DOE/AL/98934--T1

The New Mexico Technology Deployment Pilot Project: A Technology Reinvestment Project

(Contract No. DE-FC04-94AL98934)

Final Report

**Sandia
National
Laboratories**

The University of New Mexico

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Preface

By any standards, the New Mexico Technology Deployment Pilot Project is a successful project (NMTDP). It surpassed all its goals for the two years it was funded by the Technology Reinvestment Program (TRP). However, a dry report of objectives met does not fully communicate the accomplishments of this project. The results of the project are of national significance, and have implications for public policy on several levels.

Since the original TRP was initiated, there has been a significant change in policy related to technology transfer efforts. The need to control costs, reduce expenditures, and still meet the national laboratory defense mission, has resulted in a withdrawal of support for technology transfer activities. Certainly it is essential that national laboratories focus their limited budgets on accomplishing their missions, nor should the shrinking defense budget be used to support non-defense programs. At the same time, the still substantial investment in defense-related research demands that policy makers carefully examine the products of research to see where that investment can be leveraged to perhaps reduce other costs. The various segments of the economy do not operate in a vacuum, and an expenditure in one area may have the effect of reducing expenditures in another. Conversely, budget cuts in one department may cause budget increases in another. Therefore, the TRP model of interagency collaboration to meet diverse objectives is still an opportune policy. This report summarizes the TRP-funded work of the NMTDP, however, project activities will continue.

The NMTDP prefers technology collaboration over technology transfer. By this, we mean cost-sharing technology research as a collaboration between government and the private sector, with measurable benefits to both, instead of a one-way transfer of information from one side to the other, with the primary benefit going to the technology recipient.

We are market-focused and product-focused, keeping an eye always on the return on investment. We believe that collaborative product development has benefits to defense programs beyond access to improved dual-use technology--and often these benefits are not obvious. Future uses of new technology are difficult, if not impossible, to predict. For maximum benefit, projects like the NMTDP must have the flexibility to experiment with ideas and explore new markets. At the same time, we believe that government support for such projects should be both limited and short-term, leading to self-supporting programs.

As an example, this report includes a discussion of the potential for health care savings that could be derived from collaborative projects between the Department of Energy and Veterans Affairs programs. The NMTDP provides a model for public policy of agency, industry, laboratory partnerships to solve problems of national interest.

**THE NM TECHNOLOGY DEPLOYMENT PILOT PROJECT
FINAL REPORT
SECTION ONE: EXECUTIVE SUMMARY**

Introduction

The New Mexico Technology Deployment Project (NMTDP) has been in operation for slightly more than two years. As one of the original TRP projects, NMTDP had the charter to develop and validate a new model for technology extraction which emphasized focused technology collaboration, early industry involvement, and a strong dual use commercialization and productization emphasis. Taken in total, the first two years of the NMTDP have been exceptionally successful, surpassing the goals of the project. This report describes the accomplishments and evolution of the NMTDP to date and discusses the future potential of the project. Despite the end of federal funding, and a subsequent reduction in level of effort, the project partners are committed to continuation of the project.

An interactive version of this report may be found on the World Wide Web at <http://www.nmia.com/~riattdev> after October 1, 1996. This executive summary is organized as follows:

- Summary of accomplishments
- Description of the model
- Needs assessment
- Overview of the assistive technology industry
- Assistive Technology Resource Alliance (ATRA)
- Partnerships
- Dual-use product development
- Potential future products
- Lessons learned and evolution of the project
- An implication for public policy: Reducing national costs of health care through assistive technology
- Project continuation
- Project publications

More in-depth descriptions of each of these topics may be found in the appendices and bibliography of publications comprising the balance of the report, or by visiting the Web site.

Summary of accomplishments

- Developed, tested, and deployed a model for technology transfer and product commercialization from national laboratories to private companies
- Completed extensive literature review and consumer needs assessment
- Identified a list of over 200 potential products, classified according to state of the art and underlying dual-use applications.

