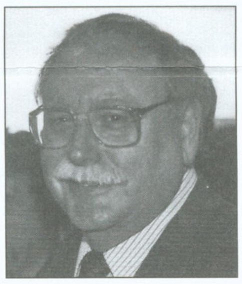
New York University

NEW YEAR NEWSLETTER 2005
Volume 2 – Number 1

Courant Institute of Mathematical Sciences

Letter from the Director



Dear Alumni, Colleagues and Friends,

We are very pleased to be sending you this New Year 2005 edition of the Courant newsletter. Courant is enjoying a time of growing interest, expansion and exposure. I would like to thank the many of you who have renewed their relationship with Courant and have provided support by staying in touch, conducting seminars, visiting, and contributing to the Alumni fund, Jack Schwartz and Cathleen Morawetz Fellowship Funds and in other ways. We welcome this opportunity to wish you a happy new year, while keeping you informed of the exciting growth at Courant. We warmly invite your input into the future of our Institute.

Courant is proud to have recruited some exciting new faculty members:

• Francesca Chiaromonte, a statistician working in genomics, joins us as Associate Professor of Mathematics and Biology. She works on the analysis and modeling of large-scale genomic data, and has been involved in projects concerning alignment scoring methodology, genome-wide variation and co-variation of divergence processes, estimation of the share of the human genome under purifying selection, and genome-wide scores to aid in the prediction of regulatory elements.

• Mehryar Mohri, joins us as Professor of Computer Science. He is the former Head of the Speech Algorithms Department at AT&T Research Laboratories where he led a broad range of work in machine learning, applying automata theory to text and speech processing. He plans to apply machine learning techniques in the general area of Computational Biology.

• Olivier M. Pauluis joins as Assistant Professor of Atmosphere Ocean Science in Mathematics with a special interest in climate and general circulation of the atmosphere, moist convection, and tropical meteorology.

Another important recruit to the Courant family is Mark Hansen, our new development and alumni affairs officer replacing Eleanor Williamson, who has relocated to Nashville where she is working both on development for Vanderbilt University and enlarging her family. Mark is new to the University development world, but he has a Ph.D. in history from Columbia and was successful in leading significant annual and capital fundraising campaigns during his eighteen years as a minister in charge of Episcopal congregations.

In addition, Scott Sheffield in Probability Theory and Daniel Stein in Condensed Matter Theory will join us in September 2005, respectively as Assistant Professor of Mathematics and Professor of Physics and Mathematics.

We are also very pleased to note that Andrew Majda was recently awarded this year's Mayor's Award for Excellence in the Mathematical, Physical and Engineering Sciences, and that Mehryar Mohri is the recipient of a major faculty development award from the New York State Office of Science, Technology and Academic Research.

On December 15 we enjoyed having our annual holiday lecture and party (some details about Tadashi Tokieda's fantastic lecture on the physics of toys can be seen on page 5 of this issue). On May 13-15 we will again gather together for the NYU reunion weekend. We hope to have many alumni join us for a Courant lunch. Please contact Mark Hansen at (212) 998-6775 or at **mark.hansen@nyu.edu** if you would like to share a meal with friends old and new.

Finally, we note that Jack Schwartz retires from active teaching after more than four decades at NYU. There was a wonderful symposium and banquet in Jack's honor on October 29, details of which are given on the back page of this issue. Jack is one of the most distinguished faculty ever at Courant, a member of the National Academies of both Engineering and Science, and the founder of the Computer Science Department. We wish him a long, happy, healthy and research-active "retirement".

Sincerely,

Chuck

CHUCK NEWMAN
Director
Courant Institute

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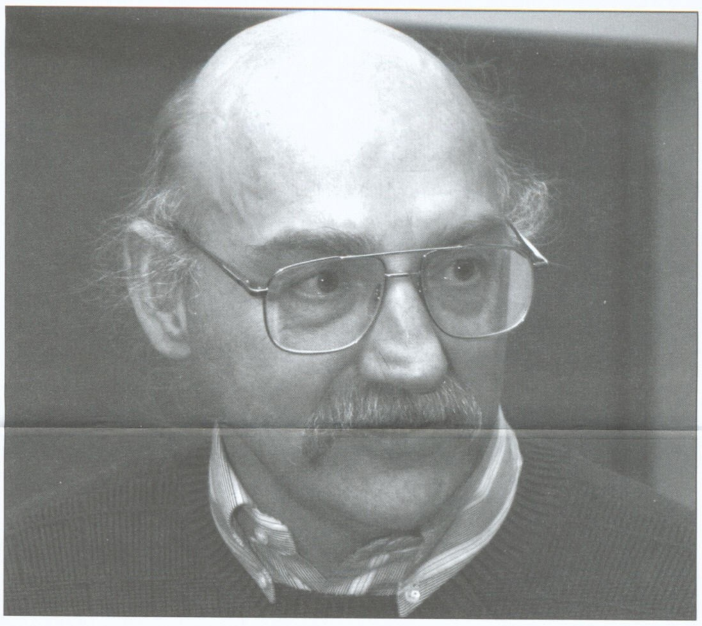
Contact Us

