SPACE TECHNOLOGY HALL OF FAME PROGRAM

In 1988, the United States Space Foundation in cooperation with NASA, established the Space Technology Hall of Fame. Its purpose is threefold: to honor the innovators who have transformed technology originally developed for space use into commercial products; to increase public awareness of the benefits of space spinoff technology; and to encourage further innovation. Each year, aerospace spinoffs, which have significantly impacted American industry and society, are reviewed for induction into the Space Technology Hall of Fame. To date, 27 technologies have been inducted while just over 100 organizational innovators and nearly 300 individual innovators from NASA and the private and public sectors have been recognized.

Each year, nominations are sought for technologies to be inducted into the Hall of Fame. The selection process is rigorous and objective. Each technology is written up using a standard one page format for consistency of style and content to enable an objective judging. Then each nomination is evaluated against a well established set of criteria.

The final selection of the technologies to be inducted is made by a preeminent panel of Americans from all walks of life. Some of the past judges include the Honorable John Glenn, astronaut and member of Congress; Fred Abatemarco, editor-in-chief, Popular Science Magazine; Norman Augustine, Chairman, Lockheed Martin Corporation; the Honorable Lionel Johns, former associate director for technology, White House Office of Science and Technology, Captain Eugene Cernan USN (Ret), astronaut; and Lon Rains, editor, Space News (a full listing appears on page 62 – 63). The selection criteria utilized by the judges are: Economic Benefit, Partnerships, Public Awareness Impact, Societal Benefit, Diversity and Longevity (explained on page 7).

After the judges make their recommendations, due diligence is performed on the highest rated technologies. The primary purpose of this effort is to identify every individual who made a significant contribution to the innovation so that all can be acknowledged. At a special dinner attended by several hundred aerospace and business executives, public officials, media and others, the selected technologies are inducted into the Space Technology Hall of Fame. The innovators are recognized during the induction ceremony held at the United States Space Foundation's National Space Symposium, the premier annual gathering of space policy leaders. Leading innovators receive a commemorative medallion in recognition of their achievement.

Plaques recognizing each inducted technology and the respective organizational innovators are on display at the United States Space Foundation in Colorado Springs, Colorado. An Internet website for the Hall of Fame is under development and may be accessed at www.ussf.org.

UNITED STATES
SPACE FOUNDATION

SPACE TECHNOLOGY HALL OF FAME SELECTION CRITERIA

Economic Benefit

The economic activity resulting from the technology. (i.e., Has the technology been the basis of, or a significant contributor to, a successfully selling product and/or generated a new growing company?)

Public/Private / Partnership/Investment

The significance of the development efforts. (i.e., Was the initial development effort an example of a significant partnership between the government and the private sector, and/or did the transformation of the space technology to the market version require significant commitment and investment by the private sector?)

Public Awareness Factor

The technology's public appeal. (i.e., Can the spinoff application be easily grasped by the general public, does it have promotional value in highlighting the benefits of space?)

Societal Benefit Factor

The important societal benefits offered by the technology. (i.e., Has the technology been shown to significantly contribute to the larger society apart from its space applications?)

Application Diversity

The breadth of use of the technology. (i.e., Has the technology been used in multiple products/applications or a singular use?)

