Evaluation

of the

Advanced Research and

Advanced Technology Programs

A Report to the

Texas Higher Education Coordinating Board

Mildred Dresselhaus, Ph.D. (Chair)
C. Robert Hewes, Ph.D.
Jiri Jonas, Ph.D.

January 2003

2002 Program Review Panel

Mildred S. Dresselhaus, Ph.D. (Chair), Dr. Dresselhaus is currently an Institute Professor at the Massachusetts Institute of Technology. She held the Abby Rockefeller Mauze Chair at MIT in Electrical Engineering and in Physics from 1973 to 1985 and served as Director of the MIT Center for Materials Science and Engineering from 1977 to 1983. From August 2000 to January 2001, Dr. Dresselhaus served as the Director of the Office of Science for the U.S. Department of Energy. She was elected to membership in the National Academy of Engineers in 1974, the National Academy of Sciences in 1985, and the Engineering Academy of Japan in 1993. Dr. Dresselhaus is also a Fellow of the American Academy of Arts and Sciences, a Fellow of the Institute for Electrical and Electronic Engineers, and an Honorary Member of Ioffe Institute of the Russian Academy of Sciences. She received the National Medal of Science in 1990. In 2000, she received the Nicholson Medal for Humanitarian Service from the American Physical Society, the Weizmann Women and Science Millennial Lifetime Achievement Award, and the National Materials Advancement Award of the Federation of Materials Societies. In 2001, Dr. Dresselhaus won the Karl T. Compton Medal for Leadership in Physics from the American Institute of Physics and the Medal of Achievement in Carbon Science and Technology from the American Carbon Society. Dr. Dresselhaus has served on the Naval Research Advisory Committee, the Board of Governors of Argonne National Laboratory, and the Board of Governors of the Weizmann Institute and as President and Chairman of the Board of the American Association for the Advancement of Science.

Jiri Jonas, Ph.D. Dr. Jonas is currently Director Emeritus of the Beckman Institute for Advanced Science and Technology and Professor Emeritus in the Department of Chemistry and at the Center for Advanced Study at the University of Illinois. He is a member of the National Academy of Sciences and is a Fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Physical Society, and the American Institute of Chemists. Dr. Jonas was a co-winner of the Czechoslovak Academy of Science Award for Scientific Work in 1958, 1960, and 1964. He was awarded the Joel Henry Hildebrand Award in Theoretical and Experimental Chemistry of Liquids from the American Chemical Society in 1983 the Senior U.S. Scientist Award from the Alexander von Humboldt Foundation of the Federal Republic of Germany in 1988. Dr. Jonas has served as Chairman of the Division of Chemical Physics of the American Physical Society and Co-Director for the NATO Advanced Study Institute on High Pressure Chemistry, Biochemistry and Materials Science.

C. Robert Hewes, Ph.D. Dr. Hewes is a Texas Instruments Vice President and Director of Digital Signal Processing Solutions R&D in Dallas. He received his BS in electrical engineering from the University of Oklahoma in 1965 and his MS and PhD from MIT in 1967 and 1970, respectively. Dr. Hewes joined Texas Instruments in 1973 and was elected Senior Member of Technical Staff in 1978. He was elected Fellow of the Institute for Electrical and Electronic Engineers (IEEE) in 1990.

Evaluation of the Advanced Research and Advanced Technology Program

Program Review 2002
Austin, Texas
October 7 - 8, 2002

Mildred Dresselhaus, Chair
Jiri Jonas
Robert Hewes

Background/Introduction

The Advanced Research Program (ARP) and Advanced Technology Program (ATP) are merit-based, competitive, peer-reviewed programs funded by the State of Texas, designed to support higher education-based basic and applied research programs in the State of Texas. The biennial grants competition makes awards totaling $60 million per two-year period to investigators in colleges and universities in Texas. Established in I987 by the Texas Legislature, the programs are complementary. ARP aims to support research "to foster understanding in the field", and also to "provide the knowledge base needed for innovation." In addition, ARP supports state-of-the-art research which serves to attract and retain in Texas the best and brightest students and researchers. The complementary ATP program has as its mission to support research with a technological objective and a long-range economic goal. The combined investments in the ARP and ATP are expected to enhance economic growth in Texas; diversify and strengthen its technological workforce; broaden its technology base, products and services; and foster new industry.

