

A large, artistic microscopic image of red blood cells, showing their characteristic biconcave disc shape. The cells are rendered in vibrant red and orange tones against a dark background. The image is split vertically, with the left side being more saturated and the right side fading into a white background where the text is located.

Beyond Measure

A Profile of ATP Health Care Investments



NIST
National Institute of
Standards and Technology
Technology Administration
U.S. Department of Commerce

Fueling economic growth

More than half of U.S. economic growth depends on advances in technology. We'd live in a different and less prosperous nation without them. NIST's Advanced Technology Program (ATP) helps to fuel the engine of economic growth by providing vital funding for high-risk, enabling technologies.

From its inception in 1990 through July 2003, ATP has awarded \$2 billion in funding to companies for 665 innovative projects. Industry matched this funding with \$1.9 billion in cost-sharing. Half of the projects funded in this time frame have been successfully completed. Many more are in the works. ATP's portfolio of investments to date is expected to return at least \$15 billion in benefits to the American people, delivering broad quality-of-life improvements, consumer savings, and productivity gains, adding to Treasury receipts (through taxes), and spurring whole new industries.

ATP's unique and vital role

It takes capital to turn ideas into new products and industries. Yet for many high-risk initiatives, initial investments will not be recovered for years or even decades, making them unattractive to private-sector companies. New ideas often fall into a "valley of death" between basic research and product development, a void where risk aversion and a resulting lack of investment capital kills innovations.

ATP funding plays a critical role in bridging this investment gap. With venture capital firms, state governments, and universities contributing only 8 to 16 percent toward early stage technology development, federal programs, such as ATP, account for between 21 and 25 percent. By sharing the costs of innovation, ATP catalyzes private-sector investment and risk-taking.

New products benefit the economy

Various studies show that of the first 50 ATP projects completed, 80 percent brought new products or processes into the marketplace and many delivered far-reaching benefits to our society (see www.atp.nist.gov/eao/sp950-2/contents.htm). Consider a few examples: a data storage technology that could return \$3.7 billion in consumer benefits; flow-control machining that is expected to increase returns in the auto industry by \$142 million annually; and, component-based software projected to yield \$840 million in public and private returns. These projects have also spurred company growth and job creation. Three out of five small, single-applicant companies have at least doubled in size, and 13 percent have grown by more than 1,000 percent. The bottom-line: The projected economic impact of a handful of these early ATP projects would pay for every ATP project funded since 1990.

Putting private-sector ingenuity to work

ATP partners with companies of all sizes as well as universities and non-profits, encouraging these organizations to take on and overcome national technical challenges that they could not or would not accept alone. In this way, ATP seeks to reap major potential benefits for the nation—benefits that extend well beyond the participating organizations themselves to broad applications that benefit society.

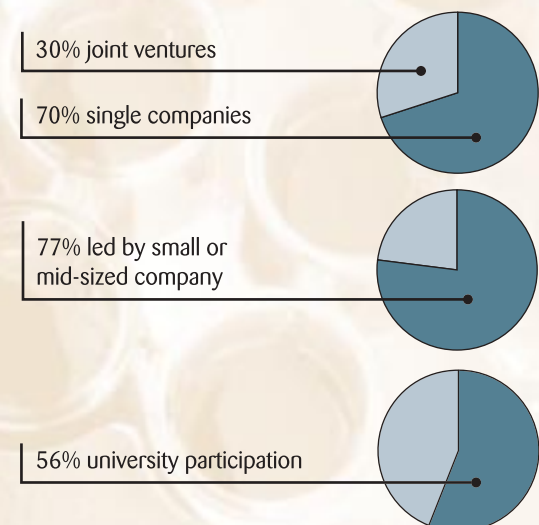
ATP accepts proposals in all industries and fields of science and technology, and awards funding as the result of open, peer-reviewed competitions. In 43 competitions through June 2003, 665 winning projects have been selected from 5,587 proposals. Proposals are evaluated by one of several technology-specific boards that are staffed with experts in particular fields. Proposals are assured an appropriate, technically competent review even if they involve a broad, multidisciplinary mix of technologies. Awards are made based on high-risk technologies that:

- Extend their benefits well beyond the companies involved in the project.
- Have broad potential applications, particularly across different industrial sectors.
- Open new potential markets or make possible wholly new products or industrial processes.