Longevity

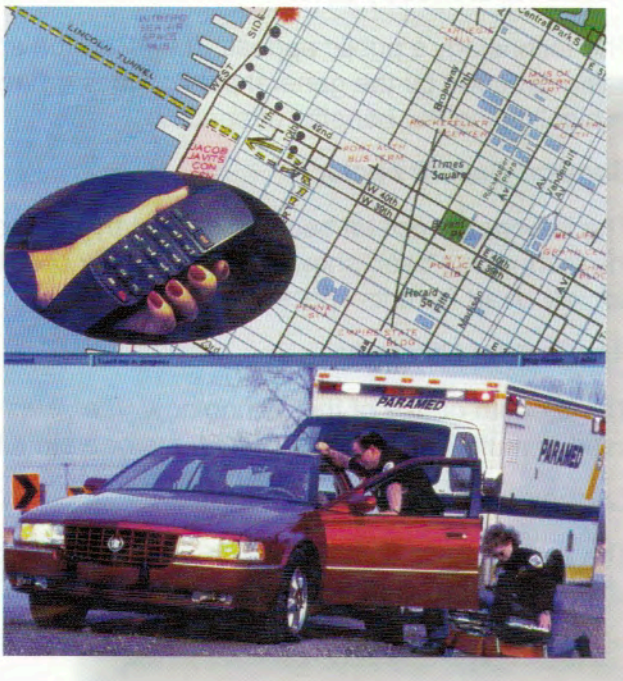
The technology's commercial life. (i.e., How long has the technology and/or its application been successfully in use?)

Inducted 1998

GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) program began in 1973 when the U.S. military services and the Defense Mapping Agency combined resources to develop a highly accurate space-based navigation system. Functions not originally envisioned, such as communications system synchronization, search and rescue, precision approaches and landings, and GPS-assisted munitions, have come into common usage within the military community.

GPS is managed by the NAVSTAR GPS Joint Program Office at the Space and Missile Systems Center near Los Angeles. This multinational organization develops, acquires, and sustains the 24-satellite constellation, a worldwide satellite control network, and more than 120,000 receiver systems that provide positioning data and other services to users worldwide. As a dual use (military and civil) space-based radionavigational signal jointly controlled by the Department of Defense and Department of Transportation, Headquarters Air Force Space Command champions GPS requirements from concept to capability to meet validated and approved civil and military needs.



This includes maintaining the Standard Positioning System (civil signal) and the Precise Positioning System (military and authorized signal) on a continuous, worldwide basis.

Ever-growing commercial applications increasingly impact everyone as this technology continues to mature. These ever-expanding uses include applications in land, sea and air transportation; surveying and geodesy; mapping, charting, and geographic information systems; geophysical applications; meteorological applications; agriculture; scientific research; and recreational uses.

INNOVATORS

General Dynamics Corp.

John Hopkins University, Applied Physics Laboratory

Magnavox

Naval Research Laboratory

NAVSTAR GPS Joint Program Office, Space & Missile System Center

Rockwell-Collins

Rockwell International

Texas Instruments

The Aerospace Corp.

U.S. Army Yuma Proving Ground

CONTRIBUTING INDIVIDUALS

Dr. Malcolm R. Currie

Roger L. Easton

Col. Gaylord B. Green

Dr. Ivan A. Getting

James R. Henry

Dr. Richard B. Kerschner

Walter C. Melton

Dr. (Col.) Bradford Wells Parkinson

Richard Schwartz

Inducted 1998

TEMPER FOAM

A NASA research program aimed at improving crash protection for airplane passengers gave impetus to the development of a cushioning material that is now used in Space Shuttle seats as well as in many commercial applications.

With the idea of developing a new airline seat to provide better impact protection and comfort during long flights, NASA Ames Research Center developed an open-cell polyurethane-silicon plastic foam that takes the shape of impressed objects but returns to its original shape even after 90 percent compression. There is no shock or bounce on sudden impact; a three-inch foam pad has the ability to absorb the impact of a 10-foot fall by an adult. The foam is temperature-sensitive, softening as it warms and getting firmer as it cools. By distributing body weight and pressure evenly over the entire contact area, this material offers better impact protection in an accident and also enhances passenger comfort on long flights.

Commercial application was initially developed by one of the inventors

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Einstein

Continued

nuclei, while the General tried to explain gravity.

However, the two theories conflict with each other, and Einstein spent the rest of his life trying to find a unified theory.

Gravity Probe B will test two predictions of the General Theory: that the presence of a mass in space, such as Earth, would warp local spacetime; and that the rotation of a mass in space would twist, or drag, the local spacetime frame around it.

