Chapter 6

Energy and Environment

American Superconductor Corporation (ASC)

High-Temperature Superconducting Coils for Electric Motor Efficiency

Large electric motors of 1,000 horsepower (hp) or more are used in many applications across the U.S. economy. If more-efficient motors could be developed and replace older ones, the savings would be substantial. The new motors would consume less electricity than older motors. In addition to cutting electricity bills, the switch to more-efficient motors would decrease the need for electricity production, with concomitant reductions in the burning of fossil fuels and in the resulting air pollution.

A 286 hp demonstration motor constructed by Reliance Electric with HTS windings supplied by ASC.

Harnessing Superconductivity to Increase Electric Motor Efficiency

American Superconductor Corporation (ASC), a young development-stage company, was eager to undertake the long-term research and development needed to capture the advantages offered by high-temperature superconductivity for large electric motors. But it lacked the necessary financial resources to do it. At the time of the ATP award in 1992, there was little competitive pressure in the electric power-generation industry, so few incentives existed to reduce costs. And, although the Department of Energy followed the ATP award with a contract to ASC, that source of funding was unavailable for the initial research the company proposed to do. ASC reports that the ATP award made the research project possible. Without the award, the company would have been unable to do the research and development on the new technology, even on a delayed-development schedule.

Superconductivity Reduces Energy Losses

The most significant energy losses in motors come from resistive heating in the windings, so superconducting motors with almost no electrical resistance in the windings could realize important efficiency gains. To be able to build such motors required significant advances in the design, fabrication and winding of HTS wires in geometries required for motor winding.

In addition to industrial motors, the new technology would be useful in generators, transmission cables and superconducting magnetic energy storage systems. It also has potential applications in x-ray lithography, ion implantation, medical cyclotrons, magnetically levitated trains, magneto-hydrodynamic ship propulsion systems, and magnetic separation for materials processing and ore recovery. Indeed, opportunities abound for reducing electric energy use via applications of the ATP-funded technology.

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PROJECT:

To develop high-temperature superconducting (HTS) wire fabrication and winding techniques that will enable the development of large HTS electric motors with almost no electrical resistance. This advance will reduce the motors' electricity consumption and save the country hundreds of millions of dollars in energy costs each year.

Duration: 7/1/1992 — 6/30/1995
ATP number: 91-01-0146

FUNDING (IN THOUSANDS):

ATP	$1,883	42%
Company	2,579	58%
Total	$4,462	

ACCOMPLISHMENTS:

ASC achieved its goal of developing HTS wire fabrication and winding techniques. It demonstrated the use of racetrack-shaped HTS coils in a 5-hp motor early in the project and in a 200-hp motor soon after project completion. The company also:

- received six patents for technologies related to the ATP project:
  - "Current Limiters in Power Utility Applications"
  - (No. 5,390,064: filed 7/7/1992, granted 2/14/1995),
  - "Superconducting Rotor"
  - (No. 5,482,919: filed 9/15/1993, granted 1/9/1996),
  - "Method of Making Superconducting Wind-and-React Coils"
  - (No. 5,531,015: filed 1/28/1994, granted 7/2/1996),
  - "Superconducting Magnetic Coil"
  - (No. 5,525,583: filed 2/7/1994, granted 6/11/1996),
  - "Magnetostrictive Superconducting Actuator"
  - (No. 5,585,772: filed 1/11/1995, granted 12/17/1996), and
  - "Variable Profile Superconducting Magnetic Coil"
  - (No. 5,581,220: filed 10/10/1995, granted 12/3/1996);
- applied for eight additional patents for technologies related to the ATP project;
- won *Industry Week* magazine's Technology of the Year Award in 1996;
- won the 100 Award in 1996 from *R&D* magazine, which selects the 100 most important innovations of the year, for its development of CryoSaver current leads, a spin-off product related to the ATP project;
- received (with partner Reliance Electric) $10.2 million in Department of Energy Strategic Partnership Initiative awards in 1996 for cost-shared development of high-horsepower, commercial-scale motors;
- received a $10-million investment from Électricité de France, the French power company, in April 1997; and
- raised $27 million via a second public stock offering in February 1994.

