Mathematics and Narrative at Mykonos

Marjorie Senechal

In July, 2005, Thales & Friends, about whom more below, hosted an unusual conference on the Greek island of Mykonos in the Aegean Sea.[1] "Mathematics and Narrative" aimed "to bring together mathematicians, historians, philosophers, literary scholars, writers, and artists, to further explore the interrelationships between mathematics and narrative."[2] The operative word here is "further": the speakers, all eminent specialists in their respective fields, were selected not (only) for that expertise, but also for their successful ventures in paramathematics, "the use of narrative to explore, convey and teach mathematical ideas."[3] That is, they all had crossed the canyon between the scientific and literary cultures, famously decried by the late C. P. Snow. The mathematicians "had also done work either in popularization, the history or the philosophy of mathematics, or mathematics and the arts – with the element of narrative playing a significant part. For the people coming from other areas, normally unrelated to mathematics, the criterion of paramathematical work meant that they had tried to approach, with some degree of success, mathematics by other means."[4]

"Mathematics and Narrative": left to right, Karine Chemla, Alecos Papadatos, Robert Osserman, DoronZeilberger. Photograph by Alexandros Mistriotis.

THE TALKS

Amir Alexander, "From Heroes to Martyrs: Changing Stories and Changing Practices in Modern Mathematics"
John D. Barrow, "Infinities and Beyond"
Pierre Cartier, "Vitae Mathematicae: The Role of Autobiographies from Mathematicians"
Gregory Chaitin, "Narratives versus formal axiomatic theories: What is mathematics?"
Karine Chemla, "Mathematical Problems as Narratives: Perspectives from Ancient China"
David Corfield, "The Role of Narrative in Mathematical Inquiry"
Leo Corry, "Calculating the Limits of Poetic License: Fictional Narrative and the History of Mathematics"
Martin Davis. "Mathematics and Biography"
Persi Diaconis, "Mathematical Stories and Stories for Mathematics"
Apostolos Doxiadis, "The story of the proof is the proof: early stations in a paramathematical odyssey"
Rebecca Goldstein, "Mathematicians as characters"
Timothy Gowers, "Describing mathematical proofs without losing the plot"
Dennis Guedj, "The Drama of Mathematics"
Barry Mazur, "Eureka and Other Stories"
Barbara Oliver, "Mathematics and Narrative - A Happening"
Robert Osserman, "The Right Spin: Spinning mathematics by spinning a yarn"
Alecos Papadatos, "Logicomix: A Graphic Novel of Logic and Mathematics"
Christos Papadimitriou, "On Narrative and Computer Programming"
John Allen Paulos, "Stories and Statistics, Numbers and Narratives"
Theodore M. Porter, "Karl Pearson's Statistical Lives"
Joan L. Richards, "Historical narrative and enlightened mathematics"
Brian Rotman, "Gesture in the Head"
Marcus du Sautoy, "The Music of the Primes"
Mary Terrall, "Mathematics in Narrative: 18th Century Scientific Expeditions"
Mark Turner, "The Role of Narrative Imagining in Blended Mathematical Concepts"
Robin J. Wilson, "Writing Popular Mathematics Books: How and Why?"
M. Norton Wise, "How Fourier Analysis Become Rigorous, or How Functions became Curves: A Dirichlet Narrative"

The kinship, even twinship, of mathematics and music has been explored for thousands of years, from the Pythagoreans (on the island of Samos, now a 6-hour ferry ride from Mykonos) to modern magnetic brain scan labs. Mathematics and Art exhibits and festivals abound (see Doris Schattschneider's article in the next issue). But who studies, writes about, speaks about, or celebrates the relations between mathematics and narrative? A recent Google search for "mathematics and narrative" turned up only 105 sites, 29 of them related to this conference. Compare this with 21,600 sites for "mathematics and art", and 16,600 for "mathematics and music"!

This relative silence is strange. Story-telling is as ancient as drawing and singing. Parallels between mathematics and narrative abound, and each is a tool for understanding the other. However Platonic mathematical objects may or may not be, and with whatever mental or sensory apparati we humans apprehend them (on these questions, as on everything else, conference participants disagreed), we use narrative to talk about, write about, and teach mathematics. In practice and, arguably, in theory as well, mathematics and narrative are inseparable.

