



B STANFORD TECHNOLOGY BRAINSTORM

THE NEWSLETTER
OF STANFORD
UNIVERSITY'S
OFFICE OF TECHNOLOGY
LICENSING (OTL)

VOLUME 4, NUMBER 1
WINTER 1994-95

IN THIS ISSUE

OTL Looks to the
Heavens with
Promising New
Inventions from
Aero/Astro

We're Sending
them to Letterman:
OTL's Top 10
Cases, 1993-94

It's Official:
OTL's Final
Figures,
1993-94

3

"The Gates of OTL"
-- A Photo of the
Crew Reveals
Thinkers

4

Inventions Based on GPS Putting OTL in a Better Position

By Eric Grunwald

The plot is familiar: The pilot has a heart attack. The co-pilot is left unconscious by a hijacker, who is in turn sucked out of the hole in the fuselage. Only you, the inexperienced but heroic passenger, can step up and, with instructions from the control tower, land the jet safely, against all odds.

According to OTL Senior Associate Joe Koepnick, himself a private pilot, such movie endings have never been realistic. And, thanks to one of a series of recent inventions for high-precision positioning and navigation from Stanford's Department of Aeronautics and Astronautics ("Aero/Astro"), they may soon be completely obsolete.

The inventions are based on use of the Global Positioning System (GPS), a constellation of 24 satellites put in orbit around the earth two decades ago by the U.S. Department of Defense.

By obtaining and comparing signals from a number of GPS satellites, one can determine his or her position anywhere on earth (or in mid-air) to within approximately 100 meters.

But Stanford researchers, using additional sat-



PHOTO: STANFORD NEWS SERVICE

"What do you mean we have to turn off our video game?!" Researchers Stuart Cobb (l) and Clark Cohen on board a United Airlines jet during one of 111 automatic landings attempted (110 of which were successful) in order to test the GPS-based Integrity Beacon Landing System (IBLS).

ellites, ground stations, and calculations, have developed ways to enhance that accuracy and pro-

Continued on page 2

OTL Informational Meetings

Because OTL receives many requests from various people for information about the office and the licensing process, we have begun holding monthly informational sessions for both potential and current inventors and licensees. The meetings, consisting of a short presentation and a Q&A period, take place the third Friday of every month, 10:00 - 12:00, at 900 Welch Road, Suite 350. All are welcome at any session, but if possible, please call Maria Gladfelter in advance at 723-0651 to inform us you will be attending.

Date	OTL Presenter
January 20	Hans Wiesendanger
February 17	Joe Koepnick
March 17	Jon Sandelin
April 21	Kathy Ku
May 19	Luis Mejia
June 16	Mary Albertson
July 21	Mona Wan

Billboard's Top Ten was Never This Complicated

By Amy Forrest

The Office of Technology Licensing had another successful year in 1993-94, signing 136 new licenses and bringing in over \$38 million. Twenty-one inventions brought in more than \$100,000, ten at least \$200,000.

Following are brief descriptions of those ten, in descending order of income for the fiscal year, which ended July 31, 1994. The top invention brought in \$23.5 million, the tenth \$200,000. All but one of these inventions was disclosed before 1987.

• Cohen/Boyer Recombinant Technology "This is the premier biotechnology tool that spawned the biotech industry," says Floyd Grolle, licensing administrator for the three patents. "These patents describe a method for producing proteins utilized in human and animal therapeutics and

Continued on page 3



Inventions Based on GPS...

Continued from page 1

vide information useful in aviation and other areas.

For example, the Integrity Beacon Landing System (IBLS), developed by Research Associate Clark Cohen, is designed for automatic landings designated as Category Three.

These occur in poor weather and visibility and require positioning accuracy of less than two feet and an integrity (an industry measure for the safety of a system) of one failure in a billion airport approaches.

The IBLS, which uses receivers and transmitters (pseudo-satellites, or "pseudolites") the size of credit cards situated around the runway, as well as advanced avionics (aviation electronics) on board the planes, beats that accuracy requirement handily.

