

## Subhash Khot wins NSF's Alan T. Waterman Award

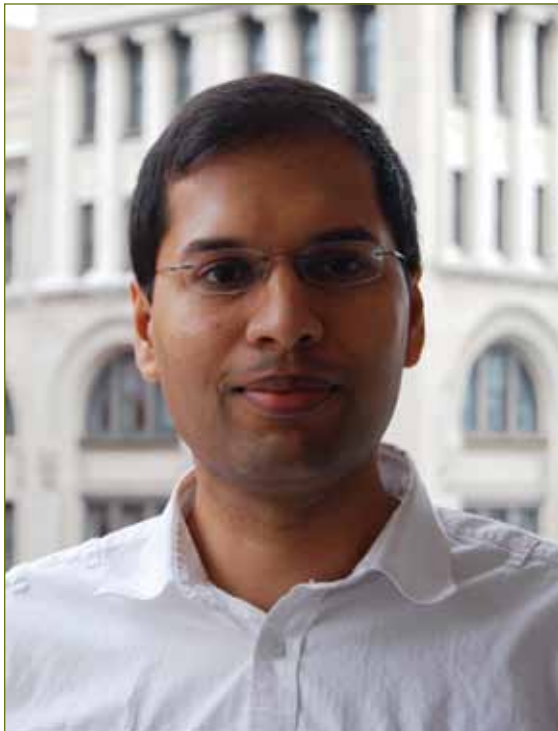


Photo: Gayatri Ratnaparkhi

This award is given annually by the NSF to a single outstanding young researcher in any of the fields of science, engineering, and social science it supports. Subhash joins a very distinguished recipient list; few mathematicians or computer scientists have won this award in the past.

Subhash has made fundamental contributions to the understanding of the exact difficulty of optimization problems arising in industry, mathematics and science. His work has created a paradigm which unites a broad range of previously disparate optimization problems and connects them to other fields of study including geometry, coding, learning and more.

For the past four decades, complexity theory has relied heavily on the concept of NP-completeness. In 2002, Subhash proposed the Unique Games Conjecture (UGC). This postulates that the task of finding a “good” approximate solution for a variant of the standard NP-complete constraint satisfaction problem is itself NP-complete.

What is remarkable is that since then the UGC has proven to be a core postulate for the dividing line between approximability and inapproximability

in numerous problems of diverse nature, exactly specifying the limit of efficient approximation for these problems, and thereby establishing UGC as an important new paradigm in complexity theory. As a further bonus, UGC has inspired many new techniques and results which are valid irrespective of UGC's truth. ■

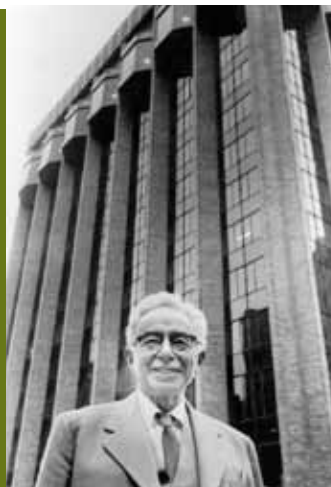
### In this Issue:

Subhash Khot wins NSF's Alan T. Waterman Award	1
The Courant Institute: 75 Years of Excellence	2-10
Computers, Technology, and Science at Courant Across the Decades	4-9
Hacking with Startups	11
Faculty Honors	11
Sam Roweis Memorial	12
Alumni Spotlight	12
Spring 2010 Puzzle	13
2010 Student Prizes	14
Bella Greenfield Memorial	14
The Generosity of Friends	14
Donors	15
Stay Connected	16
Your News	16

The Institute will be celebrating its 75th Anniversary over the course of the 2010-2011 Academic Year. Special events and activities will be planned to commemorate the occasion and to bring together CIMS and the broader scientific community.

This newsletter begins the celebration with an historical article on these first seventy-five years. While inevitably far from comprehensive, it captures the spirit of Courant — the man & the Institute.

(Photo on right) Richard Courant in front of Warren Weaver Hall



---

# The Courant Institute of Mathematical Sciences: 75 Years of Excellence

---

by M.L. Ball



Richard Courant

This article is the culmination of interviews with the following twelve faculty members of the Courant Institute of Mathematical Sciences: Marsha Berger, Sylvain Cappell, Jeff Cheeger, Steve Childress, Leslie Greengard, Ralph Grishman, Peter Lax, Andy Majda, Cathleen Morawetz, Louis Nirenberg, Michael Overton, and Raghu Varadhan. An additional participant was Lori Lax, wife of Peter Lax and daughter of Richard Courant. Thank you one and all for your time and heartfelt comments about this extraordinary man and the magnificent institute which bears his name.

