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13. ABSTRACT ***(Maximum 200 Words)***

The Assistive Technology Research Center, ATRC, is comprised of a set of interrelated research and development projects which apply modern technologies, in particular those which have been exploited in the military, to the practice of medical rehabilitation and technological support for independent living for individuals with disabilities. The Center seeks to work collaboratively to meet the particular mandates of the U.S. Army Medical Research and Materiel Command. Projects are physically conducted and administratively located in the departments of rehabilitation engineering and neuroscience at the National Rehabilitation Hospital. Individual researchers from several other hospital services and clinical professions are also involved.

This annual report presents the status of eleven projects ranging from relatively small technology design & evaluation activities, scheduled to be completed within the new grant year, to the substantially larger, multi-part multi-center ANAM activity. Deliverables span the spectrum from new fundamental knowledge, for example on gaze behavior in individuals with stroke measured in a virtual visual environment, to new beta prototype products such as a wireless rollabout videophone for telerehabilitation applications.

Activities address five overlapping themes: assessment and enhancement (a&e) of motor function, a&e of cognitive function, a&e of performance in activities of daily living, applications of Virtual Reality technologies, and telehealth.

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Introduction: Highlights, Changes, Proposed Changes, and Justifications

Highlights

- The ATRC attracted Dr. Ramloll from the U.K. He is an accomplished, published VR engineer who has completed a doctorate and post-doctoral fellowship.
- Increased utilization of ANAM by high profile athletic teams was achieved, including: invitation from the New York Giants football team to use ANAM for a second year, adoption of ANAM by the Atlanta Falcons football team, and utilization of ANAM by the U.S. Army Elite Athlete Program at Fort Carson, Colorado.
- The VR project acquired and constructed the positioning, testing and data-acquisition protocol for use of a remote, desk-top eye-tracking device. This will enable us to acquire data regardless of a subject's facial structure and will not exclude people unable to tolerate the head-worn system used previously.
- Multi-Modal Interfaces: work at Anthrotronix on virtual reality and multi-sensory interfaces was presented at multiple conferences and resulted in 2 peer-reviewed publications and a book chapter. Our results indicate that there is a discernable relationship between an individual's formally assessed spatial ability and her/his ability to benefit from virtual reality training and multi-modal interfaces.
- A rudimentary 'Virtual Mall' has been developed, peopled by Ani-Mated humans. A protocol for participatory design has been developed and is awaiting review by the MedStar IRB.
- A Digital Visual Feedback system was conceptualized, developed and subjected to preliminary testing. The DVF allows a therapist during a treatment session to remotely control a camera (similar to a webcam) and computer to acquire and archive digital image sequences which can be reviewed immediately with the patient for reinforcement of successful compensatory strategies.

Changes During Year 2 and Rationale

Staffing

Dr. Joe Hidler, recruited from the Research Institute of Chicago during grant year 1, has accepted a faculty position in the Biomedical Engineering Department of the Catholic University of America. He will maintain his research relationship with National Rehabilitation Hospital through funding from the new Neuroscience Center grant from the USAMRMC. The effects of his departure on research progress are noted in the next section ("Projects") and in Table 1 below.

Dr. Ramesh Ramloll was recruited from the University of Nottingham in the U.K. and arrived here in October, 2002. His credentials are particularly relevant for the virtual reality r&d being conducted in the ATRC. His c.v. can be found in the Appendix 1 to this report.

Cheryl Trepagnier, Ph.D., has been named to the Research Faculty of the Department of Psychology at the Catholic University of America. This appointment will strengthen the ties between the university and the hospital and lead to greater involvement of psychology undergraduate and graduate students in research projects going on at the ATRC and other research centers at NRH.

Andrew Sun, M.D. MPH, was hired in August of 2001 to fill the database manager position for the ANAM activities. The position has been expanded to include statistician duties as well as database management responsibilities. Dr. Sun is a fully trained neurosurgeon from China who recently emigrated and has a recent master's degree in biostatistics from George Washington University.

Projects

Rehabilitation Engineering-based Activities

(Note: This section deals with rescheduled and new projects in the same order that they appear in Table 1 below and in the Research Narrative.)

The *composite brace project* had been stalled around the critical issue of whether close-fitting braces on insensate individuals could introduce an unacceptable risk of skin breakdown. This potential obstacle to completing this project was overcome through consultation with orthotics clinicians and researchers at NRH, the Rehabilitation Institute of Chicago and Rancho Los Amigos, and dialogue with Jim Campbell, the engineer/orthotist at Becker Orthopedics (our industrial partner). Consensus was reached that while edema as an undetected source of swelling – leading to skin irritation – *is* a theoretical issue, there is strong clinical precedent for application of custom-molded shell orthotics. A protocol defining a brief evaluation trial of pre-production braces on four users was prepared for the NRH Research Review Committee and the IRBs of MedStar Research Institute (MRI) and the MRMC. It is currently in the hands of the MRI IRB awaiting resolution of issues related to investigational device exemption. Once that obstacle has been cleared, the study will begin and should be completed by the end of ATRC year 3. The abstract of the human studies protocol for can be found in Appendix 2.

In the *Boing! Ani-Mate project*, a decision was made to devote more effort than originally planned to a clinician-friendly animation authoring system and to a larger menu of customizable games than originally planned. In the 3rd and final year of this project, mechanical revisions to Boing! and replication for clinical trials will be completed. The current plan to end the project at that point may be reconsidered on the basis of evaluation data and commercialization prospects.

Clinical users – patients and professionals – will be more easily recruited now that NRH has formed a contractual relationship with Children's National Medical Center and will soon be opening a ten-bed pediatric rehab unit here at NRH.

The *Magic Walker project* was initially slowed by the departure of Dr. Hidler to fill a faculty position. Progress then accelerated with the identification of commercial subsystems for an appropriate braking system. The arrival of a new PhD electromechanical design engineer, anticipated in July 2002 (see below) will make it possible to complete the alpha prototype, revise as needed, and replicate the Walker for clinical evaluation by the end of grant year 3. The current plan to end the project at that point may be reconsidered on the basis of evaluation data and commercialization prospects.

Start of the *Harness Walking project* has been delayed until July 2002. This postponement was intentional and reflected the anticipated arrival of the Lokomat experimental robotic gait-training system (from HoCoMa, in Zurich). This system, purchased with philanthropic funding, was shipped in the fall of 2001 and is presently awaiting FDA approval. The departure of Dr. Hidler, who was to have been the principal investigator on this activity also contributed to the decision to postpone. The new PhD staff engineer presently being recruited (see below) will drive this activity.

Two projects were added during year 2. Both originated in the NIDRR-funded Rehabilitation Engineering Center on Telerehabilitation which is also hosted in Rehab Engineering at NRH. Both have been transferred in part to the ATRC to expand their funding. Both projects show particular promise and are good fits to the ATRC mission.

One of these projects is "code-named" *IRIS – Interactive Rollabout Imaging Station.* This is an analog videophone (H.324 standard) which is mobile, wireless, and incorporates its own power supply. It is meant for home and institutional environments where the need for two-way video/audio telecommunication must be met at many locations within a building. In the current development work, the dominant engineering issue is whether to transmit and receive audio and video signal and code/decode for the videophone at the base unit; or to include the codec in the mobile unit and transceive a cordless phone signal between the base and the IRIS. More on this project can be found below in the Research Narrative.

The other new activity is the *Wound Teleassessment project.* This too is a telehealth development activity. It is aimed at developing and evaluating a "kit" which is meant to enable visiting nurses to collect digital images and other objective and subjective information at the homes of patients who have pressure ulcers and other non-acute wounds. The data so collected will be presented on a store-and-forward basis to hub site wound care experts who will make treatment decisions. Presently, a large-scale randomized clinical trial is about to begin which will compare clinical outcomes for an experimental nurse-patient cohort with a control group. This project too is detailed in the Research Narrative below.

Neuroscience-based Activities

The main change from the original plan has been to defer initiation of the Fairfax County concussion project pending analysis of the West Point Year 2000 data in order to use the West Point data as a basis for an optimized ANAM procedure for the Fairfax County project. As described below, the West Point analysis revealed that many of our original assumptions regarding use of ANAM scores in a clinical context were wrong and that clinical classification was inadequately accurate for clinical use. As of the writing of this proposal, we have completed

extensive comparisons between five published methods for calculating reliable change indexes, and have cross-validated these approaches with "convenience samples" from previous ANAM studies. These findings are accepted for presentation at the April 2002 American Academy of Neurology meetings. We now are prepared to move forward with the Fairfax County project, using a far more sophisticated understanding of the issues in clinical application of ANAM for concussion surveillance. While this has delayed the project by approximately one year, this is more than offset by the opportunity to now do a complete prospective validation of our new ANAM scoring systems. Note that these new scoring systems also are based on using a novel format for ANAM batteries, where a smaller number of separate tests are used, but these tests are repeated within the baseline in order to create more stable baselines with higher sensitivity for detecting clinical meaningful changes.

Proposed Changes for Year 3 and Rationale

Staffing

A new job opening is currently posted to recruit a PhD research engineer. The full job description is attached to this report in Appendix 2. This individual will succeed Dr. Hidler and will specialize in directing the ATRC research stream on human motor control modeling, experimentation, assessment and enhancement. S/he will develop the "harness walking" project based in the Lokomat and will also play the role of electro-mechanical design engineer in development projects like Boing! and the Magic Walker.