The conference was prompted in part by the apparent contradiction between the public's distaste for learning mathematics and its eagerness to read about it. As the number of students pursing the mathematical and "hard" sciences declines, enthusiasm for stories about them, and their practitioners, grows. *Arcadia*, *Einstein's Dreams*, *Galileo's Daughter*, *Good Will Hunting*, *Proof*, *A Beautiful Mind*, *Copenhagen*, *The Parrot's Theorem*, *Uncle Petros and the Goldbach Conjecture*, *Turing*, *Partition*, *Infinities*, *Numb3rs, The Mind-Body Problem*, and *Properties of Light* are just a few recent English-language titles in the burgeoning list of novels, films, plays, and even television series engaging mathematics and mathematicians.[5] The public's enthusiasm is not limited to fiction: in a cutthroat market, nonfiction like *Chaos*, *Innumeracy*, *Engines of Logic*, *Fermat's Enigma*, and *Prime Obsession* more than hold their own.

Can narrative build two-way bridges between the two cultures, bridges that people will actually cross? Can narrative inspire an appreciation of mathematics, similar to art appreciation and music appreciation? Can narrative increase public understanding of mathematical ideas, and of mathematicians as human beings? Can it lure the lost students back?

Thales and Friends. "Only an extreme purist will deny that this explosion of narrative-based paramathematical activity is in some way good for mathematics," the organizers -- Amir Alexander, Apostolos Doxiadis, Robert Osserman, Christos Papadimitriou, Theodore Porter, and Doron Zeilberger -- declared.[6] Thales of Miletus (62? - 546 BCE)

was not a purist. On the contrary: he "was interested in almost everything, investigating almost all areas of knowledge, philosophy, history, science, mathematics, engineering, geography, and politics."[7] A fitting patron saint for the small

Why We Meet

Over the course of the last century, mathematics has become increasingly isolated from the culture at large. Despite enormous advances, and its central role in science and technology, the language of mathematics and its problems became so esoteric as to be completely inaccessible to outsiders. To make things worse, professional mathematicians frowned upon any outsider, however qualified, dealing with any aspect of their science. The consequence of this gap in communication has been the impoverishment of both mathematical discourse and the general culture.

However, the past few years have witnessed the beginnings of a change – and it is this that motivates our meeting. An unprecedented number of works, both fiction and non-fiction, have appeared that take their subjects from the world of mathematics. At the same time, scholars in the social sciences and humanities are showing increasing interest in exploring connections between mathematics and its cultural and historical setting. In all these, the narrative mode plays a crucial part.

On Mykonos, we hope to make progress in exploring the abundance of possibilities latent in the application of narrative to mathematics, both as a means of disseminating knowledge and as a cognitive tool for understanding mathematics itself.

http://www.thalesandfriends.org

group of Athenian mathematicians-with-other-serious-interests that calls itself Thales & Friends. The founding Friends number just five: Apostolos Doxiadis, writer, mathematician, former businessman and “Mathematics and Narrative” co-organizer; Petros Dellaportas, Associate Professor of Statistics at the Athens University of Economics and Business; Alexandros Kyrtsis, Associate Professor of Sociology in the Economics Department of the University of Athens; Tefcros Michaelides, a mathematician and translator of many “math fi” books, who teaches mathematics and philosophy at Athens College (an elite Athens high school), and Theodore Tollis, mathematician and manager. Why only five? "We’re keeping it small, at first, to keep it simple," Doxiadis told me. "We drive it, it doesn't drive us. Emotions before ideas, ideas

before organization." Nevertheless, the organization is a registered not-for-profit. And their agenda, "to promote the exploration of the relationship of mathematics to narrative," is as ambitious as it is open-ended. Thales & Friends, founded in 2004, has quickly plunged into national and international activities. In Greece, they are already running a seminar on the overlap of mathematics and narrative for high school teachers in the Athens area. And they have started a program to create mathematical reading groups in high schools, run by mathematics teachers and coordinated by Thales & Friends (see their Greek site, in http://www.thalesandfriends.org, for details).