COMMERCIALIZATION STATUS:

Commercialization is in progress. A partnership with Reliance Electric will help commercialize the large-motor technology in the form of 1,000- and 5,000-hp motors. In the meantime, ASC has introduced a related product, CryoSaver current leads, in 1996. Users of this product have already achieved better operating efficiencies in magnetic resonance imaging and commercial energy storage systems.

OUTLOOK:

The project has progressed as planned, and the outlook for achieving significant energy savings from HTS motors is excellent. Large electric motors account for about 65 percent of all electricity consumption in the United States, so even small efficiency gains in this application are likely to translate into cost savings of several hundreds of millions of dollars for the nation. In the future, large users of electric power will be able to construct new facilities with smaller, more-efficient and reliable motors based on HTS technology. Other applications of the technology could help residential electricity users in the United States save millions of dollars in energy costs each year.

COMPANY:

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Number of employees:
59 at project start, 146 at the end of 1997

Informal collaborators:
Reliance Electric Company (acquired by Rockwell International in 1995), Oak Ridge National Laboratory

. . . received six patents for technologies related to the ATP project . . .

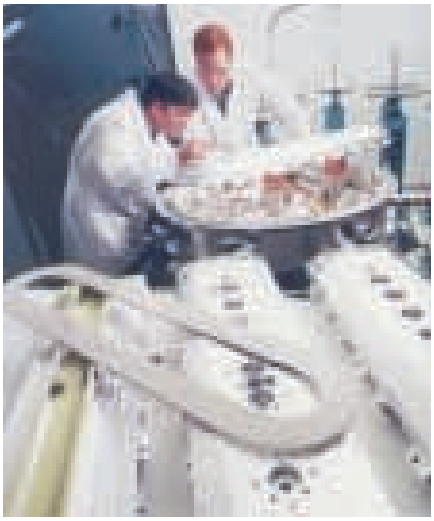
Larger and Larger Motors

Researchers from ASC and its partner, Reliance Electric Company (now part of Rockwell International), built a 5-hp HTS motor as proof of concept. This team and researchers at Oak Ridge National Laboratory then fabricated and tested a series of racetrack-shaped HTS coils of a type needed for motors. This effort included studies of mechanical and electrical properties that affect performance, as well as the development of fabrication techniques for producing flexible, durable wires in increasing lengths. Soon after the project ended in June 1995, ASC built a 200-hp HTS motor for testing and demonstration. The company is planning to complete development work on a laboratory model 1,000-hp HTS motor in late 1998 or early 1999 and then begin development of a 5,000-hp motor. Each increment in motor size represents substantial advances in the underlying technology.

This advance will reduce the motors' electricity consumption and save the country hundreds of millions of dollars in energy costs each year.

A Long-Term Endeavor on Track

ASC has viewed this endeavor from the outset as requiring a long-term commitment and substantial infusions of capital along the way to reach full commercial deployment of the HTS technology in huge electric motors. The effort is on track. In the meantime, ASC has launched its first commercial product related to the ATP-funded technology, the CryoSaver current leads, which carry power into HTS devices from external electricity supplies. Although this is not the ultimate commercial-



Placing 1000 horsepower HTS motor coils into a cryogenic cooling system.

. . . electricity users are likely to benefit from lower electricity costs enabled by electricity producers' use of the new HTS motors.

. . . won *Industry Week* magazine's Technology of the Year Award in 1996 . . .

ization goal envisioned for the technology, CryoSaver current leads provide revenue and help maintain investor interest in the company.

The CryoSaver product has received technical recognition as well as early commercial success. In 1996, it won *Industry Week* magazine's Technology of the Year award and the 100 Award from *R&D* magazine, which selects the 100 most important innovations of the year.