Projects

Rehabilitation Engineering-based Activities

As noted in greater detail in the Research Narrative below, the Unobtrusive Functional Sensing project ("Wired Independence Square") will be expanded to officially pursue the development, evaluation and deployment of the Digital Video Feedback system. Originally conceptualized and prototyped as a tool for another clinical study, this system for immediate display of occupational therapy sessions to patient and practitioner turns out to have more general merit. It will be budgeted as a component of the Unobtrusive Functional Sensing project. Deliverables will be effectiveness data from clinical trials and a beta prototype of the hardware and software-based interface.

Neuroscience-based Activities

No changes planned.

Table 1
Projects Based in the Rehabilitation Engineering Service

Continuing beyond original timeline

Project	Completion Date Proposed in Previous Annual Report	Completion Date Proposed Here	Cause of Delay
Composite brace	End of year 2	End of year 3	IRB approval, experimental device waiver
Boing! & Ani-Mate	End of year 2	End of year 3	Greater effort devoted to Ani-Mate
Magic Walker	End of year 2	End of year 3	Brake design, staff changes

Delayed start

Project	Start Date Proposed in Previous Annual Report	Start and Finish Proposed Here	Cause of Delay
Harness walking	Start of year 2	Mid-year 3 to end of year 4	Shipping of Lokomat, Dr. Hidler's move

Ongoing as projected

Project	Completion Date
"Wired Independence Square"	End of year 4
VR and Gaze	End of year 4
Home Evaluation Kit	End of year 4
VR R&D under Contract to Anthrotronix	End of year 4

New Starts During Year 2

Project	Completion Date
Technology-assisted Wound Assessment	End of year 4
IRIS videophone	End of year 4

Research Narrative

Projects based in the Rehabilitation Engineering Service

BOING! & Ani-Mate – A Home Exercise Arcade & Video Game Authoring System for Children with Disabilities

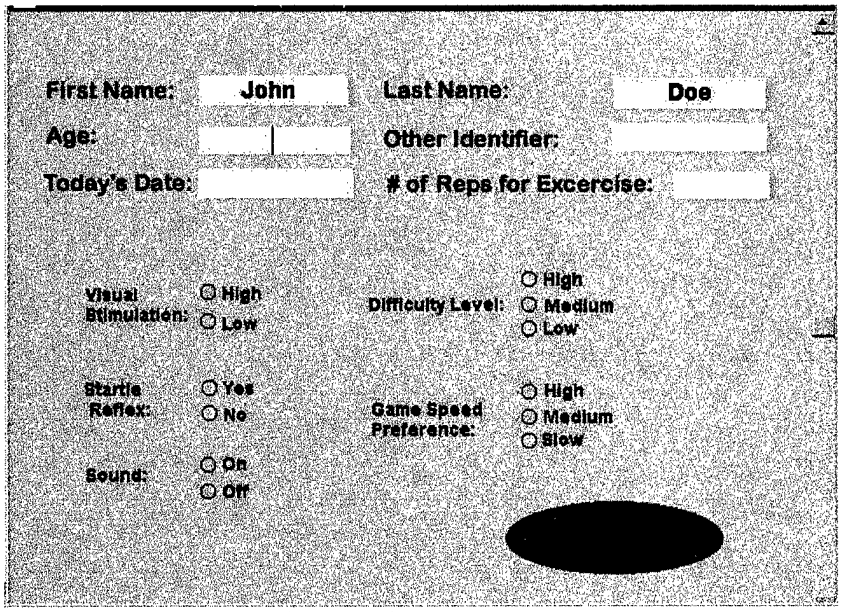
Status: continuing

Principal Investigators: Dave Brennan, John Noiseux
Co-investigators: Mike Rosen
Person-months committed:

Project abstract:
Ani-Mate is an easy-to-use video game authoring package that will allow therapists and parents to create custom games for each user in a variety of game metaphors (collision, avoidance, tracking, etc.). Options in the games such as characters, activities, light and sound levels, and number of repetitions can be adjusted to the specific needs and interests of the child through an easy to use menu-driven interface. This design will result in games that are within the child's cognitive capacities, and avoid puzzling or startling stimuli; engage her/his sense of humor by including favorite objects and situations; and offer on-screen rewards for successful completion of the desired number of repetitions.

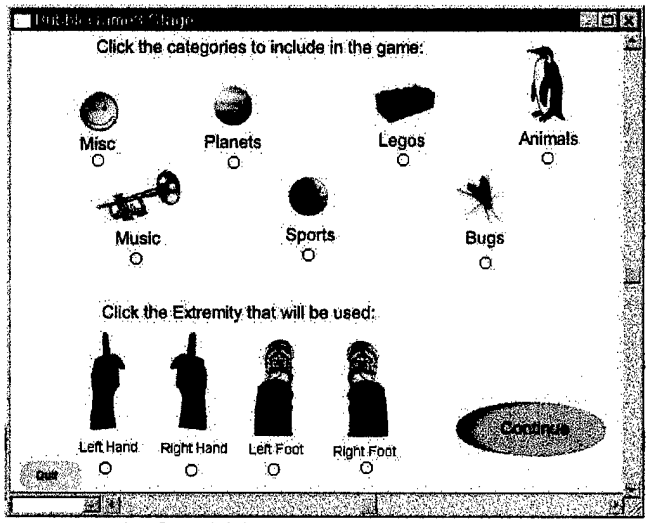
Year 1 Progress and outcomes:

The initial software infrastructure for biographical and preference information intake and storage has been constructed. This software consists of a front-end to collect appropriate personal data, and a backend that creates a personal user profile used to tailor the games. The prototype front-end currently collects the user's first and last name, age, the date, which of three speed settings to use for the games, which of three difficulty settings to set for the games, sound on or off, avoidance (yes/no) of stimuli that may trigger a startle reflex, and level of visual stimulation (high or low).

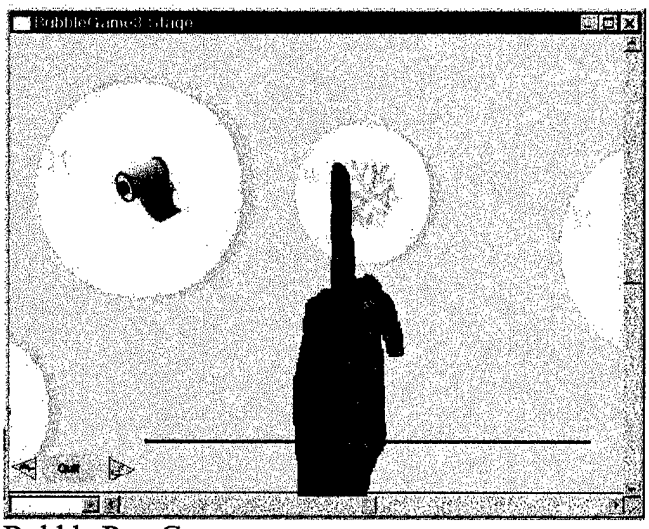


Biographical intake page from Ani-Mate start up

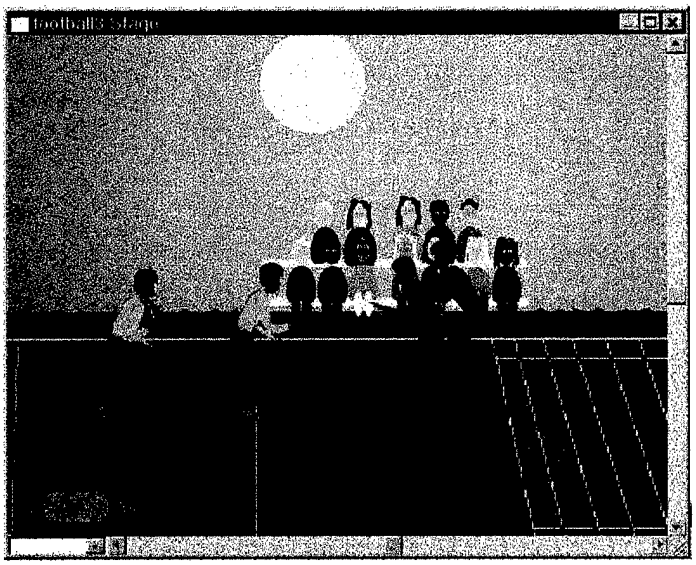
Four games, each of which interfaces with the user profiles and modifies itself appropriately, have been produced. Each game, upon completion, saves various performance parameters into the user profile. Each game (Bubble Pop Game, Football, Baseball, and Basketball) tracks and saves which game has been played, the total length of time required for the completion of the game, the number of repetitions required to complete the game and any extra repetitions performed, as well as any changes to the speed made during the game (recorded as frames per second). In addition, any time the game is quit without being completed, a note is made in the user profile. These performance parameters may be used to track changes in performance over time, as well as therapy program compliance. Images from some of the games are included below.



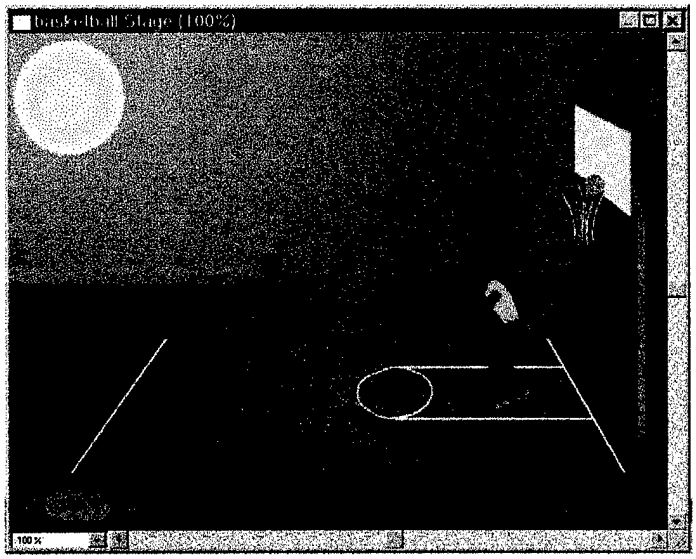
Front-end of Bubble Pop Game.