The Aegean sea at Mykonos, seen from the conference center.
Photograph by Amir Alexander.

"Mathematics and Narrative" was the Friends' first international event. The four day program was packed with 30 lectures and -- Mykonos's beguiling beaches notwithstanding -- the lecture hall was packed too. The program's sprawling scope embraced mathematics and narrative in many forms, for audiences ranging from oneself to colleagues to the wider public to children; thought-narratives, oral narratives, nontechnical expositions of branches of mathematics or particular mathematical problems, biography and autobiography, plays, film, novels, and new forms yet unexplored. So many forms, and so many motives for writing them: even with 60 participants, the pigeonhole principle never kicked in. To paraphrase,

Narrative is the key to mathematics for me: to even begin thinking about a new research problem I need to know where it comes from and why it matters.

Why don't we say things like that in our research papers? It's past time to overthrow the reigning tyranny of abstraction and find new ways of writing mathematics.

Popular math books must not mislead. They must tell the whole truth and nothing but the truth.

After reading André Weil's autobiography, "Years of Apprenticeship", a friend said, "André, you have written a beautiful novel."

Popular math books should show the reader the beauty of mathematics.

The job of the fiction writer in science is not to say this is true -- the reader doesn't care. The writer needs to show why it is moving.

Popular math books should inspire the young to study math. Remember "Men of Mathematics"?

Is proselytizing the purpose of mathematical narrative? Are stories only a tool?

Mathematical narrative should be genuine art which benefits from the particularities of mathematics!

The tension between mathematics and narrative is inescapable. Mathematics is the quintessentially rational enterprise; narrative appeals to the emotions.

“We’re making no attempt at consensus,” said Amir Alexander in his opening remarks. “We want to start a conversation that can continue to grow.”

Photograph to be supplied below

Apostolos Doxiadis and Marcus du Santoy. Photograph by Osmo Pekonen.

Mark Turner, Alexandros Kyrtsis, Takis Mathiopoulos, and Persi Diaconis at Mykonos. Photograph by Alexandros Mistriotis.

Conversations. The conversations at Mykonos were sparked by the lectures, continued in the too brief discussion periods afterwards, through lunch and dinner, and even into the swimming pool. Flowing freely from issue to issue, from viewpoint to viewpoint, the conversations can be neither categorized nor summarized. But, it seemed to me, four themes recurred with unusual frequency.

1. Mathematics, or mathematicians?

"It is a Story," by Barry Mazur, describes a conundrum in the theory of elliptic curves. Specialists have been aware of the discrepancy for 20 years, Mazur explained, but the crisis went unrecognized until he cast it in story form. An important conjecture predicts that elliptic curves have infinitely many rational points with probability 1/2, yet extensive data suggests the true probability is closer to 2/3.[8] It is not a story of a struggle between two mathematicians, or two contending schools of thought: mathematicians nowhere appear in it. The drama lies wholly in the mathematics: it is a drama of ideas.

"It is a Story" is mathematical narrative in purest (or purist) form, and mathematicians in the audience were engaged both by the conundrum and by the purity. The drama of mathematics is the mathematics itself, ongoing and eternal some insisted. *That* is the

story. Perhaps, but as a journalist noted later, some nonmathematicians in the audience were less enthused.[9] Is pure mathematical narrative then only for the cognoscenti? Is technical background (or a more general "mathematical sophistication") a necessary prerequisite for appreciating it? Most people find mathematical ideas remote and dull, several participants pointed out. We can't engage them in dramas of abstraction.

Or can we? Can the boundaries of the form be pushed? Mazur himself has done it, in *Imagining Numbers*, which began as a letter to a friend and retains a conversational tone. Edwin Abbott's *Flatland*, which has delighted children and even adults for over a century, pushes in another direction. *Flatland*'s narrator, A. Square, is the prototypical anthropomorphic mathematical object. Denis Guedj, author of *The Parrot's Theorem* and, more recently, *Zero*, employs this technique; see also "Class Reunion" by Colin Adams, in this issue.