— Mary Louise Ball

---

## *Perstare et Praestare* – to persist and to excel.

---

Thus reads the motto of New York University, and it could be said, of Richard Courant himself. A man of remarkable foresight, inexhaustible enthusiasm, and indomitable will, it is impossible to imagine the Courant Institute being founded by anyone else.

But what was it that made this man so extraordinary? How was he able to create an institute whose applied mathematics became, and 75 years later, continues to be considered the world's best? And to have created not only an intellectually rigorous environment but a warm, collegial atmosphere revered by all associated with it, causing them to stay for years, even decades?

The answers are as multifaceted as the man himself and as illuminating as the times in which he lived.

### **Courant the Man**

Descriptions of Richard Courant from present faculty who knew him run the gamut from obstreperous to congenial, but one theme runs throughout: once you met him, you never forgot him.

As Peter Lax described him, “Courant was an idealist and at the same time, a very strong skeptic; he was very contradictory. During the war, he traveled a lot. His wife Nina, a musician, once gave a party for her friends while he was away and one of the guests asked her, ‘Nina, isn’t it very inconvenient for you that Richard travels so much?’ And she said, ‘On the contrary. This way I can invite all the people he can’t stand.’”

Lori Lax, Courant's youngest daughter and the wife of Peter Lax, remembers her father as ironic and scornful, yet also possessing a great sense of humor. She recalled, "He was extremely inconsistent and couldn't stay strict. On the other hand, he was far from kind and pleasant. I remember coming home one day with a very good report from school, and he said, 'Well, from a school like *that*.' But then there's the story of my sister Gertrud who was very unhappy when we came from Germany; she had lost all her friends and didn't understand English, and because of that, was placed in a class of students much younger than she. One day when she had been sent to the principal for misbehaving, my father, with a suspicion of a smile, gave her a quarter, because she had the courage to be bad!"

Lori continued, "Sometimes my father enjoyed a wave of soundless laughter. It might have been occasioned by a person he loved, or a story, or even some pungent moment in a piece of music. I think humor was his greatest strength."



Donald Flanders

Neugebauer, a very meticulous and workaholic scholar. Courant once said, 'Neugebauer has all the virtues and none of the faults of pedantry.' Courant was not a scholar in that sense. He didn't have the patience and the temperament. Neugebauer was utterly different from Courant, but they had an extremely intimate relationship.

"Another example of this is Donald Flanders," Lax continued. "He's the one who invited Courant to NYU; he was chairman at the time. Flanders was a descendent of Puritans who came on the Mayflower, and he himself was a Puritan. Courant was the very opposite of a Puritan. Flanders was very meticulous in marking exams because they had to be judged fairly. The result was that he got way behind. He was desperate and Courant offered to help. Flanders knew Courant was not as meticulous as he and he wasn't sure if he should agree to this. So Courant said, 'Test me. Give me some exams you've already marked, cover up the mark, and see how I do.' When his marks agreed with Flanders', he agreed to let Courant help. That was their first experience together, but with time they became very close friends, and their children are friends today."

Cathleen Morawetz's first memory of Courant was at her job interview, something she will never forget. "I had on this bright green coat and I was twiddling the button, and it came off and rolled under his desk," she said. "I was sitting on one side and Courant was on the other. He immediately got down on his hands and knees, and I got down on my hands and knees, and together we looked for this button."

"After getting my master's degree from MIT in 1946," she continued, "Courant invited me out to New Rochelle and I met his family, who were so different from anyone I'd ever met before. They remained very German. Mrs. Courant was the daughter of a very well known mathematician. When they left as refugees, they brought everything with them, not only their attitudes but also their furniture – heavy German furniture. And there was always lots of music. It was a very unique atmosphere; I'd never seen anything like it."

Once hired, one of Morawetz's first assignments was to edit the book *Supersonic Flow and Shock Waves*, co-authored by Courant



Kurt O. Friedrichs

Courant's fondness for young people was universally remembered. According to Louis Nirenberg, Courant very much liked to be with them and be stimulated by them, and often invited graduate students to his house in New Rochelle. "Once we got there," Nirenberg explained, "we realized partially it was to weed his garden. I discovered recently that his teacher, Hilbert, did the same. Courant had a lot of initiative, a lot of imagination. And he had wonderful students: Kurt Friedrichs, Hans Lewy, and many others. He was full of warmth, full of humor, and very smart."

