From "MEC 95," Proceedings of the 1995 MyoElectric Controls/Powered Prosthetics Symposium
Fredericton, New Brunswick, Canada: August, 1995. Copyright University of New Brunswick

RE-ENVISIONING REALITY FOR REHABILITATION: (A PAST, PRESENT & FUTURE LOOK AT VIRTUAL REALITY)

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INTRODUCTION

There has been much hyperbole over the past few years about Virtual Reality (VR). Could this phenomenon of transporting the human mind into a computer-generated world be important in the rehabilitation realm? Is it an area of interest to the Prosthetic and Orthotic practitioner? Where did VR originate? What are VR's present applications in rehabilitation? How does the future of VR allow us to re-envision rehabilitation? Imagine if you had lived in the 1940s, and were told of a box in your living room, through which you could see and hear people speaking or performing live at a distant location; would you have believed it?

This presentation will explore the role of Virtual Reality in rehabilitation: its origin, present, and future.

PAST

Initial investigational research in the 1940s questioned why competent blind travelers could uncannily avoid poles and other obstacles as they approached them. It was determined that they were warned of their presence through a feeling of pressure on their faces [1]. This phenomenon was called "facial vision"[1]. Further research also revealed a similar "auditory phenomenon resulting from a combination of reflected ambient sound and sound shadows, renaming the phenomenon echolocation"[1]. This investigation led to further studies of visual and auditory sensory perception in research. Such findings gave researchers the insight to question, "What could possibly give individuals more insight into the needs of others than experiencing life as they experience it - walking in their shoes, so to speak?"[1].

The U.S. Air Force initiated the development of VR. They conceived projects, such as display helmets for flight simulators and interactive gloves (renamed Data Gloves). NASA Ames Research Center developed the flight simulators, were composed of two components: an electronic image display and an electronic manipulator [2]. In 1965 the first working Head Mounted Display was developed by Ivan Sutherland as a military experiment. Much of the research for VR has been initiated in the military for the primary reason of available funding. These VR computer experiments were all multi-million-dollar projects even in their infancy stages.

The revolutionary break-through for VR development occurred in the mid-80s when costs were reduced, making this technology more attainable for the civilian researcher. Founder of the research company, VPL, Jaron Lanier, first publicly demonstrated relatively inexpensive VR equipment in 1984. Lanier had designed Eye Phones, a lightweight Head Mounted Display (HMD), the first working Data Glove, and even a full-body VR exo-skeleton suit, a type of sensor-equipped skin-diving suit [5]. Lanier's perceptiveness paved the way for other researchers to explore the world of VR and apply this technology beneficially.

The term Virtual Reality is widely applied. The Virtual Reality Casebook defines, "Virtual Reality is a three-dimensional, computer-generated, simulated environment that is rendered in real time according to the behavior of the user"[3]. In "A Conceptual Virtual Reality Model," further John Latta and David Oberg explain that "Virtual Reality involves the creation and experience of environments. Its central objective is to place the participant in an environment that is not normally or easily experienced"[4].

PRESENT

Presently, according to PC Magazine article, "Virtually Here," there exist in VR two Styles of Interactivity: fly-through VR and reactive VR. The fly-through VR gives the user six degrees of freedom (6DOF), such as walking through a room. Reactive VR allows the user to have the freedom of fly-through VR with the added bonus of interaction, including the ability to grab a 3-D object and throw it or manipulate it. Furthermore, there are three Levels of Immersion. The first, "through the window," involves viewing a computer monitor. "Into the room" goes a step further than the previous level, by adding sound, and with the aid of glasses, stereoscopic images. The final level is called "immersive;" the user wears a head-mounted display (HMD), by which he or she is transported into a visual virtual world [8]. As the computer multi-media revolution takes place, high-tech VR equipment becomes increasingly realistic and more intriguing. The product range widens as more computer products increase in availability. Sophisticated products are presently being utilized, such as "Spacetec IMC's Spaceball 2003"($1,195), used for 2-D & 3-D architectural and mechanical designs, giving six Degrees Of Freedom (DOF) by hand motion. Also, the "Fifth Dimension Technologies (5DT)", 5th Glove data glove ($495 plus $45.00 for additional flexor strips) is used to sense arm tracking in a VR environment.

Currently VR is utilized by architects to construct homes and offices, and to rearrange walls and rooms in already existing buildings without any physical renovations. If the customer dislikes the layout of the rooms, changes are made by simply dragging and dropping furniture or office equipment on the screen. Interestingly, there exists a system tailored for wheelchair-mobile persons. The WAVE-4-1 (Wheelchair Accessible Virtual Environment for one user) gives people in wheelchairs the ability to experiment with the proposed room designs before construction takes place [3]. This interaction allows people in wheelchairs to remove barriers that may hinder their normal daily activities, to re-size objects such as walls, toilets, and cabinets to suit their needs, and relocate simple things like door handles [3]. According to Bob Kirsch in Orthopedics Today, experiments in Virtual knee models are also being explored. However, Kirsch estimates that it will be ten to fifteen years "before technology can really match the exquisite capabilities of the human hand"[6] in terms of surgical-hand manipulation. Still, applications of VR for teaching rehabilitation skills seem likely to advance in the near future.