- Developed a prioritization methodology for selection of products for commercialization.
- Identified, analyzed, and deployed national laboratory dual-use technologies relevant to assistive technology products and applied these technologies to product development.
- Formed the Assistive Technology Resource Alliance (ATRA), an international alliance of individuals and organizations with an interest in assistive technology product development. The ATRA has become a valuable source to assistive technology companies (especially small businesses) for market, consumer, technology, product, opportunity, funding and other related information.
- Assessed the market potential of the assistive technology industry. Information from multiple data sources was synthesized to produce an evaluation of the potential of assistive technology as an attractive market area for government investment. The results are summarized later in this report.
- Established collaborative agreements among project partners –the University of New Mexico, Sandia National Laboratories, and Laguna Industries, Inc.–that extend beyond the TRP program.
- Formed TEXCON (Technology Extraction and CONcept development team), an interdisciplinary product development team formed from a core group of national laboratory engineers and assistive technology specialists.
- Established an Advisory Board representing researchers, industry, and consumers.
- Successfully formed partnerships with industry for productization
- Developed the Generic Total Contact Seat product with the industrial partner, Numotech.
- Developed a personal security monitor product, now in the partnership phase.
- Identified additional dual-use products under development, or consideration for development, including wound and burn healing technologies; light weight, compact oxygen sources; apnea monitoring; power sources for electric wheelchairs; and indoor photovoltaic power sources.
- Identified opportunity for a national program to reduce health care costs.

Description of the Model Process

There are five key elements of the NMTDP model: (1) Focus in depth on a specific application area; (2) A management team with deep knowledge of the application, relevant tech base and commercialization; (3) An inside-the-facility team to mine the technology in terms of product concepts; (4) Provision of resources for development; and (5) A closed loop process for tracking and management.

- **Focus on a specific application area** in order to provide an efficient and manageable concentration of effort. The project focus is on potential products for individuals with disabilities–referred to as assistive technology products.

The Technology for Persons with Disabilities Act defines assistive technology as “any item, piece of equipment, or product system, whether acquired commercially

off-the-shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities." While definitions for disability vary, this project considers all people with a permanent or temporary functional limitation, whether physical, cognitive, or communicative, as potential consumers of assistive technology products. This definition of consumers includes those persons with legal status as disabled, as well as the elderly and persons who have temporary or permanent limitations due to illness, accident, or war-related trauma.

- **A project group of partners with detailed knowledge of the application area, relevant technologies, and product development.** Our group consists of the Research Institute for Assistive and Training Technologies of the University of New Mexico (RIATT), Sandia National Laboratories (SNL), and Laguna Industries, Inc. (LII).

The University of New Mexico is a nationally preeminent training center for assistive technology professionals. The success of the training program, begun in 1988, has resulted in further university support for expansion of assistive technology programs. The Research Institute for Assistive and Training Technologies (RIATT) of the University of New Mexico was formed in 1993 with the mission to advance the application of assistive technology through research and demonstration, training innovations, information dissemination, and product development and commercialization.

Laguna Industries, Inc. is a tribally-owned and operated manufacturing and service company. Over the last ten years, LII has developed a wide span of core competencies in manufacturing and design engineering, computerized production control, quality control, integrated logistic support, technical publications, metal machining and fabrication and electronics. The company is an excellent example of a small defense-dependent firm with a goal of developing a commercial market base.

Sandia National Laboratories is a government-owned, contractor-operated, multiprogram national laboratory operated for the Department of Energy by Lockheed Martin Corporation, and the primary source of dual-use technology for the project.

- **An interdisciplinary team charged with mining the dual-use tech base to conceive specific product concepts that satisfy unmet user needs for assistive technology products.** The Technology Extraction and CONcept Development (TEXCON) team, reporting to the project group, combines understanding of user needs, technological feasibility and commercial reality. Team members were drawn from Sandia, LII, RIATT, and ATRA members. *Their product concepts and preliminary designs became the vehicles for nominating specific technologies for extraction, development and deployment.*

- **A large pool of resources for product development, financing, and assistance through an Assistive Technology Resource Alliance (ATRA).** The NMTDP project facilitated formation of this alliance, which includes small and large product

application. Once the proof-of-concept stage is reached, the final development decision is made jointly by NMTDP and one or more industry partners who will take the product through the commercialization phase. The industry partner develops the product prototypes using its own resources. The loop returns to the consumer during prototyping and beta testing through direct feedback to the manufacturer. Industry is responsible for the final product design and manufacturing, production, and delivery. Finally, the loop ends where it began—with products in the hands of the consumer.

As seen in Figure ES-1, the NMTDP process links the entire deployment cycle, from identification of marketplace gaps and technology resources to delivery of the finished product to the consumer. The left side of the loop is constrained by knowledge of needs and available technologies. The right side is limited by availability of resources for development and production. Using the closed loop process, the project team can identify and address potential barriers to successful commercialization. NMTDP activities are conducted primarily on the knowledge side of the loop. Activities on the resource side are facilitated by the project through ATRA. Through ATRA, the NMTDP provides potential industry partners with information from needs assessment and concept development activities that helps identify commercially viable assistive technology products. In addition, ATRA assists members in finding partners and other resources for product development.

