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How and when did the rehabilitation engineering center program come into being?

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REHABILITATION ENGINEERING

Rehabilitation Engineering may be defined as a total approach to rehabilitation that combines medicine, engineering, and related sciences to improve the quality of life of persons with disabilities.

MILITARY AGENCIES INVOLVED IN PROSTHESES RESEARCH AFTER WORLD WAR II

Rehabilitation engineering in the United States had its roots following World War II in activities of the National Academy of Sciences (NAS) that were initiated by the U.S. Army and the Veterans Administration (VA).

It was in 1945 that U.S. Army Surgeon General, Norman Kirk, an orthopedic surgeon, asked the National Research Council (NRC), the operations arm of the NAS, to set up a Committee on Prosthetic Devices (CPD) for the purpose of providing leadership and coordination of the emerging federal programs in the Army, the Office of Scientific Research and Development (OSRD) and the (VA)—now the Department of Veterans Affairs (DVA).

The CPD was a unique committee at the time because it started with an assumption that has been critically important throughout the years: namely, that physicians, surgeons, and allied health professionals must join with physical scientists, engineers, and technical support persons when planning, undertaking, managing, and disseminating medical engineering research to aid persons with disabilities and improve their quality of life. The CPD was so constituted with such persons, and it was a joint operation of the Divisions of Medicine and Surgery and the Division of Engineering of the NRC.

Around this time, Brigadier General Fredrick S. Strong (retired) was appointed chairman of the committee, and its name was changed to the Committee on Artificial Limbs (CAL). General Strong, true to his name, had the reputation as a very dynamic and able person, but somewhat abrasive in manner. It has been suggested that the NAS/NRC leadership became concerned with his "direct" management style and, hoping to make the committee more advisory in nature, changed its name to the Advisory Committee on Artificial Limbs (ACAL). This name remained for around 10 years, but it is my impression that the name change did not have the desired effect and that General Strong continued to provide energetic involvement in many national research programs to the extent that the leadership of the NRC became concerned that his actions were exceeding the "advisory nature" of the NAS.

In 1948, thanks in part to the efforts of Congressman Edith Norse Rogers of Massachusetts, the U.S. Congress passed an Act that opened the door to the VA to fund research and development programs, both intra- and extramural. While directed at the needs of veterans, the results of these programs were made available to the public so that all persons with disabilities could benefit. A major VA service facility, the Veterans Administration

Prosthetic Center (VAPC), had become operational in New York. A Prosthetics and Sensory Aids Service (VA-PSAS) was also established at the VA Central Office in Washington, DC. The VAPC had a large service component that provided prostheses to veterans in New York City and the surrounding area as well as a group of engineers, physicians, and prosthetists concerned with developing better prostheses and methods to construct and apply them. The VA-PSAS was primarily concerned with oversight and prostheses procurement of the prosthetic and orthotic services located in a number of the VA hospitals throughout the United States.

In 1950 the VAPC became independent and able to fund outside research as well as research done in its own laboratories. This Center was closely tied to the ACAL and provided funding support for its activities.

At this point it would be appropriate to discuss very significant developments then occurring in Canada. However, in view of my limited knowledge I refer the reader to the detailed and excellent discussion of this topic by Douglas Hobson in his paper that follows this one.

The activities in Canada and the persons involved had significant impact on parallel developments in the United States. Research persons collaborated in later years on projects and took leadership positions in national committees.

THE BEGINNING OF CIVILIAN R&D IN REHABILITATION TECHNOLOGY

In 1954 Congress passed important amendments to the Vocational Rehabilitation Act that authorized the Department of Health, Education and Welfare (HEW) to fund research and development in the field of rehabilitation through the Office of Vocational Rehabilitation (OVR), soon to become the Vocational Rehabilitation Administration (VRA). This was the beginning of the civilian programs that were to run in parallel with the VA activities.

Somewhere between 1955 and 1960 a number of significant events occurred. Apparently General Strong felt ever more constrained by the NAS and resigned from the ACAL. A new committee was formed out of the ACAL to be called the Committee on Prosthetic Research and Development (CPRD).

THE COMMITTEE ON PROSTHETIC RESEARCH AND DEVELOPMENT OF THE NAS

The goal of the CPRD was similar to that of the original Committee on Artificial Limbs (CAL), but the national scene was different. The major players were the Veterans Administration (VA), with Anthony Staros, VAPC Director in New York and Eugene Murphy, Director of Intramural Research Programs in Washington, D.C. The HEW VRA, soon to be changed to the Social and Rehabilitation Service (SRS), was headed by Mary Switzer as Assistant Secretary, with her Director of Research Programs, James Garrett, and later, his staff person, Joseph Traub. Both the VA and the HEW were expanding their programs at this time, and while the VA continued to concentrate on artificial limbs, the SRS began funding a number of physical medicine and rehabilitation (PM&R) programs, including the beginnings of the rehabilitation research and training centers (RRTCs) that were based in a number of medical departments in American universities. They provided grants to support training programs for physicians to intern as physiatrists, training for allied health professionals, and general support for emerging PM&R departments. Research was an important part of these training objectives. From the beginning, technology was included as an important, but not primary, component in these efforts.

