, and Mathematics and Computer Education*. Among his co-authors and collaborators are many distinguished mathematicians and scientists including Paul Erdos, Ron Graham, E.G. Straus, Richard Pollack, Vern Hoggatt, Paul Smith, V.E. Smith, Gerald Bergum, Stephan Burr, Lee Dewald, Chris Arney, Rick Kolb, and Frank Giordano. Joseph Arkin has made over 50 presentations at professional meetings since 1972. He has attended and presented papers at the American Mathematical Society meetings, the meetings of the Metropolitan Section of the Mathematics Association of America, International Conferences on the Fibonacci Numbers, Number Theory Conferences, and Army Conferences on Applied Mathematics and Computing. Joseph Arkin has been a member of the New York Academy of Science, the Canadian Mathematics Society, the Calcutta Mathematics Society, American Legion, and Veterans of Foreign Wars. He is a founding editor of *Mathematica Militaris*, and still serves as our Insight editor.

Joseph Arkin was presented with an honorary Ph.D. from Brantridge School in England in 1967. His awards include the Certificate of Appreciation for Patriotic Civilian Service and the Commander's Award for Public Service. He is listed in Leaders in American Science, World Directory of Mathematics, Encyclopedia of Mathematics, Who's Who in the East, and Who's Who in the World.

INSIGHT

INSIGHT articles are edited by Joseph Arkin and are short and possibly informal articles of a philosophical (but still mathematical) nature. We invite you to contribute to this section. Please direct all correspondence to:

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The following is from Herta T. Freitag, Professor Emeritus of Mathematics, Hollins College.

WHAT IS MATHEMATICS?

Obviously, any discussion on the nature of intellectual struggle in any discipline is complex and difficult. What *is* mathematics? Our task in answering such query is formidable and, indeed, many answers have been given. Mathematics has been referred to as a Science, not a Science but one of the Humanities, an art, a language, a logic, a philosophy. It has even been likened to Ophelia in Shakespeare's *Hamlet*: a little eccentric and mad, but intrinsically delightful and charming.

When the famous "man in the street" meet a mathematician, his reaction invariably is: "You are lucky. You can balance your checkbook." There are two quite regrettable misconceptions in this view. One reveals the faulty view that mathematics is the study of 3 x 4; higher mathematics, then, probably, a concern with 17 x 18. Secondly, however, possible more worrisome yet, is the notion that the only justification of mathematics is its applicability; in this case, balancing the checkbook.

There are two major facets of mathematics: its theoretical side and its practical (applied) side. The latter doubtless does not need an explanation or vindication. But for representing the position of "pure mathematics," we may wish to think of B. Chandler and H. M. Edwards who say:

> It is a perennial problem for mathematicians to explain to the public at large what makes mathematics worthwhile if not its practicality. It is like explaining to someone who has never heard music what a lovely melody is....Do let us try to teach...mathematics that (students) can use...but let us...not slip into thinking that this is an essential quality of mathematics. There is a great cultural tradition to be preserved and enhanced. Each generation must learn the tradition anew. Let us take care not to educate a generation that will be deaf to the melodies that are a substance of our great mathematical culture.[i]

Pure and applied mathematics are cousins who support and fortify each other. One could not strive without the other. Historically speaking (and quite intriguing) a game of leap-frog has gone on over the centuries with one of these components preceding the other and vice-versa.

And, as we return to our question, "What *is* mathematics?", we might do best by recalling Bertrand Russell's definition: "Mathematics is the study where we never know what we are talking about, nor if what we are saying is true."[ii] The first part refers to the abstract nature of mathematics. Abstract, indeed, it IS--no mathematical concept can ever be grasped with our senses. Even just to say "three" is an abstraction. Not three sheep, three apples, three..., but what all these "real" objects have in common--their "three-ness."

And, as to "truth" as Joseph Arkin has portrayed,[iii] no self-respecting mathematician even uses the word "truth." He refers to VALIDITY, meaning: whatever deductions can be drawn from an ARBITRARILY selected frame of reference. Mathematics is an implicative discipline--we don't say, "this is so," but rather, "if you grant those assumptions, then these conclusions follow."

And thus, mathematics is not only charming as Ophelia in Shakespeare's *Hamlet*, but--towering above this--profoundly significant. Its study may open up a vision of the harmony, indeed the grandeur, of the Universe.

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[i] Chandler, B. and Edwards, H. M., The American Mathematical Monthly, vol. 99, Number 9/November 1992, p. 884.

[ii] Russell, Bertrand, "Recent Work on the Priciples of Mathematics," 1902, International Monthly, vol. 4, p. 84.

[iii] Arkin, Joseph, INSIGHT, Mathematica Militaris, vol. issue 3, Fall 1994, p. 8.