Bubble Pop Game



Football Game



Basketball Game

Continuation plan:

The software will continue to be enhanced and additional games will be produced. Goals for the coming year will include:

- Convening of an informal focus group of therapists to solicit additional design input
- Modifying of existing games and system based on additional therapist input
- Construction of additional games
- Finalizing sound and extra visual stimulation features in several of the games
- Integration of additional game options
- Initial clinical placement of Ani-Mate with Boing! or another interface for evaluation.

Magic Walker w/ Brakes

Status: Continuing

Principal Investigator: John Noiseux
Co-investigators: Richard Keller, Mike Rosen

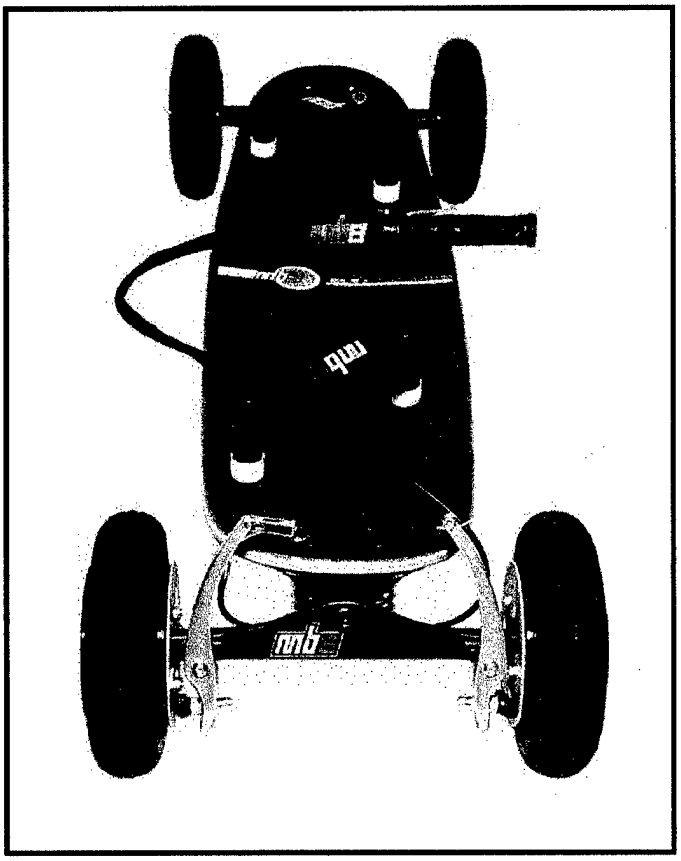
Project abstract:

The Magic Walker was designed at the University of Tennessee. It is gait trainer / walker device that provides a child with support in the upright standing position. The child's weight is partially born on the walker seat and partially supported by the child's legs. The amount of support received can be customized based on the needs of the child. Steering of the walker is achieved by flexion of the trunk laterally. The mechanical coupling of steering to lateral trunk flexion leaves the upper limbs free for other tasks or for the child to stabilize himself / herself. The utilization of lateral trunk flexion, in contrast to rotation, is what most clearly distinguishes this design from other gait trainers / walkers. The main objective of the Magic Walker Brake Development project is to incorporate a brake system into the present design of the walker. This will enhance safety and may increase the marketability of the design. In particular, it will permit the Magic Walker to be used (with supervision) in an outdoor setting where inadvertent access to down slopes requires automatic activation of the brakes.

Year 1 Progress and outcomes:

A split-caliper braking system has been identified for use with the Magic Walker. After reviewing various braking and mounting options, a split-caliper system integrated into the rear wheel assemblies and a seat/frame interface has been selected. This design has the advantage of utilizing familiar and reliable components that are readily serviceable. In addition, because the system utilizes many commercially available parts, it is anticipated that it will be economical compared with other braking options. In particular, the brake disks, pads and calipers are readily adapted from an MBS "mountain board" – the wheeled equivalent of a snowboard, now available in sports and outdoor stores. See the photograph below.

The brakes and frame are currently being modified to allow for successful integration, in particular for transmission of vertical seat deflection to brake calipers. (Activation in their original application in the mountain board is via a hand-activated grip on a bowden cable.) The underlying concept is that a user who gets moving too fast will of necessity lose her/his footing and bear full weight on the seat. Seat spring loading will make it possible to tune the behavior of this system to permit partial weight bearing without activating the brakes.



Continuation plan: Upon completing the installation of the brakes, testing of the Magic Walker with brakes will be undertaken to verify the efficacy of the brakes, characterize their behavior, and evaluate their interface with the walker. Final plans with respect to placement for clinical evaluation and commercial marketing of the walker will also be pursued. Recruitment of children to evaluate the Magic Walker should be facilitated by the opening of the new Pediatric Rehabilitation inpatient and outpatient unit at NRH. The NRH Rehabilitation Engineering Service anticipates numerous contacts with children with disabilities through clinical assistive technology service delivery activities.

Unobtrusive Functional Assessment ("Wired Independence Square")

Status: ongoing

Principal Investigator: J. Carter
Co-investigators: M. Rosen

Project abstract:
Assessment of patients' functional status in a rehabilitation setting is typically done by an observing therapist using a subjective rating scale such as the Functional Independence Measure (FIM). As a method to introduce objectivity and "ecological validity" into the assessment process, ATRC engineers at NRH installed sensors into the Independence Square (ISq) constructed in the hospital in March 1998. The aim is to add objective data to a patient's chart without requiring additional time or effort from the physical, occupational, or speech therapist. With the acquisition of the Rehabilitation Engineering Research Center (RERC) on Telerehabilitation (funded by the National Institute on Disability and Rehabilitation Research, NIDRR, of the U.S. Department of Education), the project was expanded (under the new funding) to further develop the system for use *outside the hospital in clients' homes.*

Year 2 Progress and outcomes:
The main accomplishments of Year 2 follow:

- increased focus on therapeutic needs
- more and closer observations of clinical treatment sessions
- investigation of widely accepted and acclaimed clinical assessment tool
- formalized project to develop a spin-off Digital Visual Feedback project

Year 2 saw relatively more progress on integration with therapy and less on engineering development than in previous years. After the occupational therapist (OT) who had been working on this project left NRH, we identified and are now working with Connie Davis, OTR/L, an OT whose time is split between patient care and staff education. This split will benefit the research project. The engineering research team has worked with Connie improving its understanding of how occupational therapy is practiced: what is observed, what is recorded, what is missing (as perceived by the therapists). We have also investigated one of the gold standard assessment methods in OT – AMPS, the Assessment of Motor and Process Skills. As the AMPS is the clinical tool we will use to validate processed data from our system, it is important that we understand its use and its theoretical and analytical foundation, particular the statistical data processing known as Rasch Analysis.

As mentioned in last year's report, we have initiated an offshoot project in which we conceptualized and developed a Digital Visual Feedback (DVF) system. The original specifications called for the DVF to allow a therapist to remotely trigger a digital camera (comparable to a "webcam") to record and digitally store images of a patient attempting to use a compensatory strategy. At the end of the treatment session, the therapist and patient could sit in front of a computer and review the patient's performance without the inconveniences associated

with video tape. We originated this work as part of clinical project at NRH (outside of the Rehab Engineering Service) investigating the effects of using the DVF on patient participation in treatment decisions. Clinical interest was broader than expected, however, and this led us to continue development of the DVF independent of the participation study. Based on design input from clinicians who saw the DVF during development, we have incorporated improvements over the original system and will evaluate its effectiveness in clinical settings at NRH. As noted in the Proposed Changes for Year 3 proposal section above, we propose to make this activity a formal ongoing component of the Unobtrusive Functional Sensing project.

Continuation plan:
The immediate plan of continuation is straightforward: We will begin analyzing information collected from the ISq sensors during treatment sessions, and looking at it with an eye to transforming the data to a therapist-friendly assessment scores. The purpose will be to formulate an analytically-based hypothesis regarding this mapping. We will then undertake a Phase 1 study in which we will test for correlations (across subjects) between timing data collected from sensors – processed in alternative ways – and AMPS scores (both the final Motor score and individual item scores). Throughout, we will continue to investigate the Rasch analysis underlying the AMPS method, as well as other ways in which the hardware now installed in the ISq kitchen might be useful for clinicians.

The DVF project will 1) continue to schedule the system's trial clinical use (while obtaining feedback as to potential improvements) and 2) identify and implement an experimental evaluation of the system for specific patient populations and tasks.

Virtual Reality Display and Gaze Monitoring to Investigate Impairments of Visual Processing of Social Stimuli

Principal Investigator: C. Trepagnier
Co-investigators: M. M. Sebrechts, R. Ramloll, R. Peterson, L. Baker

Part A: Virtual Environment for Assessment and Training of Social Skills - the Virtual Mall

Status: Ongoing

Project abstract:

Social perceptual deficits are a significant barrier to independence for many individuals with traumatic brain injury, stroke, and autism. This project will develop virtual environments, using the metaphor of a shopping mall, presenting social contexts in which persons with impaired social judgment can be observed as they make behavioral choices. The long-term goal is the development and evaluation of a clinically practical and ecologically valid assessment of social cognitive function and a rehabilitation modality to improve the ability of individuals with acquired or congenital social cognitive impairment to function in everyday environments.