The CPRD, lodged in the NRC, the operations wing of the NAS, was composed of medical and engineering persons, all volunteers. It was chaired at first by Howard Eberhardt, who was a professor of civil engineering from Berkeley and an amputee. The Committee was supported by an ample NRC staff led by A. Bennet Wilson and was funded mainly by the VA and VRA/SRS. Its areas of concern expanded through the years from amputations and artificial limbs to include most of the areas now included in the fields of rehabilitation engineering or assistive technology. Two key persons, Tony Staros of the VA and Joe Traub of HEW, joined with Ben Wilson to form an informal interagency management team that was very important in the development of a national rehabilitation engineering program. The CPRD, with substantial funding from the VA and HEW and with the prestige of the NAS, was able to bring together most of the leaders and workers in the field through active subcommittees, ad hoc committees, and workshops leading to the development of research priorities, exchange of research ideas, evaluation of developed devices and systems, and publications covering these activities that were

widely distributed. As previously mentioned, researchers in Canada were much involved with CPRD activities. Colin McLaurin, for example, served as Chairman for a term. The system, at its best, represented an unusually effective management approach to optimizing the resources of the nation and the effectiveness of federal funding agencies.

REHABILITATION ENGINEERING CENTERS ARE CREATED IN THE U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Between 1960 and 1970, the HEW Rehabilitation Research and Training Centers program expanded with an increasing number of centers. Most had a PM&R orientation, but a few focused on vocational rehabilitation (VR) issues. The medical specialty of physical medicine grew in size and stature as a result of this RRTC program. At the same time, but in a smaller program, science and engineering projects were supported by Jim Garrett, Chief of Research & Demonstration Programs in RSA's R&D Office, and Joe Traub was named Coordinator of Rehabilitation Engineering in RSA. The words "Rehabilitation Engineering" were apparently coined by Jim Garrett at this time.

The rehabilitation engineering center concept was first formally defined at a meeting held by the CPRD at Annapolis, Maryland in September 1970. Representatives of the federal government and persons deeply involved in the field of rehabilitation research, education, and patient service, formulated guidelines for the establishment of rehabilitation engineering centers of excellence. I remember standing at the blackboard and writing down a set of objectives for these centers-to-be as they were formulated and revised by the group. They are listed below just as they were developed in 1970.

OBJECTIVES OF THE REHABILITATION ENGINEERING CENTERS

1. To improve the quality of life of the physically handicapped through a total approach to rehabilitation, combining medicine, engineering, and related science.

   [This first objective became, at that time, the working definition of *Rehabilitation Engineering*.]
2. To perform research and development in pioneering areas wherein a center has developed unique capabilities.
3. To collaborate with laboratories and industry to carry new devices and techniques through all phases of research, development, and clinical evaluation to active production and patient use.
4. To make available new devices and techniques to all patients referred to the center.
5. To educate others to provide these devices and techniques to patients throughout the nation.
6. To cooperate with other centers in fitting and evaluating their developments whenever needed.
7. To provide an environment for education of physicians, engineers, and other technical persons in related life and physical sciences.
8. To communicate effectively with other centers through recognized means and cooperative effort.

Perhaps the most important criterion for the first of these centers was that they were to be established in institutions that had already demonstrated ability in rehabilitation engineering, were associated with a university with recognized excellence in medicine and engineering, and, above all, provided continuing rehabilitative services to patients in a clinical environment. The need for effective collaboration among physicians and allied health persons with engineering and allied technical persons was also deemed indispensable.

A word at this point about my own early experience and developing awareness may provide some further background of the concepts on which rehabilitation engineering is based. In 1946, following service in the South Pacific, I returned to MIT for graduate study. Along with many other students, I worked part time in one of the advanced technology research laboratories that had been active before and during WWII. The effectiveness of challenging engineering design and development projects occurring along with my studies left a strong and lasting impression on me. In 1960 I moved to Case Institute of Technology to found and direct a new research center that we called the Engineering Design Center (EDC). My goal was to create an environment where students and faculty would apply advanced technology to real engineering projects. A seminal experience occurred when I visited Rancho Los Amigos, the Los Angeles County Rehabilitation Hospital, during the polio epidemic. There I saw children using air-actuated, externally powered braces to move

their arms. Having worked with similar robotic devices, but which used high-pressure gas servomechanisms for testing missiles, I sought out collaborators in the Western Reserve University Medical School and the Highland View County Hospital. We applied jointly to the VRA of HEW to apply this war-developed technology to help persons with disabilities to regain function. We were funded and the character of the EDC was formed. Physicians and allied health persons joined with engineering faculty and students to attempt to improve the lives of disabled persons. The Case Research Arm Aid (now it would be called a robot) was designed and built by faculty, students, and lab technicians. It employed high-pressure gas servos with digital encoders designed by students. Hand position of a paralyzed subject was controlled via electromyographic (EMG) signals obtained from his functioning high back muscles. All of this was very new in the 1960s. The collaboration expanded when Prof. Lojze Vodovnik from the University of Ljubljana, in Slovenia (then part of Yugoslavia) brought his interest in functional electrical stimulation (FES) to the Center. That program, started nearly 40 years ago, is still strong under leaders who were then students.