The enabling legislation requires that these programs be reviewed by an external expert evaluation team on a biennial basis, thereby prompting this review.

Review Procedure

The review team was provided with an extensive package of background material prior to the site visit in Austin. During the site visit the review team met with a number of groups of investigators, administrators, industry representatives and government representatives. The visit started with a discussion with the Board's Assistant Commissioner for Finance, Campus Planning, and Research and representatives of the Governor's Office, the Office of the Speaker of the House, the Senate Education Committee, and the Legislative Budget Board. After a briefing by the Texas Higher Education Coordinating Board staff on the administration of the program, the evaluation team then broke up into two subgroups and had detailed discussions with selected ARP/ATP investigators from

different institutions. The individual panels represented a cross-section of the ARP/ATP programs, including panels from the Life Science, Physical Sciences and Mathematics, Engineering and Computer Sciences, and Advanced Technology Program Development and Transfer.

The entire panel then met with research administrators from representative Texas higher education institutions and got input from representatives of Texas industrial firms who actively collaborate with ARP/ATP investigators in the program. Finally, the panel met with a group of investigators who had hosted high school teachers, together with a high school teacher who had worked for more than one summer at an ATP project laboratory. The evaluation team also met with Dr. Norman Hackerman, chairman of the Advisory Committee on Research Programs (ACORP).

General Comments

The State of Texas should be strongly commended for creating and continuing this unique program of research support. The use of competitive research funding in Texas institutions of higher learning is an ideal way to promote excellence. The committee strongly feels that the peer review process, as opposed to block grants to institutions, is a key factor in driving the success of this program. The review team is also impressed by the very small overhead of the program operation. The program staff and their efficient implementation of the program results in essentially all of the funds appropriately being used for their intended purpose of research support. The success rate of only about 10 percent has not deterred investigators from continuing to submit high quality proposals for what is obviously a very attractive source of funds. The successful proposals have in many cases enabled investigators to use their initial research results to compete successfully for much larger research grants from federal sources, averaging a multiplication factor of about three, thereby substantially leveraging and increasing the impact of the ARP/ATP program on Texas institutions.

Recommendations

The committee is very impressed with the results of the program and by the high praise we heard consistently from investigators, administrators, and industry partners. The program management is excellent, efficient, and proactive. Of course, we also discussed issues that lead us to a few recommendations for further improvements, and the most important of these recommendations are briefly outlined below, with some elaboration given in the following section, where findings on which these recommendations are based are presented.

1. **Funding** Level – Because of the great positive impact of the ARP/ATP program on research and education in Texas universities and on enhancing

the competitiveness of Texas industry, as detailed below, it is recommended that the ARP/ATP be funded at the 1987 constant dollar level or equivalently at the 1987 constant effort level as we move into the future. Science and technology have advanced remarkably since the initiation of the programs in 1987 as have the research costs per individual researcher. In a later section of this report, the benefits of the programs to the State of Texas and to the research community are summarized.

2. **Development of Texas Industries** – To document the benefits of the ARP/ATP to the State of Texas and to the development of Texas industries, it is recommended that a longitudinal evaluation of the outcomes of the ARP/ATP should be carried out. In a later section of this report the strong benefits of the program to the Texas industrial base are briefly summarized.

3. **Increased Visibility** – In view of the fact that the ARP/ATP are highly successful and benefit the educational and technological base of Texas in a major way, it is recommended that steps be taken to improve further the visibility of the ARP/ATP. In a later section of this report, we offer one scenario to accomplish this goal.

Findings

1. Funding Level

The many advantages that accrue to the state from the ATP/ARP provide the arguments for maintaining the effort level of the 1987 programs, which has provided the State of Texas over the years with an excellent return on investment. Some of these advantages are delineated below.

