SYMPOSIUM

The Artificial Heart: Past, Present and Future

Celebrating 25 Years
at Penn State

Honoring
William S. Pierce, M.D.

PENNSTATE College of Medicine
University Hospital · Children’s Hospital
The Milton S. Hershey Medical Center
Welcome to
"The Artificial Heart—Past, Present, and Future"

The artificial organs program at Penn State's College of Medicine is recognized nationally and internationally for its achievements in the field. Tremendous accomplishments, including the development of heart-assist devices and the Penn State artificial heart, have been led by Dr. Bill Pierce.

He has directed an interdisciplinary group of physicians, engineers, veterinarians, and technical persons dedicated to the development of improved heart-assist pumps and artificial hearts since 1970. This program encompasses the design of devices, fabrication, bench evaluation, animal evaluation, and clinical use. It has an educational arm in that undergraduate and graduate students both in engineering and medical sciences have participated in the program.

The major contributions of the artificial organs program include:

- successful use of a pneumatic ventricular assist pump as a bridge to cardiac transplantation;
- development of a permanent implantable left ventricular assist pump; and,
- development of a permanent artificial heart.

An impressive record!

This symposium brings together friends, associates, and colleagues from around the world who share a commitment to excellence in artificial organs research. All of us at Hershey Medical Center are grateful for your participation in our celebration of 25 years of the Penn State Heart and recognition of the man who has served as the driving force of our artificial organs program.

C. McCollister Evarts, M.D.
Senior Vice President for Health Affairs and
Dean of the College of Medicine
THE PENN STATE HEART

WILLIAM S. PIERCE, M.D.

We have gathered to celebrate the 25th anniversary of the artificial organs program and to recognize Dr. William S. Pierce, the driving force of the artificial organs program at Penn State.

Dr. Pierce, who is the Evan Pugh and Jane A. Fetter professor of surgery at Penn State’s Milton S. Hershey Medical Center and chief of the Division of Cardiothoracic Surgery, has been a leading investigator in the field of mechanical hearts since the beginning of the National Heart Institute’s program in the early 1960s.

A high school graduate of Wyoming Seminary in Kingston, Pennsylvania, Dr. Pierce attended Lehigh University in Bethlehem, Pennsylvania, where he received a B.S. degree in chemical engineering in 1958. He enjoyed chemical engineering, but in his junior year a family friend and physician suggested that he might want to consider medical school. Dr. Pierce admits that he had never really given it a thought. Then, in the summer between his junior and senior year, he worked as an engineering aide at a large chemical plant. That’s when he began having doubts about pursuing a career as an engineer. So in his senior year, he chose courses in biology as electives to gain the needed background for medical school.

In 1958, he became a student at the University of Pennsylvania’s School of Medicine. It was there that Dr. Bill Pierce began dreaming of replacing ailing hearts with mechanical ones.

During his junior year, he made an appointment to talk with one of the cardiac surgeons, Dr. Charles Kirby, to share his idea. Kirby opened his drawer and pulled out an artificial heart. Surprised, young Dr. Pierce was unaware that there were several groups in the world working on artificial hearts. Kirby pointed out that although there were others, they didn’t work very well.

By the time he finished medical school, Dr. Pierce and Dr. Kirby had their own NIH grant for artificial heart development.

Dr. Pierce graduated from the University of Pennsylvania School of Medicine in 1962, earning a list of awards and prizes along the way.

From 1965 to 1967, Dr. Pierce was a clinical associate in the surgical section of the National Heart Institute at the NIH. There he did further work on an assist pump.

When Dr. Pierce finally finished his residency in 1970, he opted to come to Penn State’s then-new Milton S. Hershey Medical Center as assistant professor of surgery. The College of Medicine’s first class had entered only three years earlier; the University Hospital was opening that fall, and Dr. Pierce began assembling his team to design artificial hearts.

A strong engineering staff is integral to developing clinically useful heart replacement devices. Penn State’s College of Engineering would provide an obvious source of outstanding collaborators.

The animal facility at the Medical Center was another draw. Knowing that his life’s research work would involve large animals, an inner-city hospital would not suffice. Hershey Medical Center provided the ideal set-up for large animal research.

Of all his many honors and accomplishments, Dr. Pierce takes great satisfaction in his work with the assist pumps.

Penn State began using its assist pump in humans in 1976, primarily to help wean patients off the heart-lung machine after surgery. The third patient was Dr. Pierce’s first success. She was a relatively young lady, about 35, who had undergone a heart-valve replacement. It had been a very difficult operation, and she could not have come off the heart-lung machine without the assist pump. The device was put in and the surgeons were able to stop the heart-lung machine. On the fourth or fifth post-operative day, her own heart function improved readily. She was one of the first few patients anywhere helped by this type of device.

His major research activities at the present time center around the development of a permanent heart assist device and an artificial heart.

Dr. Pierce is past president of the American Society for Artificial Internal Organs. He is a member of Society of Clinical Surgery, the American Association of Thoracic Surgery, and the American Surgical Association, among others. In 1993, Dr. Pierce was elected to the prestigious Institute of Medicine. He is one of only two Penn State faculty named to the Institute. He has written articles for more than 300 publications and is the author of several books and numerous book chapters. Currently he serves as senior associate editor of the Journal of Thoracic and Cardiovascular Surgery.

In addition to his professional commitments, Dr. Pierce is devoted to his wife, Peggy, and to his two sons, William and Jonathan. He also enjoys gardening and woodworking.

He brings the same energy and enthusiasm to each of his many pursuits.
PROGRAM

Tuesday, May 2, 1995
Dinner/Reception
The Hotel Hershey
6:30 p.m. Cocktail Reception
7:00 p.m. Dinner, Garden Terrace East

Wednesday, May 3, 1995
Symposium
Hospital Auditorium, Ground Floor
The Milton S. Hershey Medical Center
8:00 a.m.-Noon

Welcome
C. McCollister Everts, M.D.
Senior Vice President for Health Affairs and Dean of the College of Medicine, Penn State’s Milton S. Hershey Medical Center

Welcome and Introduction
Thomas M. Krummel, M.D.
John W. Oswald Professor and Chair, Department of Surgery; Director, Section of Surgical Sciences; Surgeon-in-Chief, University Hospitals; Chief, Division of Pediatric Surgery; Penn State’s Milton S. Hershey Medical Center

Keynote Speaker
Birth and Early Years of the Artificial Heart and Circulatory-Assist Development
Adrian Kantrowitz, M.D.
Cardiac Surgeon at Sinai Hospital of Detroit and St. Joseph Mercy Hospital, Pontiac, Michigan

Guest Speakers
Early Years of the Artificial Heart Project
at University Park
John A. Brighton, Ph.D.
Executive Vice President and Provost, The Pennsylvania State University

Early Years of the Artificial Heart Project
at Hershey Medical Center
John A. Waldhausen, M.D.
Associate Dean and Director of University Physicians; Former John W. Oswald Professor and Chair of the Department of Surgery, Penn State’s Milton S. Hershey Medical Center

Clinical Impact of Circulatory Assist and the Artificial Heart
D. Glenn Pennington, M.D.
Professor of Surgery, St. Louis University;
Director of Cardiovascular Surgery, Cardinal Glennon Children’s Hospital; Director of Thoracic Transplantation and the Cardiovascular Replacement Service, St. Louis University Health Sciences Center

