Appendices

Appendix A

Development of New Knowledge and Early Commercial Products and Processes

Technical achievements are listed in Column B - "Technology Developed." And products being sold in the market or processes being used in production are given in Column C - "Product or Process Commercialized." For projects where there is no product or process under current commercialization, a short note concerning the author's opinion about prospects is given in Column C, in italics.

There are seven tables below, one for each of the seven chapters where results for the individual projects are presented.

Table A1. Biotechnology (Chapter 2)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (c)
Aastrom Biosciences, Inc.	Bioreactor technology for expansion of stem and other cells outside the patient's body — used in tests and clinical trials for more than 60 cancer patients.	*Commercialization likely.*
Aphios Corporation	Viral deactivation procedures based on critical fluid technology — demonstrated in cleaning contaminated blood supplies.	*Commercialization possible.*
Molecular Simulations, Inc.	Incorporation of density functional theory (DFT) into easy-to-use software — targeted toward the clinical and biotechnology communities for calculating molecular structures and energies.	Enhanced Turbomole™, a software tool that enables researchers to design new target molecules for drugs and other substances at much lower costs.
Thermo Trilogy Corporation	Genetic engineering processes — demonstrated in the production of pyrethrin, a natural insecticide that is nontoxic to mammals.	*Commercialization not likely.*
Tissue Engineering, Inc.	Techniques and procedures for enhancing tissue growth, including processing tissue, extracting and storing collagen, and spinning and weaving collagen fibers into fabrics for rebuilding lost tissues — demonstrated in production of human protheses.	*Commercialization likely.*

Table A2. Chemicals & Chemical Processing (Chapter 3)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
BioTraces, Inc.	Multiphoton detection (MPD) technology — demonstrated in enhanced immunoassay, chromatography and nucleic acid analysis.	Licensee PetroTraces: applications of the technology in the petrochemical field. Marketed directly by BioTraces: ssMPD™, for clinical diagnostics applications.

Table A3. Discrete Manufacturing (Chapter 4)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
Auto Body Consortium (Joint Venture)	Measurement and process control technology — demonstrated in reduction of dimensional variation in auto body assembly to two millimeters or less.	New measurement and process control systems in auto assembly plants that cut dimensional variation to a world-class standard of two millimeters and below, being implemented in 22 assembly plants in the United States and Canada.
HelpMate Robotics, Inc.	Specialized lidar (light direction and range) scanner and related locating technologies — demonstrated in the development of an intelligent, autonomous mobile robot capable of maneuvering around on a factory or hospital floor.	HelpMate Robots in use as delivery devices in about 100 hospitals in the United States and Canada.
PreAmp Consortium (Joint Venture)	A knowledge-based software system that can extract process "rules" from manufacturing process data — demonstrated in test automations for designing and manufacturing electronics components.	STEP Tools, Inc., an informal participant in the project, has incorporated the project's data application interface in its ST-Developer™ software tool. *Commercialization possible for the complete system.*
Saginaw Machine Systems, Inc.	Intelligent thermal-error correction technology, based on a generic mathematical model of thermal errors — demonstrated in high precision machine tool applications.	Accu-System™ — a new intelligent process controller for increasing the accuracy of machine tools.

Table A4. Electronics (Chapter 5)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
Accuwave Corporation	A process for producing photorefractive materials based on holographics technology — demonstrated in fiber optics telecommunications applications.	Wavelength division multiplexing components: wavelength controllers, wavelength lockers and fiber-optic collimators.
AstroPower, Inc.	Improved liquid-phase epitaxial growth methods and a high-throughput manufacturing technology — demonstrated in the fabrication of high-performance optoelectronic devices such as ultra-bright light-emitting diodes (LEDs).	New epitaxy technology incorporated in all company production processes, including the Silicon-Film™ solar cell.
Cree Research, Inc.	Methods for increasing the quality and size (to 2 inches or more) of silicon carbide single crystals — demonstrated in the fabrication of LEDs and other electronic and optoelectronic devices.	Less expensive blue light-emitting diodes, and improved silicon carbide wafers that permit fabrication of electronic devices that deliver more power, last longer and can withstand very high temperatures.
Cynosure, Inc.	A fault-tolerant optical system — demonstrated for a diode-laser array in a laser surgical application.	*Commercialization possible.*
Diamond Semiconductor Group, LLC	Compact high-current broad-beam ion-implantation technology for altering the electrical properties of materials — enabling production of larger semi-conductor wafers and also useful for other applications.	A new high-current ion implanter, produced by Varian Associates, which incorporates the new techniques developed in the ATP project for implanting dopants on large silicon crystal wafers measuring 300 mm or more in diameter.