Year 1 Progress and outcomes:

Recent work has focused on the design and implementation of the 3D environment and autonomous virtual humans to inhabit it, using visual, auditory and haptic media. The groundwork for implementation of the visual and auditory physics of the 3D virtual environment has been completed. Software development toolkits were chosen to balance the quality of the VR environment with speed of implementation. A 3D environment has been created which can be navigated with collision detection and appropriate rendering of sound sources. The architecture of the virtual humans is currently going through design iteration phases. The virtual human prototypes that have been implemented are able to navigate autonomously while avoiding objects, and are also able to react gesturally and auditorily as specified when in close proximity to objects. The groundwork for the virtual human facial expressions has also been completed.

The gaze-contingent software has been revised and refined. Integration of this software has been tabled for the present pending availability to the project of technology to present an immersive environment without headset or goggles. The requirement of immersiveness is dictated by the need for presence, since our expectation is that the individual's typical behavior is more likely to be evoked in a high-presence context (Mendozzi et al., 1998).[1]

Control modes were reviewed, and a provisional decision made to use an isometric joystick that also offered a torque dimension to map from the user's intention to changes in the environment, while minimizing the user's distraction from the environment.

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[1] Mendozzi, L., Motta, A., Barbieri, E., Alpini, D., & Pugnetti, L. (1998). The application of virtual reality to document coping deficits after a stroke: Report of a case. Cyberpsychology & Behavior 1(1), 79-91.

Accordingly a review was conducted of commercially available isometric joysticks that detect forces in the x and y directions as well as torque around the z-axis, and the LogiCad 3D Puckman was identified as the best fit to the specifications. Once Dr. Ramloll joined the department, in October, 2001, a decision was made to prioritize development of the virtual environment software development. Since integration of an isometric joystick would require developing a special driver, it was decided to default to a standard joystick for which a programming interface is commercially available, and postpone the purchase of a force-sensing interface.

Continuation plan:

The plan for the second year is to complete development of a first iteration of a virtual environment in which a variety of interactions with virtual people and objects can be experienced, and in which an objective, instrumented record is acquired of the operator's avatar's position, direction, speed and contact relative to objects, people and boundaries in the environment.

The creation of the artwork associated with depiction of a typical shopping mall, the look and behavior of the virtual humans, and the data acquisition system will be developed over the first four months of this year. We will purchase a joystick with throw in the x and y directions, and a handle that twists around the z-axis. There are commercially available joysticks of this type that have the additional advantage of force feedback, which will provide a convenient means of representing collisions to the user. We will also review display options at this time. We have available to us a Virtual Reality head-mounted display, and a Flock of Birds head tracker. We are looking into the possibility of accessing a no-contact 3D display.

The Virtual Mall will be tried by members of the research group and the lab, and further modified as needed. Trials will then be carried out with patients and controls, who will be asked to complete a small number of tasks in the environment (e.g., locate a lost parcel; get to the candy store before it closes). We are particularly interested in the user's perception of the experience and feeling of presence. Once the design is stabilized, we will compile quantitative scores of individuals with and without disability in order to compute a power estimate for formal evaluation of sensitivity and specificity of the Virtual Mall as an assessment of social impairment. Analysis of these data will provide an indication of whether to modify or develop the assessment further, and whether to proceed with investigating therapeutic applications.

Because of the problems associated with combining eye-tracking with immersive virtual display, discussed below, the two components are being pursued separately at present. It is very likely that over the next two or three years technology that offers vivid three-dimensional representation without wearing special equipment will become available at an acceptable price, and that will make it possible to combine eye-tracking with VR display.

Part B: Gaze Monitoring to Investigate Impairments of Visual Processing of Social Stimuli

Status: Continuing

Project abstract:
This arm of the Virtual Reality project looks at social aspects of the visual perceptual deficits associated with right hemisphere stroke. A remote eye-tracking system is used in a face- and object-recognition paradigm to ascertain whether learning and recognition of novel faces and objects is impaired in persons with a clinical diagnosis of left visuospatial neglect; whether these individuals display reduced gaze toward the left side of the images, and finally whether social stimuli (faces) are more resistant to neglect gaze deficits than non-social stimuli (objects).

Year 1 Progress and outcomes:
Despite improvements accomplished in the comfort and usability of the 'VR-Eye' system, the head-mounted display with an earlier ISCAN eye-tracking camera installed in it, the system, which was used in a study under other funding, proved to be fragile, and malfunctions entailed long periods during which it was back at the manufacturer, being repaired. It was finally decided to terminate use of this device, and pursue eye-tracking and virtual reality display as separate instrumentation for the current project, pending availability of reasonably priced immersive 3-D display that does not entail wearing of a headset or goggles. We are investigating the possibility of access to this new technology, but in the meantime we are using technology in whose reliability we can have confidence.
Since Dr. Ramloll's arrival, progress has been made in systematizing the data reduction procedures we use for this study, and facilitating verification of data integrity. The fixation analysis and display application, originally developed for use with an Onyx, has been extended so that it correctly handles data captured on the Intergraph platform. A labeled grid can be displayed in place of target pictures in order to facilitate review of identified fixations with the visual (video) record.

Testing and analysis have been carried out to determine the optimal configuration of the remote (not head-worn) ISCAN eye-tracker, the monitor on which stimuli are displayed, and the subject. In addition to an Obus support, a Versa Form foam-filled cushion is being used. The cushion can be positioned around the subject's shoulders, neck and head for stability during eye-tracking. A height-adjustable table has been purchased on which the remote eye tracker and the television monitor are placed. The table can be crank-adjusted to achieve constant visual angle between subject's eyes and monitor center, and between eyes and eye-tracker lens, regardless of subject's height.

Continuation plan:
Minor software development remains to be carried out before the protocol is ready for data acquisition. In order to test calibration, software will be produced to provide targets that can flash, and whose position and display duration can be controlled by the investigator. This will allow us to verify calibration for patients who require cuing and support in order to detect and follow the target to the perimeter of the monitor. In

addition, picture stimuli already developed for a study carried out under other funding need to be rotated and centered. Once these tasks are completed, and IRB approval is obtained, it will be possible to begin data acquisition. Regions of interest will need to be identified and mapped on the rotated pictures before data can be analyzed.

Patients clinically identified as having neglect associated with single, right-hemisphere stroke will be enrolled, and their neurological status verified by a neurologist (M. Yaseen, M.D.), who will conduct a bedside neurological examination and review the visualization studies, and by a member of the research group, who will carry out parts of the Behavioral Inattention Test.

It is anticipated that 10 patients and 10 age- and gender-matched controls will be enrolled and completed within this year, and that data analyses will be completed.

Home Evaluation Kit

Status: Ongoing

Principal Investigator: J. Noiseux
Co-investigators: M. Rosen , C. Ellis
Person-months committed: 2

Project abstract:

The outcome of this project will be a practical durable portable home evaluation kit, HEK, which can be carried into a client's home to evaluate the site for its compatibility with special needs and assistive technology. Its purpose will be to allow a home evaluation to be conducted by a trained technician, health aid or family member objectively and efficiently so that it becomes financially feasible under current restricted reimbursement. Thoroughness and objectivity will be essential to determine essential modifications, determine family training needs, select assistive devices for/with the patient, and plan define discharge criteria.

Year 1 Progress and outcomes:

Since the conceptualization of this project, the Prospective Payment System has been introduced for the roughly half of NRH inpatients whose care is covered by Medicare. This is relevant for the HEK. Originally, the primary goal of this project was to design a kit which could be used clinically at a cost per encounter lower than the standard fee for this service. Under a capitated reimbursement system, this logic no longer applies. Instead, the per-patient cost of using the HEK must be low enough that it makes clinical and business sense to do home evaluations, given the fixed amount of reimbursement NRH receives and the potential, if any, for other savings resulting from its use. The situation now is that for about half of NRH inpatients the fee-for-service logic applies; and for the other half the capitated reasoning applies.

Many person-hours of consultation have now taken place involving the Rehab Engineering r&d team (Noiseux and Rosen) and three senior clinical managers:

- Cathy Ellis, Director of PT and OT;
- Jennifer Hendricks, Care Coordination Manager; and
- Linda Christopher, Director of the Outpatient Clinic for PT and OT.

Several important distinctions have been clarified and new design possibilities defined. These include:

- Clinicians parse home evaluations under two headings, "structural" and "functional". The first signifies assessment of the living space itself to identify spatial barriers to mobility and access. The latter is a more patient-specific assay of the ADL interaction between patient and the living environment. When conducted at all, the structural evaluation ideally happens first and early in the individual's inpatient stay; while the functional evaluation typically requires that the patient come home briefly in order for a professional to observe and consider her/his current and probable functional performance interacting with the living space and systems. To this point, we have focused entirely on the former.