The Office of Alumni Relations for Courant is trying to connect Courant Alumni through new and exciting programs. If you're interested in reconnecting with the Institute and fellow Alumni through seminars, interest groups, social programs, career development, and mentoring, please take a moment and visit **[www.cims.nyu.edu/alumnisurvey.html]**.

On Andrew Majda and CAOS



Andrew Majda

Andrew Majda, the S.F.B. Morse Professor of Arts and Sciences at the Courant Institute has received the 2004 New York City Mayor's Award in Mathematical, Physical, and Engineering Sciences.

Andy is well known for his work in partial differential equations and applications to diverse physical problems such as scattering theory, shock waves, turbulence, and combustion and has received many honors for this work. Since arriving at Courant in 1994 from Princeton, Majda founded the Center for Atmosphere Ocean Science (CAOS) to promote interdisciplinary research between modern applied mathematics and contemporary climate modeling and prediction. This is one of the most challenging and important multi-scale problems in contemporary science, CAOS currently has eight faculty members, about a dozen Ph.D. students, and eight post doctoral fellows and will constitute the third department within the Courant Institute in the next few years.

One of the surprising recent discoveries is the large impact that the tropics have on mid-latitude weather beyond a few days as well as for short term climate. Andy's own applied research in the last several years has focused on the central issues involving the multi-scale interaction of clouds in the tropics, the statistical and stochastic modeling of low frequency variability in mid-latitude, and mathematical strategies to detect bimodal behavior with large confidence in practical ensemble predictions. Besides physical reasoning, modern applied mathematics enters in his approach to these problems including statistical, stochastic, and asymptotic methods and new numerical algorithms as well as rigorous theorems for judicious prototype problems. In the academic year, 2005-2006, Majda has been asked by NCAR, the National Center for Atmospheric Research, to lead a new interdisciplinary effort to foster novel applications of mathematics to atmospheric sciences and to build further connections with CAOS and Courant. Several interdisciplinary workshops at NCAR for graduate students, postdocs, and faculty are being planned for the next academic year. Further information about the CAOS program **(http://caos.cims.nyu.edu/page/home)** as well as more detailed information about Majda's research (**http://www.math.nyu.edu/faculty/majda/**) can be found at the listed NYU websites.

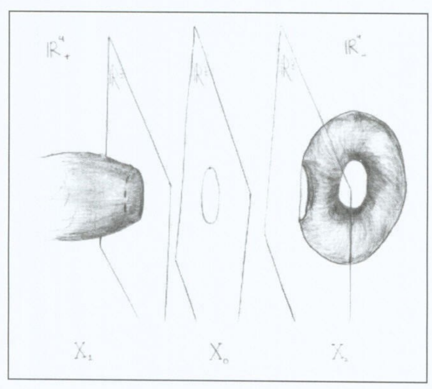
S.U.R.E. 2004

The Summer Undergraduate Research Experience

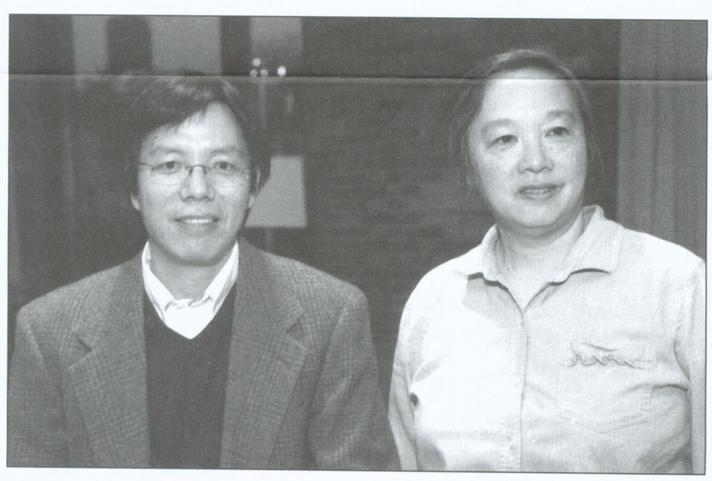
by Oliver Buhler, Atmosphere Ocean Science and Mathematics