Table A4. Electronics (Chapter 5) — continued

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
FSI International, Inc.	A dry gas wafer cleaning method — demonstrated in the cleaning of computer-chip wafers during manufacturing (which traditionally has used wet chemical processing), and suitable for the ever smaller features on new generations of chips.	*Commercialization possible.*
Galileo Corporation	New processes for fabricating micro-channel plates (MCPs) using photon detectors and other types of electron multipliers — demonstrated in night vision applications.	*Commercialization possible.*
Hampshire Instruments, Inc. (Joint Venture)	Techniques for laser pumping of high-power laser systems — demonstrated using a laser-diode array to pump a neodymium-doped gadolinium gallium garnet laser for producing low-cost x-rays.	*Commercialization not likely.*
Illinois Superconductor Corporation	Fabrication process for thick-film, high-temperature superconducting materials — demonstrated in the production of radio-frequency components for wireless applications.	Two products — SpectrumMaster™ and RangeMaster™ — installed in 22 cell phone base stations in 12 cities.
Light Age, Inc.	Broadly tunable laser source of ultraviolet (UV) light based on alexandrite laser technology — aimed at applications in science, medicine and photolithography.	Three laser products — nUVo™, PAL/UV™ and PAL/PRO™ — for laser surgery and potentially for other applications, including next-generation chip fabrication and investigation of weather conditions in the upper atmosphere (70 miles above earth).
Lucent Technologies Inc.	Fabrication, testing and alignment techniques for extremely precise aspherical, multilayer-coated mirrors — essential for extreme ultraviolet (EUV) technology, a contender for future lithography systems.	Subcontractor Tinsley Laboratories: application of improved fabrication methods learned in the project to all its aspherical mirror production. Subcontractor Tropel: a specialized interferometer it now uses in other contract work. *Commercialization possible for lithography systems.*
Multi-Film Venture (Joint Venture)	Procedures for interconnecting thin-film integrated circuits — targeted at complex, multi-film module (MFM) electronic device applications and suitable for use when the films are arranged either side by side for flat-panel displays or in layers for compact processor units.	*Commercialization possible.*
Nonvolatile Electronics, Inc.	New procedures that enhance the producibility, circuit density and signal strength of giant magnetoresistance (GMR) materials — demonstrated in random access memory (RAM) and highly sensitive sensor applications.	Highly sensitive sensors based on giant magnetoresistance materials that could be used in brakes, pacemakers, and many other applications.
Spire Corporation	Feedback-controlled, chemical vapor deposition processes — demonstrated in a reactor in a high-throughput mode for fabricating low-cost, high-quality metallo-organic laser diode arrays and other optoelectronic devices.	A prototype reactor being used for limited production of epitaxial wafers.
Thomas Electronics, Inc.	A high-efficiency electron source to enable development of new classes of efficient, bright, flat fluorescent lamps — with wide applications in computer and instrument displays and in high-definition TV screens.	Prototypes and pilot models of flat fluorescent lamps placed with more than a dozen companies for further evaluation and field testing of the new technology in cockpit and other applications.