The Whitaker Foundation’s View of Funding
Artificial Organs Research
Miles J. Gibbons, Jr.
President, The Whitaker Foundation; Executive Director, The Helen F. Whitaker Fund and The Franklin H. and Ruth L. Wells Foundation

The Future of Artificial Heart Research
John T. Watson, Ph.D.
Head, Bioengineering Research Group, Division of Heart and Vascular Diseases, National Heart, Lung and Blood Institute, National Institutes of Health

Presentation of Willem Kolff Letter
Gerson Rosenberg, Ph.D.
Research Professor, Department of Surgery and Chief, Section of Artificial Organs, Division of Cardiothoracic Surgery, Penn State’s Milton S. Hershey Medical Center; Professor of Bioengineering, College of Engineering, The Pennsylvania State University

Introduction of William S. Pierce, M.D.
Jonathan E. Rhoads, M.D.
Provost Emeritus, University of Pennsylvania; Former John Rhea Barton Professor of Surgery; and Past Chairman of Surgery, University of Pennsylvania School of Medicine

Special Presentation
Noon–1:30 p.m. Lunch
1:30–3:30 p.m. Tour of Facilities
3:30 p.m. Closing
KEYNOTE SPEAKER
ADRIAN KANTROWITZ, M.D.

Adrian Kantrowitz is a senior cardiac surgeon on the staff of Sinai Hospital of Detroit and St. Joseph Mercy Hospital in Pontiac, Michigan. Dr. Kantrowitz is clinical professor of surgery at Wayne State University School of Medicine in Detroit and adjunct professor of physics at Oakland University, Michigan.

He performed the first heart transplant in the United States. He also performed the first implantation in the world of a cardiac assist device intended to remain permanently in the body, and treated the first patient in severe chronic heart failure to be discharged to home with such a device.

For short-term use in patients in shock following a heart attack, Dr. Kantrowitz developed a temporary cardiac assist device called the intraaortic balloon pump, which is now used in 100,000 patients a year. Dr. Kantrowitz was a pioneer in the development of the implantable cardiac pacemaker, computer control of paralyzed limbs, and other artificial organ systems. He has received many honors and awards for his contributions in cardiovascular surgery and research.

Dr. Kantrowitz is chairman, Board of Trustees, of the International Center for Artificial Organs and Transplantation and a past president of the American Society for Artificial Internal Organs. He is on the editorial boards of Artificial Organs, Journal of Biomaterials Research, and Biomaterials, Artificial Cells and Artificial Organs and is an author of more than 300 scientific and clinical publications. He is president of L. VAD Technology, Inc.

GUEST SPEAKERS
JOHN A. BRIGHTON, PH.D.

John Brighton has been executive vice president and provost of the Pennsylvania State University since July 1, 1991. Dr. Brighton is a mechanical engineer and was the original engineering collaborator with Dr. Pierce. He was dean of the College of Engineering at Penn State from 1988–91, director of the School of Mechanical Engineering at the Georgia Institute of Technology from 1982–88, and served as chairman of the Department of Mechanical Engineering at Michigan State University from 1977–82. Dr. Brighton served as an assistant professor of Mechanical Engineering at Carnegie-Mellon University prior to coming to Penn State in 1965.

As second in command at Penn State, Dr. Brighton is the chief academic officer of the University. He is responsible for the president for the administration of the University’s resident instruction, continuing education and research programs and procedures, and for the general welfare of the faculty and students.

Born in Gosport, Indiana, Dr. Brighton received his B.S., M.S., and Ph.D. in mechanical engineering from Purdue University.

MILES J. GIBBONS, JR.

Miles Gibbons is president of The Whitaker Foundation, Washington, D.C., and Mechanicsburg, Pennsylvania, executive director of The Helen F. Whitaker Fund, and executive director of The Franklin H. and Ruth L. Wells Foundation. The Whitaker Foundation is the largest private funder of biomedical engineering research in the United States.

He was formerly an attorney with the firm of Morgan, Lewis & Bockius of Harrisburg, Pennsylvania, and with AMP Incorporated of Harrisburg.

Mr. Gibbons earned his bachelor’s degree from Dickinson College, Carlisle, Pennsylvania, and his LL.B. from Georgetown Law School, Washington D.C.
THE PENN STATE HEART

D. GLENN PENNINGTON, M.D.
Glenn Pennington is a professor of surgery at St. Louis University and director of cardiac surgery at Cardinal Glennon Children's Hospital. He is also the director of thoracic transplantation and the cardiac replacement service at St. Louis University Health Sciences Center. On May 12, he will become chairman of the Department of Cardiothoracic Surgery at Bowman Gray School of Medicine, Wake Forest University in Winston-Salem, North Carolina.

Dr. Pennington is a member of and has been active in several prestigious medical societies, including the American College of Surgeons, American College of Cardiology, American Association for Thoracic Surgery, American Heart Association, the Society of Thoracic Surgeons, and the American Surgical Society. He is past president of the American Society for Artificial Internal Organs (1988–90). He has served on the editorial board of multiple journals, including the Journal of Heart and Lung Transplantation and the Journal of the American College of Surgeons.

Dr. Pennington's predominant interests have been in the area of mechanical circulatory support, cardiac transplantation, especially in children, and congenital heart surgery.

JOHN T. WATSON, PH.D.
John Watson is head of the Bioengineering Research Group of the Division of Heart and Vascular Diseases, National Heart, Lung, and Blood Institute, National Institutes of Health. Dr. Watson went to NIH in 1976 from the University of Texas Health Science Center where he was chairman of the Graduate Study Program in Biomedical Engineering and assistant professor of surgery and physiology. He has bachelor's and master's degrees in mechanical engineering and earned a doctorate in physiology from the University of Texas at the Southwestern Medical School. Dr. Watson has numerous publications in the area of cardiovascular physiology and artificial organs. He is a member of several editorial boards, a consultant to the Food and Drug Administration Circulatory Systems Device Panel, and a Founding Fellow of the American Institute of Medical and Biological Engineering.

JOHN A. WALDHAUSEN, M.D.
John Waldhausen, former John W. Oswald professor and chair of the Department of Surgery for 25 years, is director of the University Physicians, a new multispecialty group practice consisting of 325 full-time faculty of the College of Medicine, as well as associate dean. He also is editor of the Journal of Thoracic and Cardiovascular Surgery.

Dr. Waldhausen became the first chairman of the Department of Surgery of Penn State's College of Medicine in 1969 and was appointed interim dean of the College of Medicine and provost of the Medical Center in 1972.

Prior to coming to Hershey, he held faculty positions at Indiana University Medical Center and at the University of Pennsylvania where, as an associate professor, he was on the surgical staff of the Hospital of the University of Pennsylvania and the Children's Hospital of Philadelphia. For two years he was a clinical associate at the National Heart, Lung and Blood Institute of the National Institutes of Health.

Dr. Waldhausen has served as director to the American Board of Surgery and is currently a director of the American Board of Thoracic Surgery. He has served in leadership positions in a number of professional organizations, including the American College of Surgeons, the American Surgical Association, the American Association for Thoracic Surgery, and the American College of Cardiology.