Development and validation of the model process has been a major accomplishment of this project. The model process was documented in detail prior to initiating deployment activities. The approach, which incorporates early involvement of industry, a focus on product concepts, close ties to consumer needs, and realistic market and commercialization assessments, has been successfully developed, refined and tested. It has since been disseminated through write-ups in national publications and industry journals.

Needs Assessment

NMTDP needs assessment activities had several related goals. The first goal was to identify unmet or inadequately met assistive technology needs of consumers and match those needs to national laboratory dual-use solutions. The second goal was to collect information and data which could be used to estimate the potential of the assistive technology marketplace in general (discussed later in this report) and the market potential of specific products that might be selected for development. As potential dual-use products were identified, focused market analyses were conducted as part of the selection process. The results of these market studies were detailed in several reports and presentations, which may be found in the reference list accompanying this report. Finally, data was collected through industry surveys to determine the needs and capabilities of potential industry collaborators.

The consumer needs for the assistive technology market were documented through collection and analysis of demographic data, review of past assessments, and direct interaction with consumers and industry professionals. This activity resulted in extensive demographic and statistical information on consumers with disabilities and needs for assistive technology, including:

- The identification of a large unmet need for products in hands of consumers—over 200 product ideas in 10 classes, classified according to the state of the art and underlying dual-use applications.
- Market analyses of highest potential products. A focused market analysis was completed on candidate products, resulting in identification of commercially viable products for the deployment phase. These needs were used directly in the derivation of assistive technology product concepts incorporating advanced dual-use technologies.
- The development of a prioritization methodology for selection of products for commercialization. The methodology is designed as a traceable process for screening a potentially large number of products, operating with limited data, accounting for TRP goals of dual-use application and participation by small defense-dependent companies, and understandable and accepted by potential industry partners. Testing of the process with the list of products generated by the needs assessment resulted in identification of strong product concept candidates for deployment.
- Members of the TEXCON team were selected and participated in a number of key activities, including interdisciplinary cross-training, a scan of national laboratory technology, identification of dual-use product applications, and development of product concepts. TEXCON activities focused on the identification of technologies that offered potential for new or improved assistive technology product development, while complementing the lab mission and technology needs.

Finally, through ATRA, a comprehensive survey of the assistive technology industry is in process. The previous needs assessment activities form the basis for a survey of assistive technology manufacturers and developers to determine industry needs and capabilities. The results of the survey will be matched with laboratory strengths and needs and viable market segments identified earlier and used to develop product concepts for collaborative projects with industry. Data collection will be completed during the fall of 1996, and a series of reports will be available through ATRA starting in January, 1997.

Overview of the assistive technology industry

The assistive technology market is an ideal area for government investment. This evaluation is based on consideration of multiple interacting factors: (1) The structure of the market; (2) Estimates of the aggregate size of the US market in terms of numbers of individuals needing products and the total dollars expended; (3) Estimates of the size of segments making up the aggregate market; (4) Analysis of market potential for specific products; (5) Examination of market and social trends; (6) Evaluation of the technology content of existing products in the market; and (7) Evaluation of the industry servicing this market, including the suitability for entry by small defense dependent companies. Further, this assessment is based on the US market alone, excluding the much larger worldwide market. A brief summary of the factors follows.

Structure and size: The assistive technology market is structured on three levels. The top, aggregate level amounts to billions of dollars annually, including

products and services for at least 35 million individuals (and up to over 70 million persons depending on definitions). Because disability expenditures come from a variety of Federal, state, and private sources, there is no single source of data on the total cost of disability care. However, in 1986, the last year in which a comprehensive study of disability expenditures was completed, Federal spending for disability-related care was estimated at over \$50 billion. The total including state and private funding was estimated at over \$150 billion. Currently, two Federal programs—Social Security Disability Insurance and Supplemental Security Income—alone pay out more than \$60 billion to 9 million people with disabilities. Between 1985 and 1994, the cost of these two programs increased more than 59%. This would suggest that current spending is at least \$200 billion. Not all this money goes into products, of course, but some of the service expenditures could be traded off for products. We conservatively estimate the current market for products to be at least \$5 to \$10 billion annually. This does not constitute a mass market however, due to the high level of differentiation of needs in this population.

The second level of structure of this market is composed of segments defined by common functional needs or technologies. There are several schemes for defining these segments. One example used by the project includes mobility, communication, transfer, personal security, and others. These market segments tend to have markets of 100's of millions of dollars. For example, there were 10 million mobility and transfer devices in use in 1992, with an installed base cost estimated at \$8 billion. The annual market for these devices is over \$1 billion. There were over 4 million communication devices (speech, vision, hearing) in use the same year. The cost of the hearing devices alone was over \$2 billion. As a last example, the market for the emergency response and service systems segment is over \$200 million annually. Although these segments at the second level constitute substantial market potential and can be defined so that they include a high degree of technical commonality, there is also significant need and product differentiation within them.