Table A5. Energy & Environment (Chapter 6)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
American Superconductor Corporation	Wire fabrication and winding techniques for high-temperature superconducting materials — with primary applications in the development of extremely efficient large motors.	CryoSaver™ — electrical wires that carry current into and out of cryogenically cooled devices, which reduces electrical resistance and helps users achieve better operating efficiencies.
Armstrong World Industries, Inc.	Process technology for controlling the microstructure of aerogel insulation materials — targeted toward cost-effectively enhancing its thermal insulating properties.	*Commercialization possible through licensing.*
E. I. du Pont de Nemours & Company	Thin-film fabrication processes for high-temperature superconducting materials — targeted toward low-cost electronics components.	New thin-film components, incorporated into magnetic resonance imaging equipment for use in hospitals and clinics.
Michigan Molecular Institute	Fundamentals of polymer compatibilization — targeted at demonstrating that mixed plastics (either from waste streams or virgin) can be successfully combined into materials with high performance characteristics.	Prefabricated wall units using compatibilized plastic panels, made by Eagle Plastics Systems of Florida in collaboration with University of Florida researchers.

Table A6. Information, Computers and Communications (Chapter 7)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
Communication Intelligence Corporation #1	New data-entry software technology that recognizes each user's natural handwriting without "training" the computer or the user — intended to allow a pen and tablet to be used instead of a keyboard.	Enhanced Handwriter® MX™ — a stylus-and-pad system that recognizes hand-printed text.
Communication Intelligence Corporation #2	A recognition system for hand-written Chinese — intended to replace a cumbersome data-entry system that uses a keyboard.	*Commercialization likely.*
Engineering Animation, Inc.	Core algorithms to enable the creation of 3D images from sets of 2D cross-sectional images — with an initial application targeting animated visualization of the entire human body.	Three CD-ROMS (The Dissectable Human™, The Dynamic Human™ and CardioViewer 3D™), plus two medical textbooks that are used to train medical personnel.
ETOM Technologies, Inc.	Techniques for writing and reading more than one bit of information at the same spot on an optoelectronic disk — and new optoelectronic disk materials.	*Commercialization not likely.*
Mathematical Technologies Inc.	Mathematical methods for managing successive digitized video images — with the purpose of removing defects from one or more individual frames of new or archived movies.	Digital Restoration Services™, integrated into postproduction movie processing at a number of facilities in the entertainment industry.
Torrent Systems, Inc.	Component-based software and user interface for building parallel processor applications — a tool for the professional programmer.	Orchestrate™ — an innovative component software prototype system that enables a variety of hardware systems to handle massive amounts of data and increase processing efficiency.

Table A7. Materials (Chapter 8)

Awardee Name (A)	Technology Developed (B)	Product or Process Commercialized (C)
AlliedSignal, Inc.	Near-net-shape gelcasting process that is safer and less costly than conventional gelcasting based on acrylamide, a cumulative neurotoxin — demonstrated by making structural ceramic parts for very high-temperature applications.	*Commercialization likely.*
Geltech Incorporated	Room temperature net-shape gelcasting method — demonstrated in the production of high-quality, silica glass micro-optics.	Materials processing and mold fabrication methods used to develop a porous-glass product which is a component of a home sensor for toxic gases.
IBM Corporation	Nonlinear optical polymeric waveguides — demonstrated in the development of inexpensive optoelectronic switches for computers and communications systems.	*Commercialization not likely.*

Appendix B

Terminated Projects

A few ATP projects that are announced are not carried through to completion. Some of them never actually start. Others are stopped significantly short of completing their proposed research agenda.

Announced projects may not start or may be stopped prior to completion, for a variety of reasons. But the main reason observed to date centers on difficulties with joint venture agreements. Sometimes companies that plan to collaborate may find last-minute obstacles to signing a joint venture agreement and decide to disband their planned partnership.

A project may also be derailed because technical challenges are found to pose too high a risk from the company's perspective, even with the ATP award. Or, a company—particularly a small company—may encounter cash-flow difficulties and have to drop its research activities to pursue short-term survival. In addition, the technology and business climate may change in ways that obviate the need for a project, or alter participants' willingness to proceed. Sometimes, companies simply change their strategic directions and get out of research areas they formerly wished to pursue. Over the multi-year span of ATP-research projects, a variety of personal, business, and technical circumstances can develop that alter original plans. Such change is to some extent inevitable.

