STANFORD TECHNOLOGY BRAINSTORM

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ARIM: From Nobel-Winning Science to Stanford Licensing

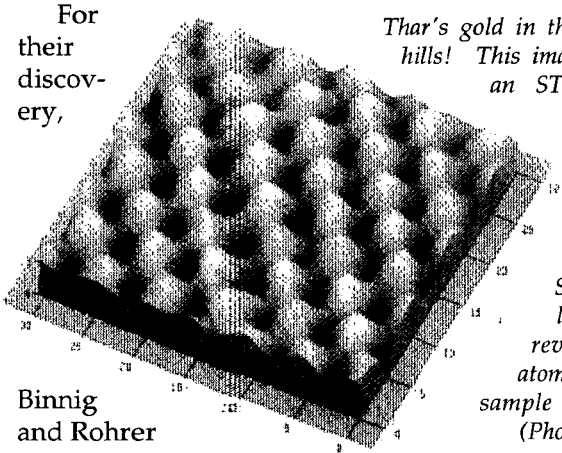
After a decade of investment by OTL in over 20 patents, a group of cutting-edge microscopy and memory technologies known as Atomic Resolution Instruments and Memories (ARIM) is finally coming to fruition through four current licensees, with others waiting in the wings.

Developed in the laboratory of Calvin Quate, Professor of Electrical Engineering and Applied Physics, the ARIM technologies are based on the "scanning tunneling microscope" (STM), first developed in 1981 by Gerd Binnig and Heinrich Rohrer at IBM's laboratories in Zurich, Switzerland.

In search of a new way to analyze surfaces, Binnig and Rohrer looked to vacuum tunneling – the bringing of two conductive materials so close together that the electron clouds of their atoms overlap, causing electric current to "tunnel" across the gap between the materials.

As the distance between the materials changes, so does the current, and the two researchers hoped that by translating those fluctuations into a computer image, they could map tiny imperfections on a given surface. It would be microscopy as analogous to Braille as to visual magnification.

Using a tiny spherical tip, the two expected to be able to distinguish features around 45 Angstroms (Å; 1 Å = 1/10,000,000,000 meter) in size. Instead they found that a protuberance on the tip allowed current to flow across an area of 2 Å — approximately the size of an atom — thus allowing, for the first time, an individual atom to be seen.



Thar's gold in them thar hills! This image from an STM made by Park Scientific Instruments, a Stanford licensee, reveals the atoms in a a sample of gold. (Photo: PSI)

For their discovery, Binnig and Rohrer were awarded the Nobel Prize for physics in 1986.

The STM found its way to Stanford when Scott Elrod, a student of Calvin Quate's, built one and wrote the first dissertation in the field, thereby establishing the first and foremost American research

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Stanford's Casper: Tech Transfer is a "Bodily Contact Sport"

So what does Stanford's new president, Gerhard Casper, think about technology transfer? Below are excerpts from Casper's opening remarks at the National Technology Initiative in Santa Clara, California, last October, which offer some interesting clues. An interview with Mr. Casper is planned for an upcoming issue.

"Ladies and gentlemen...I open this meeting with considerable trepidation as I am a mere lawyer. I have a strong suspicion that most people in this audience, if they had their way, would consider it a major "technology initiative" to do away with lawyers. Please accept me in my *new* role as president of Stanford University...

"...Technological development has been the single most important contributor to America's economic growth in this century. The transistor, the laser, and recombinant DNA techniques are just *three* American inventions from universities and industry within the past half century that have led to improvements in the quality of life and strong new business activity. The government-university-industry partnership has been a critical element in this success. This partnership has perhaps never been more important to the future of our nation's economic health and leadership than it is right now.

"Permit me a few comments from the university perspective about what I see as some major issues facing each sector.

"Let us look first at the Federal Government: The first step in technology transfer is the *education of people* and *basic research*...I believe the United States must remain committed to the support of original investigation of the first rank, and the investment in education and training that goes with it. We can readily purchase mediocrity, which will lead to

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STANFORD TECHNOLOGY BRAINSTORM

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OTL's services are available to any Stanford faculty, students, or staff who invent technologies which may benefit the public or be of commercial value.

To find out about a specific technology, or to disclose one of your own, contact us at the above address.