The six innovative health care technologies profiled in this brochure represent the mission of ATP, to bridge the gap between the research lab and the marketplace, stimulating *prosperity through innovation*.

ATP at a Glance

665 projects funded from 1990 to July 2003, resulting in 800 new patents. At the time of award,



To innovate or not to innovate?

What would have happened without ATP funding? In many cases, innovation would have been slower or nonexistent. A survey of companies that submitted non-winning proposals to ATP in 1998 reveals that over 60 percent did not proceed with their proposed projects in any way. Of the rest, about 30 percent went ahead on a smaller scale. Similarly, a 1990-1992 survey of awardees indicates that 70 percent would not have pursued technology development in the absence of the ATP award.

Time-to-market, a critical success factor for new technologies, also suffers without ATP funding. Surveys from 1993 to 1998 indicate that ATP funding accelerated the R&D cycle for nine out of ten awardees. Reduction in time-to-market by two years or more is anticipated for about 60 percent of planned commercial applications by ATP awardees.

Beyond Measure

A profile of ATP health care investments

The most hopeful news in health care today springs from new technologies. Scientists are unraveling the genetic origins of disease. Surgeons are better informed and prepared, thanks to new virtual reality simulations. Diagnoses are more accurate because of new digital imaging technology. Burn victims are recovering faster through tissue engineering.

These breakthroughs and others in U.S. health care can be traced to the Advanced Technology Program. Through the funding of early-stage technology development, ATP, an arm of the Department of Commerce's National Institute of Standards and Technology, is helping to advance technology in the field of health care.



Since its inception in 1990, nearly \$1 billion has been invested in health care, with ATP's share more than \$523 million and another \$465 mil-

lion cost shared by industry. Private companies, often working in joint ventures with universities, seek out ATP awards for critical early R&D—often deemed too risky for other investors—but where the potential payoff to society is high.

One-fourth of ATP investments are in health care, and some of the era's most important health advances—DNA diagnostic tools, telemedicine, and tissue engineering, among others—trace their origins to young companies that opened frontiers with ATP funding.

The projected economic benefits from just a few ATP successes would pay for every ATP project funded since 1990, measured in dollars to the U.S. Treasury, and result in hundreds of products and processes, and in broad social benefits. One project alone—new prosthesis technology for repairing damaged knee

ligaments—is expected to deliver more than \$100 million in net benefits, according to ATP analysis.¹

The value to humanity is difficult to measure. What is it worth, for instance, for a senior citizen to be able to remain in the familiar surroundings of home instead of moving to an assisted-care facility?

An automated system called the Independent LifeStyle Assistant™ (I.L.S.A.), under development by Honeywell, Inc., monitors the senior at home, noting activity level and whether medications have been taken on schedule. I.L.S.A. uses a variety of sensors, wireless communications devices, and servers located throughout the home. I.L.S.A. can remind the senior to take medication via telephone message or wireless web screen. The system maintains privacy—no cameras are used and communication is secure—and yet it can alert a third party, such as an adult child, when assistance may be required.

Advances such as Honeywell's I.L.S.A. have the potential to prolong independence and reduce costs for a rapidly growing part of society. It also frees up time for caregivers and provides peace of mind that the person is safe.

This and other breakthroughs in health care nurtured by ATP may improve quality of life for many by applying technology to very human problems.

Here is a snapshot of how ATP awards are expanding the boundaries of health care research across a wide range of topics.

Revolutionizing molecular medicine

Accurately diagnosing illness can be a slow process with many tests and hit-or-miss treatments that are refined slowly over time.