From the beginning of the program in 1990 through March 1997, the period covered by this report, 12 ATP-announced projects that were scheduled to complete during this period did not complete, and, therefore, are not included in the group of projects addressed in the body of this report. Of the 12, four were announced but then were canceled without ever getting underway; eight went some distance in their research agenda, but were stopped without completing substantial portions of their planned research. The ATP contributed a total of $9.4 million to the eight projects that went part way, and $0 to the four that were stopped up front.

The following analysis identifies the major factor that contributed to the termination of each of the 12 projects, while providing anonymity to the companies to preserve their rights regarding proprietary information:

Case 1: The company, a single-company awardee, found it necessary to reassign key R&D personnel in order to pursue critical short-term objectives that were unanticipated at the time it submitted the proposal. The company requested that the project be terminated before any costs had actually been incurred, and the ATP agreed.

Case 2: ATP chose not to renew this single-company project after the first year of performance because it was not demonstrated that the company could successfully carry out the technical effort proposed.

Case 3: The company, a single-company awardee, requested that the project be terminated following its acquisition by another firm which did not wish to pursue the ATP project's area of technology development, and the ATP agreed.

Case 4: As a result of financial trouble, which entailed severe restructuring, this single-company awardee decided to end its research in the technical area of its ATP project in order to concentrate its limited resources in other areas with more immediate prospects for generating needed revenue.

Case 5: Members of the joint venture wished to stop the project due to changes in market trends in the relevant technology areas, and the ATP agreed.

Case 6: The company requested that the project be discontinued when results produced from its early work on the project were not as promising as had been expected, and the ATP agreed.

Case 7: A key member of the planned joint venture membership withdrew from the project during the negotiating phase, and ATP determined that, as a result, the project was no longer competitive against the ATP's selection criteria, and canceled it before it got underway.

Case 8: The single-company awardee ran into financial trouble, and needed to stop its research effort in order to focus on short-term survival.

Case 9: The joint venture members were unable to correct organizational deficiencies identified by the ATP, and the ATP canceled the award before research work began.

Case 10: The ATP elected not to renew this joint venture award because it determined that the project was unlikely to achieve its technical objectives in a number of different areas and that the joint venture organization was not functioning effectively either managerially or administratively.

Case 11: The companies failed to negotiate with one another the terms of their joint venture agreement, and subsequently proposed significant changes to their plan and joint venture team. The ATP rejected the revisions as not competitive against ATP selection criteria, and the project was never started.

Case 12: The companies were unable to reach agreement among themselves on the terms and conditions of their joint venture project, and it was never started.

End Notes

Introduction

1 The selection criteria in effect from 1990 through 1998 are as follows: 30% for scientific and technical merit; 20% for potential net broad-based economic benefits; 20% for adequacy of plans for eventual commercialization; 20% for level of commitment and organizational structure; and 10% for experience and qualifications. The criteria are simplified for 1999 competitions: 50% scientific/technical merit and 50% potential broad-based economic benefits. A detailed description of the earlier criteria are contained in Advanced Technology Program Proposal Preparation Kits published on or before December 1997 (the kit is updated periodically). The current edition of the kit and other program materials may be obtained by calling 1-800-ATP-FUND, or viewed at the ATP Web site, http://www.atp.nist.gov.

2 For a description of the ATP evaluation plan, see Ruegg (1998).

3 EAO's published economic studies are generally available at the ATP Web site, http://www.atp.nist.gov, or can be requested by calling 301-975-4332.

Chapter 1

1 Nonprofit institutes are no longer eligible to apply as single applicants. Two nonprofits, one of which is in this grouping of 38 projects, received single-applicant awards during the early years of the program, before this change in eligibility by Congress.

2 Does not add to 100%, due to rounding.

3 Under a recent change in the ATP cost-share rules, companies as large as the Fortune 500 companies who apply as single applicants are required to cover at least 60% of total project costs, but none of these first completed projects are affected by the change.

4 Proposers to the ATP are asked to identify potential markets for products that might one day incorporate the new technology to be developed in the project. They are also asked to discuss plans and pathways for commercializing and diffusing downstream products or processes based on the technology, assuming that their proposed research objectives are achieved and commercialization becomes technically feasible. But the ATP's funding contribution to the project is restricted to research activities and may not be used for product development.