Dr. Waldhausen has published more than 200 scientific manuscripts in professional journals and has contributed 38 book chapters. In addition, he has edited two books on cardiothoracic surgery. His honors and awards include the U.S. Public Health Service Career Development Award, the Alumni Merit Award from St. Louis University, and the Faculty Scholar Award for Outstanding Achievement from Pennsylvania State University.
JONATHAN E. RHoads, M.D.
Jonathan Rhoads is provost emeritus of the University of Pennsylvania, former John Rhea Barton Professor of Surgery and past chairman of surgery at the University of Pennsylvania School of Medicine, including the years of Dr. William Pierce’s surgical training.

Dr. Rhoads has been a professor of surgery at the University of Pennsylvania School of Medicine from 1949 to date. Dr. Rhoads’ past and present affiliations include chairman, National Cancer Advisory Boards; chairman of the board, Haverford College; director of surgery, Pennsylvania Hospital; member, Board of Directors, Fox Chase Cancer Center; chairman, Board of Regents, American College of Surgeons; member, Board of Trustees, General Motors Cancer Research Foundation; chairman of the board, Measey Foundation; and chairman, Board of Managers, Haverford College and Bryn Mawr College.

He also holds membership in the National General Medical Sciences Council, NIH; the American Academy of Arts and Sciences; the Institute of Medicine; and the American Philosophical Society, which he served as president from 1976 to 1985.

Dr. Rhoads is author and co-editor of Surgery: Principles and Practice, co-author of The Chemistry of Trauma, and past editor of the Journal of Cancer. Among the many honors bestowed on him are the Goldberger Award of the AMA, the Philadelphia Award, and the Pennsylvania Medical Society Distinguished Service Award.

GERSON ROSENBERG, PH.D.
Gerson (Gus) Rosenberg, is research professor, Department of Surgery, professor of bioengineering, College of Engineering, and chief, Section of Artificial Organs, Division of Cardiothoracic Surgery.

In 1970, Dr. Rosenberg joined Penn State’s artificial heart team in 1970 as a student in mechanical engineering. He received his Ph.D. in Penn State’s Department of Mechanical Engineering in 1975. His research focused on the development of a mock circulatory system and on evaluating the performance of a left ventricular assist device.

For the past 20 years, Dr. Rosenberg has been a leading member of the artificial-heart team and has directed the continuing development of permanent electric devices.

From 1983 to 1991, Dr. Rosenberg served with Dr. Pierce as assistant chief, Division of Artificial Organs, and in 1991 he was appointed to his present position as chief.

Dr. Rosenberg has over 200 publications to his credit, including 42 book chapters. In 1990, he was co-recipient of an award naming the Penn State Heart Assist Pump as an International Historic Mechanical Engineering Landmark, by the American Society of Mechanical Engineers. He is the principal investigator on the NIH contract to develop the implantable total artificial heart. He is a member of the American Society for Artificial Internal Organs, the American Society of Mechanical Engineers, and the International Society for Artificial Organs, among others. He is a Founding Fellow of the American Institute of Medical and Biological Engineering.
The Beat Goes On . . .

Twenty-five years ago, William S. Pierce, M.D., left the University of Pennsylvania for the newly opened Hershey Medical Center to begin what would become a pioneering, world-class program in artificial heart research.

Fierce, who today is both an Evan Pugh Professor and the Jane Fetter Professor of Surgery and chief of the Division of Cardiothoracic Surgery, had begun thinking about artificial hearts while in medical school in the 1960s at Penn.

"We thought the problem wasn't going to be as complicated as it turned out to be," he says candidly, referring to the
"problem" of devising a safe and effective permanent artificial heart to replace ailing natural hearts. "As we've solved some problems, we've uncovered others. That's why it's remained a wonderful challenge."

Today, the Penn State Heart—the air-driven model that Pierce, Jim Donachy, former director of fabrication of the artificial heart program, along with mechanical engineer Gerson "Gus" Rosenberg, Ph.D., and a team of engineers and surgeons developed in the early 1980s—is one of only two air-driven hearts to win the Food and Drug Administration seal of approval to use as a bridge to a heart transplant.

Pierce and Rosenberg, who is research professor of surgery and Chief of the Division of Artificial Organs, and the Hershey team have been busy chasing the next goal of artificial heart development. In 1993, the Hershey researchers were awarded one of only three seven-year National Heart, Lung and Blood Institute grants to develop the next generation of artificial heart: a wireless, electric total version that quietly hums inside the chest, powered by an adjacent battery pack.

According to Rosenberg, the federal funding "will take us to the beginning of human clinical trials for a fully implantable permanent artificial heart by the beginning of the next century."

It's a long way from the pioneering days in 1982 when the nation's artificial heart program took its first uncertain steps into long-term permanent implants. University of Utah surgeon William DeVries implanted an air-driven device, the Jarvik-7, into the chest of a 61-year-old Seattle dentist, Barney Clark. He lived for 112 days.

Though DeVries continued experimenting with the heart, implanting it in four more patients, the device continued to have serious complications, producing blood clots and increasing the risk of stroke. The device was eventually withdrawn from the market and reintroduced by CardioWest Technologies, Inc.

In 1988, the federal government threatened to withdraw funding for the electric artificial heart. The NHLBI temporarily suspended its contracts with four research teams: Abiomed/Texas Heart Institute; the Cleveland Clinic/Nimbus; the University of Utah; and Penn State/3M Health Care. The institute had decided that the money would be better spent on developing an implantable ventricular assist device which was further along in development.

Though the funding was subsequently restored, the NHLBI asked the Institute of Medicine, an arm of the National Academy of Sciences, to evaluate the artificial heart program. In its 1991 report, the IOM recommended that the NHLBI continue to support total artificial heart development and not let its contract with the four programs expire in 1993. The IOM noted that such hearts would probably cost about $200,000 per patient, and only add about five years of life. Still, in 10 to 15 years, the IOM estimated, some 10,000 to

FEELING GOOD, FEELING GRATIENT

Seven years ago, at age 20, George Meiser X worked for a local golf course and spent most of his free time with friends, leading a fairly carefree and enjoyable life.

Today, he continues to work for the golf course, cutting grass and doing routine maintenance, still hangs out with friends, and plans to get married in August. But the last seven years have been anything but carefree, and many of his days have been downright unbearable.

Meiser, however, is glad—glad to be alive.

The young Reading man began coughing repeatedly on April 6, 1988, while working at the golf course. Within days, his heart was failing, and his parents were told that his chances of survival were slim. He was transferred to University Hospital in Hershey and immediately placed on a waiting list for a heart transplant. Until a donor heart was available, Meiser was connected to the ventricular assist device for 26 days. On May 13, he received a successful transplant and returned home. By January 1989, Meiser was back on the golf course.

"I feel good," says Meiser today. "I have no problems. I go to Hershey for a check-up once a year and see a dietitian every so often for high cholesterol."

In spite of his good health, Meiser and his family have suffered a major blow since the transplant. His brother Christopher was also age 20 when he too received a heart transplant at Hershey in February 1993. Christopher, however, suffered a setback and died rather suddenly in April of that year. Both Meiser brothers developed cardiomyopathy as a result of a genetic disease they shared. His brother's death has been tough on both Meiser and his parents, but he remains grateful for his own second chance and looks ahead to life with his future bride.

"I wouldn't be here without that pump," says Meiser. "The doctors said that, another day—and I would have been gone."

Meiser may not be quite as carefree as he once was, but he is enjoying life again. And he deserves that.

