INTRODUCTION

Research and Development. Both words have multiple meanings. Even within academic disciplines the term *research* has multiple definitions. Dr. Reswick's opening article, "What Constitutes Valid Research? Qualitative vs. Quantitative Research," summarizes attempts to delineate research that is basic and research that is applied. Dr. Reswick argues that all forms of research have outcomes of equal merit; none are more equal than others.

The term *development* is closely associated with the applied end of the research continuum. The more applied the research, the more likely some development will follow. Taken as a phrase, "research and development"—the applied intent is even more apparent. Research and development, or "R&D," means advancing knowledge or practice to result in a tangible product or outcome. All products in the marketplace, be they automobiles, CD players, or adhesive tape, are the result of research and development. But a product's value is determined by the product user. Since a product is intended for use in some context, the product's development must consider both the context of use and the user. Within the field of assistive technology, the context of the product's use is restoring or sustaining some function. The product user may be a person with a disability, a family member, or a care provider. The research and development preceding the market delivery of an assistive device is inextricably linked with the product user.

This issue of *Technology and Disability* presents the research and development of various centers conducting work with assistive devices for use by persons with disabilities. The R&D is directly related to their daily lives and independence. The articles demonstrate the evolving nature of research, thereby emphasizing the importance of sustaining R&D funding over extended time frames of five years, ten years, and beyond. These centers recognize the importance of communicating with their constituents. Due to the high number of worthy submissions for this issue, we will publish a second issue on R&D next year.

Five articles describe the work of Rehabilitation Engineering Research Centers (RERC). The National Institute on Disability and Rehabilitation Research (NIDRR), U.S. Department of Education, funds sixteen RERCs across the nation. Some RERCs focus on assistive technology for specific disabilities, for example, augmentative communication devices for use by persons with speech impairments, support and mobility devices for persons with low back pain, and alternative access systems for persons with low vision and blindness. Other RERCs receive funding to address a range of devices across entire age groups (e.g., devices for older persons, devices for children with orthopedic disabilities) or to address a needed process (e.g., technology transfer). All the RERCs ensure full consumer participation in all aspects of the R&D process, as embodied in the Consumer Oriented Research and Development policy promulgated by the NIDRR.

The Vermont RERC for Low Back Pain is the subject of the first of the five articles. It is in a third five-year funding cycle. About 80% of adults have episodic back pain impairments, and about 4 million people are permanently disabled by back disorders. The project descriptions show how funding R&D over a long time frame allows the program to build upon and extend its prior work. Several new device development projects describe the problem identification and solution definition work that preceded them. The work involved consumers and researchers exploring options necessary to select appropriate product design.

"Rehabilitation Engineering Research in Blindness, Visual Impairment, and Multisensory Loss" shows the multiple links between researchers and end users. The RERC provides direct technical assistance to consumers on device availability and use, develops new product solutions to meet existing consumer needs, and channels information to manufacturers and clinicians alike. The focus has been on adaptations and devices for the workplace because consumers seeking employment and self-empowerment often have no other source of support.

The Center for Assistive Technology, University at Buffalo, operates two RERCs. This issue describes one. "The Rehabilitation Engineering

Research Center on Aging" describes the Consumer Assessment Study, the basis for all other work. Four hundred older persons living independently are providing information on their need for and use of assistive devices. By tracking their needs across years, the RERC is developing an understanding of this diverse population through their own perspectives. The needs identified translate into device development and environment improvement projects. The results provide materials for the center's education, training, and information dissemination projects.

"The Applied Science and Engineering Laboratories, The University of Delaware and the A.I. duPont Institute" also describes the work of two RERCs. First, the RERC on Augmentative and Alternative Communication Devices is in a second five-year funding cycle. Its projects help persons who cannot speak or hear to communicate and people with speech disorders to improve their communications ability. This RERC is transferring devices developed over the past five years to manufacturing partners and addressing newly identified research needs.

The second RERC, on Robotics to Enhance the Functioning of Individuals with Disabilities, is completing its first year. Robotic technologies developed through military, energy, and space programs have promise as assistive devices. The center is working to transfer such technologies into this field. In addition to developing robotic devices, the RERC is establishing criteria for power and control units, and assessing current standards for production and use. Both RERCs describe collaborative projects involving researchers, corporate partners, and consumers.

The RERC on Technology for Children with Orthopedic Disabilities, described in the next article, began operation in 1990. Its nine projects address problems and solutions in orthoses use by children. For example, prehensors exist for children but their effectiveness in gripping objects is limited by the user's strength and the device's efficiency. New design specifications will improve future devices. Development projects include integrated controllers, contracture reduction orthoses, and an articulated joint for ankle-foot orthoses. Research includes outcomes studies on critical success factors and psychosocial and developmental milestones for device use. These research projects are as important as device development in ensuring successful use by consumers.

Research and development is not confined to the U.S. In many ways, the health care policies of Canada and the European Community give them advantages in the development and marketplace delivery of new products. Two articles describe current work in Canada.

"Research and Development in Assistive Technology at the Centre for Studies in Aging in Toronto" describes some of the most common problems encountered by older persons. The focus is on three problem areas: the risk and prevention of falls, mobility aids for increased independence and self-care, and supporting cognitive function. The center has moved multiple products to the marketplace by working closely with manufacturers and consumers to design and deliver products with universal appeal.

"Rehabilitation Engineering at the Rehabilitation Engineering Department: The Hugh MacMillan Rehabilitation Centre" focuses on devices for use in rehabilitation and community reintegration. The projects cover powered mobility, adaptive seating, gait and movement analyses, prosthetic and orthotic designs, environmental controls, computer accessibility, and multimedia telecommunications. The center manages a device production and marketing company which distributes some products developed in-house and others licensed for distribution by outside companies.

Collectively, the articles in this issue show that R&D takes time and resources. The less defined the objective, the more time and resources required. Identifying needs, exploring options to address the need, reducing the selected solution to a practical item, testing and refining the product, then locating manufacturing, distribution, and support partners, all have open-ended time frames and budgets. All of the projects described receive some level of support from government agencies, which fund R&D in the field of assistive technology because no one else can justify the costs. Some centers also conduct collaborative R&D with for-profit corporations. These corporations perform some R&D of their own, but with a

bottom line based on weekly payroll and the next quarter's profits, they cannot invest sufficiently in longer-term R&D.

Assistive technology is a high-risk, low-return environment. It does not attract significant funding from venture capitalists or private investors. Even companies working in this field can afford only the basic R&D necessary to deliver a product for sale. All the groundwork has to be performed by someone else, in some other setting. This is the domain of academic and clinical research laboratories.

Over the past several years, some argued that government resources devoted to R&D should be redirected to fund immediate service delivery. If the argument had won, some people would undoubtedly today have greater access to the range of products that were produced for sale in 1992. However, those products came from the R&D of the past three decades. If government funding for R&D did cease, products in the marketplace would freeze at that state of product development—largely based on the technology of the preceding decade. Imagine if development of the automobile had ceased at the Model "T," or if computer technology had stopped with Univac.

There is a legitimate, essential place for R&D in the national agenda. As in other sectors, the assistive technology field can improve the efficiency and effectiveness of the R&D process. Close collaboration with customers, corporations, universities, and government agencies will leverage available resources to achieve results we all desire.

R&D funded by government is the only path to new generations of assistive technology products based on today's discoveries. Nanotechnology, superconductivity, and smart materials all have a place in the products of the year 2000. As you read about the R&D projects of today, think about the age of technology underlying these new products. Then imagine how changes in those underlying technologies will alter the products of the future.

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