Most mathematical narrative, however, follows the standard practice in popular science writing: embedding the science in human stories, blending the drama of the discovered with the drama of the discoverer. We can view this, as reader or writer, in two ways: the human story brings the mathematics "to life"; or, the mathematics helps the reader grasp what it is the human characters are struggling to understand. In either case, the writer must tell both stories well, and get the balance right. But what if the discoverer leads a quiet, undramatic life? Eric Temple Bell embellished some of those lives a bit –-and also his own.[10] Some mathematicians are shy and private, Pierre Cartier pointed out in his lecture on mathematicians' autobiographies, while others, like Bertrand Russell, consciously construct their lives like narratives. It's the same with musicians and other artists, he noted. For some, it is just hard work. But Schubert said you create music by breaking your heart.

Pierre Cartier giving the opening lecture of “Mathematics and Narrative.”
Photograph by Alexandros Mistriotis.

Fiction can convey the mathematician's inner world -- and heartbreak. “Mathematicians crystallize the human predicament," said Rebecca Goldstein, author of *The Mind-Body Problem* and other novels whose characters are mathematicians. "The mathematician is the classic hero, seeking entrance to the realm of immortals, a juxtaposition of transcendence and cluelessness."

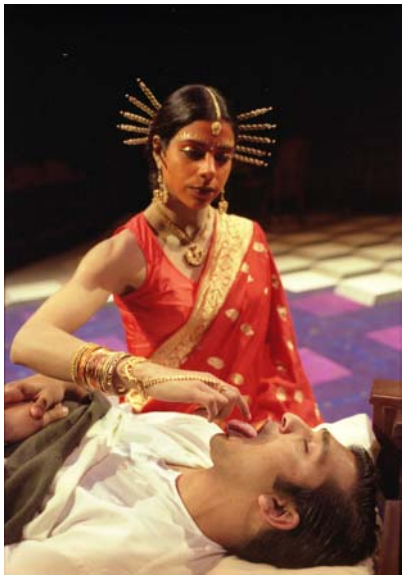
2. Lies, or poetic license?

Readers of *The Man Who Knew Infinity*, Robert Kanigel's 1991 biography of Srinivasa Ramanujan, understand its dramatic possibilities. The mathematician G. H. Hardy, who helped bring Ramanujan from India to Cambridge, England and worked with him in the few years remaining to Ramanujan, called their collaboration "the one romantic incident of my life."

Barbara Oliver, director, actor, and co-founder of the Aurora Theatre Company in Berkeley, discussed her staging of the world premiere, in 2003, of Ira Hauptman's play, *Partition*. The title refers to the mathematical theory of partitions, on which Hardy and Ramanujan collaborated, and also to the invisible partitions of personality, culture, and mathematical style that kept them, tragically, apart. *Partition* was a popular success on the stage and also in the series “Readings of Science Plays” at the Exploratorium in San

Francisco. Oliver explained the issues she faced in staging it, the choice of actors, the complexities of the production.

She did not explain the choices that the playwright made as he reshaped the story for the stage. In *Partition*, the Hindu goddess Namagiri writes mathematical formulas on Ramanujan's tongue, a classicist colleague is invented for Hardy (whose eccentricities are exaggerated), and Hardy urges Ramanujan to find a proof of Fermat's "last theorem". Namagiri consults Fermat, but he can't help; Ramanujan fails in his quest for a proof but, before dying, tells Hardy that Poincaré and modular forms together will provide the key.



Ramanujan (Rahul Gupta) receives inspiration from Goddess Namagiri (Rachel Rajput) in Aurora Theatre Company's production of Partition by Ira Hauptman. Photograph by David Allen.

In one of the conference's more dramatic moments, a mathematician leapt to his feet, protesting, "the play is a lie!" These characters are nothing like the real Hardy and Ramanujan! Ramanujan didn't work on FLT! The viewing public was misled and most of it will remain so!

Consternation ensued: Is it the playwright's duty to teach history, or to illuminate the human condition? How much can truth be distorted in the service of truth? In Apostolos

Doxiadis's *Uncle Petros and Goldbach's Conjecture*, the fictional Petros meets his Greek compatriot Constantine Caratheodory in Berlin in 1916. The real Caratheodory was very much alive in 1916, but he was not in Berlin: the author chose the date to suit his story. No one seemed upset about this.