The Gravity Probe B spacecraft will use four gyroscopes so precise, they can measure a change in spin axis alignment to 0.1 milliarcsecond – equivalent to the width of a human hair as seen from a distance of 100 miles.

Put another way, the anticipated spin axis drift for the frame-dragging effect is 42 milliarcseconds. If you climbed a slope of 42 milliarcseconds for 100 miles, you would gain 1 inch of altitude.

Even the launch itself had to be timed to the second.

"As the Earth rotates, there are guide stars out there," Green explained. "We had to launch when the Earth was under a specific star (IM Pegasi) so it would be exactly in the plane of that star."

There is a one-second window of opportunity to do so each day.

Gravity Probe B was launched on the second day that everything was in place.

The experiment was first proposed by George Pugh and a Stanford physicist, Leonard Schiff, 10 years before man even walked on the moon. NASA first funded Gravity Probe B in 1964.

It has taken four decades of scientific and technological advancement to get it off the ground.

If it corroborates the two predictions, it will have provided crucial evidence that it will impact all of physics.

After the spacecraft has been in orbit for two months – it's 22 days into its mission – it will begin the scientific end of things and collect data for 13 months.

"We want to go for 12 months so that the Earth can orbit the sun," Green said, "and then one more month so that we overlap, and can check our figures. If you're going to tell the world Albert Einstein was wrong, you don't want to screw it up."

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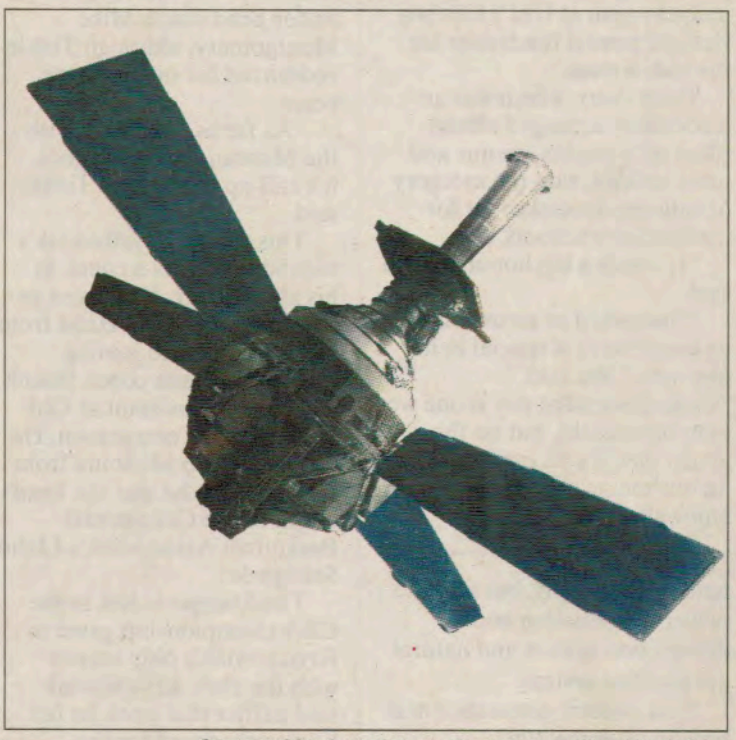
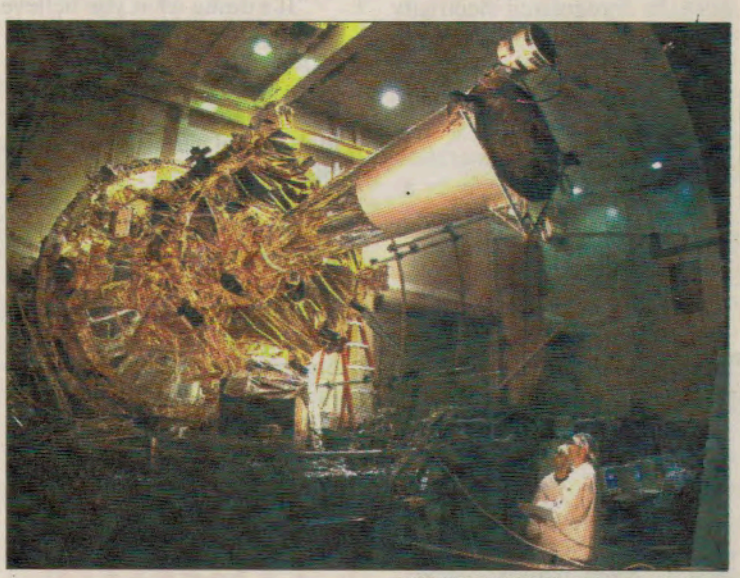
– Gaylord Green