20,000 people would need new hearts. Only a few thousand donor hearts would be available, while another 2,000 remain on a waiting list. Roughly 20 percent of heart transplant patients die before they can get on a waiting list. The IOM estimates that ultimately between 35,000 and 70,000 patients a year could be helped by permanent artificial hearts and left ventricular assist devices.

Pierce is philosophical about funding uncertainties. "This research is very fragile," he says. "If we ever lost our funding, we'd lose a great deal of time. We have a cadre of the best engineers and physicians working on this project. If the funding stops, they go on and do other things. Everyone who works in this field has to be concerned."

"A lot of people make strong arguments for preventive medicine for heart disease," he says. "While that is important, if the United States wants to remain competitive internationally in prosthetics and artificial devices, this type of research must continue."
**ONE OF THREE**

The NHLBI contract began in September 1993. Technically, it's a three-year award; based on the Penn State/3M Health Care team's progress in that time, the medical center is eligible to receive funding for four more years bringing the total award to $13.9 million over seven years.

The goal of the contract, Rosenberg puts succinctly, "is to complete the studies by the year 2000 and then apply for permission from the FDA to begin clinical trials.

"The purpose of the original work was to develop a completely implantable electric artificial heart that would allow a patient to lead a relatively normal lifestyle," Rosenberg says. "We already have a complete system; we achieved that in our last contract."

In 1991, a calf named Holly survived for a record 13 months on an electric total artificial heart that used skin-piercing wires attached to an electronic controller. The next year, the artificial heart team announced that it had implanted the world's first wireless total artificial heart in a five-month-old calf named Winston. Though the heart worked well for a record two-and-a-half months, a data-gathering line that pierced the animal's skin became infected and the calf died.

"We've had three animals live more than 100 days with completely implanted electronic systems," notes Rosenberg. "We were the first group to do that."

He says that the team's goal is to develop a wireless model that will last for five years, which would represent a significant benefit considering the critical illness of the potential candidates.

"In theory, the electric heart will offer advantages over a transplanted heart. There will be no chance for rejection, so people will not need anti-rejection drugs that cause side effects for people with heart transplants. People who have electric hearts will need anti-coagulation medication, but this is generally not problematic and has few side effects.

---

**Penn State's Long Road to Excellence**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. William S. Pierce and James H. Donachy, Sr., developed new uses for segmented polyurethane at the National Heart Institute, part of the National Institutes of Health.</td>
<td>Dr. Pierce attached the first Penn State pneumatic ventricular assist pump to the heart of a patient who had undergone open heart surgery at Penn State's Hershey Medical Center.</td>
<td>Penn State researchers implanted a cam-type electric motor artificial heart in a calf named E.T., short for Electric Total. E.T. survived for 222 days with an electric total artificial heart, setting a world record.</td>
<td>A calf, David, survived for 354 days with a Penn State pneumatic artificial heart, setting a world record for an experimental animal with an artificial heart.</td>
<td>Tony Mandia was the first recipient of the Penn State Heart; he survived 10 1/2 days on the device before transplantation. He lived another 18 days after transplant.</td>
<td>Robert Cresswell was the second recipient of the Penn State Heart. He was sustained for 397 days on the device.</td>
</tr>
</tbody>
</table>

"Many people die while waiting for donor hearts. The electric heart could be on the shelf and ready for implantation as soon as the patient needs it."

A little more than two years ago, Rosenberg told a reporter for the *Journal of the American Medical Association*, "the thrust is toward getting a device that you can put into a patient, then have that patient leave the hospital and live a relatively normal life." Rosenberg went on to predict that "once the device is perfected, patients who have it could hold a job and climb stairs and do moderate exercise—and not have to worry about being connected to something that might get caught and pull on their skin."
Pierce explains that the total artificial heart will be permanent, and probably not used as a bridge to a transplant as the air-driven model is now. "The fact that the electronics must be implanted in the body suggests that the optional use will be as a permanent device," he says.

"We also have a better appreciation for which patients are good candidates for transplants and which are not. We're targeting patients who are not transplant candidates to receive this device," he explains.

"Candidacy is based on age and the presence of other diseases—insulin-dependent diabetes, for example—that preclude the use of immunosuppressive drugs," which are crucial for heart transplants.

Pierce notes that most of the patients who are candidates for the air-driven heart as a bridge can be given the left ventricular assist device. The LVAD, as it's called, helps a weakened heart pump blood as it recovers from surgery.

"The LVAD is a much better bridge technique," Pierce says.

"You don't have to remove the heart, which requires much surgery and results in scarring. Most bridging done today in the United States is with an assist device."

Both laboratory and animal testing continue. Before the electric heart goes into a human chest, Rosenberg and his research group will run the heart through its paces, beginning with long-term testing on a mock circulatory system that was used to verify the operation of the device before it went into animals. Such "readiness testing" mimics a heart beating inside a person's chest.

At the same time, gently pampered calves at the Medical Center's Animal Research Facility will continue to serve as the artificial heart's living laboratory in which each new aspect and modification of the heart is examined.

The electric system consists of a compact electric motor-driven heart, an implanted electronic control system, a device for transmitting power across intact skin, and a shoulder bag battery pack.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>Penn State received $5.7 million over five years from the NIH to develop the next generation of artificial hearts.</td>
</tr>
<tr>
<td>1988</td>
<td>Rev. John Urban was Penn State's third artificial heart recipient, surviving 11 days on the device.</td>
</tr>
<tr>
<td>1990</td>
<td>The Penn State Heart-Assist Pump was named an International Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers.</td>
</tr>
<tr>
<td>1991</td>
<td>An 18-month-old calf named Holly lived 388 days on a Penn State electric total artificial heart, setting a record for the longest-living calf on any artificial heart.</td>
</tr>
<tr>
<td>1992</td>
<td>Winston, a six-month-old calf, ushered in the era of the wireless, electric total artificial heart, living 118 days on the Penn State device.</td>
</tr>
<tr>
<td>1993</td>
<td>Penn State's Hershey Medical Center was one of three institutions awarded a three-year, $5.4 million contract from the National Heart, Lung and Blood Institute to develop a permanent electric artificial heart.</td>
</tr>
</tbody>
</table>
FEELING GOOD, FEELING GRATEFUL

An article in the October 25, 1991 Potomac Republican began, "A Port Carbon heart transplant patient's emotional sendoff from Hershey Medical Center Monday prompted calls from more than 130 prospective organ donors in less than 24 hours."

The patient was 45-year-old Paul Shollenberger, who, at that time, had spent a record number of 57 days on the left ventricular assist device. He had been hospitalized at Hershey, awaiting a heart transplant, from March to August 1991, when he was placed on the assist pump. Finally, on October 9, he received his much-anticipated transplant.

His good-bye party at the Medical Center two weeks later was attended by staff, physicians, fellow patients, family members, and reporters, resulting in newspaper articles and TV news spots conveying Shollenberger’s plea for organ donors.

Shollenberger says today, "Fantastic!" when asked how he feels. "I had two bouts of rejection early on, but that's it. I try to eat a healthy diet," he says, explaining that he doesn't add salt to foods, nor does he eat prepared foods.

He has been able to return to his job as a bookmaker because the wet grinding that the job entails involves chemicals that could interfere with the immune suppressants he takes. Otherwise, he has no physical restrictions. His daily activities include working around the house and in the yard, running errands, and even shoveling snow in winter.

