August 2, 1997

A Passion for Pi

I consider myself a loyal member of the Ancient and Honorable Society of Pi Watchers. During the last few years, IÕve written about the discovery of an algorithm for calculating individual, isolated digits of pi, the computation of the value of pi to a record 4.3 billion decimal digits (now up to an amazing 51.5 billion digits), and the use of the distribution of bright stars across the sky to approximate the value of pi.

Representing the ratio of a circleÕs circumference to its diameter, pi turns up in an astonishing number of settings. Its digits have also been the subject of considerable scrutiny and memory work.

Some of you may be familiar with the sentence: *How I want a drink, alcoholic of course, after the heavy lectures involving quantum mechanics!* The number of letters in each word represents successive digits of pi: 3.14159265358979.

Over the years, pi enthusiasts have created mnemonic devices encoding pi in just about any language you can imagine -- from ancient Greek to modern Armenian. These sentences, poems, miniature dramas, comic episodes, and so forth reflect not only the digits of pi but also the considerable ingenuity of their authors. Even going beyond the 31st decimal digit requires invoking some new rule -- such as using 10-letter words -- to encode the zeros of pi. A quick tour of the World Wide Web turns up a host of mnemonic devices, including one astounding example encoding 740 digits of pi in a lengthy poem modeled on Edgar Allan PoeÕs "The Raven."

I came across another remarkable memory feat involving pi a few years ago when I was researching the discovery by David Bailey, Peter Borwein, and Simon Plouffe of a truly fantastic formula for computing any given hexadecimal (or binary) digit of pi without being forced to calculate the preceding digits. "No one had previously even conjectured that such a digit-extraction algorithm for pi was possible," notes Steven Finch of MathSoft, Inc. Recently, Plouffe, Borwein, and Bailey established that the 400 billionth binary digit of pi is 0.

Plouffe now works as a technical associate at Wolfram Research, though he is still associated with the Centre for Experimental and Constructive Mathematics, a research institute at Simon Fraser University in British Columbia. He is the coauthor with Neil J. A. Sloane of the *Encyclopedia of Integer Sequences* . He also once held the world title for memorizing decimal digits of pi -- a total of 4,096 digits. This achievement was duly recognized in the 1977 French edition of the *Guinness Book of World Records* .

Actually, Plouffe had memorized 4,400 digits but settled on 4,096 as a nice round number (2^12) to report to others interested in his feat. Back then, "I was young and I had not much else to do, so I did it," Plouffe recalls. He simply liked numbers and was fascinated by pi.

Having a good memory for numbers and the ability to recognize numbers by sight has proved useful to Plouffe in his mathematical work, which often involves looking for relationships between different mathematical series or different number sequences. He is now working on a project to develop an automated system for doing the kind of numerical pattern recognition that he himself does so naturally (see From Number to Formula).

To Plouffe, memorizing the digits of pi was close to a mystical experience. He worked with blocks of

100 digits. He started by writing out a block five or six times. He then tried to recite these digits in his head. To preserve the numbers in his long-term memory, he periodically isolated himself in a room -- no lights, no noise, no coffee, no cigarettes. "Like a monk," Plouffe says. As he recited the digits to himself, they would gradually seep into his mind. After a day or two, he would be ready to go on to the next block.

When Plouffe got to 4,400 he decided to stop. "You can continue . . . forever," he explains. "You stop mainly because it is boring to do that all the time."

Two years later, the person who had held the previous record of 3,025 digits came back with 5,050 memorized digits. "I knew I could beat him, but . . . I had had enough," Plouffe says. The record now stands at 42,000 digits!

There is something delightfully irrational about this enduring interest in -- or perhaps obsession with -- pi. ItÕs the kind of passion that can sometimes lead to interesting, even useful mathematical discoveries. By analogy, you have only to consider how a fascination with prime numbers and factoring on the part of a few eccentrics long ago has now played out in the development of cryptographic schemes for maintaining the security of computer systems and networks.

"Pi is one of the few concepts in mathematics whose mention evokes a response of recognition and interest in those not concerned professionally with the subject," Len Berggren, Jonathan Borwein, and Peter Borwein write in *Pi: A Source Book* . "It has been a part of human culture and the educated imagination for more than twenty-five hundred years."

"The computation of pi is virtually the only topic from the most ancient stratum of mathematics that is still of serious interest to modern mathematical research," the authors continue. "And to pursue this topic as it developed throughout the millennia is to follow a thread through the history of mathematics that winds through geometry, analysis and special functions, numerical analysis, algebra, and number theory. It offers a subject which provides mathematicians with examples of many current mathematical techniques as well as a palpable sense of their historical development."

NOTE: The next MathLand article will appear on Sept. 6.

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Information on the computation of pi to 51.5 billion digits is at http://www.cecm.sfu.ca/personal/jborwein/Kanada_50b.html. You can visit Simon Plouffe at http://www.cecm.sfu.ca/~plouffe/. MathSoft has a nice introduction to "The Miraculous Bailey-Borwein-Plouffe Pi Algorithm" at http://www.mathsoft.com/asolve/plouffe/plouffe.html. A good place to start exploring pi mania on the Web is the "Uselessness of Pi and Its Irrational Friends" site at http://www.go2net.com/internet/useless/useless/pi.html. For a somewhat different perspective, you can try http://www.geocities.com/SiliconValley/Pines/5945. Mike KeithÕs poetic mnemonic encoding 740 digits of pi is at http://users.aol.com/s6sj7gt/mikerav.htm.

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Comments are welcome. Please send messages to Ivars Peterson at ip@sciserv.org.

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*NOW AVAILABLE in paperback: *Fatal Defect: Chasing Killer Computer Bugs* by Ivars Peterson. Vintage Books, 1996. ISBN 0-679-74027-9. U.S. $13.00.

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