- Home evaluation of sorts is presently undertaken by means of standardized questionnaires sent home with family members, completed and returned. Typically, the primary purpose is *not* to establish what modifications will be needed (although this is considered). Rather this is a key component of "discharge planning", a process which begins at admission and sets clear criteria for a patient's readiness to return home and function in that environment.
- Consideration has been given to conducting home evaluations as part of the delivery of *outpatient care*, i.e. after the patient has gone home. A tentative decision on that concept is negative; typically patients who return for treatment as outpatients do so to address challenges which have nothing to do with functional compatibility with the home environment.
- There is however, a ten-day transition period between return home from inpatient care and availability of visiting nursing care. A current topic under consideration by NRH clinical managers is a closer tie between NRH and the Visiting Nurses Association (VNA) of MedStar (the health care corporation of which NRH is a member hospital). The possibility that functional home evaluation could become a component of early VNA care is under consideration.
- From these issues, a bifurcation emerges in the tree of design possibilities. The design of the HEK will be directed toward either ...
    - facilitating effective and cost-effective structural evaluation early in the period of inpatient care as a means of enhancing discharge planning and accommodations

    or ...
    - conducting functional follow-up soon after discharge of the patient to home, which can be conducted either ...
        - by means of capture of digital images by a health aid and store-&-forward delivery of this and other functional data to an outpatient physician in preparation for an outpatient visit by the patient to that physician

        or ...
        - by means of live virtual presence via videophone of that physician at the patient's home during the presence of the health aid, i.e. a "virtual house call".
- In the case of the technology-assisted functional follow-up, it is possible – pending regulatory decisions regarding licensure and reimbursement for telehealth – that outpatient visits specifically to go over the results of this in-home evaluation will be billable. This may also be true of the physician's time during the virtual house call.
- For one or more of these approaches, it may make financial sense to send the HEK home with a family member. The design challenge that results from designing the kit to be used by untrained individuals in uncontrolled environments would be considerably greater than for a kit meant to be used by trained aids or technicians. This must be traded off against the likelihood that the financial constraints would be met better by a kit meant to be used by individuals who cost the hospital nothing.

Materials of several kinds have been collected to support design choices. In particular, the survey instruments used by occupational and physical therapists at NRH as well as accessibility questionnaires from several other rehabilitation hospitals and a commercial service to conduct structural home evaluations have been obtained and scanned for their similarities and differences. In addition, specifications and demonstration software has been obtained for several programs which facilitate rapid rendering of floor plans, elevations, perspective views and walk-

throughs. These applications include Sierra Home's *Visual Home*, Punch! Software's *Professional Home Design*, and IMSI's Floor Plan 3D Design Suite v6. The capability of "reverse architecting" a home or apartment, quickly and with dimensions, remains under consideration for a possible HEK for structural evaluation by a trained aid.

In addition, an application called "Cool 360" sold by Ulead Systems, Inc., has been ordered for evaluation. This inexpensive software makes it possible to produce more-or-less seamless panoramas by digitally matching features and knitting together a set of images taken roughly 30 degrees apart. Such panoramas from each room in a living space might be a useful way for a trained OT and rehab engineer to conduct a virtual structural evaluation and identify particular features for follow-up questions to family members.

Continuation plan:

In the coming year decisions will be made regarding: the potential usefulness of the Home Evaluation Kit in the current billing and reimbursement atmosphere, various potential goals and configurations of the kit (including hardware and software), and the target users of the kit. Based on these decisions, prototypes will be constructed with the goal of developing an easy-to-use and robust tool for improving the quality of information gathered in a homesite evaluation, as well as the likelihood that one can be performed within financial constraints and the current clinical culture.

Multi-Modal Interfaces and Transfer of Training from Virtual to Real Environments

Status: Ongoing under contract with Anthrotronix

Principal Investigator: Corinna Lathan (formerly Associate Professor of Biomedical Engineering at the Catholic University of America)
Co-investigator: J. M. Vice

Project abstract:
This project has two major objectives: 1) To provide children with disabilities opportunities to navigate and manipulate their environment using advanced interfaces; and 2) To explore the use of virtual environments to teach motor skills. This year marked a turning point in the activity; we published and presented much of our work on motor learning and transfer of training and began shifting our efforts to include social and cognitive as well as motor learning.

Year 2 Progress and Outcomes:

Objective 1: We presented our paper on multi-modal interfaces for children with disabilities, *"Meeting Rehabilitation Goals with a Multi-sensory Human Computer Interface"*, at the International Conference on HCI and published in the peer-reviewed book of proceedings. We have begun to apply our results from our multi-modal interface research to collaborate with Dr. Cheryl Trepagnier using multi-sensory stimulation as a combined stimulus/reward to train children in social-cognitive behaviors.
Objective 2: This year focused on presenting and publishing our scholarly work on transfer of training. In addition to publishing the VR Handbook Chapter on Transfer, we also completed and submitted a manuscript for peer-reviewed journal publication. It is, at this writing, being edited for resubmission after peer review. Both of these publications are included in the Reportable Outcomes section at the end of this Annual Report. The results from our research thus far have indicated the following:

- an individual's spatial ability is correlated with her/his ability to perform a 3-D navigation or motor manipulation task;
- multi-sensory feedback for motor tasks results in better performance than single-channel feedback; and
- individuals with lower spatial abilities may benefit from VR training more than those with higher abilities.

Continuation plan:

We are expanding our research on immersive VR as a learning environment to include social and cognitive skills as well as motor behaviors. We continue our interest in the transfer of the learning to real environments. In year 3 we will focus on the role of VR to assist children with social and cognitive deficits such as those that are secondary to Autism. This will be done in partnership with ATRC investigator Cheryl Trepagnier who has been awarded an NSF Small Grant for Exploratory Research (SGER), for her project entitled *"Development of an interactive virtual environment for delivery of rehabilitative intervention to children with social cognitive*

deficits". Dr. Lathan's ATRC contract work will be an adjunct activity with an engineering focus on:

- the development of the mechanical interface and system to integrate VR environments with eye tracking
- and a mechanical/video ride – "VRide", Virtual Reality interface to development-promoting environments – to motivate and contingently reward children at risk for digressions from normal development for appropriate behaviors such as eye contact.

Timeline and Deliverables:

Quarter 1: February 1-April 30

⇒ Design of new VR system
⇒ Finalize specifications and begin production
⇒ Attend CSUN conference

Quarter 2: May 1 - July 30

⇒ Deliver VR system
⇒ Pilot system with able-bodied children
⇒ Begin testing with children with autism

Quarter 3: August 1 - October 30

⇒ Make hardware modifications from pilot data
⇒ Continue data collection
⇒ Expand experimental design

Quarter 4: November 1 - January 30

⇒ Write papers and publish results
⇒ Medicine Meets Virtual Reality Conference
⇒ Year 3 report

Teleassessment of Pressure Ulcers and other Wounds

Status: New start during year 2

Principal Investigator: L. Halstead
Co-investigators: T. Dang, M. Elrod, M. Rosen

Project Abstract:

Wounds represent a significant and costly health-care problem for many individuals. This Project assesses the use of telerehabilitation to address this problem in 2 patient populations in 2 phases. Phase I (completed) compared the teleassessment of pressure ulcers in individuals with spinal cord injury (SCI) in a simulated "remote" setting with live assessments in a wound clinic by a plastic surgeon. The mean agreement was 89 % (range 80-95 %). Phase II (pending IRB approval) will assess in-home wound management in a 3-way controlled study of 180 subjects referred to the MedStar VNA. (MedStar is the health care corporation to which NRH belongs.) One group will receive telemedicine and weekly consultations with a wound care specialist (WCS). A second group will receive weekly consultations by a WCS without telemedicine. The third group will receive usual and customary care. Outcome measures will include time to heal, wound status at discharge from the VNA, number of nursing visits, length of stay, costs, adverse events, and satisfaction.

Year 1 Progress and Outcomes:

This Project was transferred at the beginning of this year from the Rehabilitation Engineering Research Center grant on Telerehabilitation to the ATRC grant. During this time, Phase I of the Project was completed. The goal of Phase I was to compare the teleassessment of pressure ulcers in individuals with SCI in a simulated "remote" setting with in personal assessments in a wound clinic. We assessed pressure ulcers using a 3megapixel digital camera and then uploaded images of each ulcer to a laptop in a separate room along with a medical history and wound database form. The chief of the NRH wound clinic, a plastic surgeon, reviewed the images and database and completed a questionnaire concerning his "remote" teleassessment. The plastic surgeon then assessed the individual and wound live and completed the same questionnaire used for the teleassessment. 17 individuals with 20 wounds were evaluated. The total percent agreement for tele-vs live decisions was 89% (80-95%). The highest percent agreements (95 %) were for the need to change wound management and the need for referral; the lowest percent agreements were for satisfaction with teleassessment for making treatment decisions (80%) and the need to obtain additional information (85%). The results of this Phase have been accepted for publication in the journal Advances in Skin & Wound Care. Based on our experience with Phase I, we initiated Phase II during this year, which will apply our expertise in a telemedicine study in the community.

Continuation Plan:

Our goal for the coming year is to implement, in collaboration with MedStar's VNA, a study to assess wound management and healing in subjects treated at home using 'store and forward' teleassessment. At the present time, these individuals are managed by visiting nurses who do not have special expertise in the evaluation and treatment of wounds. Studies have shown that when a wound care specialist (WCS) –a health care professional with special training and expertise in the management of wounds – is consulted on a regular basis, the healing time, rate of complications and overall cost of healing chronic wounds is significantly less than when patients are provided with usual and customary wound care. Unfortunately, the number of WCSs is limited and most visiting nurse agencies can only afford a few so they cannot personally visit every individual who needs their help. The purpose of this project is to address this health care need by investigating in a controlled study 3 methods of treating individuals with wounds at home by nurses and consulting WCSs employed by MedStar VNA. 180 patients will be divided into 3 groups with the assignment of 60 participants and their visiting nurses to each group made by chance. One group (telemedicine) will have visiting nurses who take digital photos of the patients' wounds to supplement weekly consults with the WCS. The second group (non-telemedicine) of patients will have visiting nurses who consult with a WCS each week but without the use of digital images. The third group (control) of patients will have visiting nurses who provide usual and customary care and obtain consults with a WCS as needed. To determine which of the three groups receives the most effective wound care, we will collect and analyze a number of types of data including wound healing time, complications, cost, number of nursing visits, and satisfaction of the participants, visiting nurses and WCSs.