A Sampling of License Agreements Signed by OTL in the Last Quarter

Docket(s)	Title(s)	Uses	Company(-ies)	License Type
S74-043	"Cohen/Boyer Recombinant Technology"	DNA Cloning -- production of proteins	Elf Sanofi, Inc.; Prizm Pharmaceuticals	Non-exclusive Non-exclusive
S81-026	"Fluorescent Conjugates for the Analysis of Molecules and Cells"	Tagging and tracking molecules and cells	CLB (Amsterdam); Dako A/S	Non-exclusive Non-exclusive
S81-035 S83-042 S86-042	"MINOS" "NPSOL/QPSOL" "LSSOL"	Optimization Software Programs	Stanford Business Software	Total Exclusive to Sublicense to users
S85-103	"Novel Immune Modulators"	Treatments for T-cell Mediated Diseases	Immulogic Pharmeceuticals	Co-Exclusive
S91-126	"Deformable Grating Modulator"	Optical signal processing -- light modulation	Teledyne-Brown	Field Exclusive
S92-093	"Angiotensin II Modulates Proliferation of Vascular Smooth Muscle Cells..."	Treatment of Cardiovascular Disease	CV Therapeutics & Genta (Joint)	Field Exclusive
S92-108	"Identification of SNRPN Gene as the First Expressed Gene..."	Diagnosis of Prader-Willi syndrome	Oncor, Inc.	Field Exclusive

ARIM Technologies Taking Off

Continued from page 1

program in tunneling microscopy.

Envisioning applications for the STM far beyond microscopy, Stanford in 1982 applied for a broad patent covering the processes of making a molecular or atomic change on a surface and coming back to read that change — in essence, a memory device.

Current optical disk technologies store data bits about 2 microns (20,000 Å) apart. Some predict that with STM it will become possible to reduce that distance to 20 Å, thus increasing data density by a factor of one million.

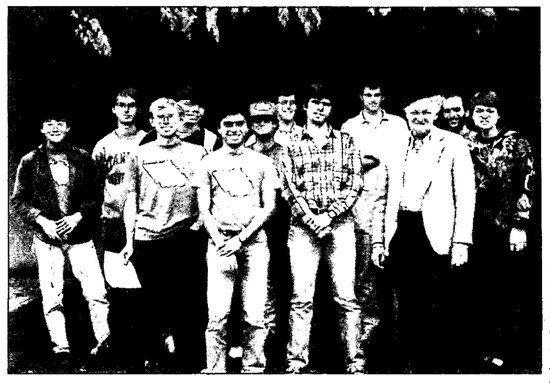
One Japanese company already expects to be able to store 1 Gigabit (1000 Megabytes) of information in one square centimeter by the year 2000.

Aside from increasing computer memory and speed, such storage abilities would also facilitate the digital storage of visual images, which require massive amounts of memory.

Thus, a future "filmless camera" may store large numbers of images digitally, allowing them to be shown on a high-definition television or taken on disk to a photo shop for processing.

Because of STM's ability to draw and read very fine lines, other applications include lithography, quality and process control, and other areas in which the accurate measurement of small dimensions is important.

Driven by such possibilities, several Stanford students have developed improvements to STM, including enabling it to better handle thermal fluctuations and vibrations, miniaturizing it, integrating it into one piece, and fabricating an "STM on a chip" — using conventional semiconductor processing to make 200 STMs on a 7.6 cm silicon wafer.



The "STM gang" -- some of the students who, according to Prof. Calvin Quate, have made ARIM happen. L to R (faces): Jun Nogami, Chris Lang, Tom Albrecht, Mehrdad Moslehi, Moris Dovek, Mike Kirk, John Foster, Lloyd Lacomb, Tom Van Zant, Quate, Rex Wright, Alison Lang.

According to Jon Sandelin, the Senior Associate responsible for licensing the ARIM technologies, OTL's original hope was to form a consortium among Stanford, the Government, and several companies to commercialize ARIM and protect the technologies for U.S. Industry.

Under the arrangement, Stanford would have licensed the basic patents to industry, Government agencies would have provided funds to companies for long-term research, and the companies would have worked together, sharing results in a "pre-competitive" phase of development.

The consortium would have also acted as a model for future development of other areas of technologies besides ARIM.