5 "New" in this context means that the product or process is new in fundamental terms or that it is significantly improved over earlier versions. The 38 completed projects under study here have commercialized products or processes of both kinds. And the term "product" is also used, where there is little chance of confusion, to include both products and processes.

6 Figure 2 and the explanatory text are taken from Ruegg (1999). An earlier version of Figure 2 may be found in Ruegg (1994).

7 See Powell (1997).

8 See Laidlaw (1997).

9 The Torrent Systems project was funded in ATP's Component Based Software Focused Program Competition in 1994.

10 As noted above, ATP funding and the research and development work it supports typically are part of a larger picture. A recipient frequently will have started some related research and development work before receiving ATP funds and may continue with additional efforts after the ATP project has been completed. It is unusual to find a project in which there is an exact one-to-one matching between technical achievements of the ATP-funded project and an award citation. For all of the entries in the table, company officials confirmed that the award was for achievements that were at least partly the result of the ATP-funded project.

11 For two projects, the company response to the question about patent applications that had been filed but for which the grant had not yet been received was "several" instead of a precise number. For tabulation purposes, the number four has been used; it is the simple

average of the number for the ten projects for which a precise answer was given.

12 Includes projects reporting “several” papers.

13 For a detailed treatment of the relationship between spillover benefits (knowledge and market) and commercialization, see Jaffe (1997). With reference to spillovers that occur as a new product is sold commercially, he notes: “Market spillovers will not be realized unless the innovation is commercialized successfully. Market spillovers accrue to the customers that use the innovative product; they will not come to pass if a technically successful effort does not lead to successful commercialization” (p. 12). In commenting on spillovers that occur because new knowledge is disseminated to others outside the inventing firm, he observes: “Note that even in the case of knowledge spillovers, the social return is created by the *commercial use* [emphasis in original] of a new process or product, and the profits and consumer benefits thereby created” (p. 15).

14 There were several reasons why answers were not available for the six remaining projects. In one case, the lead company was out of business and the owner deceased. In another instance, the company had changed hands twice, and the current owners were not knowledgeable about the role of the ATP. In other cases, key staff on the project had left the company. Finally, answers in a few cases were too ambiguous to tabulate.

15 Project leaders for three of these 21 projects said their companies would have gone out of business had the ATP award not been made.

16 Another factor potentially influenced by ATP funding — the scope and scale of the project — was not explicitly covered in the interviews for this report.

17 Mansfield, et. al. (1977).

18 When the awardee supplied a range, the midpoint is used for this tabulation. One company, HelpMate Robotics, said the research was completed “much sooner” than it could have been done without the ATP funds. It was counted in the 21 months lag group, which is the median.

19 It is unclear whether the authors used 8 or 15 years in their calculations for this set of innovations. Therefore, both numbers are given here.

20 See Ruegg (1998) and Powell (1997).

21 The ATP’s Economic Assessment Office has commissioned detailed economic evaluation case studies for selected projects. See Ruegg (1998).

22 See RTI (1998), pp. 1-22, table 1-3.

23 See Consad Research Corporation (Consad) (1996).

24 See Consad (1996). The Consad study estimated economywide benefits for applications of the technology in the automobile industry only, so its estimates contain no information about potential benefits from application of the new technology in other industries.

25 See RTI (1998), pp. 1-23, table 1-4.

26 See RTI (1998), pp. 1-22, table 1-3.

Chapter 2

1 See Research Triangle Institute (RTI) (1998), p. 3-3.

2 Ibid., pp. 1-22, table 1-3.

3 See RTI (1998), p. 1-22, Table 1-3.

Chapter 4

1 These estimates and others below are from Consad Research Corporation (1997).

Chapter 7

1 EAI Web site, at http://www.eai.com.

2 *Technology Transfer Report* (1994).

3 Gupta (1995).

References

Consad Research Corporation (1997). *Advanced Technology Program Case Study: The Development of Advanced Technologies and Systems for Controlling Dimensional Variation in Automobile Body Manufacturing*, Report to the Advanced Technology Program of the National Institute of Standards and Technology, NIST GCR 97-709. U. S. Department of Commerce, Gaithersburg, MD, March 1997.