An HTS motor of at least 1,000 hp is needed to achieve efficiencies and cost savings in line with the project goals. ASC is deliberately waiting until it proves the concept at the 5,000-hp level before moving the HTS motor into commercialization. The company expects to demonstrate a commercial-scale 1,000-hp motor in 1999.

Following the ATP award, ASC received funding from the Department of Energy as part of a $21 million motor program with Reliance Electric and several other companies to complete the development work. In addition, it raised $27 million via a second public stock offering and attracted another $10 million in private investment from the electric utility industry. It is actively protecting its intellectual property position through patent filings.

Pole set and double pancacke HTS coils for 1000 horsepower Reliance Electric motor.

Potential for Huge Benefits

Users of ASC's CryoSaver current leads have achieved better operating efficiencies by improving the transmission of electricity for cryogenic devices. In the future, users of large electric motors (electric utilities, steel mills, water pumping stations) will be able to have motors that are smaller, more reliable and more efficient than today's motors.

This may be particularly important when competition is introduced into the electric power industry, which ASC has selected as its first commercial target. Companies in that industry have generally operated as regulated monopolies. With competition in the production of electricity, cost savings will be far more important in the electric power generation marketplace. Some of those cost savings are likely to be achieved by electric power generation companies switching from conventional large electric motors to HTS motors from ASC.

Lower costs for power generation companies, together with pricing pressure as several companies compete for the right to supply commercial and residential customers, is likely to result in cost savings at the power generation level being passed on, at least partially, to customers. The end result of this chain of events, which is still in the future, is that electricity users are likely to benefit from lower electricity costs enabled by electricity producers' use of the new HTS motors.

The possibility exists for a large return to the economy as a whole from the implementation of this new technology, since even small gains in motor efficiency translate into large energy savings to the companies and to the nation.

The company expects to demonstrate a commercial-scale 1,000-hp motor in 1999.

Armstrong World Industries, Inc.

New Materials for New-Generation Thermal Insulation

Armstrong researchers planned to investigate the microstructure of insulation material and the air cells, or pores, within it. The project aimed to learn how to control the molecular morphology — structure — of the solid material (to reduce its thermal conductivity), the geometry and orientation of air cells (to optimize pore morphology), and the size and distribution of air cells (to reduce the thermal conductivity of air within a cell).

Developing Super Insulating Materials

Though they were not able to fully achieve their goals, the researchers made important progress in the development of super insulating materials as a result of their study of materials with high porosity and of nonspherical pores that are nanometer in size. The technical work followed two major tracks: the fabrication of polyethylene and polystyrene foams with carbon dioxide blowing while attempting explicitly to control the formation of the air pores, and the development of new process technology for the synthesis of aerogels for use in insulation products.

The blowing of polyethylene and polystyrene foams with carbon dioxide entailed substantial challenges in attempting to optimize the mechanics to achieve the foam without a pressure drop leading to collapse of air cells. The researchers ran into problems working with polyethylene and, in addition, concluded that modification to extruder equipment would be necessary to achieve success with carbon dioxide as the blowing agent. Both changes raised production costs. Armstrong subsequently shifted away from polyethylene to other thermoplastics and began blowing with butane, in addition to carbon dioxide, but costs could not be lowered enough to justify commercialization. No patents or papers resulted from this track of the ATP-sponsored research.

Researchers achieved more technical success in their work on process technology for the synthesis of aerogels.

Researchers achieved more technical success in their work on process technology for the synthesis of aerogels. The aerogels and xerogels produced by the process have both a high porosity and small pores; that is, the resulting material is microporous, with about 25 percent of the pore volume in pores less than 50 nanometers in diameter. The process also promises to substantially lower the costs of aerogel production. Armstrong received three patents for its technical advances in aerogel synthesis.

Company Shifts

At the time the project was awarded, Armstrong saw the ATP project as providing an opportunity to broaden the company's capabilities along lines that it otherwise would not have pursued. By developing new forms of insulation with superior performance, Armstrong saw the opportunity to broaden its focus from the technical insulation market (insulation for heating, refrigeration, plumbing and specialty applications) to the structural insulation market (insulation for buildings and other large structures). Armstrong officials expected their first aerogel application to be for rigid technical insulation, with eventual opportunities in structural applications.