"The uncertainty in the position of the airplane lies inside the volume of a baseball," says Cohen. "If anything doesn't agree to a few centimeters, you know something is wrong," and the landing is aborted.

"The biggest challenge with GPS in aviation is to put a plane down on the numbers in the fog," says Cohen. "If you can do that, you can do anything." And, from recent flight tests with a United Airlines commercial jet, which successfully landed automatically 110 times in 111 approaches using the IBLS, it appears Cohen can.

And the 111th landing? "We actually think of that one as the most successful," says Cohen, explaining, "We don't plan for a genuine problem with the GPS to happen in a test flight, but about a minute before the landing, the Air Force shut down one of the satellites for maintenance."

The IBLS, detecting the problem, disconnected the autopilot and aborted the landing. The plane simply flew a "go around," then continued its tests.

Moreover, the Federal Aviation Administration (FAA) allows no more than two seconds between the time a problem occurs and the cancellation of a landing, and even that is considered very stringent. "We nailed it to within a quarter of a second," says Cohen proudly.

Since such high-precision accuracy and fast warnings are not necessary for better weather conditions, however, researchers have also developed other, less extreme enhancements of GPS. For example, a group led by Research Professor Per Enge is developing a system called "Wide Area GPS."

"Wide Area and the IBLS are two parts of the whole concept," says Enge. "The IBLS is a very localized application for very demanding situations. Wide Area is not as accurate, but it is wide." When completed, Wide Area GPS will involve six

A Sampling of Licenses Granted by OTL in the Last Quarter

Docket(s)	Title(s)	Uses	Licensee(s)	License Type
S74-043	"Cohen-Boyer Recombinant Technology"	DNA Cloning - Production of proteins Total number of DNA licensees: 304	Myriad Genetics; Helena Laboratories; Biogenesis, Inc.; Biofin, Inc.; Hyseq, Inc.; Darwin Molecular Corp; Biometra	Non-exclusive
S79-066, S83-007	"Mouse Anti-Human..." "Anti-Leu-12 Monoclonal..."	Tumor diagnosis; Cell differentiation	Novocastra	Non-exclusive
S82-011	"Monoclonal Antibody..."	Research reagents	Dynal	MTA*
S84-104	"Layered & Homogeneous Films of Aluminum..."	Semiconductors	Oki	Non-exclusive
S91-078	"Autoantigen(s) involved..."	IDDM Identification	Immulogic	Total Exclusive
S92-180	"Monoclonal Antibody..."	Protein purification	Boehringer Mannheim	MTA*

*MTA = Material Transfer Agreement

to eight additional satellites independent of GPS, as well as 20 to 30 ground stations across the continental United States.

Wide Area GPS is designed for situations from a Category One landing (breaking through clouds at 200 feet) up to more normal situations, such as non-precision approaches, flying in the terminal area, and en route navigation.

Joe Koepnick is currently negotiating a license to Wide Area GPS with a local company. He has also signed one license with Trimble Navigation for another GPS invention and has other licenses in the works. "GPS is definitely a hot area," he says. "There are a lot of inventions coming out of Aero/Astro, and there's a lot of interest from industry."

The GPS research program at Stanford started as an outgrowth of Gravity Probe B, an experiment led by Professor Brad Parkinson, who as a colonel in the U.S. Air Force was also instrumental in launching the GPS in the early 1970s.

(Parkinson, Enge, and Professor David Powell now comprise the triad of professors leading the Stanford research into GPS applications.)

Gravity Probe B is a spacecraft scheduled to be launched in 1999 to test in space Einstein's general theory of relativity. Thus, like many other successful inventions at OTL (i.e., recombinant DNA and FM synthesis), the first GPS inventions were the serendipitous by-products of basic research.

It was while testing the concepts behind the IBLS - namely, to align and orient Gravity Probe B - that Cohen got the idea to apply them on aircraft. "Research doesn't get any more fundamental than testing Einstein's theories," says Cohen, "but the pseudolite is a piece of technology that benefits the man in the street."