He especially enjoys the company of his family—his wife, daughter, son, and daughter-in-law—who supported him during his long wait for a donor heart.

Shollenberger recalls that, once he was on the assist pump, "I felt terrific. I even exercised. It was a great bridge for those eight weeks."

"I'd be 'belly up' without the LVAD. I'm forever grateful to the research at Hershey."

The Penn State team was an early innovator in two unique features of artificial heart design: an automatic electronic control system and a seamless blood sac. These have since been adopted by other research groups.

Two plastic pumping chambers with seamless, polyurethane blood sacs replace the heart's left and right ventricles. The upper portion of the patient's heart, the left and right atria, remain intact to act as holding chambers for the blood, much as they do for the natural ventricles. A tiny electric motor and a small mechanism called a rollerscrew push flat plates against the sacs to pump the blood. Artificial heart valves—such as those commonly used to replace diseased valves—control blood flow.

The electronic control system directs the electric motor and thus the blood flow according to the system's assessment of the body's requirements. Its needs change, for example, depending on whether a person is lying down or exercising.

A battery, which is kept close to the patient, powers the heart. The battery sends energy across the skin by a pair of wire coils. A four-inch diameter coil lays on the skin and sends energy to a smaller coil implanted under the skin. This energy is used by an implanted electronic control system to power the small electric motor that provides the force for the pump. A battery, housed in the same container as the electronics, provides some 30 minutes of operation when the external coil is removed.

"We will build a second-generation electric artificial heart, which will have a number of system refinements," Rosenberg explains. "Specifically, we'll look at whether it is comfortable and user-friendly," he says, referring to the 10-pound, eight-hour battery pack. "We'll look at whether we can make improvements in the telemetry and energy transmission systems, or other electronic refinements, taking advantage of the latest electronics," he notes.

The wireless system also can pass information back and forth between the implanted heart and physicians and researchers. With such information readily available, various manipulations now done on the natural heart by drug therapy can be made by changing control system settings.

HELPING, NOT REPLACING

While the artificial heart team looks to early in the 21st century to begin testing the permanent total electric heart in humans, the LVAD should be ready earlier.

The assist device does just that—it supports a weak left ventricle. Most candidates for the device have a faulty pump; the heart's left ventricle can't muster enough strength to perform its job of sending blood to the rest of the body.

The Penn State air-powered assist pump has a dual function. Its original intent was to let the heart rest and help it recover after surgery. As transplants became more common, its use shifted to a bridging device, helping keep some patients alive while they wait for a donor heart.

The pump works with the natural heart and adjusts its pumping rate as the person sits, stands, and walks.

Ventricular assist pumps are usually used to help the left ventricle, which fails most often because it has the most strenuous task to perform. The pump, about the size of a fist, is essentially half a heart. It has the same rigid plastic outer shell and smooth, seam-free, polyurethane blood sac as does the artificial heart.

The current assist pump sits on the patient's abdomen and is connected to the patient's natural heart with plastic tubes that pass through the skin of the chest. A large power unit sends
timed pulses of air against a diaphragm that presses against the filled blood sac, squeezing blood out and throughout the circulatory system. The cycle is completed when a vacuum draws blood from the natural heart’s left atrium to refill the blood sac in the pump.

In 1990, the Penn State Heart-Assist Pump was named an International Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers.

Since 1976, more than 500 Penn State pumps have been used at 18 centers in the United States and abroad as a bridge to heart transplantation to help save lives. That’s a Catch-22 situation because there are far fewer available hearts for transplants than are needed.

And that’s precisely the reason that the Penn State team is pushing the research envelope once again in proposing a permanent, electric LVAD that could be powered by rechargeable batteries. It could potentially help as many as 50,000 patients.

Hershey researchers have been working with Arrow International to bring the electric LVAD into general clinical use within five years, says Rosenberg. Clinical trials may begin by 1998.

“That’s taking a device that started here as an air-driven device to being an electronic device that will be fully implantable,” he says. “It has done well in the animals tests to date; Arrow will take it through the testing and the FDA approval process.”

The LVAD would be a permanent version for patients who have heart failure affecting the left side of the heart but don’t need a transplant or a total artificial heart. The initial device would last for two years, Pierce says, whereas subsequent models could go as long as five years.

“The thinking is that if you take a group of patients who are not transplant candidates and ask what device should they have, two-thirds would be helped by an LVAD, and one-third by a mechanical heart,” Pierce says. The latter group of patients would be those with much more serious heart disease, where virtually nothing short of a new heart will help.

Above, the Penn State implantable electric total artificial heart (from left to right): the portable power pack, energy transmission coils, electric controller, and the blood pump assembly.

THE FUTURE

In mid-1992, when a JAMA reporter was visiting the medical center, Pierce predicted that the day may come when people walking around with an artificial heart will telephone their doctor for a checkup, not unlike pacemaker wearers do now. This patient will have a modem and be able to electronically transmit information about his heart to the physician.

“Since the 1960s, when I got into this field, the revolution has been in electronic technology,” Pierce says.

Pierce, reflecting on a Hershey career in surgery and research spanning a quarter of a century, says that he’s most proud of “being able to take a patient who comes in with severe heart failure, putting one of our bridging devices in, and seeing a week later that he’s out of bed and with his family.

He’s also proud of “taking blocks of plastic, steel and titanium, and within the umbrella of Penn State, building the most successful mechanical heart in the world and showing that it can work in an animal for a year.”

Another source of pride, adds Pierce, is the more than three dozen Ph.D.s and master degrees supported by the artificial heart program.

—Steven I. Benowitz
TRIBUTES TO WILLIAM S. PIERCE, M.D.

...You have distinguished yourself, the College of Medicine, and The Pennsylvania State University during your quarter-of-a-century tenure with this institution.

...On behalf of The Pennsylvania State University, I wish to express our gratitude for your long and notable record of service to society and your contributions to the betterment of humankind.

Josh Thomas
President
The Pennsylvania State University

William Pierce...is a role model, a pioneer, and a humanitari-an...On behalf of the institution, I salute and thank him for his contributions.

C. McCollister Exerts, M.D.
Senior Vice President for Health Affairs and Dean
Penn State’s Milton S. Hershey Medical Center

I consider myself extremely fortunate for the opportunity to have worked with you, as I considered you to be a man of great vision. That vision, along with your enthusiasm, led those of us who worked with you to be successful in an area that most people considered a risk beyond what would be reasonable for a career project.

John A. Brighton
Executive Vice President and Provost
The Pennsylvania State University

I looked up the first paper written by William S. Pierce and published in the Transactions of the ASAIO, 8:118-122, 1962, titled, “Problems encountered during the development of our artificial heart.” Dr. Pierce was a student at that time so it shows a long-life dedication to the cause of the artificial heart.

In 1989, I had an opportunity to predict that Dr. Pierce would place a motor-driven artificial heart inside a patient. I stand by that prediction! But Dr. Pierce, in any of his carefully constructed research, has never been in an undue hurry. Therefore, he will not take shortcuts or be less careful to beat the clock or to beat others. This reflects his integrity!