- Peer reviewed research projects result in the highest quality proposals getting funding, thereby forcing continuous improvement of faculty research programs in order to compete successfully for funding.
- This program is a better investment than formula funding because the competitive nature of the funding attracts and rewards the best and brightest. By not taking a “shotgun” approach in research selection, high impact work is more likely to be funded.
- New companies are formed and jobs are created as a result of discoveries that would never have happened otherwise.
- Seed dollars provided by this program are used to achieve promising initial research results that are subsequently leveraged for follow-on funding from other sources, such as the National Science Foundation.
- High return on investment has been observed by promoting federal support, with an average leverage ratio of federal, industry, and private foundation funds to state funds of three-to-one over the program duration.

- The programs help with start-up funds for young faculty which can be important in attracting the top talent to Texas.

Besides the advantages of ARP/ATP to the State of Texas enumerated above, the programs have other attractive features from the point of view of the research investigators.

- The ARP/ATP encourage researchers involved in basic work to enlarge their horizons and look for practical applications – good for Principal Investigators (PIs) and for the education process of students, and good for industry.
- The ARP/ATP build bridges between university researchers and industry.
- The ARP/ATP allow PIs to work in areas that are more pre-competitive industrial research-oriented than what National Institutes of Health and National Science Foundation would fund.
- The ARP/ATP facilitate establishment of centers in universities (as in manufacturing) by leveraging funds that would not have otherwise been available.
- The ARP/ATP facilitate interactions between schools within a university such as Engineering, Science, and Mathematics, or between different universities and health-related institutions through PIs working together.
- ARP/ATP grants can be used for cost sharing for federal grants, thereby providing additional leverage.
- The ARP/ATP promote interdisciplinary teaching of graduate students who work together across disciplines.
- The ARP/ATP are particularly helpful for supporting “small science.”
- Proposal reviews are helpful to investigators in improving their proposals for the next submission.
- The ARP/ATP promote industry involvement in the educational process, and provide peer review of education programs from an industrial perspective.

2. Development of Texas Industry

Findings from the meetings of the review panel showed that the ARP/ATP have very strong benefits to the State of Texas and to the development of Texas industries through the many outputs of the programs, as enumerated below. The benefits of the programs to Texas industry need to be assessed in greater depth.

- Trained students are the most important product of the program. These students and their professors advance the state of the art in the selected fields of study, and then they become agents of technology transfer when they go on to industrial jobs, to start-up business enterprises, or in some cases to academic positions. Through these relationships, students are able to better understand the directions they want to take in their future careers, and industry partners in Texas are able to evaluate students even before they graduate.
- The mutually beneficial contacts between industry and universities result in industry having closer ties and more detailed knowledge of research

programs and in the professors and students learning a great deal about the industrial world. Industry-university contacts are required by the program, but once the contacts are formed, the relationships tend to grow and extend beyond the project funding period.

- Universities are the ideal places to explore research areas where companies have interest but lack expensive facilities and expertise. The company can collaborate with the university to explore the area without the otherwise very large investment that they would have to make. After a successful exploratory period, the company can then decide whether or not to invest in development with lower risk.
- In many cases, new or improved products are developed on the basis of the ARP/ATP. These new products or even new businesses result in more jobs in Texas and growth of Texas industry.
- The quantity and quality of graduate and undergraduate students and of outstanding new faculty are enhanced by the availability of ARP/ATP support. These unique programs provide Texas institutions with an advantage over other states and regions in recruiting the best and brightest undergraduate and graduate students and faculty.
- By increasing the quality of Texas universities, the programs help to create a favorable environment to attract new businesses, and to cause existing business to expand in Texas rather than choosing to go elsewhere for expansion.
- Industry finds the intellectual property produced under the ARP/ATP easier to deal with than other intellectual property produced at individual universities.
- The panel feels that with a deeper public understanding of the ARP/ATP, more companies will find compelling reasons to increase or start interactions with the programs. Therefore increased visibility of the programs is recommended, as described in the next section.