This was the fourth year of the NSF-funded undergraduate research experience, which offers advanced undergraduate students the opportunity to work together with a faculty member on a summer research project in mathematics. The aim of this program is to give our undergraduates a taste of mathematical research, something that is very different from taking classes. The program enriches our students' mathematical education, it promotes informal links between students and faculty, and it also allows students to make a better-informed decision on graduate studies. The applications to this popular program and the matching of students to faculty members occurs in late March to early April, and the research is usually done from June to August. Participating students receive a stipend to help with their living expenses in NYC over the summer. At the beginning of the new semester the students hand in a written report (these are available on the web under **http://www.cims.nyu.edu/vigrenew/ug_research.htm**) and the experience then concludes with oral project presentations that are attended by interested students and faculty.

The research experience program brings together students and faculty from all branches of pure and applied mathematics and there is a correspondingly wide range of projects that are pursued. For instance, Ryan Witko worked together with Prof. Percy Deift on testing a recent hypothesis from random matrix theory by investigating the statistical distribution of names in the New York Phone directory. Their joint project, entitled "Are Tracy and Widom in your telephone directory?", gave a vivid demonstration of how pure mathematics can be brought to bear on very practical questions. Thomas Ferris worked with Prof. David Holland on a theoretical, numerical, and experimental study of ice glacier growth and flow. They tested their theory against available field data and are preparing a laboratory experiment to demonstrate its main features. They have also developed a number of software tools that will be made available on the internet. Tatyana Kobylyatskaya worked with Prof. Sylvain Cappell on the theory of knots in higher dimensions. Specifically, they used Van Kampen's theorem to establish that there are infinitely many knotted tori in four dimensions. This was an unusual project because Tatyana was only in her Freshman year at NYU.



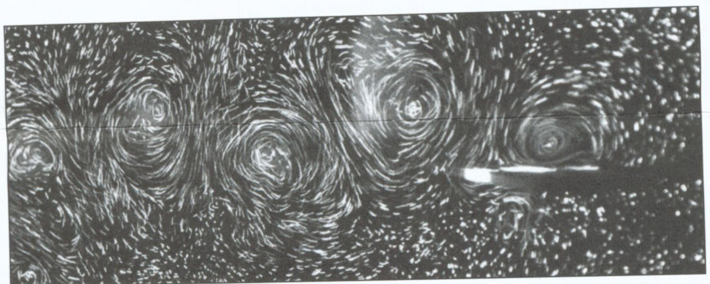
A sketch from Tatyana Kobylyatskaya's project on knot theory that indicates what three-dimensional slices of a four-dimensional object look like.



Fang-Hua Lin and Lai-Sang Young. New members of the American Academy of Arts and Sciences.

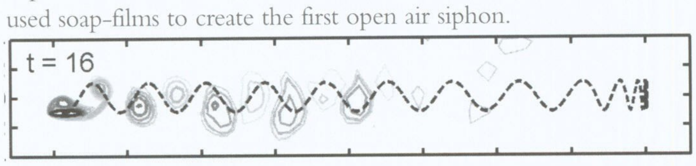
Michael Shelley on the Applied Math Lab

Many of you may not know that experiment is now an integral part of research life at the Institute. The AML (Applied Math Lab) opened in 1998 on the ground floor of Warren Weaver Hall, extending the long tradition of fluid dynamics research at the Institute to experiment and its interaction with theory and simulation. The AML is "directed" by myself and Steve Childress, and by Jun Zhang who is an experimental physicist and faculty member of NYU Physics and Courant. The work in AML reflects our joint interests in biologically inspired fluid dynamics.



The rotating, flapping wing passing left to right through a sheet of light, where the fluid has been seeded with small bubbles to visualize the reverse von Karman vortex street behind it. This wing began from a state of no rotational motion. From Vandenberghe, Childress, and Zhang (*Journal of Fluid Mechanics*, 2004).