Courtesy of Stanford's Katherine Stephenson, Lockheed Martin Corp.

A collage of images edited to form the completed space vehicle.



RUSS UNDERWOOD/Lockheed Martin Corp.

The completed space vehicle undergoes thermal vacuum environment testing before launching.

Prior to this mission, Green was instrumental in the development of the Global Positioning System.

Green, who grew up on a ranch (his father, Ralph, now lives in Florence), says ranch life helped prepare him for his career.

"You get your own set of engineering know-how on a ranch," he said.

After high school, Green attended the Air Force Academy, graduating in 1964. He earned a master's degree from Stanford University in aeronautics and astronautics in 1965.

During a long Air Force career, he was on the team that developed GPS. He remembers turning his living room into a mockup of space, positioning a globe, hanging model satellites from the ceiling and then playing the sun himself.

"It was 1972, and we really didn't have computers to speak of," Green said. "It was difficult to envision, everything rotating, the satellites, the Earth, so that was one way to do it."

He retired as a colonel in 1988 and started his own company, NavAstro, now a $4 million-a-year business and a key player in Gravity Probe B.

"When I was graduating from Superior, they gave us a battery of tests, and I scored high in science, so that's what I did," Green said.

He also established a scholarship now worth $8,000 over four years for seniors graduating from Superior or St. Regis – where Green would have gone to high school had the family not moved to Superior after his sixth-grade year – who are interested in pursuing a scientific career.

Superior High alum looks to test Einstein's general theory of relativity

by John Q. Murray

Just as the first measurements of the speed of light led Einstein to develop his theory of relativity, a Superior High School alumnus is hoping that his team's measurements of gravity bending space-time will lead future physicists to improve on Einstein's work.

"Today we know that Einstein does not explain the universe in which we live," said Gaylord Green, the director of the Gravity Probe B satellite project.

Gaylord, who graduated from Superior High in 1958, said his team is concluding a project almost four decades in the making, and one that has consumed the last 18 years of his working life.

"Einstein predicted that space-time is curved, so the satellite is designed to test that theory by measuring the curvature of space as caused by the earth's gravity. Because the earth rotates, it should drag space-time with it," explained to the *Chronicle* this week.

The satellite has finished collecting all its data, and now the project is in its final, analysis phase, he said.

After Gaylord's team finishes processing its data in about 11 months, the results will show either that Einstein was right or Einstein was wrong, he said.

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Gaylord Green, center, accepts his second Space Technology Hall of Fame award at the 2006 induction banquet. His first award was for the development of GPS technology, and the 2006 award was for an advanced application of that technology--auto-driving tractors, developed at

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Einstein

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The results could lead to the next great leap in physics, he suggested.

The Michelson-Morley experiment, which showed that the speed of light was a constant in every direction, led Einstein to revise the physics of his day. Up until then physics had been dominated by the work of Sir Isaac Newton. Einstein showed that Newton's gravity was just a special case of a broader theory—Einstein's theory of relativity.

Similarly, the Gravity Probe B satellite's measurements—showing exactly how much space-time is curved—could help physicists build a new model that represents our next step in understanding the universe, Gaylord said.

It would cap quite a career for the kid from the Broken Heart Dude Ranch who started school in the one-room schoolhouse in Haugan.