But in the end the Government, wary of being seen as developing industrial policy, declined participation. So Sandelin turned to a non-exclusive licensing program that has to date produced three American licensees and one Japanese licensee.

Sandelin says the American companies – Park Scientific Instruments, a Sunnyvale company started by two former Stanford students; Digital Instruments, an instrument company in Santa Barbara; and Topometrix, located in Santa Clara – have so far concentrated on supplying the microscopy and instrumentation market.

The Japanese (Olympus is the current licensee), however, tend to look toward the consumer electronics, memory, and other more "pie-in-the-sky" applications, which, like the filmless camera, may be several years away from commercial viability.

ARIM is a hot area. Sandelin says he's now discussing licenses with another American and two other Japanese companies. And research into new technologies and applications is ongoing.

As Charles Petit, a writer for the National Science Foundation, has written, STM has undergone a "profound metamorphosis" since its development:

"[STM's] have not only taken microscopy to the limit at which images become metaphors for the probability waves inside atoms," Petit wrote in 1989, but "they themselves are shrinking to the point where their users cannot see them without the aid of a microscope similar in power to that of the first lens applied by van Leeuwenhoek to a tiny drop of pond water three hundred years ago."

But while the STM keeps getting smaller, our knowledge, along with opportunities to apply that knowledge, keeps growing. ♣ *-EG*

Stanford's Casper: Tech Transfer a "Contact Sport"

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nothing other than more mediocrity. But excellence requires a long term investment.

"When the government funds university research, it is first of all investing in *people – students and scientists.* Graduates of research universities have probably a much larger impact on the economy than specific inventions created or discovered by those universities. The extensive use of graduate students in the conduct of university research as part of their training has helped to make the United States' basic research enterprise so outstanding.

"As Jim Gibbons, Dean of Stanford's School of Engineering, has said on several occasions, students trained at America's top research universities learn to think from "first principles" and arrive at "fresh conclusions." They acquire from their faculty mentors expectations of scientific breakthrough and a knowledge-base that are the hallmarks of Silicon Valley's success stories. They learn to be open to the possibility of regularly incorporating new ideas and new technologies as they become available.

"...The majority of these well-trained scientists and engineers transfer technology by taking their place in American industry. Their skills, honed in the research labs of our universities, are amplified in the industrial setting where they contribute to technology development, product design, and practical applications.

"...[Also,] the research projects funded by the government need to support the quest for *new* knowledge of fundamental properties and processes, regardless of the potential for application of that knowledge. We should not permit the government to fall into the trap of shifting resources to those projects which seem to have promise of immediate...payoff at the expense of basic research.

"It is frequently the scientific breakthrough that is neither foreseen nor planned that leads to new technologies. For example, in 1970, it would have occurred to few government or industry leaders that research in genetics was about to trigger a multi-billion dollar industry in the as-yet

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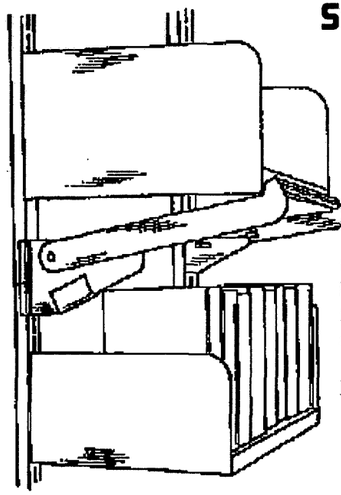
Seismoguard™ Licensed to Advanced Seismic Devices, Inc.



The Seismoguard™, reported in the inaugural issue of *Brainstorm* a year ago, has been licensed to Advanced Seismic Devices, Inc., of Freedom, California, and will soon be available for purchase and installation.

The Seismoguard™ is a self-triggering device for keeping library books (and potentially other items) from falling from their shelves during an earthquake.

For information contact:
Advanced Seismic Devices, Inc.
P.O. Box 1148
Freedom, CA 95019
(408) 663-5486

Stanford's Casper: Tech Transfer is a "Bodily Contact Sport" *Continued from page 3*

unheard-of field of "biotechnology."

"But the recombinant DNA patent, shared by Stanford and the University of California, is now the biggest commercial success ever licensed by the University. This single invention 20 years ago has led to an industry which has yet to realize its full potential....[And] the investigators were simply pursuing new knowledge, not application of that knowledge.