The third level is the market for a specific product. Each product is targeted at a specific market. At this level annual sales for a particular product tend to range from \$100's of thousands up to \$10's of millions. For example, the personal status monitor developed by the project is expected to have sales averaging about \$6 million annually.

Thus, *the assistive technology market can best be described as a large aggregate of niche markets*, with niches at the second and third levels. In aggregate, the market is quite large, but in terms of penetration, it must be approached at the niche level.

Industry composition: The industry is adapted to this fact. There is limited interest from giant companies, especially when introduction of new or specialized products is concerned. There are estimated to be more than 2000 companies currently providing products to this market, by far the majority being micro and small businesses. These are structured to make a profit from products with sales on the order of millions (as opposed to billions for large companies). These small companies often tend to be specialized. Many could benefit from technology

infusion. Further, many small defense dependent companies are well suited to enter this market due to good matches of production quantities and tech base.

Technology content: The needs assessment revealed that the market is underserved in terms of products and quality. The availability of suitable products often falls short of needs. The technology content of products that are available tends to lag the state of the art in some applications with high market potential. Some applications are "begging" for technology breakthroughs. Major advances in some areas, such as battery technology, will have widespread mainstream applications.

Social and Market Trends: The aging of the US population, along with improvements in health care leading to longer life span, has already been reflected in increasing gross numbers of people with functional limitations. In terms of numbers, by the year 2000 over 29 million Americans will be over age 65, and 18 to 20% of these people will need some assistance due to impairment. At the same time, a growing social acceptance of device use and civil-rights legislation promoting the social integration of people with disabilities has already begun to impact this market. Since 1980, the number of available assistive devices has grown from 3200 to more than 21,000. Projected growth for this market is 10% to 12% per year. The overlapping markets in durable medical equipment and home health care are both growing at 10% to 15% per year.

Synthesis. The assistive technology market is a very attractive area for government investment. The market is significant in aggregate and growing in numbers, dollars, and social importance. Economic and demographic trends will continue to focus national interest, and likely resources, into the area. The market is underserved in terms of products and quality-ripe for infusion of technology. Despite its overall size, the market is too highly differentiated for the mega-companies, yet is very well matched to a target population of micro and small companies currently in the market or looking to diversify beyond defense. These are the very types of companies that can capitalize on the technologies and opportunities offered by this project. Finally, some if not many of the technologies deployed in this project to the assistive technology market will migrate into the mass market arena.

Assistive Technology Resource Alliance (ATRA)

As part of the model process, the NMTDP has demonstrated the importance and rewards of comprehensive industry involvement in the technology extraction process. The project has had dramatic success in forming links to the assistive technology industry and in establishing an industry-wide alliance of assistive technology companies. This organization, called the Assistive Technology Resource Alliance (ATRA), is key to the continued success of the NMTDP in applying advanced government technologies to the assistive technology marketplace. The ATRA has achieved national recognition in the assistive technology market, and has attracted members who actively pursue new assistive technology products and technologies in collaboration with the government research organizations participating in this project.

The Assistive Technology Resource Alliance (ATRA) is a network comprised primarily of industry participants, and designed to facilitate commercialization of new and improved assistive technology products. The ATRA provides members with technology, market, consumer and product information while also conducting market research, matchmaking activities and other support functions for the members. ATRA World Wide Web Home Page service for members includes an on-line database of member interests and capabilities to facilitate networking and forming of partnerships among members. In addition, the ATRA helps to link the project with potential industry partners and commercialization resources.

The data and services are provided both as a benefit of the membership and on a for-fee basis for more extensive efforts. Membership dues are expected to be a significant element of the funds for organization self-sufficiency by the end of the next two years of operation. As of December 31, 1995, ATRA had attracted more than 600 members. The majority of ATRA members are assistive technology companies, in addition, other resources in the deployment process, such as technology sources, tech transfer centers, distributors, and service providers have participated as members of ATRA.

Partnerships

Cooperation for mutual benefit has become a theme of the NMTDP project, in keeping with its evolution toward technology collaboration over technology transfer, and in line with the focus on dual-use technologies and companion products. The cooperative arrangements exemplified by the multi-agency administered Technology Reinvestment Program, have propagated at all of the working levels to yield successful product development from the New Mexico Technology Deployment Program.

Successful partnership programs have been initiated and successfully prosecuted at several levels. At the federal level, the Technology Reinvestment Program provides partial funding for NMTDP through the Department of Energy. This partnership requires collaboration between the Department of Defense's Advanced Research Projects Agency, which managed the TRP, and the Department of Energy, Headquarters.