But consider David Foster Wallace's nonfictional *Everything and More: A Compact History of Infinity*, reviewed by Martin Davis in this issue. The elephant in the conference hall at Mykonos, *Everything and More* was not the subject of anyone's lecture, but it poked its trunk into the program's interstices. This book, published in 2003, kicked off W. W. Norton's "Great Discoveries" series which, according to the company's website, "brings together renowned writers from diverse backgrounds to tell the stories of crucial scientific breakthroughs—the great discoveries that have gone on to transform our view of the world." Wallace, a celebrated, idiosyncratic, and iconoclastic writer who "disliked and did poorly in every math course he ever took, save one, which wasn't even in college" (p. 2), immersed himself in his subject and produced, according to *Booklist*, "a brilliant antidote both to boring math textbooks and to pop-culture math books that emphasize the discoverer over the discovery." Isn't this what we wanted? Well, maybe not. Conference participants who had read *Everything and More* – many hadn't – disagreed vehemently: "I refused to review it!"; "Me, too!" "I think it's great -- the author is a closet mathematician!"; "The worst book I ever read!"; "I found it delightful and fresh!"; "Filled with mistakes, arrogant!"

In our concern that popular writing be accurate, mathematicians are not alone. In October, 2005, a few months after the conference, *Dr. Atomic*, a new opera by John Adams and Peter Sellars, opened in San Francisco to great acclaim. Its reception might have been otherwise, at least in the scientific community, for in rehearsal, the opening chorus began:

> Matter can be neither created nor destroyed
> but only altered in form.
> Energy can be neither created nor destroyed
> but only altered in form.

No! Einstein's equation of matter and energy was the insight that produced the bomb!, the president of the American Physical Society, who was present, protested. The startled and chagrined authors promised to rewrite those lines – eventually. (But they were sung on opening night.[11])

Which brings us to poetic license. Do the Faustian Robert Oppenheimer, the scheming Edward Teller, the blustery General Groves, and other re-imagined characters in *Dr. Atomic* resemble their real counterparts? Do physicists have the right to demand that they do? If you think so, then consider *Amadeus,* a play by Peter Schaffer later made into a film. *Amadeus* is a story of revenge, driven by a second-rate artist's overpowering jealousy of a silly and undeservingly gifted genius. But the real Salieri was not-second rate and he did not kill Mozart. Neither man is accurately portrayed in the play or in the film. Is *Amadeus* a lie? Or is it a universal story of human character? Do Salieri and Mozart belong only to musicians? Do Hardy and Ramanujan belong only to us? "To enjoy the play, one must relax the implicit identification between the historical Hardy–Ramanujan and the characters on stage," says Ken Ribet in a review.[12] As for Ramanujan working on FLT, "Theater-goers . . . can make their peace with historical distortion that allows the audience to hook up with a familiar and famous problem. Once I was able to separate the real Hardy and Ramanujan from their counterparts on stage, I found only good things to say about *Partition*."

Perhaps mathematicians are loathe to grant poetic license, Leo Corry suggested, because, by training and habit, we read critically, line by line. But fiction works through suspension of disbelief. In *Copenhagen*, for example, author Michael Frayn explores the uncertainty principle as Niels Bohr and Werner Heisenberg reenact Heisenberg's mysterious wartime visit to Bohr in Copenhagen, again and again, many years after both of them are dead.

Underlying all our discussion, Corry continued, is the distinction between science as drama as in Greek tragedy (we know what will happen: that's the drama), and science as

Brechtian epic theater (things can happen this way, but they can also happen some other way.) Theater has much to teach us.

3. Stories as Math

Mathematics and narrative have similar structures, Doxiadis argued. For example, a proof, like a story, is built on two levels: a guarantee plus an explanation.[13] The guarantee is provided by the logical low-level step-by-step check of every detail; the explanation -- "what is really going on" -- is a high-level outline that shows how the parts of the proof relate to one another. Like proofs, stories may have subplots that ring true and enrich the larger story, though the details are not essential to understanding it. Both narratives and proofs are stratified and self-similar, with rich local structure and many levels that are relatively independent of one another. And the points of linkage between the levels in a narrative or in the levels of a proof play the same role: they are the elements of causality.