3. Increase Visibility

The panel found that the ARP/ATP are not well known by Texas industry nor by Texas citizens. It is important that Texans understand the very positive impact and contribution of these programs to the state, its universities, and its business environment. To increase the visibility of the ARP/ATP, the following steps should be taken.

- Carry out a longitudinal study of the impact of specific ARP/ATP funded projects to document long-term benefits and long-term impact of ARP/ATP funded research programs to both the educational and industrial enterprises in Texas.
- Data on the successful translation of ATP results to commercialization should be collected. These data should document new major industrial programs that originated from ATP projects, new companies that were spun off, and new jobs that were created.

- The current web site should be modified to include an interactive database aimed at informing Texas academia, industry, legislators and the general public about the ARP/ATP regarding several topics:
    - New industrial program generated with industrial partners
    - New companies spun off
    - New jobs created in Texas
    - Quantifiable research outcomes from former ARP/ATP projects
    - Research funding from federal sources leveraged from ARP/ATP funding
    - Research highlights of currently funded projects
    - Number of students (graduate, undergraduate, and postdoctoral) trained

Appendix

Review Process

Material provided for review included

- Program Review Schedule
- background material on Texas higher education research programs
- Texas Higher Education Code for the Advanced Research Program (chapter 142) and the Advanced Technology Program (chapter 143)
- description of the six-step project selection process
- *Advanced Research Program/Advanced Technology Program – 2001: Program Announcements*
- tables showing number of proposals submitted by research area and by institution
- list of reviewers
- evaluation forms
- *2001 Advanced Research Program/Advanced Technology Program – Report of Awards, May 2002*
- documents regarding an open records request
- description of ARP/ATP on-line submission system
- 2001 post-award evaluation survey results
- historical comparison of number of proposals funded and dollars awarded by research area and by institution
- briefing sheet on ARP/ATP
- summaries of outcome measures for annual progress reports filed in July 2002
- quotes from principal investigators filing progress reports (July 2002)
- *Advanced Research Program/Advanced Technology Program Metrics: Progress Reports for Projects Selected in 1997 Grants Competition – April 2002*
- Samples of web pages from www.ARP/ATP.com

- *Advanced Research Program/Advanced Technology Program Fiscal Year 1999 Progress Report with a Special Report on Texas-Mexico Border Research 1998-2000*

- *Follow-Up Report on the Summer 1999 Supplemental Program to Provide Research Experiences for High School Science and Math Teachers*

- *Research Experiences for High School Science Teachers – Summer 2002*

- *Research Experiences for High School Science Teachers – Summer 2001*

- recommendations and actions taken following the 1999 ARP/ATP evaluation

- *Evaluation of the Advanced Research and Advanced Technology Programs,* January 1999

- recommendations and actions taken following the January 2001 evaluation

- *Evaluation of the Advanced Research and Advanced Technology Programs, January 2001: A Report to the Texas Higher Education Coordinating Board*

- Bios of the Advisory Committee on Research Programs (ACORP)

- *Closing the Gaps by 2015,* Texas Higher Education Plan, October 2000

The number of proposals funded by research program and the total number of research proposals funded has varied very little over the last five competitions (1991, 1993, 1995, 1997, 1999, and 2001), with funding levels held constant at approximately $60 million for each competition. Outcomes measures were provided for the 1999 and 2001 awardees according to standardized interim progress reports filed with the Texas Higher Education Coordinating Board. Tabulations were provided for the number of researchers (faculty, staff, undergraduates, and graduates), new knowledge created (refereed papers, conference papers presented, technical reports, and book chapters), the generation of additional external funding (totaling $215 million for projects funded in the 1999 and 2001 competitions) and new technology developed (patent applications filed, patents awarded, copyrights granted, licensing agreements completed, and new businesses formed). Our review agenda also included interviews and interactions with groups of investigators, administrators, industry collaborators, and government officials.

Texas Higher Education Coordinating Board

Advanced Research/Technology Program Review

October 7-8, 2002

Review Team: Mildred Dresselhaus, Ph.D., (Chair)
C. Robert Hewes, Ph.D.
Jiri Jonas, Ph.D.