One signature experiment of the lab, motivated by the swimming of fish, studied the flapping of flags in a unique setting: a "soap-tunnel" where the high-speed flow of a soap-film interacts with a length of flexible silk thread wetted into the film. This "dead-fish experiment" reveals how the inertia of a flexible body can constructively couple to a fluid flow to drive the body into oscillations – i.e., flapping. This experiment and the questions it raised provoked many mathematical models and analyses, other experiments, and numerical studies (including several by Professor Charlie Peskin and his students). Soap film flows continue to be a workhorse for the lab. Using very thin lengths of fiber-optic glass, the soap-tunnel was used to examine how flexible bodies can streamline themselves, this being inspired by the observation that in high winds, tree leaves can roll into tight cones and so lower the wind drag on the tree. We combined these experiments with an elegant mathematical theory to show that streamlining of elastic bodies can lead to universal, self-similar shapes with new, much reduced drag laws. Other soap-film experiments have studied the instabilities of ultra-heavy jets, and used soap-films to create the first open air siphon.



A numerical simulation of body/fluid interaction. (From Alben and Shelley, 2004)

Two new and beautiful experiments in the lab -- the flapper and the micro-flyer -- examine basic mechanisms underlying locomotion in fluids. The flapper experiment is deceptively simple, and may shed light on the origins of animal locomotion. A camberless wing mounted on an axle is plunged up and down in a tank of water. Plunge slowly enough and the wing is motionless, but increase the frequency slightly above a critical value and it moves spontaneously into rotation. Visualizing the flow around the rotating wing shows a system of vortices -- a reversed von Karman street -- that is associated with thrust production and the flapping locomotion of birds and fish. What is this experiment showing? One, that unidirectional locomotion is an attracting dynamical state for oscillating nonlocomoting bodies, and two, that a sharp division exists between the low and high Reynolds number realms in the way bodies can interact with a surrounding fluid. Subsequent simulations of flapping wings in viscous fluids have expanded our understanding of this experiment by showing the surprising roles that wing shape and body inertia can play in the whole process.

The micro-flyer, and other AML experiments like continental drift on a table-top and valveless pumping, I leave as mysteries for another newsletter. The AML has involved Courant faculty, post-docs, graduate students, undergrads, and NYC-area high-school students, and is an almost unique facility for a mathematics institute. Indeed, its existence expresses the broad interpretation the Institute has of what constitutes and inspires mathematical activity. To learn more of what goes on in the AML, visit our website **www.math.nyu.edu/aml**, or just drop by.

Snapshots on a Random Walk

By Michael Abrams

If you're about to throw your nest egg into Google stock you might want to first take a class with Marco Avellaneda, professor of mathematics at Courant, who offers a financial seminar on Thursday evenings, open to the public and attended by many a Wall Street high roller.

Avellaneda uses models of the stock market to figure out which stocks are profitable, low-risk investments. By taking a snapshot of the market at any given moment, he can examine a thousand or so stocks at the same time to see how they're priced in relation to one another. Using sophisticated mathematical tools, he can look for discrepancies and imbalances. "Someone might say, 'Oh yeah, earnings are coming out on Nokia and the volatility is cheap, so you should buy Nokia options.' But that wouldn't do it for me. I already know that," he says. "I try to look at the whole thing together." By locating minor price differences in a variety of different kinds of stock, Avellaneda keeps risk to a minimum. "Mathematicians," he points out, "are extremely scared of not hedging."

His technique is a complex version of what you ought to do when you buy real estate. "One way to be a little scientific is to look around and see what other things are worth," he explains. "Let's say you want to live on Park Avenue. You'll want to know how much the apartment next door, below and above went for."

The real question, of course, is whether his technique makes him a lot of money. "A lot? No. But I teach a lot of people, and they make a lot of money," Avellaneda says. "I have 50 or 60 students working on Wall Street now. So something works—at least they get paid."

Reprinted from *NYU Alumni Magazine*, Fall 2004

Courant Honors and Awards

Major Faculty Development Award from the New York State Office of Science, Technology and Academic Research: *Mehryar Mohri*

Mayor's Award for Excellence in the Mathematical, Physical and Engineering Sciences for outstanding achievement in science and technology: *Andy Majda*

2004 Sidney Fernbach Award given by the IEEE Computer Society for outstanding contributions in the application of high performance computers using innovative approaches: *Marsha Berger*

Margaret and Herman Sokol Award in the Sciences: *Leslie Greengard.*

Elected as a Fellow of the Association for Computing Machinery for achievements in computer science and information technology: *Allan Gottlieb*

ACM Regional Programming Contest First Prize for successfully solving more problems than any other of the competing 70 teams from several dozen colleges and universities in the Greater New York Region (including teams from Cornell, Columbia, Yale and Rutgers): NYU Computer Science Team (*Chien-I Liao, Michael Kim, Yu Tung Chen*) – this team will go on to the International Programming Contest in Shanghai in the Spring. All 15 participants on the 5 NYU Computer Science teams turned in successful performances.)