The search for a proof is like a story of a quest, said Doxiadis. It may end in triumph or in defeat or, less conclusively, somewhere in between.

Story	Proof
The hero reaches his goal and . . .	The mathematician finds a proof and . . .
The hero reaches his goal but . . .	The mathematician finds a proof but . .
The hero reaches his goal only partially and a) realizes and accepts this; b) realizes this but does not accept it; c) does not realize it.	The mathematician find a partial result and a) gives up; b) persists in a new way; c) is clueless.
The hero does not reach his goal	The mathematician does not find a proof.

Stories and computer programs are similar too, Christos Papadimitriou pointed out. In programming, the data types are characters: their definition creates the work of the story and their complexity is that of the story. Branching is like an interactive novel in which the reader discovers the implicit rules by trying things out ("if you want Guinevere to fall in love with Lancelot, click here!"). Programs invoke other programs; narratives tell

stories within stories. Programs and narratives can be recursive, or self-referential. Both programs and stories must "work": programs must compile and run; stories must get published and be read. Programs usually contain bugs that prevent them from accomplishing their purpose; often novels do too. Programs and stories exist only tentatively until they are executed or read. Programs and narratives are mind-bogglingly combinatorial; writing them requires the same kind of puzzle-solving.

No one mentioned the Oulipo (short for "Ouvroir de Littérature Potentielle"), the ongoing "Workshop for Potential Literature" founded in Paris 45 years ago by the mathophilic novelist and poet Raymond Queneau and chess grand master François Le Lionnais. The Oulipo, a font of combinatorial frolic and serious literary innovation, pioneered the modern paramathematical canon. Its members (elected for eternity) include, among others and in addition to the founders, such writers of stature as Italo Calvino, Georges Perec, Claude Berge, Paul Fournel, Marcel Bénabou, and Harry Mathews. "Mathematics – particularly the abstract structures of contemporary mathematics – proposes thousands of possibilities for exploration, both algebraically (recourse to new laws of composition) and topologically (considerations of textual continuity, openness and closure)," the group declared in its opening manifesto. "We're also thinking of anaglyphic poems, texts that are transformable by projection, etc."[14]

4. *Fabulas* and *syuzhets*

The entire mathematical tradition, from the Babylonians to Bourbaki and beyond, is a telling and retelling of stories through the changing lenses of notation, classification schemes, and sensibilities, the historians at Mykonos pointed out. Each retelling brings changes of meaning and intent. Historian Karine Chemla, setting aside centuries of reinterpretation to examine an ancient Chinese text in the form it was written, showed that the ancient Chinese conveyed generality through model examples, not through our modern abstraction. A lesson apparently lost to mathematics educators today, despite David Hilbert's dictum, "The art of doing mathematics consists in finding that special case which contains all the germs of generality."

Literary theorists distinguish the *fabula* (the story as it happens) and the *syuzhet* (the story as it is told); Doxiadis suggested that this terminology can help us see how closely mathematics and narrative have always been intertwined. In many histories of mathematics, the development of mathematical ideas is traced through nested sequences of *fabulas* and *syuzhets*, each *syuzhet* serving in turn as a *fabula* for the next. I'm oversimplifying, of course; even the oft-told story Fermat's Last Theorem is a disorderly tangle of *fabulas* and *syuzhets*: Pythagoras's theorem, Fermat's conjecture, Fermat's own proof (apocryphal, false, or true), the centuries of attempted proofs before Andrew Wiles, Wiles' Cambridge proof, Wiles' published proof, Barry Mazur's Vancouver lecture on FLT, Simon Singh's *Fermat's Enigma*, and -- someday, perhaps -- another proof that is totally new and unexpected, one satisfying Hilbert's criterion, "a mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first man whom you meet on the street." Though in *Partition* Fermat gloats over the failure of his successors to prove his "last theorem", he would have understood none of these *syuzhets,* except Hilbert's.