Later company reorganizations and strategy shifts changed the company's plans for applying its new technical know-how. Armstrong officials concluded that — despite the remarkable insulating properties of the aerogels and the new process technology, which dramatically reduced production costs — the unit costs were still too high to penetrate the structural insulation market. The company's initial excitement over the potential of aerogels for the structural market dimmed. Armstrong scaled back its estimated demand for aerogels and decided to procure what it needed through suppliers rather than produce them in-house.

The company has decided to license the three aerogel process patents to potential suppliers, and not to be in the aerogel manufacturing business itself. To the extent that suppliers who obtain the licenses can use technology to produce aerogels more cheaply, Armstrong will benefit from its research in terms of a lower-cost supply. Other buyers may also benefit from lower-cost aerogels, depending on the specific licensing arrangements negotiated by the suppliers with Armstrong.

The company's initial excitement over the potential of aerogels for the structural market dimmed.

PROJECT:

To develop process technology for a new-generation insulation material based on controlled morphology (structure) in order to achieve superior insulating properties and associated energy savings.

Duration: 8/1/1992 — 7/31/1995
ATP Number: 91-01-0025

FUNDING (IN THOUSANDS):

ATP	$1,868	41%
Company	$2,650	59%
Total	$4,518	

ACCOMPLISHMENTS:

Armstrong researchers performed research in two major areas: process technology for aerogels and carbon dioxide blowing of polyethylene foams. The company received three patents for technologies related to the ATP project:

"Preparation of High Porosity Xerogels by Chemical Surface Modification"

(No. 5,565,142: filed 4/28/1993, granted 10/15/1996);

"Thermally Insulative, Microporous Xerogels and Aerogels"

(No. 5,525,643: filed 7/28/1995, granted 6/11/1996); and

"Wet Silica Gels for Aerogel and Xerogel Insulation and Processes for the Wet Gels"

(No. 5,762,829: filed 3/5/1997, granted 6/9/1998).

COMMERCIALIZATION STATUS:

Armstrong has decided to license its low-cost aerogel synthesis patents to suppliers, rather than to manufacture aerogels directly, but the licensing has not yet occurred.

OUTLOOK

Despite extremely good insulating properties of the aerogels and lowered processing costs, early applications of the aerogel are expected to be limited to niche markets, such as rigid technical insulation for heating, refrigeration and plumbing, or to speciality applications such as superconductivity insulation. Even with lowered costs, the aerogels do not at this time appear to be cost-competitive with conventional insulation materials for structural applications. Armstrong is continuing its research on the use of carbon dioxide foaming of thermoplastics, and this approach may hold promise for the future.

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Thus far, no licensing agreements have been achieved. But, according to company officials, Armstrong stands ready to negotiate licensing agreements for its aeorogel process technology.

In fall 1996 Armstrong combined, with another unit, the research unit where the ATP project was carried out, a consolidation that also entailed personnel changes. The principal investigator on the ATP project left Armstrong and set up a separate business that is reportedly working in areas related to the ATP project. This movement of people who worked on the research project and the establishment of a new business pursuing related technological goals may provide yet another possible path of technology diffusion.

The company has decided to license the three aerogel process patents to potential suppliers, and not to be in the aerogel manufacturing business itself.

Over time, Armstrong's primary interest has shifted away from the aerogel technology and toward the foam blowing technology, as indicated by the company's continued involvement in this area. Here, too, Armstrong's research effort shifted away from the initial ATP project focus towards techniques and materials that now are seen to offer more promise of achieving the high-performance foam insulating products that were the ultimate goal of the ATP-funded research.

E.I. du Pont de Nemours & Company

Thallium/Lead Thin Films for Advanced Superconducting Electronic Devices

Superconductivity holds great promise for reducing energy consumption in practically any process that uses or transports electricity. Radar components, power transmission lines, communications satellites, and a host of electronic and electrical devices, for example, are good candidates for superconductor applications.