Post-World War II government funding, which propelled the Courant Institute onto the national stage, can be directly traced to Courant's enterprising nature and ability to forecast the future of mathematics, Nirenberg added. "He was one of the early mathematicians to get money from government agencies," he said. "He and Friedrichs wrote a book on shock wave theory, which was not his original subject at all, which helped him obtain funding from the Navy."

Another facet of Courant's personality which greatly influenced how the Institute developed was his affinity for people with different views. "It was his nature," said Peter Lax. "He was extremely close with people who were his opposite, like



Raghu Varadhan, Cathleen Morawetz, and Olof Widlund.

and Friedrichs – a delicate balancing act. “Courant was a brilliant writer but sometimes he let style overpower correctness,” she said. “Friedrichs was a poor writer but would never let anything pass that was not exactly accurate. They were opposites but very good friends. So I would fix up the English of Courant and bring it to Friedrichs, who would then look it over and decide it wasn’t accurate. He would change the wording but then it was unreadable. I would then take it to Courant again, and so it went, back and forth.”

She described Courant as “a fascinating person. Not a very good lecturer but a very good writer,” she said. “He was very smart, and a very good mathematician. People tend to underestimate what a good mathematician he was, and he worked at it all the time.”

And of course, one of the most well-known characteristics of Courant was his great love of the piano. Having taught himself to play the instrument as a teenager, it became a permanent fixture in his life. His wife Nina, an accomplished violinist, was as passionately devoted to music as he, and together they filled their home with music. According to Nirenberg, there was a joke that when Courant interviewed people for possible jobs, he would ask them if they played music. If they did, he would truly consider hiring them – unless they played the piano.

### A Herculean Achievement – Twice

The fact that Courant developed one internationally renowned center of mathematical excellence and then created a second has as much to do with his personality as his mathematical brilliance. Rising to the directorship of the Göttingen Institute, only to be removed in 1933 by the Nazis, would have shattered most any man. But in the words of Peter Lax, it was Courant’s “inexhaustible

optimism in the face of seemingly insurmountable obstacles” that propelled him to recreate Göttingen here in America.

According to Andy Majda, “Courant took the tradition of Göttingen – of mathematics as science – and brought it here because of the circumstances of pre-World War II Nazi Germany. Then he was lucky enough to be blessed with this incredible group of young students – Joe Keller, Peter Lax, Cathleen Morawetz, Louis Nirenberg, Martin Kruskal, Harold Grad – who later became some of the most important mathematicians of their generation. He and Kurt Friedrichs nurtured them in a remarkable way. He was also one of the few mathematicians who capitalized on WWII to get funding from the government, stressing NYU’s role as an applied mathematics institute and tying this to national security. Now the Courant Institute is the world’s most famous place to do mathematics and its applications. It’s an incredible success story.”

Sylvain Cappell reiterated the monumental quality of what Courant achieved. “Courant’s talent at establishing this kind of extraordinary institution isn’t just a matter of chance. The fact is, he did this twice in his life. First in Germany, he created an international-level research institution, and then he recreated it on these shores. Hilbert was the central intellectual figure in Göttingen, but Courant was the one who really carried it forward and was the organizational genius. Then he played the same role over here. Quite an extraordinary thing to have done twice in a lifetime.



Louis Nirenberg and Peter Lax

## Computers, Technology, and Science at Courant Across the Decades

1954:  
Official Instillation  
of the UNIVAC



Cappell continued, “He brought a very sophisticated European tradition that melded pure and applied mathematics. Plus there was government funding available on a completely unprecedented scale as a result of the demonstrated military value of science during the war, and following that, during the Cold War years. I would also emphasize the fact that he had fantastic good judgment about whom to bring aboard. That gave the Institute a precious legacy both in terms of the mathematical genius and the human qualities in the people he brought. We’re still the beneficiaries and heirs of that.”

Equally as significant as Courant’s ability to recreate Göttingen at NYU was the way he structured the new Institute, insisting that pure and applied mathematics be combined. “Courant had very original and very unusual ideas of collaboration,” said Peter Lax. “Mathematics for most people is a very lonely profession. Of course there are collaborations but it is typically the lonely individual thinking about the problem. That was not Courant’s idea.”