At the local level, the Department of Energy, Albuquerque Branch (DOE/AL) administers the TRP funding for the project, and is actively involved as a member of the management team. The University of New Mexico and Sandia National Laboratories provide additional funding for the project through a cooperative agreement with DOE/AL. The management team includes representatives from DOE/AL, the University of New Mexico, Sandia, and Laguna Industries, Inc. The program is a team effort and the contributions of all parties are essential to its overall success.

The third level of partnership occurs during product development. One or more industrial partners contribute to the development of each product. ATRA members form the bulk of the development, manufacturing, and marketing resources available to the team during the deployment phase. In the case of the Generic Total Contact Seat product, the industrial partner was itself a partnership

among the Sepulveda Veterans Affairs, the University of California, Los Angeles, and Numotech, Inc.

While the direct benefits to the commercial arena are more strikingly obvious, the partnership of a forward-thinking private business, a group of dedicated university and government researchers, and a team of engineers and scientists at a DOE National Laboratory has brought both direct and indirect benefit to DOE programs and SNL staff.

Continued encouragement to such partnerships will bring vital technologies to the laboratories, and continue to provide motivating challenges to maintain high levels of technical competency of laboratory personnel.

Dual-use product development

Through the NMTDP, technology extraction from the National Laboratories has been successfully demonstrated on a number of companion products. Companion products are those which benefit the governments primary interests (such as defense), but also have application, either directly or with minor adaptations, to the commercial marketplace. The NMTDP has emphasized, in its technology deployment and productization efforts, the parallel development of companion products.

Generic Total Contact Seat. The most notable success of the NMTDP has been the success in developing and deploying dual use products based on federal technologies, exemplified by the recent joint announcement of the Generic Total Contact Seat by Numotech, Inc. and the NMTDP. Numotech is a small business located in California which has developed, in collaboration with NMTDP, a new seating system for wheelchair users. This seat is a major advancement in the prevention and cure of decubitus ulcers (pressure sores) which afflict nearly 80% of all long-term wheelchair users sometime during their lifetime. This seating system has been shown to be capable of accelerating the healing process of decubitus ulcer pressure sores. NMTDP expects that the seat will significantly reduce the probability of occurrence of these sores. Decubitus ulcers are one of the most serious health threats to long-term wheelchair users and cost Americans \$3-5 billion annually in medical and related expenses. In addition, the seating system has applications in military and commercial transportation. Further, the integral technologies can be applied to several companion products for the military and commercial markets.

Personal Security Monitor: miniaturized, body-worn vital signs monitoring system. In addition to the Generic Total Contact Seat, the NMTDP has developed the Personal Security Monitor system to the proof-of-principle stage. This system is designed for use in home health care monitoring, battlefield soldier monitoring, law enforcement, critical personnel monitoring, and other military and commercial uses. The NMTDP project has demonstrated the integration of a set of primary technologies for sensing pulse, motion, falls, and orientation. Work is continuing on extracting respiratory rate and blood oximetry. These technologies, together with miniaturized telemetry and advanced signal processing techniques, could be applied to both military needs and a personal security monitoring system for home care and hospital monitoring. The product is currently under consideration by industrial

partners for commercialization in several fields of use. A large number of other medical, commercial and military applications are feasible.

Other activities. In addition to those products developed directly by the project, through ATRA the NMTDP has played a key role as a "matchmaker" in putting together the partnership of companies producing the Raynes Rail Audio Unit, a product which provides audio messages to visually impaired individuals in public facilities. This product is receiving international recognition and interest for use in transportation centers, museums, public buildings and other facilities requiring adaptation for the disabled.

The NMTDP has identified numerous other potential dual use and companion products as a result of the model process which has been developed and employed. These products, several of which are being actively pursued by the project in collaboration with industry, are described in the following section.

Potential future products

A key focus of the NMTDP has been in generating real products for the assistive technology market. As a result of the first phase of this project, numerous other candidate products in the assistive technology have been identified. The project has a long list of potential dual use assistive technology products that utilize industry and national laboratory technologies and await funding for final development. The following is a list of some of those product and technology opportunities which could be developed during the next two years:

Wound and burn healing technologies. Two approaches to rapid wound and burn healing are under development. Topical hyperbaric oxygen systems have been shown to promote rapid healing in burn, skin ulcers and other surface wound conditions. However, precision control of the wound environment is essential to successful treatment. The project is pursuing systems to provide automated precision control of the local wound environment for topical hyperbaric wound healing systems. Additionally, it has been shown that irradiation of wounds by specific electromagnetic radiation sources in the millimeter wave band can promote more rapid healing. The project has available Sandia developed technologies for employing radiation based enhanced wound healing, including miniaturized millimeter wave generators and radiation monitors and controls.