IRIS – Interactive Roll-about Imaging Station for Telerehabilitation and Support in the Workplace

Status: New during year 2

Principal Investigator: Dave Brennan
Co-investigators: John Noiseux

Project abstract:

Videoconferencing is a simple method for bringing rehabilitation expertise to people for whom it might otherwise be inaccessible. By combining video with voice, communication is enhanced, thus allowing for challenges and solutions to be described and demonstrated. However, existing videoconferencing equipment has limitations that make it a sub-optimal choice for many locations. IRIS is a wireless audio-video terminal that uses standard analog phone service and allows for fully mobile videoconferencing. A clinician at a rehabilitation facility can connect to her/his clients at their homes and "bring them along" to different areas of the facility to demonstrate tasks, teach techniques, or recommend equipment. Similarly, this system can be used in a consumer's home to allow her/him to demonstrate problems or barriers s/he faces to a remote clinician. In the workplace, workers can consult from their job sites with remote vocational counselors or ergonomics specialists.

Year 2 Progress and outcomes:

Revisions were made to the IRIS design and a second generation working prototype has been fabricated. The mobile IRIS unit incorporates a 15" flat panel video monitor, an electronic Pan-Tilt-Zoom camera, and a rechargeable power supply. The IRIS base-station consists of a StarView 400 Pro POTS-based videophone. Wireless connectivity is achieved with two pairs of 2.4 GHz audio/video receivers and transmitters. The audio and video signals captured by IRIS are transmitted to the base station where they are input to the videophone, coded, and sent over a POTS line to the remote location. In parallel, audio and video signals from the remote location received and decoded by the videophone (base unit) are transmitted to IRIS where they are presented to the viewers.

The current IRIS system has a wireless range of up to 100 feet indoors, through and around walls (with considerably better performance in large open spaces) and operates for over three hours before needing to be recharged. With the prototype completed and fully operational, its performance characteristics are being documented and applications for its use, within both the RERC and NRH as a whole, are being investigated. The dominating technical challenge presently is improving the signal-to-noise ratio for received and transmitted video and audio signal, minimizing in particular the cross talk between the sent and received signals. The original reason for placing the videophone codec at the base unit was that the alternative – keeping the codec on the IRIS and trans/ceiving cordless phone signals between the base and mobile units – was that interruption of the wireless signal tended to cause "hang-ups"; i.e. the call disconnected itself. The possibility of returning to this approach with a more robust "wireless jack" is being investigated.

Future plans call for developing a smaller, scaled-down IRIS with the aim of increasing portability and decreasing cost. In addition, a collaborative agreement is being investigated between NRH and TeleCare, Inc., a small California-based start-up company with a background in medical robotics and remote surgical tools.

Continuation plan:

Further refinements will be made to both the IRIS mobile and base-station units in an effort to simplify and streamline the setup and operation of the system. The base station components will be integrated into a portable equipment case allowing for ease of deployment and transport. A second mobile unit will be developed with the goal of increasing portability and decreasing cost without unacceptably diminishing features or capability. This mobile unit will likely take the form of a wheeled suitcase that can be carried and setup by one person. All components will be able to be stored inside during transport and removed and quickly affixed in their proper locations during a videoconference sessions.

The identification of potential placements for IRIS will continue. Several projects within the RERC on Telerehabilitation, both at the NRH and Sister Kenney facilities, are likely to make use of IRIS. In addition, NRH's clinical ROHP (Regional Occupational Health Program) initiative has recognized IRIS as a potential tool for providing remote evaluation of workplace ergonomics. Once it is determined in which settings IRIS will be used, replications of the system will be fabricated. Any necessary customizations will be made on a case-by-case basis.

Projects Based in Neuroscience

Automated Neuropsychological Assessment Metrics (ANAM): Psychometric Development and Integration into Military and Civilian Studies of Cerebral Concussion and Psychopharmacologic Treatment of Brain Injuries and Diseases

Status: Ongoing
Principal Investigator: J. Bleiberg (NRH)
Co-Investigators: D. Reeves (U.S. Navy), R. Kane (Veterans Administration and NASA), T. Elsmore (Private Consultant), and K. Winter (U.S. Naval Computer and Telecommunications Station, Pensacola)

Products:

1. NRHReview. This is a software program for displaying ANAM data in a fashion useful for clinical interpretation. NRHReview provides a turnkey, single-step solution for aggregating serial testing data from a single subject, extracting the data from raw ANAM data files, automatically creating tabular and graphical data displays, and generating printed reports suitable for inclusion in medical records. We have been field-testing NRHReview this past year with athletic trainers and sports medicine physicians in various settings, including collegiate athletics at the University of North Carolina and professional athletics with the New York Giants football team. The software has gone through three major revisions this past year to accommodate user-friendliness issues as well as several of the psychometric issues described below. NRHReview was developed by Drs. Elsmore, Reeves, and Bleiberg, and is scheduled for multiple enhancements this coming year. Specifically, the current version only compares a subject's current data with his/her previous data. The planned enhancements will include comparison with normative databases and the use of Reliable Change Index (RCI) statistics to identify and flag clinically meaningful changes in performance. As described below, we currently are using multiple data sets acquired this past year to explore and compare the five different published methods for calculating RCI's in order to determine the most clinically useful RCI procedure to incorporate into NRHReview. Clinical usefulness, in this context, is determined by analysis of Receiver Operating Curves and clinical "hit rates" (false positives and false negatives).

2. ANAMOnline.com. This is the product of last year's subcontract from NRH to Kathy Winter at the U.S. Navy Computer and Telecommunications Station, Pensacola. It is a Web site designed to provide several functions for integrating and facilitating work within the ANAM user community. The Web site has the capacity to support chat groups and discussions, to allow users to download and upload data files, to serve as a central repository for all of the existing ANAM technical and scientific literature, and for distributing ANAM software. The Web site has been completed but has not gone "live" because of the current MRMC patent application for ANAM and the prohibition on distributing ANAM software pending completion of the patent application. Discussions on February 21, 2002 with Kathy Winter indicate an estimate of May 1, 2002 for the Web site going online.

3. Provisional Patent For ANAM Data Displays. *Method and Apparatus for Monitoring Brain Health and Performance, Application Number 60/219,677.* This provisional patent was filed by Dr. Bleiberg in July of 2000 to protect data management and display concepts prior to a major lecture in Chicago, at which several commercial interests and ANAM competitors would be present. The provisional patent was turned over to MRMC this past year. It is not known to what extent it has been incorporated into the current ANAM patent application. Several of the concepts in this provisional patent have been superseded by the above described enhancements in NRHReview, and, in general, we have identified and currently are pursuing better methods than those described in the provisional patent.

4. NRH ANAM/Access Database. This is a Microsoft Access database designed to extract and manage extremely large ANAM data sets. It originally was developed in 1998 and was widely distributed to the ANAM user community, including VA, NASA, and DOD scientists and clinicians. This past year many of the ANAM software executables were upgraded by NCTS, and Drs. Elsmore and Reeves have upgraded the ANAM/Access database to be able to handle the new ANAM executables. We plan to distribute this upgrade when ANAMOnline.com is operational.

Funded Research Incorporating ANAM:

(One of the primary objectives stated in last year's progress report was to expand the ANAM user base. Described below are extramural and intramural federally-funded research projects, and pending grant applications, in which NRH has assisted other agencies to incorporate ANAM into their research programs, and in which NRH staff have become coinvestigators.)

1. Sports Medicine Department, University of North Carolina Chapel Hill. This group has had an ongoing sports concussion surveillance grant funded by the Centers for Disease Control. Their existing grant used conventional neuropsychological tests as primary outcome measures and made no use of computerized tests. This past year, Dr. Bleiberg, working with Dr. Kevin Guskiewicz, director of sports medicine for UNC, submitted an application for supplemental funding to the CDC in order to support the addition of ANAM to the existing traditional neuropsychological test battery. The application was approved by the CDC and work started on January 1, 2002. The UNC sports concussion surveillance program covers the contact sports teams (male and female) at 20 NCAA universities and 26 high schools from all regions of the United States. One very important feature of the supplemental application is that it supports repeated ANAM administrations in healthy control subjects. This is essential information for calculation of increasingly precise RCI's for use with injured subjects. The terms of the collaboration between NRH and UNC will make this normative data available for incorporation into the clinical interpretation modules of NRHReview. Moreover, the UNC project will be available as a testbed for an Internet-enabled ANAM.