Recalling his introduction to Richard Courant, Lax said, “My mentors in Hungary wrote to American mathematicians of Hungarian descent about me. My father, a physician, consulted von Neumann but more importantly Szegő at Stanford, who was actually an old friend from Hungary. Szegő said that Courant is wonderful with young people, and so my father took me to see Courant. I was not yet sixteen. I remember very well – Courant got very excited, and we talked about mathematics. But I had to finish high school, so I think the first concrete thing that developed from that meeting was that Courant became my father’s patient.”

Lax remembers those early years well. “I married one of Courant’s students – my first wife, Anneli, a fellow graduate student,” he said. “I was Friedrichs’ student and got my Ph.D. in ’49; my wife got her Ph.D. with Courant in ’56. She was among his last students. My work with Courant went like this: he would bring up a problem and my task was to get hold of it technically. I would periodically report to him on the progress that I made, and he would comment on it.”

---

**“Courant’s talent at establishing this kind of extraordinary institution isn’t just a matter of chance. The fact is, he did this twice in his life. First in Germany, he created an international-level research institution, and then he recreated it on these shores...Quite an extraordinary thing to have done twice in a lifetime.” — Sylvain Cappell**

---

Nirenberg concurred, adding, “Courant felt that mathematics was mathematics and there should be no separation between pure and applied.”

### The Institute’s Early Years

In 1934 Courant was hired to develop NYU’s mathematics graduate program, which was originally called the Graduate Center for Mathematics.

According to Peter Lax, “Friedrichs’ coming to the Institute in 1936 was very significant. Then when Stoker, an American who had studied in Zurich, came in ’37, they formed a triumvirate. And they had brilliant students. But the big uplift came during the war when suddenly there was federal money available for research. That was what turned a very modest enterprise into a much bigger one. Finally it became quite clear to the government what Courant had known for some time – how important technology and mathematics and science were to national defense, as exemplified by radar and the atomic bomb.”

It was serendipity that brought Louis Nirenberg to the Courant Institute. In the summer of 1945, he was working on atomic bomb research at the National Research Council of Canada in Montreal. Two of his colleagues were Ernst Courant, Courant’s oldest son, and his wife Sara. “She’s the one who led me to Courant,” said Nirenberg. “It was pure luck. I came down in the summer of ’45 to be interviewed by Courant and Friedrichs. They agreed to give me an assistantship so I came back in the fall. At the time, the offices were in Judson Hall, on the south side of Washington Square Park.”

He continued, “There were some young assistant professors, Max Shiffman and Bernard Friedman, and just a very few of us students: Eugene Isaacson, Martin Kruskal, Peter and Anneli Lax, Cathleen Morawetz, and Harold Grad. It was quite a small group of graduate students but really a very bright bunch of people. Courant’s idea was unlike most mathematics departments; typically, after people graduate with a Ph.D., they’re sent to other universities. Courant’s idea was to keep the very good students, so he kept a whole bunch of us for a number of years. It was a great time.”

**1960s:**  
**The IBM 7094**

Peter Lax, Robert D. Richtmeyer and student.



**1965:**  
**The CDC 6600**

Malcolm Harrison and Jack Schwartz.

The CDC 6600 was then the fastest machine in the world, although it could not do time sharing.



Ralph Grishman, another long-time faculty member, began his career at CIMS in 1964 after graduating from high school. “For a couple of years, the Institute had been offering a summer program for high school students to teach them how to program,” he said. “I took that course for about six weeks over the summer, working with an IBM 7094.”

The year 1964 was also when Steve Childress came to Courant as a post doc. “I had been working in aeronautical engineering and mathematics at the Jet Propulsion Laboratory in Pasadena, California, doing theoretical fluid dynamics. I was aware of the Courant Institute because of the early work on the fusion problem, the magneto-fluid dynamics laboratory run by Harold Grad, and also Joe Keller’s work. Gerald Whitham had just come to Caltech and had spent some time at Courant. He recommended me for a post doc there under Harold Grad, and I jumped at the opportunity. Once there, I met Harold and Jerry Berkowitz and Joe Keller. Offices were in the Waverly Building. We moved to the new building in ’65. Everyone was involved with designing the interior before moving in, so it was pretty exciting.”

### The Advent of the Computer

When the Atomic Energy Commission’s much-sought-after UNIVAC supercomputer contract was up for grabs in 1954, it can be said that Richard Courant’s tenacity, his Washington connections, and his fighter’s will made sure it was awarded to NYU. A major turning point in the Institute’s history, the UNIVAC guaranteed federal investment in the NYU mathematics department and the realization of Courant’s long-held dream.