Jaffe, Adam (1996). *Economic Analysis of Research Spillovers: Implications for the Advanced Technology Program*. Report to the Advanced Technology Program of the National Institute of Standards and Technology, NIST GCR 97-708. U. S. Department of Commerce, Gaithersburg, MD, December 1996.

Laidlaw, Frances Jean (1997). *Acceleration of Technology Development by the Advanced Technology Program: The Experience of 28 Projects Funded in 1991*, NISTIR 6047, October 1997.

Mansfield, Edwin, J. Rappaport, A. Romeo, S. Wagner, and G. Beardsley (1977). "Social and Private Rates of Return from Industrial Innovation," *Quarterly Journal of Economics* 91(2):221-240.

Powell, Jeanne (1997). *Development, Commercialization, and Diffusion of Enabling Technologies: Progress Report for Projects Funded 1993-1995* , NISTIR 6098, December 1997.

Research Triangle Institute (1998). *A Framework for Estimating the National Economic Benefits of ATP Funding of Medical Technologies*, Report to the Advanced Technology Program of the National Institute of Standards and Technology, Advanced Technology Program, NIST GCR 97-737. U. S. Department of Commerce, Gaithersburg, MD, April, 1998.

Ruegg, Rosalie (1994). "Overview of ATP's Evaluation Plan and Early Impacts," presentation (unpublished), at a NIST seminar, September 1994.

_______ (1998). "The Advanced Technology Program, Its Evaluation Plan, and Progress in Implementation," *Journal of Technology Transfer*, vol. 23 (2) Summer 1998: 5-10.

_______ (1999). "The Advanced Technology Program's Approach to Technology Diffusion," invited paper for the NATO Science and Technology Policy Workshop Report, 1999.

Technology Transfer Report (1994). November 1, 1994.

Udayan Gupta (1995). "Plan to Kill U.S. New-Technology Funding Draws Fire —- Backers of Cuts Cite 'Corporate Welfare'; Critics Decry Loss of Seed Money," *The Wall Street Journal* , May 25, 1995, p. B2.

About the Advanced Technology Program

The Advanced Technology Program (ATP) is a partnership between government and private industry to conduct high-risk research to develop enabling technologies that promise significant commercial payoffs and widespread benefits for the economy. The ATP provides a mechanism for industry to extend its technological reach and push the envelope beyond what it otherwise would attempt.

Promising future technologies are the domain of the ATP:

- Enabling technologies that are essential to the development of future new and substantially improved projects, processes, and services across diverse application areas;
- Technologies for which there are challenging technical issues standing in the way of success;
- Technologies whose development often involves complex "systems" problems requiring a collaborative effort by multiple organizations;
- Technologies which will go undeveloped and/or proceed too slowly to be competitive in global markets without the ATP.

The ATP funds technical research, but it does not fund product development. That is the domain of the company partners. The ATP is industry driven, and that keeps it grounded in real-world needs. For-profit companies conceive, propose, co-fund, and execute all of the projects cost-shared by the ATP.

Smaller companies working on single-firm projects pay a minimum of all the indirect costs associated with the project. Large, "Fortune-500" companies participating as a single firm pay at least 60 percent of total project costs. Joint ventures pay at least half of total project costs. Single-firm projects can last up to three years; joint ventures can last as long as five years. Companies of all sizes participate in ATP-funded projects. To date, more than half of the ATP awards have gone to individual small businesses or to joint ventures led by a small business.

Each project has specific goals, funding allocations, and completion dates established at the outset. Projects are monitored and can be terminated for cause before completion. All projects are selected in rigorous competitions which use peer-review to identify those that score highest against technical and economic criteria.

Contact the ATP for more information:

- On the World Wide Web: http://www.atp.nist.gov;
- By e-mail: atp@nist.gov;
- By phone: 1-800-ATP-Fund (1-800-287-3863);
- By writing: Advanced Technology Program, National Institute of Standards and Technology, 100 Bureau Drive, Stop 4701, Gaithersburg, MD 20899-4701.

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