2. Sports Medicine Department, State University of New York at Buffalo. NRH assisted in the preparation of an R03 application to NIH submitted on February 1, 2002. The application is similar to the UNC project in that it involves concussion surveillance at a number of universities and high schools in the Buffalo area. However, it has the unique feature of

incorporating a detailed comparison of the efficacy of two computerized neuropsychological test batteries, ANAM and Impact. Impact is the product of the University of Pittsburgh's long relationship with the National Football League. Impact is similar to ANAM, but it is Internet-enabled and has been field-tested and validated with approximately half of the NFL teams. This "head to head" comparison of two computerized batteries will generate important information regarding what is effective and what is not effective, both in terms of psychometric properties as well as the user-software interface and other practical usability issues. This project also includes a brief battery of traditional clinical neuropsychological tests (the original pencil and paper "NFL battery" from the University of Pittsburgh), such that the psychometric properties of both ANAM and Impact can be analyzed. This application currently is under review and the outcome is not known.

3. NIH-National Institute of Drug Abuse. Dr. Bleiberg assisted in the preparation of two NIDA projects which have been approved for intramural funding and in which Dr. Bleiberg is a coinvestigator. The first study uses ANAM in a dose escalation study of lofexidine for relapse prevention in methadone maintenance patients. The purpose of the study is to determine the cost/benefits of various doses of lofexidine in terms of reduction of cravings versus onset of sedation and cognitive impairment. The second study examines the effectiveness of adding bupropion to a cocaine-abuse treatment program consisting of buprenorphine and cognitive-behavioral therapy. In this study, ANAM is used to explore the treatment's effects on attention and concentration in patients with dual diagnosis of cocaine abuse and attention deficit hyperactivity disorder.

4. University Of Texas at San Antonio Medical School -- Systemic Lupus Erythematosus. UTSA currently has a major NIH grant for an SLE research and training center, which includes an inception-cohort SLE monitoring project. Steven Holliday, Ph.D., the senior neuropsychologist on this project, has been using a DOS version of ANAM for the past three years (acquired at one of the ANAM courses taught by Drs. Reeves, Kane, and Bleiberg at the American Psychological Association in 1995). This year, Dr. Bleiberg visited San Antonio, gave neurology Grand Rounds on ANAM and computerized testing, demonstrated and installed current ANAM software in the UTSA SLE Clinic, and participated in preparing an application to NIH for supplemental funding to the existing UTSA SLE project for a large-scale ANAM norms and validation study in SLE patients and matched controls. This application was approved and work commenced in November of 2001. The basic design of the study is for all 300 patients to receive the American Academy of Rheumatology recommended traditional neuropsychological test battery at annual intervals and receive ANAM at each quarterly clinic visit. Similar procedures will be applied to an equal number of matched controls. This project monitors extensive serological and other disease activity markers of SLE, such that the relation between disease activity and cognitive function can be explored in this design. Moreover, this will provide a very solid foundation for clinical use of ANAM with SLE and similar populations.

5. NIH Clinical Center SLE Clinic. The preparations for the UTSA SLE project provided the foundation for approaching NIH regarding incorporation of ANAM within the NIH SLE Clinic. This clinic serves as the central hub for SLE at NIH and supports numerous SLE research projects. The director of the clinic, Gabor Illie, M.D., following a presentation from

Dr. Bleiberg on the UTSA ANAM project, requested that Dr. Bleiberg install ANAM on the NIH SLE clinic's computer system. Work started on December 20, 2001 and continues to the present. The version of ANAM used at NIH is identical to that at the UTSA project and the intention is to maintain common methods across both projects, upgrading and enhancing the NIH version based on results of the UTSA project. We consider this project important because it represents the incorporation of cognitive testing as a routine feature of clinic-based medical services -- essentially embodying the primary objective of NRH's efforts to develop ANAM as an instrument for assessment of cognitive function as a routine and efficient element of primary care medicine and public health surveillance. The prime obstacle is that the NIH Clinical Center database uses Macintosh computers in each exam room. Dr. Illie currently is acquiring IBM PC notebooks for several of the exam rooms, but this is not a satisfactory long-term solution. Removal of hardware compatibility problems such as this is one of the primary objectives of an Internet-enabled, platform-independent, ANAM.

6. American Fibromyalgia Syndrome Association (AFSA) Proposal. Arthur Weinstein, M.D., of the Department of Medicine at the Washington Hospital Center has submitted a proposal for a trial of gabapentin for treatment of physical and cognitive symptoms of fibromyalgia. ANAM is the primary cognitive outcome variable and Dr. Bleiberg is a coinvestigator on this proposal. This proposal currently is under review.

7. US Army Elite Athlete Program. Last summer, CPT Anthony Bare, director of sports medicine for the U.S. Army World Class Athlete Program contacted Dr. Bleiberg for assistance with monitoring concussion in the boxing and tae kwon do teams. In October of 2001 CPT Bare came to Washington for a full day of training from Dr. Bleiberg in use of ANAM, and installation on his notebook computer. In December of 2001, when CPT Bare was having difficulty using NRHReview on his notebook computer, Dr. Bleiberg shipped him one of the NRH notebook computers which around the software correctly. As of January 10, 2002 CPT Bare wrote Dr. Bleiberg to inform him that he had baselined 23 of the military athletes as well as more than 60 ANAM administrations to each boxer before and after competitive bouts. Because of local budget problems, CPT Bare would have been unable to attend the January 2002 boxing matches at Ft. Huachuca; given the importance of this activity, the NRH project funded CPT Bare's attendance.

8. The Chicago Medical School. John Woodard, Ph.D., of the Psychology Department at the Chicago Medical School, has been collaborating with Dr. Bleiberg in various sports concussion studies, sponsored intramurally by the Chicago Medical School and with private support from the Atlanta Falcons football team. The preliminary results of an ANAM validation study in high school football players, comparing ANAM to traditional neuropsychological tests, was listed previously and was presented at the February 2002 International Neuropsychological Society annual meeting in Toronto. A similarly structured project has collected data on 32 Atlanta Falcons, with results quite consistent with the high school subjects, though these data will not be published due to agreement with the Atlanta Falcons. The Chicago Medical School group also works closely with the University of North Carolina group, and is one of the participating data collection sites for the UNC/ANAM project described previously. Dr. Woodard is an expert statistician and is working on a novel RCI calculation in which we will use an individual subject's standard deviation rather than

the more typically used group standard deviation. Dr. Woodard has been included in the present budget as a consultant.

Data Analysis:

1. Reanalysis of Data Sets from Other ANAM Users. As the result of collaborations described in previous progress reports, we now are beginning to receive ANAM data sets for reanalysis. This includes: three years (N = 100) of geriatric chronobiology data from Phyllis Zee, M.D. Ph.D., Northwestern University Medical School; a placebo-crossover clinical trial (N = 54) of a heat shock protein inducer (TEX-OE) as a treatment for ETOH hangover, performed by Jeff Wiese, M.D., Department of Psychiatry, Tulane University School of Medicine; and, also from Dr. Wiese at Tulane, a dose-escalation pilot-study (N = 12) of ANAM performance at baseline and three increasing dose levels of ETOH.

2. Analysis of Year 2000 West Point Concussion Data. The Year 1999 West Point concussion data has been analyzed and published (Warden, Bleiberg, et al., 2001). The Year 2000 West Point data has been through preliminary analysis and has been accepted for presentation at the American Academy of Neurology meetings in April of 2002. We also are doing extensive exploratory analyses of the Year 2000 data. These analyses center on the issue of clinical inference procedures and developing ways for clinical interpretation of ANAM data at the single subject level. Our 1999 data used concussed subjects as their own controls, employing pre-injury baselines obtained in July of 1999 with post injury serial testing in the subsequent academic year. No uninjured controls were employed in that study. We found significant differences, at the group level, between baseline and post-injury performance. In Year 2000, we added a control group of uninjured subjects, tested at identical intervals to the concussed subjects. This permitted exploration of the "hit rate" achievable using ANAM scores to classify injured versus uninjured subjects. To our surprise, individual ANAM tests which had shown highly significant differences between groups had quite poor hit rates and were not far from chance in terms of accuracy of differentiating injured from uninjured subjects. Andrew Sun, M.D., MPH, the statistician we hired in August, 2001, along with Drs. Bleiberg, Reeves, and Kane, have completed extensive exploratory analyses for developing scoring systems with better "hit rates." The systems are based on Reliable Change Index (RCI) procedures and permit the analysis of the contribution of ANAM scores to correct classification both for individual and combined ANAM subtests. There are five published RCI procedures and we have compared them in terms of utility for clinical classification with ANAM data. The results show that no single ANAM subtest, by itself, effectively classifies concussed from non-concussed subjects. However, various indexes employing three or more ANAM subtests produce quite good subject discrimination. We now are in the process of cross-validation of these indexes using available "convenience" samples including the Tulane hangover data set and the previously published Imitrex studies, essentially determining whether the classification schemes developed from the exploratory analysis of the Year 2000 West Point data can correctly discriminate between baseline and hangover and between baseline and migraine headache. Further cross-validation will be possible when we harvest the Year 2001 West Point data at the end of the current academic year.

3. Fort Bragg Concussion Study. ANAM data from over 5000 82nd Airborne baselines have been analyzed and summarized, and constitute an extensive normative database. This project currently is transitioning into a helmet design study and Dr. Reeves is serving as the principal contact for ANAM-related issues. We will continue to support this project but the details have not yet been worked out with Dr. Reeves and LTC Friedl.

Modifications to Existing ANAM Projects:

1. Georgetown University CFS Studies. We had hoped to obtain access to Dr. Dan Clauw's ANAM data from his MRMC-supported studies. However, repeated attempts to obtain this data have not been successful and it is likely that this effort will be terminated following several additional attempts at accessing the information.