Light weight, compact oxygen sources. Many medical applications require large amounts of oxygen for patient treatment. The Trauma Pod envisioned by military medical planners is one such system. The development of a light-weight oxygen low pressure supply system could be a significant advancement to the ARPA combat casualty pod.

Apnea monitoring. Several technologies under development could be applied to apnea monitors and SIDS monitors for infants. These include pressure sensing pads for cribs or hospital beds, and ultrasonic detectors of larynx motion. The vital signs monitoring technologies described above could also be applied to apnea monitoring.

Power sources for electric wheelchairs. The NMTDP needs assessment identified alternate power sources for wheelchairs as a high priority item for

consumers. Users of powered chairs frequently requested power sources that would allow them to travel further and/or connect auxiliary equipment. Current lead-acid batteries, while relatively inexpensive, do not supply sufficient energy for a normal day's activities for most users. Present lead-acid battery technology also has other drawbacks, including: a limited life cycle (increasing the overall cost of use), danger from caustic electrolytes, and potential fire hazard during recharging from hydrogen gas generation.

Very light weight, non-obtrusive, liquid fuel conversion that can be used indoors may prove achievable in the distant future. However, our investigation revealed that "traction batteries" being developed for electric vehicles have much higher specific energy densities (energy per unit volume), are safer to operate, lighter, and with anticipated manufacturing advances will become cost competitive with the lead acid technology. The technology already exists for the commercial advancement of two systems--nickel hydride batteries and nickel cadmium. Nickel hydride technology promises to yield energy densities approximately 2.5 times that of standard lead-acid technology, while nickel cadmium has only about 1.5 times greater energy density. Nickel hydride is not yet in commercial production which takes it out of contention because of the relative high cost of current production techniques. On the other hand, nickel cadmium is becoming increasingly cost competitive with lead-acid technology. The major detraction of nickel cadmium batteries is the potential environmental effects if the batteries are improperly discarded and significant amounts of toxic cadmium migrate to the water table. While not reaching the desired increase in energy density of 2.0, nickel cadmium batteries do provide sufficient additional energy to propel and average user approximately the same distance that most non-disabled people walk, and have many other very attractive features that support their introduction into this market, including lighter weight, longer life cycle, safer transport, and safer charging characteristics. NMTDP, with support from the state of New Mexico and the US Department of Energy, will be investigating alternate distribution methods where the users are not responsible for the disposition of used batteries and investigate better recycling technologies for removal of toxic components. When in place, such systems will allow wheelchair users to avail themselves of advanced battery technology immediately.

Indoor photovoltaic power sources. One of the most costly features of preparing public buildings for accessibility by persons with disabilities in compliance with the Americans with Disabilities Act is the installation of new electrical power bus to support emergency indicator equipment for persons who have sensory deficits. Typically the cost to modify the electrical supply in an existing building to support the proper placement of emergency informational equipment is approximately three times the cost of the equipment. Usually, wherever people are working or congregating, there are sufficient light levels to support photovoltaic cells which when optimized for indoor use and for enhanced conversion to electrical energy of infrared radiation can provide sufficient energy to recharge small, light weight advanced batteries capable of powering the required emergency equipment. The use of portable, photovoltaically rechargeable energy sources allows equipment placement to be optimized for the best use of people with disabilities. If

pursued, NMTDP believes this area has the potential to be very attractive to companies wishing to optimize the infrared conversion of solar cells and build portable, easily installed power sources to support emergency building equipment.