My best wishes,

William J. Kolff, M.D., Ph.D.
Distinguished Professor of Medicine and Surgery
Research Professor of Bioengineering
The University of Utah
Salt Lake City

Dr. Pierce, early on in his medical career, recognized the need for the application of engineering principles to advances in surgery. Thus, he wished to establish a total artificial heart. He has pursued that interest with a single-mindedness that is exceptional and enviable. It ultimately has culminated in the development of the Pierce-Donachy Left Ventricular Assist Device, the first LVAD of practical usefulness, the Penn State Heart, and now more recently, the Penn State Electric Heart.

...Bill has been a model academic surgeon. He has provided enthusiasm and leadership to both medical students and residents resulting in their ultimate pursuit of academic careers in cardiothoracic surgery. He has placed the artificial heart program on a scientific basis second to none.

Thus, on this day, we congratulate Bill for twenty-five years of continued success.

John A. Walldgangen, M.D.
Associate Dean and Director, University Physicians
Penn State’s Milton S. Hershey Medical Center

...Your team’s approach to tackle such a difficult project is indeed a model for contemporary surgical investigation. Many thanks for both the project and the example.

Thomas M. Krummel, M.D.
John W. Oswald Professor of Surgery
Director, Section of Surgical Sciences
Chair, Department of Surgery
Penn State’s Milton S. Hershey Medical Center

Upon first meeting Dr. Pierce in 1970 I was inspired by him as were many others. His enthusiasm for his work seemed contagious. His honesty and integrity, his intellect and compassion, his vision for the future, combined with his warm personality have made it a pleasure to work with him. Now, twenty-five years later, he is still inspiring. My admiration for him has grown, he is truly a most valued friend.

Gerson “Gas” Rosenberg, Ph.D.
Chief, Section of Artificial Organs
Penn State’s Milton S. Hershey Medical Center

Memories of the last 25 years make me go back beyond that to the years at the National Institutes of Health. That was my first beginning with you and artificial heart work. Many years together with the artificial heart team brought rejoicing with success and learning with failures. One day at a time brought the program to where it is today. I am so proud and honored to have been a part of the family of doctors, engineers, and technicians that have worked hard toward the goals that you have set. You are the great leader that brought the program to what it is today. The lives saved and the teamwork known around the world began because of your goals to develop an artificial heart and heart assist. All honor and thanks must be given to you for 25 great years.

James H. Donachy
Director of Fabrication, Artificial Heart Program (retired)
Penn State’s Milton S. Hershey Medical Center

Bill Pierce came with a vision to combine his engineering and surgical background in an interdisciplinary program to improve patient care. The team has successfully solved innumerable details in careful, long-range animal studies before cautious human trials were considered with the artificial heart. The success is recognized by long-term professional, and financial support.

The ultimate goal of an electric powered heart giving freedom of movement and acceptable lifestyle seems achievable. What has been learned may be extended to other organs over the years.

His personal warmth with patients, workers and collaborators has been a key ingredient from the beginning.

George T. Harrell, M.D.
Vice President for Medical Sciences Emeritus
Penn State’s Milton S. Hershey Medical Center
Why should we pay homage to a fellow like William S. Pierce? His accomplishments in cutting-edge research involving mechanical support of the failing heart are unprecedented, and he has obtained continuing monetary and overall research support for these last 25 years.

...Professor Pierce is a mentor, a master teacher and a mature, unfailingly kind and gentle cardiac surgeon. Despite his achievements and accolades he has achieved a commendable measure of success which seems even more elusive. Wearing jeans and driving a pickup truck, he has found satisfaction growing daylilies, battling the squirrels in his garden, and making sawdust in his woodworking shop. This husband and his wife have raised two sons and cultured a productive life together despite having to overcome serious medical illness. It is most certainly appropriate that we recognize Bill and Peggy Pierce together—the reasons are simply obvious.

David B. Campbell, M.D.
Professor, Division of Cardiothoracic Surgery
Department of Surgery
Penn State's Milton S. Hershey Medical Center

Bill Pierce is a consummate scientist, surgeon, and teacher...
in the field of circulatory support, Dr. Pierce is a real giant and has been a universal mentor for the rest of us working in the field.

D. Glenn Pennington, M.D.
St. Louis University

As we all celebrate Dr. William S. Pierce's 25 years at The Pennsylvania State University and the artificial heart team's impressive achievements, I would like to congratulate him on all of his successes that he has managed to balance during his difficult, and often times, long hours of work.

For his work at PSU he has garnered worldwide respect, and simultaneously he has provided unending support, direction, and love for his wife and two sons. He has never faltered as a leader, a husband, or a father while relentlessly pursuing his lofty goals at PSU. As my brother and I grow older it is more and more difficult to imagine how he has worked so hard and loved so much for all these years. Although words cannot express my thoughts, I say thanks for the love and congratulations on all the successes both as a father and at The Pennsylvania State University.

Jonathan D. Pierce

...Your scientific accomplishments and the recognition you have received are enviable and well-deserved...

Gordon L. Kaufman, Jr., M.D.
Chief, Division of General Surgery
Penn State's Milton S. Hershey Medical Center

...Despite all of his accomplishments and well-deserved recognition, Dr. Pierce never fails to give credit to those who work for him, and for all who have the good fortune of working for him, he has been a valued friend...There can be no finer testimonial to this man than to say he is not only a great surgeon, inventor, and scientist, but also a thoughtful, caring individual.

Yvonne A. Hricak
Secretary & Division Coordinator to William S. Pierce, M.D.

...I have long admired your dedication to medicine and improved care of patients, as well as your contributions in the field of artificial organs.

...It was my privilege and pleasure to experience your dedication to excellence in research as we collaborated in research activities related to cardiac assistive devices, and as we served together in the US-UK Joint Program on the Artificial Heart.

May the next twenty-five years be as productive for you in all your endeavors, as have been the last twenty-five, resulting in even greater improvement in health care benefits to cardiothoracic patients.

Warmest good wishes.

Michael E. DeBakey, M.D.
Chancellor, Baylor College of Medicine

Homer's Odyssey recounts the wanderings of the king of Ithaca, Odysseus, following the Trojan War. Odysseus entrusted the education of his son, Telemachus, to his friend, Mentor. Since those early beginnings, a mentor has been known as one who is a trusted counsellor or guide. For your friendship, patience, counsel and guidance during the past 15 years, I will be forever grateful.

Wayne E. Richenbacher, M.D.
Division of Cardiothoracic Surgery
The University of Iowa Hospitals and Clinics

Somewhere near his extra birdhouses and clumps of wintering bulbs, my dad keeps a small pile of seeds that he distributes now and then to friends, patients, colleagues, and members of our family. When he gives them, these seeds grow slowly, unobtrusively, but with the strength of a vine and the beauty of a flowering tree. Everyone who is lucky enough to receive one shelter it unknowingly at first, then with quiet pleasure and finally with gratitude.

My father's friendship, ideas, creativity and advice have given me powerful optimism in a world that often lacks his grace. I think he has given something to all of us. He has planted in us something of himself.

Bill Pierce

Bill Pierce came to the Hospital of the University of Pennsylvania as a house officer, July 1, 1962. As he had done everywhere he had worked, he excelled as an intern and resident. In every clinical assignment, his performance was superb...

Jonathan E. Richaud, M.D.
Professor Emeritus
University of Pennsylvania

During the first weeks that we shared dorm space at medical school, I was very impressed regarding Bill's methodical approach to our studies. I attributed this somewhat to his training as a chemical engineer, but as time went on, it was evident that this was deeply ingrained in his character...