Yet, one may question the exigency for such high-level technology in aiding clients with rehabilitation. Technical writer Dave Sims quotes Jutta Treviranus, a former employee with the Hugh MacMillan Rehabilitation Centre in Toronto, Ontario, and a specialist in microcomputer applications: "Computer technology - specifically art, music, multi-media, VR applications, and input devices - has evolved to the point where it can fill that gap" by giving technological accessibility to children [9]. Treviranus added "that these early creative experiences are necessary for academic success, which in turn is necessary for vocational success"[9]. In response to her collected information, Treviranus concluded that present technology impedes VR advancement in terms of input or creative control - beyond choosing where you

Otto Bock 757M8 Myotrainer Set
(System Structure)

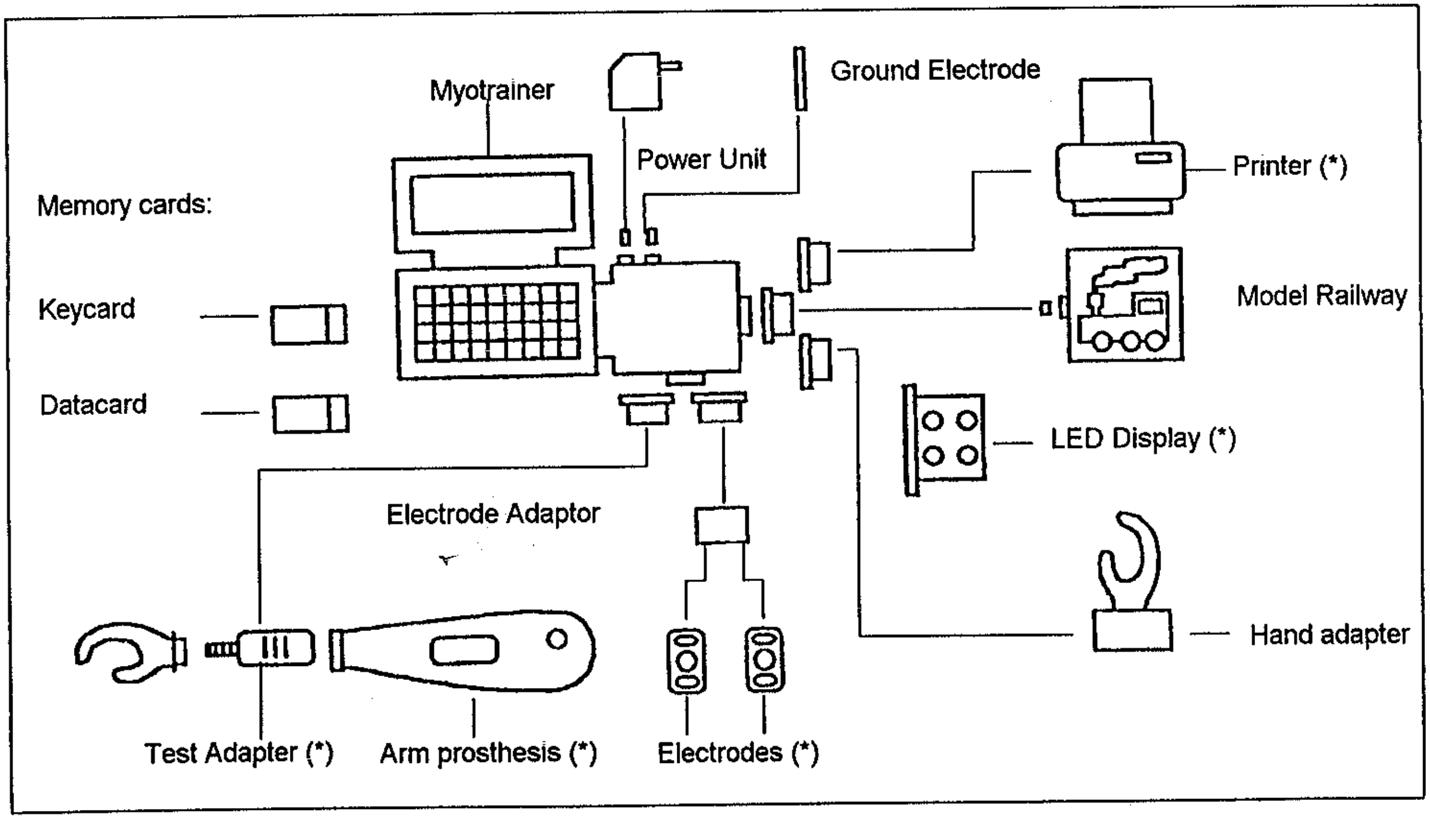

Figure 1
The OTTO BOCK Myotrainer Set is shipped without the components marked with (*).

want to go and view what you want to see, as multi-media. Treviranus' primary goal was to teach children, "that with a little help from technology (multi-media), they can gain control" of their speech, movement, and gestures [9]. One of the most encouraging benefits to multi-media and artistic usage is that restricted people learn that exploring and making mistakes are not called mistakes, but rather "creating" [9]. This multi-media approach offers a more optimistic perspective for rehabilitation than text-based approaches do.

In the realm of Powered Upper Extremity Prosthetics, multi-media is presently used to aid the prosthetist or physio-therapist in training myoelectric clients. Clients learn through the aid of the Otto Bock 757M8 Myotrainer-Set (Fig.1) how and when their hand opens or closes. Consequently, clients can receive visual feed-back as to what their muscles are achieving. This training program includes a documentation procedure to facilitate the prosthetist or therapist in evaluating the positioning and level setting of the electrode(s).

FUTURE

In summary, virtual reality is still in its infancy stage. Complete immersion in a "virtual world" is yet impossible because Virtual technology still cannot simulate instantaneously all of the five senses: sight, smell, taste, touch, and hearing. According to EDN, "Despite the media hype and the fantasy images of Star Trek: The Next Generation's Holodeck, the reality is virtually this: virtual reality today would disappoint most potential users"[7]. However, the medical community is already utilizing VR as a teaching medium. Thus, future rehabilitation and research should expand the practical applications of VR. For example, the future may well allow the Upper Limb amputee to "experience" the capabilities of a myoelectrically controlled prosthesis prior to the prescription and before the actual hardware is even ordered from the manufacturer.

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