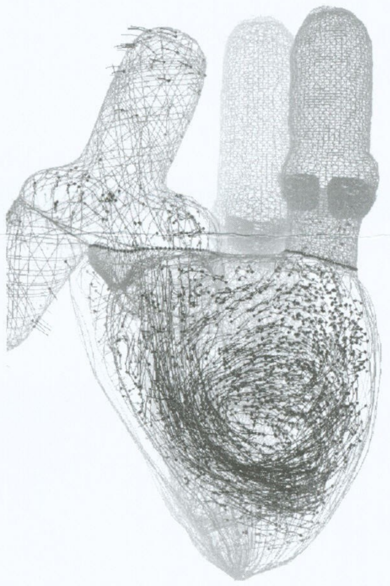
Owners of a Lonely Heart

By Michael Abrams

David McQueen and Charles Peskin set out to create a complete, detailed, working virtual heart. Based on CAT scans of a graduate student's heart, this software organ already behaves as a real one. When it contracts, virtual blood is pumped in and out, virtual valves open and close, and virtual diseases are easily spotted. Using this groundbreaking tool, heart surgeons and cardiologists should soon be able to make scans of a patient's heart, spot any problem and try myriad solutions before turning to the scalpel.

McQueen has programmed the fibers of his virtual heart to contract when they're supposed to, but the rest happens because of nature's clever architecture. "The valve opens or closes as it wishes," he says. "It's what the fluid mechanics make it do—in real life and in our model." And McQueen has already created a naturally occurring disease. In an earlier version of the heart, the leaflets (flexible little doors that open and close to keep blood moving in the right direction) of a valve were flowing back into the atrium after they should have closed. "I made a mistake," he says. "I changed something by a factor of a hundred, instead of a factor of two." When his colleague Peskin saw the heart pumping on-screen, he immediately recognized the valve's behavior as a common real-world malfunction known as mitral prolapse syndrome.

A big part of modeling the heart is understanding how the blood interacts with the muscle membrane. That's where Peskin and his "immersed boundary method" come into play. The heart, of course, is a big muscle that pumps fluid. But that fluid also has an effect on the muscles of the heart, making the whole system a complex two-part problem that has to be solved simultaneously, in which Peskin's method treats a membrane as part of the fluid that surrounds it. The technique has applications anywhere a flexible structure is in fluid: cells in blood, the inner ear, eels in water or flies in air.



David M. McQueen and Charles S. Peskin, Courant Institute, NYU

"Biology is generally squishy stuff interacting with fluid," Peskin points out. "There's less distinction between solid and fluid in biology than in other places."

The way in which applied math is used in the biomedical and biological worlds is at a crossroads, notes Courant's Leslie Greengard, who specializes in finding better algorithms to process image data. (His co-invention of the Fast Multipole Method was named one of the top 10 algorithms of the century by Computing in Science & Engineering magazine.) For years, Greengard explains that scientists have been used to doing experiments with a small number of parameters and a lot of data—a situation in which conclusions are a snap. Now, a single experiment has an enormous number of parameters and the tools for handling such data don't yet exist. Eventually, the right algorithm will be found. "It's an important enough problem that I think it's worth sacrificing a lot of bodies on—bodies of mathematicians," Greengard says.

Reprinted from *NYU Alumni Magazine*, Fall 2004

Francesca Chiaromonte

Francesca Chiaromonte

Francesca Chiaromonte received a PhD in Statistics from the University of Minnesota in 1996. She was a research scholar at the Santa Fe Institute (1991) and the International Institute for Applied Systems Analysis (1996-98) in Vienna before joining the Statistics faculty at the Pennsylvania State University in 1998, where she is also a member of the Center for Comparative Genomics and Bioinformatics. At NYU, Dr. Chiaromonte holds a joint appointment between the Mathematics Department of the Courant Institute and the Department of Biology, and is involved in the new Center for Comparative Functional Genomics.