"Mrs. Cosgrove was my teacher," he recalled. "We had eight to 13 kids in first through eighth grades. She had the younger students on the right-hand side of the room and the older students on her left-hand side. You started out on the right-hand side of the room and worked your way up through."

One year, he recalled, the class consisted of seven boys and his sister.

They moved to Howie Miller's ranch on west Mullan Road, and he attended Superior High School. There he recalled studying physics from Mr. Clyde Fields and playing for the Bobcats. "I always liked football and math and science," he said.

After graduating, he accepted a nomination to the Air Force Academy in Colorado Springs from Sen. Lee Metcalf. He obtained advanced degrees from Stanford in aeronautics and astronautics and worked at the Space Division (now the Space Missiles Center) in Los Angeles.

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stein

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companies and con-
adopt it. "It was like
ning of TV," he

explained. "You couldn't get people to buy TV sets because there were no TV stations, and you couldn't get anyone to invest in a TV station because people didn't have TV sets."

Even the military didn't at first see the need for GPS. Until the first Gulf War, that is. When the tanks were out in a desert of shifting sands, with no landmarks, the GPS devices came in handy. "They had all these handhelds I'd gotten for the troops and they opened up a tank to get a fix from the satellites," he recalled.

The accuracy of the system was almost a problem, too, he recalled. The Navy Seals used the GPS—accurate to within a foot—to set a rendezvous point after completing a mission. The mother ship dropped them on the beach, and they completed their mission and returned to the assigned location. The mother ship came to pick them up at the exact same point, and almost injured some of the Seals. "That's when we learned to assign multiple rendezvous points," he recalled.

The technology has been adopted by car manufacturers, and he confided that as the inventor he feels compelled to always have a car with a GPS location system in it, "because it would be too embarrassing not to have it."

One of the more recent interesting applications is for farming. Stanford students put GPS on tractors, which allow farmers to d
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Often found at skydiving school — DROPOUTS

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7	4	3	1	9	6	8	5	2

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Einstein

Continued from page 11

which has involved all of physics. "It's been a lot of fun," he said.

Now that the scientific data collection is complete, Gaylord is seeking to turn the ongoing operation of the satellite over to students—cadets from the Air Force Academy. That decision will be made in July, he said.

Meanwhile, he is also seeking to encourage other Mineral County high school students to combine their entrepreneurial skills by sponsoring a scholarship of $2,000 for each of their four years.

The first scholarship was offered this year to St. Regis student Angela Hetchler. Science teacher Chris West offered students the opportunity to either write a paper or develop a business plan for the scholarship.

"The students have to have to do a little bit of work on the science area to qualify and then come up with a business plan suitable for Mineral County," he explained. They then just have to maintain a B average in their major, whatever their major is. The idea is to encourage entrepreneurs in Mineral County.

Those kinds of thinking skills come in handy when you're spending a million dollars a day managing projects for the Air Force and NASA. Those are the kinds of skills that he wants to pass along to other students getting their start in Mineral County.

And, the *Chronicle* suggested, perhaps he could also help the students in Mineral County get a jump on the next generation of physics research. Would he reveal whether the preliminary data showed that Einstein was right or wrong?

"That's the result you've got to wait a little longer for," he laughed. "But you can clearly see the curvature of space in the data."

The project team posts regular updates on its website at einstein.stanford.edu.

The *Chronicle* hopes to follow the team's progress and pass along the final results when they are available.

the longest-running project a
NASA— needed a satellite, b
NASA wouldn't give them o
unless they found someone
capable of managing the proj

Even after they hired Gaylord, the project was so advanced and complex that NASA was afraid to launch it he said.

"They didn't want it to fa
You could come up with three
possible results: Either Einstei
was right, Einstein was wrong
or the satellite didn't work rig
They were very concerned tha
they would wind up with egg
their face," he said.

The project had multiple phases, expanding from the physicists during the design phases in the 1960s up to a pea
of a couple hundred people while building the satellite and shrinking back down to about 20 people during the current analysis phase.

Between 80 and 90 PhDs were awarded on the project,

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