Since the initial inventions were recognized, funding for research into civil uses of the GPS has risen sharply, according to Enge. "In the last three years," he says, "the FAA has really begun to champion the use of the GPS in aviation," as have other organizations such as General Aviation, the Air Transport Association, and major airlines.

The reason for such support is simple, says Enge: "Because GPS will save the airlines money, and our airline industry needs the help." Moreover, he adds, "This is the best case I can think of for defense conversion: using a defense product for both military and civilian purposes."

Cohen explains that FAA support is important, because a GPS system is not the only one possible. Several countries have invested heavily in the Microwave Landing System (MLS), and at a meeting in March, 1995, representatives from several countries will choose a standard.

"The U.S. position is resoundingly clear [in favor of GPS]," says Cohen. Describing the various contributions and support from NASA, the FAA, Stanford, and the airline industry, he adds, "For the first time in recent history, everyone is pulling in the same direction. Industry, government, and academia are working together to make this happen."

"GPS is more market driven than anything else," Cohen continues, "and it has a large potential for growth. It can be installed for less in countries that now don't have a system." The current system, ILS (not MLS), costs more than a million dollars per runway. The IBLS, says Cohen, could cost as little as 10-20% of that.

In the long term, Enge foresees "a real revolution in air traffic control. It will take a while to see

Continued on page 4

Billboard's Top Ten was Never This Complicated

Continued from page 1

diagnostics. Also, recombinant research and development have recently yielded a variety of new plants applicable for food and fiber."

Cohen/Boyer is OTL's primary source of revenue and has grossed over \$100 million to date. The patents, which expire on December 2, 1997, are assigned to and administered by Stanford, though royalties are split with the University of California.

• **FM Sounds** "Yamaha's efforts made this method of synthesizing a musical sound into a de facto standard in the multi-media industry," says Senior Associate Joe Koepnick, adding, "The 20 million dollars this invention generated during its lifetime made it the second biggest moneymaker of all time for OTL." Unfortunately, the U.S. patent for this invention expired on April 19, 1994.

Koepnick says the FM technology will positively impact the future of music technology because royalties from the exclusive license to Yamaha funded Stanford's Center for Computer Research in Music and Acoustics (CCRMA); spawned what is expected to be one of the next big moneymakers for OTL, the "waveguide" technology; and supported the instigation of the Sondius™ trademark program.

• **Fluorescent Conjugates for the Analysis of Molecules and Cells** "Phycobiliproteins," as they are also known, are light-harvesting, fluorescent proteins found in blue-green and red algae. They can be attached to monoclonal antibodies which seek other "target" cells according to particular characteristics, such as surface enzymes, thus becoming fluorescent "tags" that can be used to analyze, detect, or separate molecules and cells.

These three patents are licensed non-exclusively to 40 companies and continue to generate interest. According to Senior Associate Luis Mejia, "Because the FM patent expired this year, and Cohen/Boyer will expire in 1997, unless a fantastic new revenue-generator suddenly appears, this technology will be Stanford's primary source of licensing income as of 1998."

• **Computer X-Ray Section Scanner** "This is the basic detector technology in Computer Axial Tomography (CAT) medical imaging," explains Senior Associate Jon Sandelin.

Although the U.S. patent expires in February, 1995, General Electric, the exclusive licensee, has broadly sublicensed in Japan and Europe, so royalties will continue while the foreign patents are in effect.

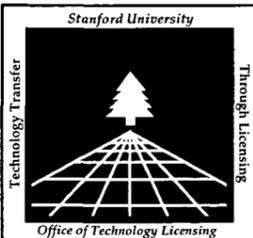
• **System and Method for Attitude Determination Using GPS** One of several inventions recently disclosed to OTL that utilize the Global Positioning System (see article, page 1). Licensed non-exclusively to Trimble Navigation of Sunnyvale.