Monday, October 7

All meetings at the Marriott at the Capitol, 701 East 11th Street, Austin, Texas, in the William Barton Room or the Jacob Bickler Room.

7:30 a.m. Team meets for breakfast with Don W. Brown, Commissioner of Higher Education; Teri Flack, Deputy Commissioner; Deborah L. Greene, Assistant Commissioner of Finance, Campus Planning and Research; Linda Domelsmith, Director of Research; and Reinold Cornelius, Program Director of Research. They will go over the day's schedule and discuss state programs.

8:30 a.m. Discussion with representatives of the Governor's Office, the Lt. Governor's Office, the Speaker's Office, the Senate Finance Committee, the House Appropriations Committee, and the Legislative Budget Board.

The purpose of this session is to give the team an overview of the objectives of the program from the perspective of the groups responsible for funding it and administering it.

State Government Officials, William Barton Room

Trish Conradt
Office of the Speaker of the House

Judy Coppolo
Senate Education Committee

Patrick Francis
Legislative Budget Board

Macgregor Stevenson
Office of the Governor

9:15 a.m. Briefing and discussion of the administration of the programs and program outcomes. (Team, Deborah L. Greene, Linda Domelsmith, Reinold Cornelius)

The staff will present an overview of how the program is operated and some outcomes of the program.

10:15 a.m. Meet with ARP/ATP investigators from different institutions. Investigators have been told not to prepare formal briefings on their specific projects, but to be prepared to discuss policy issues related to the programs. Dr. Dresselhaus will visit with about seven faculty members working on life sciences projects. Drs. Jonas and Hewes will visit with about seven faculty members working on physical sciences and mathematics projects.

The purpose of this session and the ones that follow is to give team members an opportunity to get a faculty view of the programs. Previous review teams have felt that these sessions are very useful. Program staff does not attend these sessions.

Life Sciences Panel, William Barton Room

John Buynak
Southern Methodist Univ.

Glenn Dillon
UNT Health Science Ctr. at Ft. Worth

Jaquelin Dudley
The Univ. of Texas at Austin

Randall Goldblum
UT Medical Branch at Galveston

Lorenz Lutherer
Texas Tech U. Health Sciences Ctr.

Rhonda Miller
Texas Agricultural Experiment Sta.

Mike Norgard
UT Southwestern Med. Ctr. at Dallas

Philip Serwer
UT Health Science Ctr. at San Antonio

Neal Waxham
UT Health Science Ctr. at Houston

Physical Sciences/Mathematics Panel, Jacob Bickler Room

Andrew Brandt
The Univ. of Texas at Arlington

John Ferraris
The Univ. of Texas at Dallas

Alex Freundlich
Univ. of Houston

Randy Keller
The Univ. of Texas at El Paso

Karen Lozano
The Univ. of Texas-Pan American

Stephen Martin
The Univ. of Texas at Austin

Liwen Shih
Univ. of Houston-Clear Lake

Richard Smalley
Rice Univ.

11:15 a.m. As above, except Dr. Dresselhaus will visit with seven faculty members with engineering projects and Drs. Jonas and Hewes will visit with seven faculty members with Advanced Technology Program Development and Transfer projects.

Engineering/Computer Science Panel, William Barton Room

Michael Becker
The Univ. of Texas at Austin

David Carnes
UT Health Sci. Ctr. at San Antonio

Robert Cartwright
Rice Univ.

Radovan Kovacevic
Southern Methodist Univ.

Theresa Maldonado
The Univ. of Texas at Arlington

Dan Moldovan
The Univ. of Texas at Dallas

Robert Wallace
Univ. of North Texas

Technology Development and Transfer Panel, Jacob Bickler Room

Behnaam Aazhang
Rice Univ.

James Bonner
Texas A&M Univ.-Corpus Christi

Mehrdad Ehsani
Texas Engineering Experiment Sta.

Ron Elsenbaumer
The Univ. of Texas at Arlington

Gary Evans
Southern Methodist Univ.