Dr. Chiaromonte's interests as a statistician cover multivariate analysis, regression, computational techniques and Markov modeling. Her main research area in theoretical statistics, which she pursues with colleagues at UMN and Penn State, is Sufficient Dimension Reduction - a body of theory and methods for handling high-dimensional regression and classification problems, whose application scope is increasing steadily along with the availability of large-scale data in many scientific fields.

In particular, Dr. Chiaromonte is intimately involved in the analysis and modeling of large-scale genomic data, research that sits at the crossroads of statistics and genomics, computational biology and bioinformatics. With colleagues at Penn State and UC Santa Cruz, she participated with the Mouse, Rat and Chicken genome sequencing consortia. Alignments of the human genome with those of other species provide comparative information that is crucial for investigating how genomes evolve, as well as predicting and annotating functional sequences within them. Dr. Chiaromonte is involved in projects concerning alignment scoring methodology, genome-wide variation and co-variation of divergence processes, estimation of the fraction of the human genome under purifying selection, genome-wide scores to aid in the prediction of regulatory sequences, etc. She also works on the analysis of data produced by high-throughput techniques (e.g. microarrays) that record transcriptional activation for thousands of genes at a time. These diverse problems offer an excellent application ground for the statistical methods employed by Dr. Chiaromonte.

If Archimedes Had a Computer

Dr. Rorres is shown at his home with two Archimedes-inspired finials he designed for his fence.

On October 15, 2004 Courant Alumnus Dr. Chris Rorres, '69, presented a talk on his research – "If Archimedes Had a Computer". Dr. Rorres has studied the life and work of the ancient geometer/scientist/engineer for more than 30 years. In the past five years, he has been featured in two BBC Television documentaries, the second of which ("Infinite Secrets") aired on the PBS television science series NOVA last fall.

In Book I of *On Floating Bodies* Archimedes began the field of hydrostatics, the study of how things float. According to tradition this study arose from a royal request to test the purity of his king's golden crown, leading to science's original "Eureka!" moment. In Book II, motivated by his desire to examine the stability of ships, Archimedes recorded his studies on the stability of specific floating bodies. (His interest in ship stability also led him to design formidable war machines that capsized attacking warships as the Roman navy tried to invade Syracuse.)

The specific floating bodies that Archimedes studied in Book II were paraboloids (solid cone-shaped objects with rounded noses and flat bases). He examined the effect of the shape and density of a paraboloid on its stable floating positions. However, his results were restricted to the case where the flat base of the paraboloid lies entirely above, or entirely below, the fluid surface.

More than 23 centuries later, Dr. Rorres has computed all possible floating positions of a floating paraboloid (both stable and unstable) for all possible shapes and densities. He shows that the most interesting things happen when the base of the paraboloid is partially submerged in water – precisely the situation that Archimedes could not handle with the mathematical tools available in his time.

In applying his findings to modern-day situations, Dr. Rorres demonstrates what happens as an iceberg (shaped like a paraboloid and floating point-down with its base above water) slowly melts. The iceberg gradually tilts until its base is partially submerged, then falls catastrophically onto its side – just like the iceberg that unexpectedly fell on the Nautilus in Jules Verne's *20,000 Leagues Under the Sea*. Similarly, Dr. Rorres shows that a tall paraboloidal-shaped structure (a building, for example) standing on water-saturated soil, initially sinks and tilts during an earthquake as the soil under it liquefies. If the structure continues tilting to a point where its base is exposed above ground, it will suddenly topple onto its side. Tumbling icebergs and toppling structures are the kinds of extreme phenomena studied by mathematicians in the field of catastrophe theory – a field that Archimedes could have initiated had he been able to determine all possible positions of his floating bodies.

Dr. Rorres' website on Archimedes has become a premier teaching site for tens of thousands of students around the world. The web address is: **http://www.math.nyu.edu/~crorres/Archimedes/contents.html**

Upcoming Reunion and Alumni Receptions

We invite you to join us for the University's regional alumni gatherings, hosted by John Sexton. Please see the NYU alumni web site at **www.nyu.edu/alumni** or give the alumni office a call at (212) 998-6946 for more information.