A more remarkable feat has been Bill's ability to couple his tremendous effort [on the artificial heart] with maintenance of his personal skills as an exceptional physician as well as being a wonderful husband and father to the Pierce family and a great friend to many of us.

George R. Green, M.D.
Abington Medical Specialists
To my Cardiac Surgeon, Friend, Academic Colleague and Fellow, Penn Graduate, Bill Pierce

As one of a large group of your grateful patients I undoubtedly have more reason than some to be thankful for your skill, since you performed my coronary by-pass surgery in 1981 and again in 1989. The ensuring 14 years of life have been a treasured gift...

Perhaps the best accolade...is that you would have been an excellent family physician and I will give you a warm endorsement if you should like in your next career to follow that path!

Hiram L. Wier, M.D.

Congratulations on a career of real distinction. Sir William Osler wrote:

"The great possession of any University is its great names...Not its wealth nor the number of its schools, not the students who throng its halls—but the men who have trodden in its service the thorny road through toil."

...We wish you much joy in continuing discovery.

Ernest K. Maunder, M.D.
Professor of Surgery and Pediatrics
Chief, Division of Plastic & Reconstructive Surgery
Penn State's Milton S. Hershey Medical Center.

It is a privilege for me to write about our very special relationship. A significant aspect of our relationship is that as a patient you very kindly gave me a new aortic heart valve.

In terms of our University association, it was a pleasure to work with you in successful negotiations with benefactors of the Hershey Medical Center. I can truly say that as a fundraiser, you are outstanding.

Now I would like some kind of guarantee that my heart valve will continue to do its job so we can enjoy our relationship for many more years.

Congratulations, Bill, for 25 years of outstanding service.

Charlie Lupton
Director of Development Emeritus
The Pennsylvania State University

...Under Dr. Pierce's guidance the Penn State Total Artificial Heart and Assist Pump have emerged from the drawing board to successful clinical application being recognized as International Historic Mechanical Engineering Landmarks. Simultaneously, a number of his students, myself included, have matured under his tutelage to carry on basic and applied research in this area.

...but the greatest achievement is yet to come in the form of the development of totally implantable devices and his impact on the next generation of cardiac surgeons. Certainly, the pleasure has been all mine to have had him as a teacher, friend, mentor, and associate. Good luck in the next 25 years!

Walter E. Pax, Jr., M.D.
Professor of Surgery
Division of Cardiothoracic Surgery
Penn State's Milton S. Hershey Medical Center

I recall a conversation with Bill Pierce on the corner of 40th and Spruce Streets in Philadelphia in the late 1960s just before he left to begin his NIH Fellowship. At that time he was a quiet, humble, talented individual who told me of his interest in applying his engineering background to cardiac disease. Over the years Bill remains that same talented, humble individual, a remarkably successful example of combining the ability with long term commitment to a vision and excellence.

Thomas J. Rohmer, Jr., M.D.
Chief, Division of Urology
Penn State's Milton S. Hershey Medical Center

We met when we were both medical students at the University of Pennsylvania in 1958 and your friendship has been important to me since that time. Your commitment to the development of an artificial heart, your intelligence, enthusiasm, energy, total intellectual honesty and your concern about your patients, as well as your family and friends, were evident from the start. Bill, your reputation transcends geographical as well as specialty boundaries and your accomplishments are a source of pride to those who have known you and worked with you. I congratulate you and your family on your wonderful achievements to date and am confident that your career will continue to be as outstanding in the future.

Daniel M. Albert

A telephone call 25 years ago from a physician in William Pierce's hometown suggested that I become acquainted with a great young doctor who was becoming a member of the Hershey Medical Center staff. During a dinner conversation soon after Dr. Pierce's arrival in Hershey, I readily sensed the significance of the telephone call. The years that have followed certainly confirmed the good fortune inherent in Bill's arrival.

Beyond his academic brilliance and exceptional scientific skills, Bill...displays a gentle and caring spirit, and shows humility amidst his dramatic achievements.

John O. Hershey

As a mother reminiscing on her only son's growing up from kindergarten to Wyoming Seminary, Lehig University, University of Pennsylvania Medical School, graduating as a doctor and serving for 25 years at Hershey Medical Center, and now realizing the part he played in the development of the Penn State Artificial Heart and recognizing his dedication to his dream, I am very proud and happy. It is an honor to be part of this great day and celebration and it is something I will treasure forever. I only regret that his Dad did not live to be here today.

Doris Schuler Pierce
ACKNOWLEDGMENTS

Over the past 25 years, numerous faculty, staff, students, and others have contributed to the success of the artificial organs program. Penn State wishes to thank all who have contributed and especially would like to acknowledge the following:

Faculty, Staff, and Students
Sharon Fox
David Frischmehl, M.S.
Stephen Furkay, M.S.
Wayne Gaines, M.D.
John Gardner, Ph.D.
Laura Garrison, Ph.D.
Roger Gaumond, Ph.D.
David Geselowitz, Ph.D.
Eve Gesty
Paul Gibbons
Susan Greathouse, M.S.
James Gunshin, M.S.
Bill Gurum
Randy Haluck, M.D.
Kirsten Hansen, M.S.
Bruce Hardy
Philip Harris, M.D.
James Hart, M.D.
Jon Hanick
Kane Harnischfeger, M.D.
Karey Hoffinan, B.S.
Rachael Horn
Jay Hricak
Yoav Hricak
Quynh Huang, B.S.
Wen-Mei Huang
Michael Ignatowski, B.S.
Peter Jarvis, M.S.
Eduardo Jorge, M.D.
Michael Jermyn, M.D.
David Katz, B.S.
Osamu Kawaguchi, M.D.
Shigeru Kazama
Chris Kelly, M.S.
Steven Kern, M.S.
David Kloss, M.D.
Glenn Klute, M.S.
Martin Koch
Jeffrey Koontz, B.S.
Patti Kost
Novel Kowalski, M.D.
Thomas Krummel, M.D.
Hirosi Kusagawa, M.D.
Theodore Lamson, Ph.D.
Gayle Land
Donald Landis
C. Max Lang, D.V.M.
Siu Lai, B.S.
Elizabeth Laybourne
Soo-Mi Lee, M.D.
John Leisey
Jay Lenker, Ph.D.
Michelle Lester
Vicky Lewis
Dan Light
Joan (Lineweaver) Light
Ed Liszka
Delano “Pete” Lohr
Rebecca Long, B.S.
Lisa Love, M.D.
Sharon MacNichol, M.D.
James Magovern, M.D.
Kelly Malone
Carole Mammoser, B.S.
Kenneth Mann, M.S.
Beth Mark, B.S.
Larissa Martin
J.C. Maymura
Robert McCool
Jeff McIngvale
Virginia McGurty
Ann McGregor
Alexander McKoy, M.D.
Sanjay Mehta, M.D.
Dick Meyer, M.S.
Cynthia Miller, B.S.
Gerald Miller, Ph.D.
Michael Mirmaha
Jeanette Mohle
Joyce Mohle
William Mohle
Christine Morgan
Nancy Moyer, B.S.
John L. Myers, M.D.
Gini Nissley
Mary North
Charles Nydegger, M.D.
Timothy Oaks, M.D.
William O’Brien
Ouma Mijung, M.S.
Eric Olsen, Ph.D.
Alan Ostrow, M.S.
Walter E. Pae, B.S.
Salvatore Parascandola, M.D.
William Park, Ph.D.
Dennis Patich
John L. Penrock, M.D.
Dave Peters
Stacy Peters
Betty Jane Potts
Don Peaper
Winfred Phillips, D.Sc.
Jonathan Pierce, B.S.
William Pierce, B.A.
William S. Pierce, M.D.
G. Allen Prophet
Steven Prophet
Marjorie Rawhouser, M.S.
John Reibson, B.S.
Lynford Reichert
J. Spencer Reid, M.D.
Karen Reigel
Suzanne Reigel
Anthony Reimel
Geri Riesinger, D.O.
Wayne Richenbacher, M.D.
Gregory Rigney, M.S.
Elizabeth Rohm
Gerson Rosenberg, Ph.D.
John Sapirstein, M.D.
Mark Schwartz, B.S.
Reka Shaw, M.D.
Rhonda Schultz
Tammy Shearer
Debbie Snapczenko, M.S.
Alan Snyder, Ph.D.
Steve Spald, M.S.
George Spady
John Stalnasky, B.S.
David Striemburg, M.S.
Suzanne Swartz
John Tarbell, Ph.D.
Judy Taratula, M.S.
Dennis Trumble, M.S.
Lori Trumbo
Urs Tsch, Ph.D.
Don Tufte
Mark Vierna
Zane Wade, M.S.
Gordon Waldhausen
John Waldhausen, M.D.
John “Tank” Waldhausen
Clifford Weber
James Weber
William Weiss, M.S.
Paul Weidner, M.D.
Dennis Williams
Michelle Williams
Sally Williams
Ronald Wilson, D.V.M.
Carolyn Wine-Shaffer, M.D.
Robert Wise
Craig Wisman, M.D.
Conrad Zapanta, M.S.
Brent Zarlenga
Annie Zarlenga