New Technology for Making Superconducting Components

At the time of its proposal to the ATP, DuPont had carried out a three-year research program to develop high-temperature superconducting (HTS) materials and was debating whether to disband the effort because of its high technical uncertainty. The properties of HTS materials were still not well understood, fabrication processes had not been developed, and the technical and commercial viability of the materials had not been proven. DuPont said later that continuation of its HTS research hinged on receiving an ATP award, which the company considered an indicator of the promising nature of the work.

With its ATP award, DuPont developed thin-film HTS fabrication technology. It is generic enough to use with a variety of HTS materials that have form, structure and performance properties similar to those of thallium/lead. The technology is particularly useful when using thallium/barium or thallium/lead in the fabrication of HTS electronics components. The company developed two thin-film fabrication processes — a two-step approach using sputtering and post-annealing and a single-step approach with simultaneous sputtering and annealing. Photolithographic and ion-milling techniques are used to form circuits and other electronic features in the films. The viability of the two processes was demonstrated by constructing and testing several basic electronic components, including oscillators, filters, mixers and coplanar-designed transmission lines.

. . . continuation of its HTS research hinged on receiving an ATP award . . .

. . . HTS component technology recognized as one of the "Top Products of 1993" by *Microwaves & RF* magazine . . .

Many New and Potential HTS Products

DuPont has developed six electronic-component products: thin films of two or three inches in diameter made on HTS substrates of erbium/barium, thallium/barium or thallium/lead. All six of these products use the new HTS thin-film fabrication technology developed in the ATP-funded project. In addition, the company usually fabricates electronic components on the thin-film wafers, cuts the wafers into discrete components and encases them in metal casings, all according to customer specifications.

The company has begun substantial marketing efforts and is successfully selling products. Most of these are made with erbium/barium and thallium/barium rather than thallium/lead. Applications requiring the higher operating-temperature capabilities of thallium/lead HTS components have not yet developed significantly, due in part to improved cryogenics technology that has increased the number of application areas where the two other HTS materials are useful.

DuPont has maintained its long-term vision and continues to develop HTS electronics components based on erbium/barium, thallium/barium and thallium/lead. The payoffs may be coming soon, especially in magnetic resonance imaging (MRI) equipment and possibly in terrestrial and satellite communications. HTS materials also have potential use in nuclear magnetic resonance instruments, superconducting quantum interference devices and a variety of microwave applications.

For superconductor technology to realize its full potential, however, more advances have to be made in the technology. DuPont continues to fund its HTS research program at significant levels.

. . . this technology . . . could make magnetic resonance imaging and terrestrial and satellite communications less expensive and more efficient to operate . . .

. . . published more than 20 research papers on the technology in professional journals . . .

. . . a small equipment supplier, the Kurt J. Lesker Company . . . improved fabrication equipment . . .

PROJECT:

To develop thin-film fabrication processes needed to produce high-temperature superconducting (HTS) electronics components at reasonable cost.

Duration: 4/1/1991 — 3/31/1994

ATP number: 90-01-0064

FUNDING (IN THOUSANDS):

ATP	$1,590	67%
Company	784	33%
Total	$2,374	

ACCOMPLISHMENTS:

DuPont accomplished the R&D goal and has demonstrated several component products that directly use the new technology. It has also marketed products based in part on procedures developed by the project, but using thallium/barium as a key ingredient instead of thallium/lead. Indicators of successful development of the technology are that the company:

- published more than 20 research papers on the technology in professional journals;
- had its HTS component technology recognized as one of the "Top Products of 1993" by *Microwaves & RF* magazine in December 1993;
- introduced HTS thin-film products that, when built into larger systems such as magnetic resonance imaging machines and communications satellites, can lead to higher performance at lower overall cost; and
- worked with a small equipment-supplier company to develop improved HTS thin-film fabrication equipment.