"As my former Chicago colleague, Merton Miller, the Nobel Laureate in Economics recently said in *The Wall Street Journal*, some basic research may not be worth very much in the long run, while some is worth a great deal. 'Though,' and I quote here, 'such is the cruelty of our fate that we won't know which is which until many years have passed.'

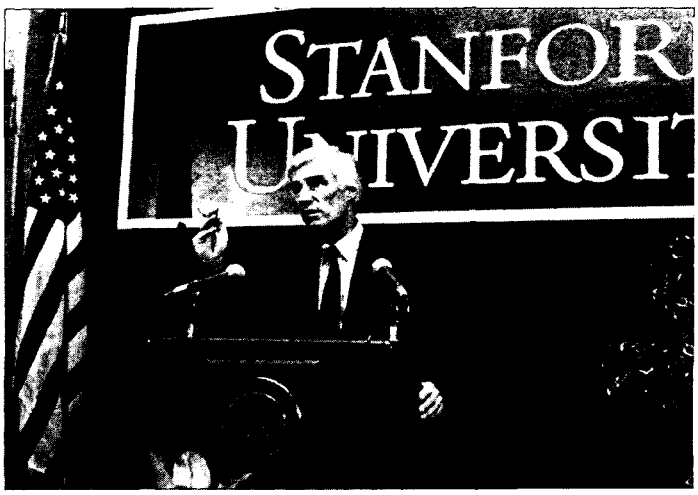


PHOTO: STANFORD NEWS SERVICE

Stanford President Gerhard Casper on a new theme: "Die Luft der Technology Transfer weht." The winds of tech transfer are blowing, in Casper's view, continued funding for basic research is crucial to keeping them blowing. His comments begin on page 1.

"...Another challenge facing Washington is the need to reduce the *layers of regulation* that make government contracting for both universities and industry a laborious, time-consuming, and wasteful process.

"The National Institutes of Health recently revised its proposal forms required to be used by universities. The old forms were estimated by NIH to take 10 to 15 hours to complete; the new forms are estimated *by NIH* to each take *50* hours to complete (aside from the technical components of the proposals, that is). What benefit will befall the public from requiring 50 hours to complete a single proposal, which, I might add, has less than a 1-in-5 chance of even getting funded?

"...I urge the government to simplify its relationship with research performers. It is not productive to try to solve the nation's ills through all of the regulations contained in government contract clauses. Good work and good institutions need a lot of breathing space. Please let us not imitate the worst aspects of European bureaucracy.

"Universities too have their challenges: We need to take whatever steps are necessary to restore public confidence in the integrity and relevance of American universities' research enterprises. In particular, we need to be accountable through self-regulation...

"While some parts of the government are urging stronger university-industrial ties to insure transfer of technology, other parts...are urging tighter restrictions on university-industrial relations to prevent conflicts of interest. *Universities need to solve these problems themselves.*

"...And the challenges facing industry? I am sure there are many of which I am not even aware. Nevertheless, I will make one observation: Looking at the past 20 years, it has been argued that many new technologies have been created in the United States, but that the *links from the invention to advanced R&D and marketing stages* have been weak, due in part to industries' short-term payoff strategies rather than long term investments.

"While American companies must be willing to make selected long-term investments...we recognize that industry cannot afford to make major investments in every new potential innovation.

"...*Universities may be able to play a role here* by involving industrial scientists more in university research activities, which, in turn, may help to give industry a longer-term view of scientific directions, processes, and strategies. Also, universities' curriculum and research could benefit from increased understanding of industry's needs and problems.

"...I encourage United States industry to consider this option...[Technology transfer] is a "bodily contact sport," the "rubbing of mind against mind" depending on person-to-person exchanges of ideas and information. To the extent that industry can send their best people to participate in university research programs, the better the chances are for technology transfer to occur on both sides.

"...In summary, let us all understand the distinct role of each of our sectors in technology transfer without micromanagement of each other. The R&D enterprise in American can easily be smothered by internal and external politics, pressures and red tape. Let us find ways to simplify our relationships with each other. And, most of all, let us find ways to increase trust in ourselves and each other."

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