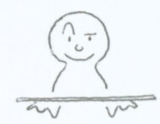
February 7	Palm Beach, Florida
March 1	Albany, New York
April 14	Los Angeles, New York
May 24	Washington, DC

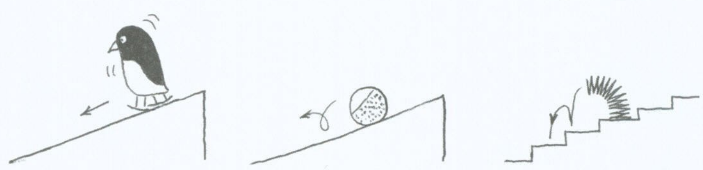
May 13-15 NYU Alumni Reunion Weekend in New York City

There will be a special Courant reunion lunch on Saturday, May 14th. More information and invitations will be forthcoming.

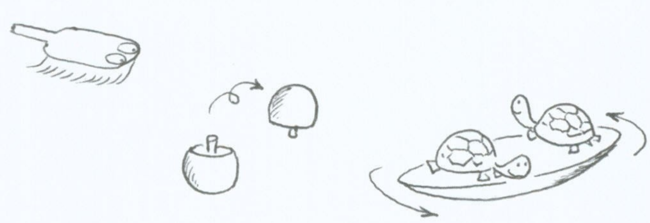
The Physics of Toys

Presented by Tadashi Tokieda





Todashi Tokieda presented a wonderful holiday lecture on December 15. Dr. Tokieda is an ex-topologist who has turned to classical applied mechanics. He recently moved from New York City to Cambridge England but still returns to the city often. His work is a mixture of theory and application to interesting mechanical phenomena. In fact, he not only uses many of these devices to illustrate his lectures, but he also brought them to entertain and dazzle the guests at the holiday party.

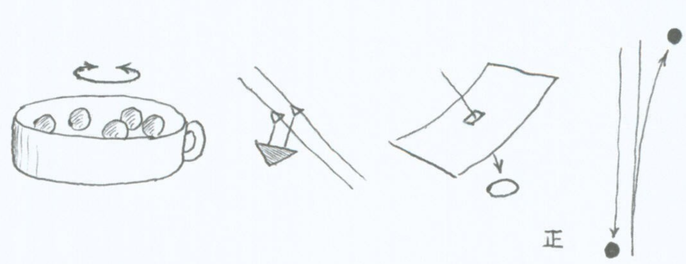


In advance of his Holiday lecture titled: "Physics of Toys" Dr. Tokieda wrote:

"Would you like to see some toys?

Look carefully at many toys and you will find that they rely on interesting physics. I will show a number of simple toys that have intrigued me, both for the fun they bring and for the complex physical and mathematical principles underlying them. The main theme is the effects of friction and of nonholonomic constraints. I hope that the lecture will be nontrivial for seasoned scientists and entertaining for young children."

Judging from the response of those present, he succeeded in his ambitious goal.



Jack Schwartz

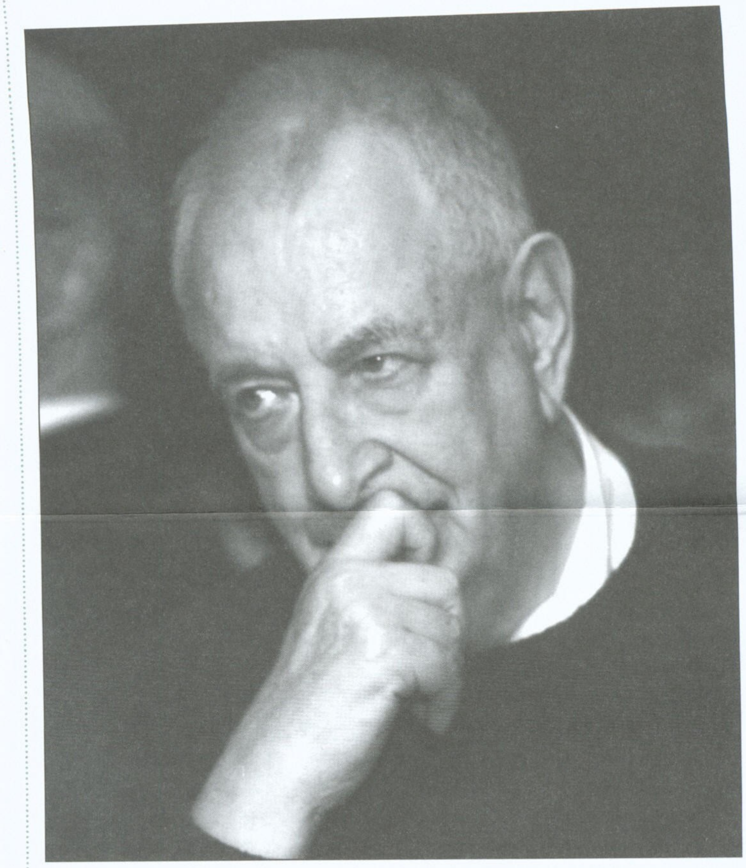
In his long and distinguished career as a mathematician and computer scientist, Jacob T. Schwartz has made very many important contributions to a remarkable variety of different subject areas. His style has been to enter a new field, to master quickly the existing research literature, to add the stamp of his own forceful vision in a series of research contributions, and finally to leave behind an active research group that continues fruitful research for many years along the lines he has laid down. A brief list of some of the areas to which Schwartz has made major contributions gives some notion of his breadth: spectral theory of linear operators, von Neumann algebras, macroeconomics, the mathematics of quantum field theory, parallel computation, computer time-sharing, high level programming languages, compiler optimization, transformational programming, computational logic, motion planning in robotics, and most recently multimedia.