COMMERCIALIZATION STATUS:

The market for new products based on the fabrication technology developed in the project is well established, even though applications that use thallium/lead as the HTS material have been slow to develop. Several products made with the new HTS technology are being marketed. The company has invested large sums to scale up for production in anticipation of increased demand in the near future.

OUTLOOK:

Use of the new process technology can substantially reduce the cost and improve the quality of superconductors in many applications. Applications based on this technology could, for example, make magnetic resonance imaging and terrestrial and satellite communications less expensive and more efficient to operate, generating widespread benefits valued at tens of millions of dollars.

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Less-Costly, More-Efficient Electronic Equipment

HTS processes developed in the ATP project could make superconductivity-based equipment less costly and more efficient to operate. HTS-based signal coils, for example, permit the use of a low-cost permanent magnet for MRI, an arrangement that could reduce the installation cost of this MRI machine to as little as one-tenth that of a standard MRI device. In addition, the use of HTS electronics enables equivalent or better MRI performance at much lower cost. IGC, an MRI manufacturer that uses DuPont HTS electronics in its products, reports that operating costs for its MRI machines are expected to be about one-sixth those for currently available competitor machines that use low-temperature superconducting technology. Thus, the new technology helps reduce MRI capital and operating costs while improving diagnostic effectiveness.

The benefits of the new HTS technology are likely to be substantial and widespread. In MRI and satellite communications, for example, the chain of events leading from the manufacturer of the components to the end users has many steps. At each step, some benefits from the technology are likely to accrue to intermediate customers and end-users, who pay for only a small part of the value they receive from the technological advance. Given the large number of end users for MRI and satellite services, the aggregate value of those spillover benefits is likely to be in the tens of millions of dollars.

During this project, DuPont worked with a small equipment supplier, the Kurt J. Lesker Company, to develop improved fabrication equipment for depositing HTS material on a wafer. Lesker is now making these improved machines available to other companies, as well as to DuPont.

Michigan Molecular Institute (MMI)

Recycling Mixed Plastics

Like turning swords into plowshares, the idea of turning waste plastics into fenceposts, park benches, building blocks and other useful, long-lasting items holds tremendous promise for the welfare of society. Wood rots, iron rusts and stones weather, but plastic endures. You can tear, bend or break plastic. But words like "rot" or "rust" simply do not apply — a blessing when durability is at issue; a curse when plastics are dumped into landfills.

Wood rots, iron rusts and stones weather, but plastic endures.

Technology to Recycle Much More Waste Plastic

The U.S. economy produces about 75 million pounds of plastic products each year, and the idea of recycling them is appealing. A problem with reusing plastics, though, is that the many kinds do not mix well in recycling processes. Recycling today requires sorting of plastics, many of which still get dumped because they are not compatible with the others. This ATP project with Michigan Molecular Institute (MMI) aimed to develop a technology that would dramatically increase the proportion of plastics that can be recycled. The new technology would "compatibilize," or alter, various plastics so they mix well in recycling. They could then be formed into pellets with essentially the characteristics of virgin plastics. These pellets would be mixed into a slurry fed into a continuous flow process that puts out a mixed plastic strong enough for construction materials.

. . . a curse when plastics are dumped into landfills.

A key technical goal of the project was to develop the science and technology of polymer compatibilization, which would enable polymers in the commingled plastic-waste stream to be recycled into commercially useful products. Collaborating researchers from Eastman Kodak, Eastman Chemical and the University of Florida (UF) accomplished that goal by establishing the fundamentals of compatibilization of multiphase polymer blends, including new knowledge about the "morphology" — the shape and structure — of polymer blends. The team also prepared compatibilizers using a variety of chemical approaches and produced and tested prototype compatibilized materials. Researchers found effective methods to compatibilize commingled-plastic waste.