The innovation: An integrated system will acquire, analyze, and manage complex genetic information to provide rapid and accurate diagnoses of a wide variety of diseases using DNA biochip technology.

In the past 10 years, more than 45 ATP awards have supported the development of diagnostic tools used to isolate and evaluate genetic information. Indeed, ATP has been called the “Godfather” of the DNA diagnostic tool industry.² Developments include production of a nucleic acid microarray, a microfluidic system, an informatics package, and an integrated platform that offers faster and cheaper methods of producing genetic data on a routine basis.

In one example, ATP funded a joint venture between Affymetrix and Molecular Dynamics (now Amersham Biosciences) to develop miniaturized, integrated devices to perform sample preparation for genetic analysis. The ATP award has been in part responsible for the development of DNA-chip-based assays that are revolutionizing the study of biology at the molecular level. These chips are allowing researchers to more rapidly understand the molecular basis of disease, to diagnose different kinds of diseases that until recently were very difficult to identify, and to determine personalized, therapeutic regimens to treat disease.

The DNA chip created by Affymetrix has revolutionized the clinical analysis of genetic data and is expected to be routinely used

¹ Sheila A. Martin et al., *A Framework for Estimating the National Economic Benefits of ATP Funding of Medical Technologies* (NIST GCR97-737 April 1998).

² Neil Swan, “Smaller U.S. Firms More Aggressive with Federal Grants,” *Nature Biotechnology* 16 (December 1998): 1306.

in hospitals and doctors' offices, allowing physicians to prescribe highly personalized treatments. For instance, bacteria identified by a particular DNA fingerprint may be treated with a highly targeted antibiotic—without exposing the patient to unnecessary and perhaps even harmful drugs.

Perfecting surgical techniques

Surgeons today are limited to practicing critical new procedures on cadavers or animals, a less-than-ideal situation.

The innovation: Just as flight simulators help airline pilots to practice and perfect techniques, new virtual reality software and computer simulations allow surgeons to rehearse specific operations.

Immersion Medical, Inc., of Gaithersburg, Maryland, has designed a virtual reality surgical simulation that allows surgeons to rehearse procedures using patient-specific data. Using its AccuTouch® Simulation System, a surgeon can practice, for example, an endoscopy on a virtual patient—a computerized head-and-shoulders dummy programmed to mimic the true patient's characteristics and symptoms, such as the location of a tumor or the size of an arterial blockage. More sophisticated than a virtual reality video game, the system mimics the feel of the patient for the practitioner; it even groans like a sedated patient.

The technical challenge of mastering the requisite algorithms, video compression, and graphic display made this a high-risk project, but one with a clear, broad economic benefit. The simulation improves training and quality of care, while reducing training costs. Physicians can simulate many more complications and view a much wider range of pathologies than they would encounter in the field.

More broadly, the surgical preparation technology project is one of many ATP awards in the area of health care informatics, wherein the creative use of data is helping to slash health care costs while improving delivery.

The area of health care informatics has seen many other recent advances thanks in part to ATP funding, including the automation, validation, and distribution of clinical practice guidelines; the automation of clinical notes and the production of a database of codified clinical data; an open architecture to interface between independent health care information systems; and tools to develop a master patient index.

Detecting, diagnosing, and treating disease

The lives of millions of Americans depend on the precision of medical images used to detect and diagnose cardiovascular disease and cancer.

The innovation: New imaging technologies are allowing physicians to see diseases earlier, diagnose them more accurately, and provide minimally invasive treatment options to patients in lieu of major surgery. Because of an all-digital amorphous silicon (a-Si) based technology developed by General Electric (GE), physicians at hospitals across the nation now have access to images with unprecedented detail and clarity. This technology converts X-ray signals into digital images at the point of acquisition to produce images that give physicians a new level of clinical accuracy.