Jack Schwartz began his career in mathematical analysis, specifically in the theory of linear operators. The monumental three volume treatise {\it Linear Operators} written with Nelson Dunford, for which the authors were awarded the Leroy P. Steele prize by the American Mathematical Society, is not only the definitive work in the area, but is also a wonderful compendium bringing together results from various branches of analysis and much that was new, all presented in an exciting manner.
The need to provide formal descriptions for a myriad of algorithms, that would be of use to practicing programmers as well, led Schwartz to the design of the programming language SETL. SETL, though never widely adopted in its original form, proved highly influential and useful.

Although parallel processing is now recognized as a major discipline in computer science, this was hardly the case almost three decades ago when Jack Schwartz began his work in this area. A paper published in 1966 introduced a class of architectures he called {\it Athene}, nowadays called shared-memory MIMD computers. In this early work, Schwartz already anticipated the major challenge in obtaining an effective implementation of this class: memory latency. Like its modern counterparts, the Athene architecture featured a uniform address space, ``public" and ``private" variables, and special coordination primitives. Although the technology of the sixties was clearly inadequate for the actual construction of an Athene computer, interesting simulation studies were carried out. By the beginning of the eighties, Schwartz felt that technology had caught up. His seminal paper {\it Ultracomputers} presented a collection of parallel algorithms for a computer using a shuffle-exchange interconnection network complete with complexity analyses. This work served to initiate a substantial research effort that continues at NYU to the present day.

Another of Schwartz's interests has been in robotics. He initiated work in the geometry of motion planning and served as the leader in the development of a robotics laboratory. Most recently, with the aid of funding from New York State, he has founded a major multi-disciplinary effort in the emerging field of multimedia.

Jack Schwartz was never an ivory tower scientist. One way or another, he has always taken a keen interest in public affairs. He has served as Chair of the Computer Science Board of the NRC and of the NSF Advisory Committee for Information, Robotics and Intelligent Systems. With a leave of absence from his academic duties, he served for two years as Director of ISTO-DARPA. His interest in pedagogical issues has been a constant of his motion. From an early illustrated presentation of special relativity (one of his first published works, recently recast in the form of interactive software) to the use of electronic music instruments to teach elementary mathematics through rhythm in public schools, Jack Schwartz has embodied the ideal of the teacher, guiding and inspiring generations of students and researchers.



Computer Animation Festival Jury for SIGGRAPH 2004 at NYU

Jacob T. Schwartz Fellowship Fund

As a part of Jack's retirement celebration we are very pleased to announce the creation of a graduate fellowship in honor of Jack, The Jacob T. Schwartz Fellowship. We are pleased to invite you to participate in building this fellowship, which has been initiated by Jack's family and the Courant community. The fellowship comes at an important time in the life of the Institute, as Courant works to increase its private support. Checks can be sent to *New York University Office for University Development and Alumni Relations, c/o Mark Hansen, 25 West Fourth Street, New York, NY 10012*, and made payable to New York University. All contributions are tax-deductible under United States Law.

Thank you for considering making a gift to the Jacob T. Schwartz Fellowship.

The Courant Institute thanks alumnus Neil Sarnak for his very generous gift of $20,000 to the Jacob T. Schwartz Fellowship Fund.

If you would like to submit information to appear in the next Courant Alumni Newsletter, or for any inquiries, please write to courant.alumni@nyu.edu.

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