Continued on page 4

OTL Fiscal Year 1993-94

Final Figures

- Invention Disclosures: 166**
- Patent Applications Filed: 84**
- Patents Issued: 60**
- Total Income: \$38.14 M**
- Cohen-Boyer DNA Patents:**
 - Total Income: \$23.48 M**
 - New Licenses: 62**
 - New License Income: \$0.43 M**
- All Other Technologies:**
 - Total Income: \$14.66 M**
 - New Licenses: 73**
 - New License Income: \$1.83 M**
- OTL Budget: \$2.1 M**
- Distributions:**
 - Departments: \$6.82 M**
 - Schools: \$6.82 M**
 - Inventors: \$6.82 M**
 - Other Institutions: \$10.95 M**
 - Dean of Research: \$2.8 M**



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Stanford Technology BRAINSTORM is published quarterly by Stanford University's Office of Technology Licensing (OTL) to provide information about OTL and general information of interest to the licensing community, both within and outside Stanford.

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

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

Inventions Based on GPS Putting OTL in a Better Position

Continued from page 3

how these inventions impact the way air space is managed, but it will be very interesting."

"The next really hot thing will be GPS for vehicles," he continues, explaining that while electronic car maps already exist in Japan, U.S. firms are "doing something wise," designing systems with audio cues and "heads-up" displays to reduce the dangers of looking back and forth between the road and map.

In the shorter term, one Wide Area satellite is already in orbit, another will be launched this summer, and four more will follow in 1996.

As for the IBLs, Cohen says that despite the successful tests, "It's still a brass board. It's not at the prototype stage at all."

He agrees with a United Airlines estimate that a full design will be ready in three to five years, though the FAA's estimate is by the turn of the decade.

Meanwhile, inventions based on GPS, such as the determination of angular velocity and the pseudolite used by the IBLs, continue to arrive at OTL.

But Koepnick is quick to point out that success in licensing is by no means assured. "In licensing we're always working in 'low-visibility conditions,' because there are so many factors that are out of our control," he says.

"My biggest fear is that the immediate success of our GPS-related inventions will hinge more on politics than technology. So it's premature to say they'll be successful in the aviation world during the lives of the Stanford patents. But since there are other commercial applications, the odds of success are increased." ▲

Billboard's Top Ten was Never...

Continued from page 3

• **Amplification of Eucaryotic Genes** A tool for enhancing production of recombinant proteins. Associate Mona Wan says, "Its utility improves as time goes on, and the eight non-exclusive licensees have put a lot into it to achieve such success."

• **Stanford T-Shirt Logo** The income from the 192 licensees to the Stanford logo varies greatly from company to company. Royalties go to athletic (40%) and non-athletic (60%) student scholarships.

"The vast majority of the licensed products are fairly traditional apparel," says Maria Gladfelter, manager of the emblematic licensing program, as it is called at OTL.

"We do get a few goofy, novelty-type items, though, that make the licensing fun," she says.

• **Variable Rate Selective Excitation Pulses for Magnetic Resonance Imaging** The only invention on the list created solely by a graduate student, it allows MRI's to be performed at lower power levels.

"This has obvious economic benefits and is also important for health reasons because lower energy levels mean less radiation exposure to the patient," explains Jon Sandelin.

• **Anti-Leu-1 Monoclonal**

Antibody and Anti-Leu-12 Monoclonal Antibody Hans Wiesendanger, the Senior Associate responsible for licensing these two unpatented mouse antibodies, says that "although they've taken some time to reach a high level, royalties generated from these licenses prove there is a good market for research reagents." ▲



PHOTO: KIM BUDD, VISUAL ARTS SERVICE

There's irony here, somewhere: the OTL staff in front of Auguste Rodin's "Gates of Hell" on campus. Back row, l to r: Adam (in bronze), Kevin Nash, Mary Albertson, Floyd Grolle, Brian Kissel, Eric Grunwald, David Guerrero, Sandra Bradford, Antje Ackermann-Isaac, Mona Wan, Hans Wiesendanger. Front row, l to r: Luis Mejia, Kathy Ku, Joe Koepnick (prone), Celeste Beirne, Amy Forrest, Evelyn Mazzanti, Maria Gladfelter, Sally Hines, Jon Sandelin. Not shown: Kay Ankerbrand, Maggie Feinstein, Brenda Martino, Jeff Payne.



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