Peter Lax remembered the UNIVAC as “having a memory of 1000 words and able to do 500 operations a second, which is nothing today. And it was huge. It was built by Remington Rand, and the inauguration was an important enough occasion so that the CEO, James Rand, came and brought his board with him. The chairman of the board was General Douglas MacArthur, and also on the board was General Leslie Groves, head of the Manhattan Project. There’s a photograph showing Courant with General Groves and General MacArthur, and I’m there too.”

In 1965, NYU had another supercomputer, a CDC 6600 worth \$3 million. In 1970, it narrowly missed being the victim of a bomb plot. Lax explained, “It was just a few days after the Kent State shootings, and the protesters calculated that the University and the police would not act very aggressively. They occupied the Courant Institute because we had the most valuable piece of property. They demanded that the University post bail for some Black Panthers or they would blow up the computer. The protest lasted two days. I was in the lobby with a number of Courant



Harold Grad and Cathleen Morawetz

colleagues, particularly from the Computing Lab – I was Director of the Lab – and when the occupiers left, I could smell smoke and said, ‘Let’s run up and see what’s going on.’ We went up and found a burning fuse, which two of my younger colleagues stomped on and put out. The rest of us went to the computer and disconnected the fuse, saving the computer. My wife said to me later that I was crazy to run into a room with a burning bomb fuse and I said, ‘I was so angry, I wasn’t thinking.’”

**“In the early days,” said Steve Childress, “when you wanted to study something, you would take your punch cards and put them in the machine; the next day you’d come back and if you were lucky, your program had run. If you’d made a mistake, you’d have to go back and start all over again. It could take days and days just to get a result – now it’s seconds. Being able to generate and interpret large data sets and study a model very quickly – that revolutionized the field.”**

Ralph Grishman also described what it was like when computers were the new phenomenon. “After the summer course I took at Courant in 1964, a couple of the students were invited to be part-time employees in the fall,” he said, “and I started doing research one afternoon a week with Jack Schwartz. We wrote a parallel processing simulator in Fortran, which was way before people were thinking about that, but Jack was always thinking ahead.

“I worked for Jack for four years, then took a break when I started graduate school,” he said. “Jack then connected me with Naomi Sager who was doing natural language analysis and needed someone to do part-time programming. When I finished my physics Ph.D. at Columbia, I decided doing natural language was more interesting than physics. Jack, having founded Courant’s

### Mid-1970s: The PUMA

Robert Dewar,  
Ralph Grishman, and  
Malcolm Harrison



(Right) PUMA memory board held by architect Ralph Grishman

The PUMA computer ran the same programs as the CDC 6600, with 4 processor boards replacing the 6600’s thousands of logic modules.



Photo: Dan Creighton

computer science department in 1969, offered me a faculty position and I've been here ever since."

At the time, "there were not many departments offering computer science degrees – Courant wasn't, Columbia wasn't," he said. "Most of the faculty at that time had either science or math degrees." Michael Overton, now chair of the Institute's computer science department, was the first person hired with a Ph.D. in computer science, in 1979.

In the 1970s, the department was quite small, but in the 1980s, it grew considerably, establishing much-needed lab space on three renovated floors of 715-719 Broadway. These included robotics and parallel computing labs, both initiated by Jack Schwartz.

According to Overton, "Jack was absolutely instrumental in the growth of computer science at Courant in those critical years, the '70s and '80s. He had a huge impact on setting the research agenda here and establishing what areas were important, what areas to hire in," he said. "He was also remarkable for his breadth; the fact that he made significant contributions in many areas of computer science *and* mathematics – that was really very unusual."

Sylvain Cappell echoed this assessment of Schwartz. "Jack had analytic powers that were really breathtaking. He could take up a field and master it to the front lines and teach it in a matter of weeks. He did that many times."

Another key player in computer science at Courant was Martin Davis, a logician who became famous for his work on Hilbert's 10<sup>th</sup> problem, one of the celebrated problems Hilbert posed in 1900.

Over the last three decades, Courant's computer science department has experienced substantial growth, greatly expanding its significance and visibility. "We've hired a lot of very good people in the last ten years and now have a number of areas of strength that weren't there before," Overton explained, "such as machine learning, graphics and multimedia, algorithms and theory, cryptography, and verification."