Lessons learned

- **The ultimate measure of successful technology deployment has to be taken in terms of products in the market place.** Further, technologies will only transfer if the incorporating product is commercially viable. Therefore, the project must consider the entire process—from identification of user need, through technology application, to product availability for the end user—with user needs and cost as crucial considerations at all stages.
- **National weapons laboratories such as Sandia are an excellent source of interdisciplinary based, dual-use technologies** because of the laboratories unique mission of uniting basic science with best-practice engineering in the nuclear and advanced conventional weapons programs, and supporting core competency and energy program research.
- **Development projects involving national laboratories must complement the lab mission and technology needs.** The compelling demand of the lab mission requires that those resources be leveraged rather than exploited. Therefore, NMTDP developed a focus on companion products, and technology collaboration rather than transfer. We believe that technology transfer implies a one-way benefit, while true collaborative projects require that all parties deliver a clear and meaningful contribution and receive a measurable return on investment.
- **Focus on assistive technology leads to an exceptionally broad target population.** As discussed later in this report, an opportunity exists to reduce cost and improve effectiveness in education and health care. Individuals needing assistive technology products are usually under-employed or unemployed and have high costs associated with daily living, health care and education. The Americans with Disabilities Act (ADA) requires businesses and public buildings to make reasonable accommodations to employ or provide services to individuals with disabilities. This has inevitably added to the cost of doing business and stimulated markets for cost saving devices or techniques that reduce this cost while maintaining or improving performance. Initial product development in this industry tends to be fragmented. The sector has traditionally been a government-driven niche market for products with limited application. However, current trends indicate significant growth in this area as wider applications are developed, especially if costs can be lowered.
- **An entity such as ATRA is needed to be the focal point where national laboratories, universities, industry, and consumer needs come together.** Many of the small businesses that comprise the assistive technology industry lack the resources and broad range of technical personnel necessary to remain innovative. At the same time, nascent industries such as the assistive technology industry have little experience in collaborating with large research labs or universities, or even with each other. The challenge for product developers who wish to collaborate with national laboratories is to show a clear connection between the needs of the

laboratory and the proposed commercial product to result from the collaboration, when that developer is unlikely to have access to possibly classified information from the national laboratory relating to laboratory needs. In addition, research organizations often lack an understanding of the specific market forces or technology needs or strengths in a particular industry. The ATRA serves as an interface between industry and government that is crucial to successful collaboration.

- **Industry partners must invest and participate in product development at an early stage of the process.** Involving industry partners early in the process helps to keep the focus on collaboration rather than transfer, and ensures commercialization will occur. If the idea is taken too far before involving industry, it may interfere with the product development cycle of the industry partner, and the potential for commercialization may be lost.
- **New products must be based on identified consumer need and market viability.** Full participation by industry will not occur unless there is a demonstrated payoff for industry investment.
- **In the long term, deployment projects can and should be self-supporting.** Based on the experience of this project, we believe deployment projects such as NMTDP can become self-supporting within four to five years through industry investment and return on royalties and licensing fees. Government support during the start-up period is necessary. However, this project suggests that the benefits of effective deployment are worth the initial investment.

An Implication for Public Policy: Reducing National Costs of Health Care Through Assistive Technology

The thrust of the NMTDP was on designing products, and partnering to produce them, with the objective of improving the quality of care while simultaneously reducing cost—at the national and consumer level—and to do so within the commercial competitive economic environment. This section builds on the success of this project to outline a general approach for reducing national health care outlays. The expenditures targeted for reduction are labor intensive services associated with caring for persons with disabilities. These services are provided during periods ranging from relatively short duration during recovery of functionality, to time spans of years when loss of functionality is permanent. A very large component of total cost is associated with personal, labor intensive care of individuals who are for one reason or another significantly incapacitated or confined to hospitals or institutions for long periods—the “non-acute tail” of health care. This “tail” is where this project was focused. Medicine may have little or nothing left to offer in these phases of health care, but engineering certainly has much to contribute in terms of reducing total cost and improving quality of life by means of concrete products and improved processes. The potential for doing this is just beginning to be recognized at the national level. Experience with the NMTDP provides substantial confidence that costs can be significantly reduced by development and introduction of consumer/patient and provider products

specifically designed to mitigate the cost of care while improving the quality of life and service to the consumer.

Figures 1 and 2, following, show that both the VA and HHS have experienced

Figure 1: VA and DOE Funding

Figure 2: HHS, DoD and DoE Funding

arguably uncontrollable cost growth in recent years. It is broadly agreed that this growth is a major source of pressure on the federal budget, and hence impacts on many of the other important activities funded by government, including defense. Control of these costs could significantly reduce the pressure on other sections of the federal budget.

A two phase approach is needed, building on, and extending the results of, the New Mexico Technology Deployment Pilot Project. In the first phase, a detailed analysis should be conducted to identify the flow of funds in the delivery systems of the two key government agencies funding long term health care insurance programs, and to quantify the amounts attributable to service and care of disabilities. Concurrently, a continuing pilot program should be funded by appropriate government agencies to extend the partnerships between the local operating elements of the VA/HHS and the DOE to the headquarters of the agencies. Under the umbrella of agency level partnerships, continued product development programs should be conducted with industry, following the general model pioneered by the NMTDP. Given the expected success of the pilot, the second phase would then institutionalize the program within the partner agencies.