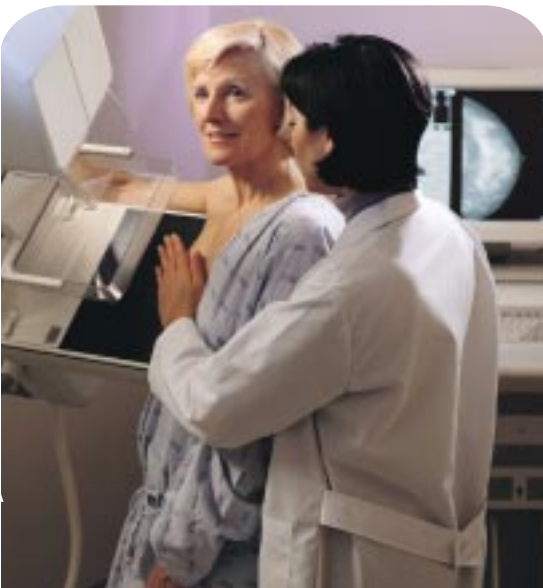
Virtual surgery simulation technology enables surgeons to rehearse specific procedures for individual patients, improving preparedness and reducing error.

GE's breakthrough imaging systems for cardiovascular disease and oncology come at a time when the number of cases diagnosed has reached new heights. One in five American adults experiences some form of heart disease, which is the leading killer in the United States according to the American Heart Association. Nationwide, one in four people who die this year will do so as a result of cancer, which is the country's second leading killer according to the American Cancer Society.

ATP has helped enable all-digital imaging, which will have a significant impact on cardiovascular and cancer-related patient care by reducing cost-prohibitive barriers to designing and manufacturing the technology. The number of processing steps has been cut significantly, improving yields and ultimately lowering the cost of manufacturing the digital imaging systems. As a result, digital imaging technology is proving to be a valuable, cost-effective medical tool that is expected to make conventional film-based imaging obsolete.

ATP support was a catalyst for the technology infrastructure needed to transition GE's digital detector technology to PerkinElmer's manufacturing facilities, where the digital detectors are produced. The ATP project infrastructure played an important role in accelerating GE's a-Si digital imaging technology, which is being rapidly adopted nationwide in the digital transformation of health care.

Putting this technology in the hands of thousands of physicians is a critical step in the fight against cardiovascular disease and cancer. The company plans to expand its all-digital, medical imaging portfolio to address a broader range of disease states in the future.



The Senographe® 2000D Full-Field Digital Mammography System is becoming more affordable and may soon replace standard film-based X-rays for breast cancer detection.

Photo: Courtesy of GE Medical Systems

Repairing heart muscle

Cardiovascular disease is America's No. 1 killer. More than 60 million people have some form of heart disease, according to the American Heart Association.

The innovation: Osiris Therapeutics, Inc., a Baltimore, Maryland firm, is looking at ways to repair damaged heart tissue using adult stem cells derived from bone marrow.

Stem cells are essentially primordial cells of a person, capable of becoming many of the 210 different kinds of tissues in the human body—from bone to cartilage to skeletal muscle. Stem cells are of particular interest in heart research because the cardiac muscle typically has limited capacity for self-repair. Osiris researchers are harvesting adult mesenchymal stem cells (MSC) from bone marrow, and developing therapies based on the in situ differentiation of the mesenchymal stem cells in the body. Short of becoming cardiomyocytes, the MSCs still seem to have benefit. Implanted in the heart, MSCs improve function to damaged heart tissue. The challenge is to optimize the culture and conditions that induce the best maturation into cardiac muscle.

It's an exciting, novel approach that pushes the boundaries of tissue engineering. In contrast to typical tissue engineering projects involving implanted materials, the MSCs undergo their transformation inside the body. In Osiris animal studies, heart tissue is already showing strong signs of regeneration.

As occurs in many ATP projects, Osiris is conducting the work with university researchers—in this instance from Johns Hopkins University, the University of Florida, and Emory University. More than one-half of ATP awards include a university researcher among the principals, which speeds the dissemination of the new technologies across the field.