The major message of this history is that rehabilitation engineering requires open collaboration among its practitioners. How an engineering effort may meet the need of a person with a disability is seldom clear in the beginning. Neither the engineer nor the user nor the caregiver may be able to define the problem in terms that specify a solution. Most often, the first attempt disappoints but does serve to show what needs to be done. In the end, the assistive technology must be useful and be accepted by the person for whom it is intended. This is the goal of rehabilitation engineering.

THE FIRST FIVE REHABILITATION ENGINEERING CENTERS ARE CREATED

In July of 1971 Elliott Richardson, then Secretary of HEW, convened a panel of experts to further define the need for rehabilitation engineering centers and to give the concept highest visibility within the executive and legislative branches of government. The Massachusetts Institute of Technology (MIT) was involved in the Washington meeting and took the lead. Dr. William Berenberg, who was active in the United Cerebral Palsy Organization (UCP), got Leonard Goldenson, Vice President of ABC who was also active in UCP, to attend the hearings and to lobby Congress. I believe Senator Randolph of West Virginia was the key senator. This activity, with the behind-the-scenes maneuvering of Joe Traub and Jim Garrett, led to the special section in the Rehabilitation Act of 1973 that defined the RECs and even mandated that 25 percent of research funding under the Act go to them.

Joe Traub encouraged five groups to apply for RECs. They are listed as follows with their core areas and proposed directors:

1. Rancho Los Amigos Hospital, University of Southern California, “Functional Electrical Stimulation of Paralyzed Nerves and Muscles,” James B. Reswick, ScD, and Vernon Nickel, MD, Co-Directors. Other areas included the Functional Electrical Stimulation group of Donald McNeal, PhD, the Kinesiology Laboratory of Jaqueline Perry, MD, the Low Back Pain Clinic of Vert Mooney, MD, and the Powered Orthoses group of James Allen.
2. Moss Rehabilitation Hospital, Temple and Drexel Universities, “Neuromuscular Control Systems,” Richard Herman, MD.
3. Texas Institute for Rehabilitation and Research, Baylor College of Medicine, and Texas A&M University, “Effects of Pressure on Tissue,” William Spencer, MD. A second important area, led by Thorkild Engen, CP/O, dealt with the design of prostheses and orthoses employing advanced plastic techniques.
4. Harvard University and Massachusetts Institute of Technology, “Sensory Feedback Systems,” William Berenberg, MD, and Robert W. Mann, ScD, Co-Directors. Research at the Children's Hospital focused on children with cerebral palsy and at MIT, a second major area dealt with quantification of human physical performance.
5. Northwestern University and Rehabilitation Institute of Chicago, “Internal Total Joint Replacement,” Clinton Compere, MD. A second major track, led by Dudley Childress, PhD, was the development of assistive technology for persons with significant disabilities including control systems for powered wheelchairs, environmental control systems, communication aids, and so forth. Gene Lautenschlager and Evan Greener worked in the endoprosthesis (hip implant) project.

I had come to Rancho Los Amigos Hospital in Downey, California, 2 years before to set up a rehabilitation

engineering program with Vernon Nickel, MD, Medical Director and Co-Director on the REC application. We all got to work and sent in applications that were reviewed by a panel convened by CPRD and approved. We all expected early funding, but this was not to be. Mr. Haldeman, President Nixon's Special Assistant for Domestic Affairs (who later achieved notoriety in connection with the Watergate scandal), acting on instructions from the President to reduce domestic spending, exercised a “rescission” in the budget to eliminate funding of these new centers. Fortunately for the nascent program, Dr. Roger Eggeberg, former Dean of Medicine at the University of California was then Special Assistant to President Nixon for Medical Affairs. Dr. Harold Mazur, Medical Director at Rancho Los Amigos was a good friend of Dr. Eggeberg, so he arranged a meeting with him in Washington that I also attended. Dr. Eggeberg personally intervened and was able that same day to rescind the rescission and provide the desperately needed first years of funding.

Concurrent with launching the REC program, Jim Garrett urged Joe Traub (SRS) and Tony Staros (VA) to find means for the centers to meet and exchange information. They, with Ben Wilson (CPRD), organized a series of yearly national meetings with support from the VA and the SRS. It was these government supported conferences that led to the creation of the Rehabilitation Engineering Society of North America (RESNA). RESNA (now the Rehabilitation Engineering and Assistive Technology Society of North America) has matured into an internationally recognized, fully operational society that brings together all persons from inventors and engineers to persons with disabilities and the professionals who serve them.

So this is my remembered story of the birth of the rehabilitation engineering centers. Now, over 25 years later, there are 17 RERCs (RECs have become rehabilitation engineering research centers), with 5 more having been announced by NIDRR for funding in 2002. A description of these present centers may be found at the website of the National Rehabilitation Information Center (NARIC), [http://www.naric.com/search].