Continuation of Project Activities

As discussed in this report, the NMTDP has been successful during its slightly more than two years of operation, including developing a comprehensive understanding of the consumer needs and the assistive technology market, developing an effective model process for technology deployment, establishing an international alliance of assistive technology companies to support the involvement of industry in the model process, and developing and commercializing assistive technology products employing dual-use technologies from the national laboratories. Although the project was not able to reach full self supporting status in the limited two year funding period (nor was it expected to), it has demonstrated both success in product development and potential for generating sufficient revenue from royalties and licenses for self-support in the long term. Therefore, the project partners believe that the project should be continued and are committed to pursuing additional funding sources until self-support is reached.

Pending identification of new funding, project activities will continue at a reduced level of effort in two main areas: (1) Product development activities will continue as funding is available. Proposals for funding of products already identified for development will be submitted on an individual product basis. Investment by an industry partner will be a prerequisite to product development. (2) The Assistive Technology Resource Alliance (ATRA) is being incorporated as a non-profit organization in the state of New Mexico. Project partners will serve as members of the initial board of directors for ATRA on a volunteer basis for at least the first six months. Once ATRA is incorporated, partial support for ATRA activities will come from membership fees and charges for services.

Project Publications

A number of papers that describe project activities in detail have been and are being produced by the New Mexico Technology Deployment Pilot Project. The following list of publications is grouped by topic. All current project publications will be available electronically at <http://www.unm.edu/~riatt> by the end of 1996. These papers constitute the balance of this report. Future publications will be posted electronically as they are completed. Print copies of project publications are available upon request from the University of New Mexico.

NMTDP Model and Project:

- New Mexico Technology Deployment Pilot Project (1996) Final Report. Unpublished manuscript, University of New Mexico at Albuquerque.
- New Mexico Technology Deployment Pilot Project (1995) Phase One Review. Annotated briefing, University of New Mexico at Albuquerque.
- New Mexico Technology Deployment Pilot Project (in progress) Task by Task Summary. Unpublished manuscript, University of New Mexico at Albuquerque.
- Weaver, K., Carter, S., & VanEtten, G. (1995) Applying advanced technologies to assistive technology products: the New Mexico Technology Deployment Pilot Project (NMTDP). Technology and Disability. 4, pp. 175-186
- Weaver, K. and Shanahan, M. (1996) The New Mexico Technology Deployment Pilot Project in Proceedings of the RESNA '96 Annual Conference. Arlington, VA: RESNA Press.

Needs Assessment:

- Adamson, G., Behrens, B., & Carter, S. (1994) Assistive Technology for Home Living. Unpublished manuscript, University of New Mexico at Albuquerque.
- Carter, S. (1994). Identifying Needs of Individuals with Disabilities: A Review of Research. Unpublished manuscript, University of New Mexico at Albuquerque.
- Carter, S. (1994). Identifying Assistive Technology Needs: A Review of Research. Unpublished manuscript, University of New Mexico at Albuquerque.
- Gonzales, D. & Miller, A.K. (1995) A study of advanced power systems for mobility devices. Sandia National Laboratories at Albuquerque
- Lee, J.F., Bertrand-Hines, T., & Carter, S. (1994). Proceedings: Assistive Technology Futures Think Tank. Unpublished manuscript, University of New Mexico at Albuquerque.
- Miller, A. K. (1996). Roadmap for Rehabilitation Science and Assistive Technologies. paper presented at the Biomedical Technology Roadmap Workshop. Sandia National Laboratories at Albuquerque, April, 1996
- Probst, K. (1996) Emerging visual technologies. Assistive Technology News, 3(9&10), pp.1, 15.

Weaver, K. (in progress). Facilitating technology transfer between national laboratories and the assistive technology industry. Doctoral dissertation, University of New Mexico at Albuquerque.

Assistive Technology Resource Alliance (ATRA):

Shanahan, M., & Weaver, K. (1996). The Assistive Technology Resource Alliance: Facilitating new assistive technology product commercialization through industry networking and technology cooperation with national laboratories and private industry in Proceedings of the RESNA '96 Annual Conference. Arlington, VA: RESNA Press.

Weaver, K. (1995). Information needs of small businesses in the Assistive Technology Resource Alliance (ATRA). Unpublished manuscript, University of New Mexico at Albuquerque.

Miscellaneous reports and publications:

Behrens, B., Probst, K. & Weaver, K. (1995). Assessment of emerging technologies and processes of incontinence control. Unpublished manuscript, University of New Mexico at Albuquerque.

New Mexico Technology Deployment Pilot Project. (1995). Technical data package for the emergency monitor development. University of New Mexico at Albuquerque.

Probst, K. (1995). Focused market analysis for EM experimental products. Unpublished manuscript, University of New Mexico at Albuquerque.

Probst, K. (1995). Market survey for commode lift products. Unpublished manuscript, University of New Mexico at Albuquerque.