## Many Paths to Courant

The unique circumstances that led each of these twelve professors to the Courant Institute vary greatly, but the common thread has been the certainty that this was the best, most exciting place to be.

Raghu Varadhan arrived in 1963 from Calcutta, India. "I was interested in what was going on here," he explained. "I'd developed some interests while working in India and I was told this was the best place to pursue them. In those days it was easy;

there was plenty of money available for visitors. I thought I would come for a year, and I never left! I enjoyed being here and I liked my colleagues and never saw the point of moving elsewhere so I just stayed on. And I like New York City; I like big cities."

Cathleen Morawetz sought out Courant due to the urging of her father. "My father, John L. Synge, was an applied mathematician and he had met Courant. They had exchanged thoughts about the fact that their daughters had married and that this was going to mess up their careers. My mother was actually the one who encouraged me to have a career."

Sylvain Cappell immigrated to the United States from Belgium with his family in 1950. "In 1963 when I was in high school," he said, "I was the top national winner of what was then called the Westinghouse National Science Talent Search; now it's called the Intel National Science Talent Search. I began my career as a mathematical researcher, worked at several places, and eventually came to Courant in 1974."

Leslie Greengard, current Director of the Courant Institute, joined the faculty in 1989 and like so many others, has been there ever since. "This was the place I wanted to come to," he said. "I'm very social and I loved the atmosphere here. I couldn't see myself being anywhere else, and I still feel that way."

"It was the great people at Courant that brought me here to begin with," said Marsha Berger. "Peter Lax, for example. In the field that I'm in, he's the shining light. I first came as a post doc in 1982 and ended up staying, so I've spent my whole professional career at Courant."

Jeff Cheeger came from Stony Brook in 1989, becoming the Institute's first professor in the field of differential geometry. "For a long time prior to when I came, this was a field where the Institute wanted to establish some sort of presence. On the pure side of mathematics, traditionally Courant had been relatively narrowly focused with a massive presence in nonlinear PDE (partial differential equations) and probability, with more limited coverage of other areas. It was unique for the level of its applied mathematics and for having absolutely top people who did both."

Andy Majda's story involves oceans, Princeton, and NYU's current Provost. "I was a professor at Princeton when Dave McLaughlin, who was my Princeton colleague and is now NYU's Provost, got an offer to become the Director of Courant. I wanted him to stay at Princeton because I had worked hard to hire him – I can say I hired NYU's Provost – when I was running the Applied Math program there. He said to me, 'I'm going to NYU to become Courant's Director and I'd like to see what I can do to attract you.'"

### 1980s: The Ultracomputer

Design Underway:  
Mal Kalos, Allan Gottlieb,  
and Jack Schwartz



Allan Gottlieb points to the Switching board of the Ultracomputer 3. These custom VLSI switches designed at NYU were the first to "combine" memory requests, an Ultracomputer innovation.



Photo: Dan Creighton

Majda continued, “My wife is a professor of Geosciences at Princeton and had some colleagues who were involved in climate atmosphere ocean science (CAOS) and were working at Princeton’s geophysical fluid dynamics laboratory. These fields had had an interaction with applied mathematics twenty years earlier, in a very traditional mode. But applied mathematics had developed and matured a lot, with huge improvements in how people thought about numerical algorithms, asymptotic modeling, and the use of rigorous mathematics tools to prove things. And I thought these problems were unbelievably important for climate change science. So I thought, ‘If Dave McLaughlin wants to attract me to NYU, he’ll provide the resources for me to set up a program in climate atmosphere ocean science.’ He did, and it’s come true in a very, very nice way.”

Cappell went on to explain how the melding of pure and applied math is also a critical component of the Institute’s appeal. “We’ve worked to preserve the tradition of joining pure and applied math; it’s not always easy to do. The National Research Council does assessments of departments all over the U.S. and they have now separated pure and applied mathematics into separate categories. Which is not, from our point of view, a good thing to do. We’re always trying to build up discussions and exchanges which will serve as bridges between the two. Another thing which distinguishes us is that our record at identifying young talent is superb; this goes back to Courant.”