Financial Supporters
Arrow International Inc.
Barnes & Noble - Louis S. May Co.
BBDT Cunningham & Walsh
Camden County Cardiac
Comm.
Charles E. Culpeper
Foundation
Mr. Orville Eberly
Mr. Robert E. Eberly
Fraternal Order of Eagles
Mrs. Helen Savard
Gaithersburg
Mr. Robert E. Galbraith
Green Hosp. of Scripps
Clinic
Robert J. Helin C.
Kellogg Foundation
Mrs. Ruth Lewis
McKean County Heart
Association
Medical College of
Georgia
Medtronic Foundation
National Institutes of Health
Pennsylvania Pork
Producers Association
Pennsylvania Science and
Engineering Foundation
Sains/3M Health Care
Mrs. Mary K. Sunderland
Whitaker Foundation
FOR FURTHER READING


PENN STATE'S MILTON S. HERSHEY MEDICAL CENTER

FOUNDING
In 1963, The M.S. Hershey Foundation offered $50 million to The Pennsylvania State University to establish a medical school in Hershey. With this grant and $21.3 million from the U.S. Public Health Service, the University built a medical school, teaching hospital, and research center. Penn State's Milton S. Hershey Medical Center opened its doors to the first class of students in 1967 and accepted the first patients in 1970.

FACILITIES
The 550-acre campus, located along Route 322 on a former Milton Hershey School farm, currently consists of medical sciences buildings and hospitals, outpatient physician center, animal research farm, student apartments, fitness center, magnetic resonance imaging building, heliport, and other support buildings. On June 4, 1991, a $41.5 million South Hospital Addition opened, expanding the licensed bed capacity of University Hospitals to 504 beds. In September 1991, the $31.3 million East Addition opened, giving University Hospitals a new main entrance, lobby, and admitting area; and a new surgical intensive care unit; and in the fall of 1992, the seven-story $46.3 million Biomedical Research Building opened, providing needed laboratory and office space for the Medical Center.

An expansion of the University Physicians Center was completed in spring of 1993.

A major component of the improved and expanded emergency services is the new emergency area opened in September 1994.

VISION
The first 25 years of the Medical Center's development have established it as a complete academic medical center offering the finest in education for health professionals, biomedical research, and patient care.

Hershey Medical Center's vision for the twenty-first century is to be recognized as one of the nation's premier academic medical centers. Penn State is recruiting faculty members who are internationally known for their accomplishments in research, education, and patient care. Research programs into cures and treatments of the major diseases, such as AIDS and cancer, are being expanded. Faculty physicians will continue to integrate the latest biomedical knowledge and technology with compassionate care of our patients.

EDUCATION
Penn State's College of Medicine at the Hershey Medical Center confers the doctor of medicine, doctor of philosophy, M.D./Ph.D., and master of science degrees. In addition, the Medical Center provides graduate education for allied-health professionals and nurses, and continuing medical education.

Since the time when the College of Medicine accepted its first class of 40 medical students and University Hospital admitted its first patients, the Medical Center has grown substantially. The number of full-time faculty has increased to more than 500, the number of medical and graduate students to more than 670, and the number of residents and postdoctoral fellows to more than 370.

RESEARCH
The acquisition of new knowledge that is fundamental to the improved diagnosis, treatment, cure, and prevention of disease has been an important part of the mission of the Hershey Medical Center since the institution was established. The high priority given to research was reflected in the original plans for physically integrating research laboratories in the Medical Sciences Building with adjacent clinical facilities in University Hospital.

PATIENT CARE
The Medical Center offers a full spectrum of diagnostic and therapeutic alternatives, many of which are not available elsewhere in the region. Our health care, while close to home, meets national standards of quality. It retains a humanistic touch, combining state-of-the-art technique with dignity and compassion.

University Hospital and the Children's Hospital offer acute services such as cardiothoracic surgery, high-obstetrical care, adult and pediatric cancer treatment, transplant surgery, neonatal intensive care, and spinal cord injury surgery and rehabilitation.

The University Physicians Center houses outpatient services in a comfortable and convenient setting.

The Penn State Community Health Center offers family and community medicine, obstetrics/gynecology, radiology, and internal medicine in a community setting.

The Medical Center is accredited as the only adult and pediatric regional resource trauma center in south central Pennsylvania. The LIFE LION aeromedical service has become an important asset for regional trauma care.
International Historic Mechanical Engineering Landmark

**Penn State Heart-Assist Pump**
1976
The Milton S. Hershey Medical Center
The Pennsylvania State University
Hershey, Pennsylvania

This is the first extremely smooth, surgically implantable, seam free pulsatile blood pump to receive widespread clinical use. The pump pioneered the application of fluid-mechanics principles in blood-pump development and the use of segmented polyurethane as the blood-contacting material. An interdisciplinary group designed the pump using fundamental engineering principles and problem-solving techniques.

In its use in more than 250 patients, it has been responsible for saving numerous lives.

American Society of Mechanical Engineers
1990

We would like to thank St. Jude Medical S.C., Inc., for underwriting production of this commemorative booklet.

This publication is available in alternative media upon request.

The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Direct all affirmative action inquiries to the Affirmative Action Office, The Pennsylvania State University, 201 Willard Building, University Park, PA 16802-2801.

Produced by the Office of Public Relations, Penn State's Milton S. Hershey Medical Center, and Rice & Rice, Ltd.  U. Ed. HMC 95-081