Rosa Fitzgerald
The Univ. of Texas at El Paso

Alex Ignatiev
Univ. of Houston

Thomas McKnight
Texas A&M Univ.

12:15 p.m. Lunch. The committee may wish to dine as a small group to discuss their observations.

1:30 p.m. Meet with research administrators from nine institutions.

This group can give the team a perspective on the administration of the program and its general impact on higher education in Texas.

Research Administrators Panel, William Barton Room

Dan Alexander
UT Southwestern Med. Ctr. at Dallas

Lee Boozer
Univ. of Houston

Reata Busby
Univ. of North Texas

Bill Covington
Southwest Texas State Univ.

Greg Foxworth
Texas A&M Univ.

Kathleen Harris
Texas Tech Univ.

Wayne Kuenstler
The Univ. of Texas at Austin

Larry Smith
Southern Methodist Univ.

Jane Youngers
UT Health Science Ctr. at San Antonio

2:45 p.m. Break

3:00 p.m. Meet with a group of industry people who have either helped in the review process or who have participated in ARP/ATP research projects with university investigators. Industry people and reviewers will attend in person or be available by conference call.

This group can provide a reviewer's perspective and also a Texas industry perspective on the program.

Industry/Reviewer Panel, William Barton Room

Collin F. Norman (industry)
3M

Due to technical difficulties, this session did not go as planned. Panelists who attempted to participate via telephone conference call could not connect with the review team. The following individuals were able to speak with each other on the conference call. Three of them (Ellis, MacNaughton and Sharp) subsequently e-mailed written comments that were provided to the review team.

Doug Chojecki (industry)
Stewart and Stevenson

Hugh Ellis (reviewer)
The Johns Hopkins University

Peter Gao (industry)
Applied Materials

Michael MacNaughton (reviewer)
Southwest Research Institute

Robert Morff (reviewer)
Sentron Medical

Al Schultz (industry)
Ionwerks, Inc.

Jeff Sharp (industry)
Marlow Industries, Inc.

Mark Sunderland (industry)
Nokia

Prabodh Varshney (industry)
Nokia

Rick Vaters (industry)
Northrop Grumman

4:00 p.m. Meet with investigators and teachers funded under the Supplemental Grants to High School Science and Math Teachers Program. Investigators and teachers will either attend in person or be available via conference call.

The purpose of this session is to give team members an opportunity to learn both the investigator and teacher perspectives of some of the results of the Supplemental Grants Program.

Supplemental Teacher Grants Panel, William Barton Room

Robert Flake
The Univ. of Texas at Austin

Glenn Masada
The Univ. of Texas at Austin

Charlotte May
Bowie High School, Austin

Nelson Passos
Midwestern State Univ.

Suresh Sharma
The Univ. of Texas at Arlington

This session was plagued by the same technical difficulties as the previous one. The following individuals were able to speak with each other on the conference call. Three of them (Atman, Gonzalez and Wuthrich) subsequently provided written comments.

Miguel Gonzalez
The Univ. of Texas-Pan American

Sarah Griffin
Westwood High School, Round Rock

Cerise Wuthrich
Archer City High School, Archer City

Jay B. Atman
James Martin High School, Arlington

Miguel Torres
McAllen High School, McAllen

6:30 p.m. Dinner with Dr. Norman Hackerman, Chairman, Advisory Committee on Research Programs

Informal dinner at a local restaurant. The committee may wish to dine as a small group in order to discuss their observations of the day and share opinions.

Tuesday, October 8

All meetings at the Texas Higher Education Coordinating Board's Office, 1200 E. Anderson Lane in the Bluebonnet Room.

8:00 a.m. Meet in hotel lobby for transportation to the Coordinating Board.

8:30 a.m. Meet as a group to discuss conclusions and prepare first draft of final report.

This time can also be used to follow up on any questions that might be remaining from the previous day.

11:00 a.m. Exit interview with Deputy Commissioner, Assistant Commissioner and others.

12:00 p.m. Depart