Jeff Cheeger remembered that when he came to Courant, he received a very warm welcome from Peter Lax, Louis Nirenberg,

---

**“Most large academic settings are very different from Courant — people don’t have quite the same sense of attachment to their colleagues. Here, there is a feeling that we’re part of something larger than ourselves. This stems from our history – from the culture established by our founders and from our continuing work as a mission-oriented institution. At the same time, no one could say that the place is calm – there’s an incredible energy here and an astonishing variety of problems that people are exposed to. For people who thrive in a stimulating environment, there’s no place like it.”**

**— Leslie Greengard**

---

### **What Makes Courant Special**

When asked what makes the Courant Institute such a unique place, the answer given – consistently – was very simple: extraordinary scholars who are also extraordinary people.

“The place has always had a family feeling about it,” according to Sylvain Cappell, “despite being a research institute where everybody has their own scientific concerns. People who have been associated with it – students, post docs, faculty – continue to feel like they’re members of the Courant Institute even when they’re working elsewhere.

“The Institute also greatly benefitted from the fact that a lot of its key people were great human beings,” he added. “These are people of unusual warmth and generosity, and they provided a setting which is charming. I always say that my colleagues come in here like Englishmen to their club. It makes all the difference in the world. They could work at home. But here, they like hanging around, they like interacting, and they enjoy the feel of the place. It’s very important for us to preserve that atmosphere because it’s part of what makes this place distinctive.”

and Cathleen Morawetz. “They are not just great scientists, but great people, and that certainly is very important in setting the tone of the place,” he said.

He also emphasized that “the Institute is still a place of incredible breadth and quality. One amazing statistic is that of the nine Abel Prize winners, three are here: Peter Lax, Raghu Varadhan, and Misha Gromov.”

Steve Childress said that when he started at Courant Institute, he knew he was going where a lot of interesting work was being done in the applied mathematical field he wanted to work in. “I had been around experimentalists in the theoretical fluid dynamics division at the jet propulsion laboratory at Caltech, but I was really interested in working with theorists such as Joe Keller and Harold Grad. It was an honor to be close to these guys.”

“I have always had great affection for the Courant Institute,” said Andy Majda. “The most important science part of my career was from 1973–75 when Peter Lax and Joe Keller taught me various things about mathematics and applied mathematics. It’s

#### **1990s: Observing Fluids**

The primary instability of a heavy flag in high-speed current is studied by Jun Zhang in the Applied Math Lab.

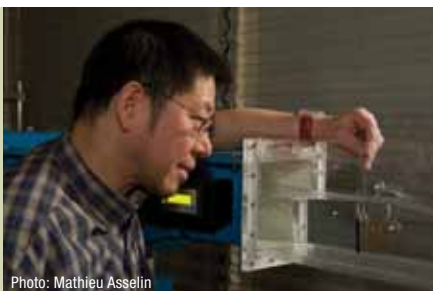


Photo: Mathieu Asselin

A potential application of extracting energy from the flows, using flexible sheets instead of turbines, is investigated experimentally and theoretically.

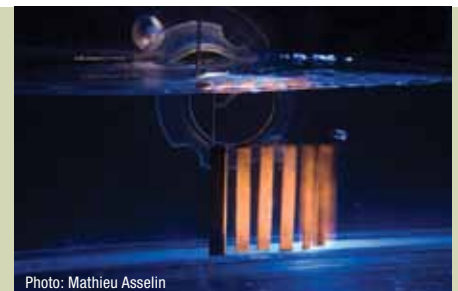


Photo: Mathieu Asselin





**Groundbreaking of Warren Weaver Hall**

a remarkable place, a place where all kinds of mathematics and sciences coexist. You do mathematics *and* the sciences, so Courant is not only on a very high intellectual level but it's driven by the sciences. I have had the most wonderful collection of supportive colleagues, spanning the entire Institute."

For Michael Overton, Courant is unique because "it's a place where you really have a lot of freedom to do what you want. When I came here, the senior faculty were very supportive of what I did, particularly Olof Widlund, chair of computer science at the time. Also, everyone wants to come to New York, so you have the best people from around the world coming through, and you get to work with them. The city is a real draw for students, too. We have outstanding Ph.D. students here and that's one of the reasons."

Leslie Greengard cited the genuine and lasting sense of community, rarely found in other institutions. "Most large

academic settings are very different from Courant - people don't have quite the same sense of attachment to their colleagues," he said. "Here, there is a feeling that we're part of something larger than ourselves. This stems from our history - from the culture established by our founders and from our continuing work as a mission-oriented institution. At the same time, no one could say that the place is calm - there's an incredible energy here and an astonishing variety of problems that people are exposed to. For people who thrive in a stimulating environment, there's no place like it."