In March 2003, Osiris Therapeutics and Boston Scientific Corporation initiated a strategic alliance to develop and commercialize a new therapy to treat cardiovascular disease by administering adult MSC technology to patients who have suffered a heart attack.

Fingerprinting blood

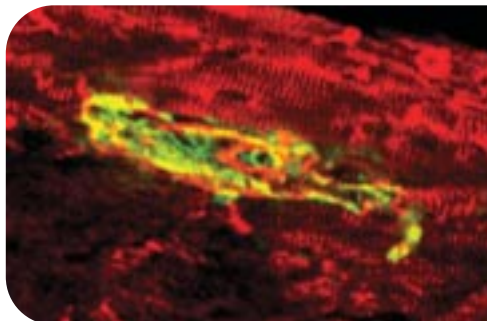
About 1,500 people die every year from ineffective blood screening techniques that lead to transfusions of mismatched or infected blood.

The innovation: SurroMed, Inc., a biotech company, is developing an exceptionally powerful biological assay tool for on-the-spot testing of blood, or "blood fingerprinting."

Currently, tests are performed on the 13 million units of whole blood donated every year in the United States to keep the blood supply safe. Limitations associated with these tests may contribute to additional health issues. With nanotech partner Quantum Dot Corporation, SurroMed is casting a wide net to search for relevant molecular markers of disease in the blood, thereby continuing to expand the safety of donated blood products.

SurroMed's breakthrough technology, called blood fingerprinting, uses laser scanners to identify specific molecules that have been tagged with nanometer-sized semiconductor crystals, which emit light at different wavelengths. Once the technology is commercialized, clinical practitioners will be able to rapidly identify blood-carrying infectious agents or blood that doesn't match a recipient. Matches will be precise down to cell-surface markers, pathogens, and biologically important soluble factors. The result should be a safer blood supply, added assurance that transfusions are well matched, and ultimately, lives saved.

For more information on health care projects and other ATP-funded innovations, visit www.atp.nist.gov.



Human MSC engrafted in an adult mouse heart at about 60 days.

Snapshots of profiled projects

Information technology

Sponsor: Honeywell International, Inc., Minneapolis, MN
ATP funding: \$1.9 million
Nov. 1, 2000 to April 30, 2003

DNA diagnostics

Sponsor: Affymetrix, Inc., Santa Clara, CA
ATP funding: \$31.5 million*
Feb. 1, 1995 to Jan. 31, 2000
Other participants: Amersham Biosciences (formerly Molecular Dynamics, Inc.), Sunnyvale, CA.; Molecular Applications Group, Palo Alto, CA; Lawrence Livermore National Laboratory; Stanford University; University of California (Berkeley); California Institute of Technology; University of Washington

Tissue engineering

Sponsor: Osiris Therapeutics, Inc., Baltimore, MD
ATP funding: \$2 million
March 1, 1998 to Feb. 28, 2001

Medical informatics

Sponsor: Immersion Medical, Inc. (formerly HT Medical Systems, Inc.), Gaithersburg, MD
ATP funding: \$1.9 million
Oct. 1, 1997 to Sept. 30, 1999

Digital imaging

Sponsor: GE Global Research, Schenectady, NY
ATP funding: \$1.6 million*
Sept. 18, 1995 to Sept. 17, 2000
Other participant: PerkinElmer, Sunnyvale, CA

Biotechnology

Sponsor: SurroMed, Inc., Mountain View, CA
ATP funding: \$5.59 million*
Jan. 1, 2001 to Oct. 31, 2003
Other participant: Quantum Dot Corporation, Hayward, CA

*Joint ventures

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The Advanced Technology Program is part of the Department of Commerce's National Institute of Standards and Technology. ATP's mission is to *accelerate the development of innovative technologies for broad national benefit through partnerships with the private sector.*

Cover image: Red blood cells on a capillary wall. *Dennis Kunkel Microscopy, Inc.*



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