The current explosion of paramathematical literature is a *fabula*; the "Mathematics and Narrative" conference, convened to reflect on that *fabula*, was a *syuzhet*. And the conference itself was in turn a *fabula*, the post-conference accounts of it posted on www.thalesandfriends.org its *syuzhets.* In telling this *syuzhet* I've taken poetic license, for which none of the helpful critics of earlier drafts – Chandler Davis, Apostolos Doxiadis, Jean-Michel Kantor, Osmo Pekonen, Doris Schattschneider, and Stan Sherer – should be blamed.

Paramathematics. Like Molière's character who discovers he has been speaking prose all his life, it is now evident that *The Mathematical Intelligencer* is a journal of paramathematics. (And, indeed, The Mathematical Intelligencer was well-represented at Mykonos by editors and correspondents Pierre Cartier, Jean-Michel Kantor, Osmo Pekonen, Robin Wilson, and me.[15]) To conclude, let's reflect a little on that term.

Paramathematics should not be confused with metamathematics, an obsolescent term referring to the logical analysis of mathematical reasoning, nor with parascience, "the study of phenomena assumed to be beyond the scope of scientific inquiry or for which no scientific explanation exists" (Oxford English Dictionary). Yet, as we see, it shares something of both.

The conference "Mathematics and Narrative" reached no consensus nor was consensus the goal. It did demonstrate – as was its goal – that paramathematics is a serious subject for serious study and serious practice, both of which it is beginning to receive.[16] The roots of paramathematics run deep: the seismic impact of Plato and Galileo on philosophy, science, and the wider culture cannot be separated from their witty dialogues and brilliant prose. Plato and Galileo understood and we are now rediscovering that, in the conference organizers' words, "one can speak intelligently, and occasionally even profoundly, about mathematics without always moving down the long-familiar tracks of the definition-axiom-proof triad."

You, the narrative-conscious readers of *The Mathematical Intelligencer*, are invited to continue these conversations in these pages. Complain to the editors! Write book reviews! Contribute your viewpoints!

Notes and references

[1]The conference was supported in part by Mathematical Sciences Research Institute at the University of California in Berkeley.

[2] See “Meeting Statement” on http://www.thalesandfriends.org/.

[3] “Paramathematics” was coined by Thales Friend and conference co-organizer Apostolos Doxiadis.

[4] Interview with Apostolos Doxiadis, http://www.thalesandfriends.org/.

[5] For an extensive list, see Alex Kasman's "Mathematical Fiction" website, http://math.cofc.edu/faculty/kasman/MATHFICT/default.html/. The list includes a few works in other languages.

[6] See note 2.

[7] Internet Encyclopedia of Philosophy

[8] www.math.ucsd.edu/~williams/diaconis/It.is.a.story.3.pdf

[9] Sarah Tomlin, "What's the plot?", *Nature*, vol. 436/4, August, 2005, 622–613.

[10] Constance Reid, *The Search for E. T. Bell*, Mathematical Association of America, 1996.

[11] Matthew Gurewitsch, *The New York Times*, September 25, 2005; see also Dennis Overbye's review of *Dr. Atomic* in *The New York Times*, October 18, 2005.

[12] *Notices of the AMS*, vol. 50, no. 11 (2003), 1047-1048.

[13] This distinction was first introduced by the computational logician Alan Robinson.

[14] Warren F. Motte, Jr., *Oulipo: a primer of potential literature*, Lincoln, Nebraska, U.S.A.: Dalkey Archive Pr, 2004

[15] Kantor's account of the meeting, first published in *La quinzaine littéraire*, is also posted on www.thalesandfriends.org.

[16] In 2003 and 2004, the Banff International Research Station for Mathematical Innovation and Discovery (BIRS) in Banff, Canada, held workshops in creative writing in mathematics and science; a third is scheduled for June, 2006. The first two workshops were organized by Chandler Davis and Marjorie Senechal; in 2006 they will be joined by poet, musician, and philosopher Jan Zwicky, and the director of the Banff Centre Program in Writing and Publishing.