According to Marsha Berger, what made Courant distinctive early on was its emphasis on actually solving scientific problems of real interest. "The applied math that was done at Courant wasn't just paper and pencil but was really driven by problems of independent scientific interest - problems that needed to be solved," she said.

She added, "I think I'm really lucky that I ended up here. It's a great place to work. The fact that the computer science department and the math department are in the same institute is truly unique. I'm a faculty member in computer science with an appointment in math. Ph.D. students can work with anybody in either department. The fact that it's so seamless is unusual."

Sylvain Cappell offered a representative story of what makes Courant so unique. "Once I was meeting with a prospective hire," he said, "and I told him I had a set of criteria for identifying people who would particularly be interested in coming here: people who were interested in communication; who had a serious cultural interest of some kind, like opera or art; people who were members of some ethnic or cultural minority, because everything is accepted in this city; and people who had a spouse with career interests. And then along with all these criteria, I added one more. I said, 'It also helps if they're a little bit crazy, and happily, you satisfy all my criteria so you should accept our offer!' And he did."

## The Future of Courant

By all accounts, the story of the Courant Institute's past is truly remarkable. Now the question to be asked is, "Where is it going?"

As Sylvain Cappell put it, "You've got to work with where science is at, and where the world is at. Science is a lot bigger than when I was young. There were always some sciences that were moving along quickly but there were others that were kind of sleepy. That's not true anymore. *Everything* is moving, partially because advances in any science create opportunities for other sciences by providing exploratory tools or ideas or problems. This is true in mathematics on every scale. Applied mathematics has grown from being entirely based upon classical analysis to having other methodologies play a

### 2000s: Measuring Ocean Data

David Holland prepares to deploy an AXCTD into the Jakobshavn Fjord in Greenland (2007). This is the first time such probes were used to acquire ocean temperature data.



Photo: Denise Holland

An Airoborn Expendable Conductivity Temperature Depth probe (AXCTD), 1 meter in length, launched from a helicopter into an ice-covered ocean.



large role, methodologies that come out of computational science and that involve statistical and numerical analysis.

He added, “The University as a whole has improved tremendously. NYU has managed to reposition itself more in the last 30 years than any other university in the United States. That’s an amazing achievement, particularly when you realize that it’s competing successfully with top-level institutions that have far larger endowments.”

Jeff Cheeger commented that “the Institute continues to have a number of the very top people in areas such as nonlinear PDEs, in which for many years we were almost completely dominant. But we cannot expect to have the same kind of virtual monopoly as before, because competition in these areas from other top places has increased dramatically. Therefore, in pure math, it makes sense for the Institute to define itself more broadly than in the past, as with our small but high level presence in algebraic geometry.”

He stated that since there are a number of areas of proven central importance in which Courant could sensibly build, he would emphasize choosing truly exceptional people in any of those areas, rather than strategizing to preselect an area. He also stressed the value of preserving the level in areas such as differential geometry, in which over the last twenty years, the Institute has built a world class presence. “Even in the face of ongoing raids from other top institutions,” he said, “it is far easier to preserve the level than to be forced to rebuild it from scratch.”

According to Andy Majda, the direction the Institute should go in should be data driven. “We have massive data sets available, from observations from satellites to sending up weather balloons,” he said. “How to use these to improve our understanding and prediction with physics-based and math-based models is a great mathematical problem.”

Steve Childress believes that neuroscience might represent a future direction for Courant. “This is supposed to be the century of the brain. I think its modeling is going to be one of the areas of applied mathematics that’s going to be at the forefront of research,” he said.

Marsha Berger observed that a very welcome change will be the upcoming merger with NYU-Poly. “Those of us who do applied work on the engineering side have had to look elsewhere to find collaborators, which is how I came to work with NASA. When Poly becomes the engineering school of NYU, this will open up a whole host of new applications and new potential collaborators.”

Raghu Varadhan, a Courant faculty member for almost 50 years, summed it up. “In mathematics, fortunately, you can identify talent at a very young age. Already at the time someone completes his or her Ph.D., it’s possible to see where that person will go. At Courant, we are able to identify and attract such talented people to come and work here. That’s where the future is, so if we can keep doing that, the place will thrive.”

By all accounts, it is. Surely, Richard Courant would be very, very proud. ■

### Observing Fluids

1950s Soap Bubble experiments with Courant. From right to left: Louis Nirenberg, Anelli Lax, Harold Grad, Eugene Isaacson, Joe Keller, unknown, and Richard Courant