New Recycled-Plastic Products

Results of the ATP project are being used by Eagle Plastics Systems of Florida to produce compatibilized plastic panels for housing parts, in collaboration with UF researchers who were involved in the ATP project. Large 4-inch-thick panels are fabricated by sandwiching fiberglass insulation between thin plastic sheets attached to galvanized steel studs. These wall units are then used for the construction of low-cost modular houses, many of which are used following a fire or other disaster, when temporary housing must be built quickly. The company plans to construct full-scale compatibilized plastic-panel manufacturing plants in the near future.

Eagle constructed an assembly plant in Kentucky and began manufacturing modular houses there in late 1996. It uses recycled plastics brought from a pilot plant to the site by railroad cars that left the state loaded with coal. Because of the extremely low cost of the recycled plastics, the company can manufacture its houses for about $6 per square foot, much lower than the cost of conventional housing, which runs as high as $50 per square foot. During its first year producing the modular houses, Eagle generated more than $100 million in contracts.

Results of the ATP project are being used by Eagle Plastics Systems of Florida to produce compatibilized plastic panels for housing parts . . .

In addition, attempts to commercialize the technology are under way via the development of two new MMI research and development projects in the auto industry that focus on recycling plastics from auto parts such as dashboards and door panels. Both projects rely on the knowledge of polymer blend morphology discovered in the ATP project. If these projects generate applications in the auto industry, the ATP technology will be commercialized via that route, as well.

Commercialization efforts did not proceed as quickly as anticipated when the proposal was submitted. One obstacle to the speed of commercialization was a change in ownership and direction of Waste Alternatives, one of the initial collaborators on the project and the company that was planned to play a key role in commercializing the technology.

ATP Funding Critical for Recycling Research

Without the ATP award, MMI officials say, the project would not have been undertaken. The funding helped MMI forge relations with research partners at the University of Florida, Eagle, Eastman Kodak and Eastman Chemical. Research on post-consumer plastics packaging recycling, based on the ATP-funded technology and substantial funding from Eagle, is continuing at the university. In addition, researchers there have extended the ATP technology to develop new virgin plastics alloys that are expected to lead to further commercialization. A 30-acre plastics recycling industrial park is being constructed on land owned by the UF Foundation, and continuing support for research amounting to about $100 million over the next 15 years is anticipated.

In addition, the use of knowledge developed by the ATP project may have advanced the two succeeding studies at MMI for recycled plastics parts in the auto industry by as much as two years. The scientific information generated by the ATP project has also been made generally available, via published technical papers, to the plastics and recycling industries.

PROJECT:

To develop methods for polymer compatibilization — adding small amounts of a substance to a blend of different plastics to make them chemically compatible so that the material fabricated from them has good mechanical and physical properties. This technology would greatly increase the amount of waste plastic that can be recycled.

Duration : 8/15/1992 — 8/14/1995
ATP number: 91-01-0088

FUNDING (IN THOUSANDS):

ATP	$1,642	30%
Company	3,808	70%
Total	$5,450	

ACCOMPLISHMENTS:

MMI researchers and their collaborators established the fundamentals of polymer compatibilization, which enables polymers in a waste stream of different kinds of plastics to be recycled into commercially useful products. Indicators of this accomplishment are that MMI and its collaborators:

- published more than 10 papers on the technology in professional journals;
- made the technology available to Eagle Plastics Systems to develop and test materials for the housing construction industry; and
- made the technology available through MMI to two on-going R&D projects in the automobile industry that focus on recycling plastics from auto parts such as dashboards, door panels and tail lights.

COMMERCIALIZATION STATUS:

One collaborating company has begun to use the technology in the construction of low-cost modular houses. Information on the technology generated by the project is now available to the plastics and recycling industries via published technical papers, and some of it is being used in additional research projects.

OUTLOOK:

Commercialization is underway and is expected to increase substantially in the construction of modular housing. The technical base developed in this project is also being used in two new projects that focus on recycling plastic auto parts.

ORGANIZATION:

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Informal collaborators:
University of Florida; Eagle Plastics Systems; Eastman Kodak Company; Eastman Chemical Company; Inter Recycling, Inc.

One obstacle to the speed of commercialization was a change in ownership . . .