2. Kaiser Permanente Primary-Care Demonstration Program. The intent of this project was to conduct a feasibility study of incorporating ANAM into routine primary-care medical evaluations at an HMO. While initial meetings and discussions with Kaiser were quite promising, roadblocks became evident when Kaiser IS was asked to install the ANAM software. These roadblocks primarily were regarding security and confidentiality of Kaiser's clinical information. While we have not yet officially ended this project, it is looking increasingly less promising.

3. Kronos Foundation. The two projects described in last year's progress report, one on omega-3 fatty acid supplementation and the other on testosterone replacement therapy, have been approved by the Kronos IRB but there have been unexpected funding problems and it is not known when these projects will start. We remain willing to support these projects in the event that they do start.

Ongoing and Continuation Projects:

1. Fairfax County High School Concussion Project. This project has three objectives. First, is to develop a model program for high school sports concussion surveillance and management, utilizing newly developed instruments such as the NRH-ANAM, the Virginia Neurological Index (VNI), and the Standardized Assessment of Concussion (SAC). Second, is to generate a detailed description of natural history of recovery from sports concussion in male and female adolescents, with special emphasis on the female athletes who heretofore have not been well covered by previous research. And third, to develop an Internet-enabled version of ANAM and use the Fairfax project as a testbed for psychometric validation of the Internet version against the conventional version of ANAM. Progress to data has consisted of preparation of a formal research proposal which has been approved by the Research Committee of the National Rehabilitation Hospital and the MedStar IRB. It was reviewed by the DOD IRB and returned with extensive comments and requested revisions. We are nearly finished revising the protocol and plan to submit it on or before March 15, 2002.

2. ANAM Dissemination, Support, and Technical Assistance Core. Many of the richest sources for ANAM development consist of collaborations in which NRH directs and manages the ANAM component of studies sponsored by other institutions. The major advantage of engaging in these collaborations is that they are an extraordinarily powerful way of leveraging NRH's and DOD's research dollars, rapidly and efficiently expanding the ANAM user-base and facilitating the creation of a vibrant ANAM user community. Moreover, each of the collaborative projects contains a scientifically important neuroscience research problem. We propose to aggregate these types of projects into a program core of "ANAM Dissemination, Support, and Technical Assistance," with a single budget that has provisions for support of the above described projects, as well as for stimulation and support of new projects.

   The specific activities included in the ANAM Dissemination, Support, and Technical Assistance core are:

   1. Consultation between NRH personnel (Drs. Bleiberg, Kane, or Reeves) and outside investigators to determine if ANAM is an appropriate tool for a proposed study, and to determine whether the proposed study is of sufficient quality to justify investment of NRH-DOD resources
   2. Provision of an ANAM "workshop" to the investigator's laboratory or institution, including installation of ANAM and training in its use
   3. ANAM software modifications and enhancements to address specific needs of the proposed study, typically performed under subcontract from NRH to Navy Computer Telecommunication Station (NCTS) and/or Tim Elsmore, Ph.D.
   4. Provision of assistance to outside investigators for writing ANAM-related sections of research proposals, IRB submissions, and study procedure manuals
   5. Data extraction, data management, and data analysis for ANAM and related data
   6. Participation in delivering scientific papers and posters, and preparation of papers for publication
   7. Integration and facilitation of the above via ANAMOnline.com, with emphasis on automating as many of the above support functions as possible

Key R&D Accomplishments

- A second-generation IRIS (Interactive Rollabout Imaging Station) has been fabricated consisting of a mobile unit (with a 15" flat panel video monitor, an electronic Pan-Tilt-Zoom camera, and a rechargeable power supply with over hours of run-time) and a base-station. IRIS utilizes 2.4 GHz receivers and transmitters for wireless transmission of audio and video signals. StarView 400 Pro videophones are used to code and decode the signals and transmit them over standard analog POTS phone lines.
- As part of the VR work, real-time gaze-fixation detection software has been further refined and accelerated so that changes occur in the display contingent on the direction of the participant's gaze. This will be utilized in a future project to train individuals with social cognition deficits to direct their gaze at face-borne communication.
- A preliminary design of the Wound Telehealth Kit was completed based on recommendations from the MedStar VNA nurses, who will be involved in the phase II study. The kit will consist of a digital camera, tripod, laptop computer, portable lighting and a rolling hard case. The nurse will use the laptop for gathering patient information and capturing and storing the digital images of wounds. The computer will also provide a contingent guide to use of the remainder of the equipment. The images will be forwarded to a wound specialist at a later time. A final design will be completed by mid-Spring for use in the phase II study.
- Significant progress was made developing clinical inference procedures for ANAM, the results of which have been accepted for presentation at the April 2002 American Academy of Neurology annual meeting

Reportable Outcomes

Publications:

Halstead, L.S., Dang, T.D., Elrod, M.W., Convit, R., Rosen, M.J. & Woods, S. presented a poster session on "Telerehabilitation for the Remote Assessment of Pressure Ulcers in Individuals with Spinal Cord Injury: A Preliminary Report" at the ATA 6th Annual Meeting, Fort Lauderdale, FL, June 3, 2001. Presentation was made by Michael Rosen, Ph.D.

Halstead, L.S., Balch, D., Clark, P.,Vesmarovich, S. Synopsis of Instructional Course presented at the ASIA Annual Meeting on "The Future of Telerehabilitation and Spinal Cord Injury Care". (In press in Spinal Cord).

Halstead, LS, Dang, T, Elrod, M, Convit RJ, Rosen MJ: Teleassessment compared with Live Assessment in a Wound Clinic: A Pilot Study. Advances in Skin and Wound Care. (In press 2002).

Halstead, L.S., Dang, T.D., Elrod, M.W., Convit, R., Rosen, M.J.,Woods, S. (In press 2002). Distance Evaluation of Skin Health: Teleassessment of Individuals in Remote Settings with Spinal Cord Injury and Pressure Ulcers. In (M.J. Rosen & D.E. Lauderdale, Eds.) Proceedings of the State of the Science Conference on Telerehabilitation and Applications of Virtual Reality. Washington, DC, NRH Press.

Lathan, C.E., M.R. Tracey, M.M., Sebrechts, D.M. Clawson, and G. Higgins "Using Virtual Environments as Training Simulators: Measuring Transfer" in *Handbook of Virtual Environments: Design, Implementation, and Applications,* Ed. K. Stanney, Mahwah, NJ: Lawrence Erlbaum Associates, 2002.

Lathan, C.E., and M.R. Tracey, *"The Interaction of Spatial Ability and Motor Learning in the Transfer of Training From a Simulator to a Real Task"* Invited to resubmit to Presence: Teleoperators and Virtual Environments, MIT Press.

Tracey, M. and C.E. Lathan, "Meeting Rehabilitation Goals with a Multi-sensory Human Computer Interface – A Case Study," in Universal Access in HCI: Towards an Information Society for All. Editor C. Stephanidis.Vol. 3, pp. 1012-1015. Lawrence Erlbaum Associates, Mahwah, New Jersey, 2001.

Trepagnier, C. (in press) Tracking Gaze of Patients with Visuospatial Neglect. To appear in Topics in Stroke Rehabilitation, Winter, 2002.

Woodard, J., Marker, C., Tabanico, F., Miller, S., Dorsett, E., Cox, L., Gould, F., and Bleiberg, J. (2002, February). A Validation Study of the Automated Neuropsychological Assessment Metrics (ANAM) in Non-Concussed High School Football Players. Poster presented at the International Neuropsychological Society Annual Meeting. Toronto, Canada.

Woodard, J., Marker, C., Tabanico, F., Miller, S., Dorsett, E., Cox, L., Gould, F., and Bleiberg, J. (2002). A Validation Study of the Automated Neuropsychological

Assessment Metrics (ANAM) in Non-Concussed High School Football Players. Journal of the International Neuropsychological Society, 8 (2): 175.

Conference Presentations (with Proceedings):

Bleiberg, J., Warden, D., Sun, A., Reeves, D. (2002, April). Computerized Neuropsychological Concussion Surveillance Instruments: Using the Reliable Change Index (RCI) As a Basis for Clinical Decision-Making. Accepted for presentation at the 54th American Academy of Neurology Annual Meeting. Denver, Colorado.

Tracey, M. and C.E. Lathan, "*Meeting Rehabilitation Goals with a Multi-sensory Human Computer Interface*" Presentation at the Human Computer Interaction International Conference (August, 2001, New Orleans).

C. Trepagnier. (2002) More evidence of atypical face gaze in autism and implications for intervention. Symposium on Mental Health and Rehabilitation, Medicine Meets Virtual Reality (MMVR), Newport Beach, CA, January 23-26, 2002

C. Trepagnier. (2002) Atypical Gaze in Autism & Implications for Remote Assessment. To be presented at American Telemedicine Association, June 2-5, Los Angeles, CA. Abstract to appear in *Telemedicine Journal and e-Health*

Warden, D., Bleiberg, J., Cameron, K., Ecklund, J. (2001). Persistent prolongation of simple reaction time following sports concussion. Neurology, 57:524-526.

Other Invited Presentations, Demonstrations, Theses and Talks without Proceedings:

Halstead, L.S. MD, Balch, D., Clark, P., Vesmarovich, S. presented an Instructional Course on "The Future of Telerehabilitation and Spinal Cord Injury Care" at the ASIA Annual Meeting, Long Beach, CA, May 18, 2001.

Rosen, M. and C. Trepagnier, participants in program on the Future of Medicine and the Smart Medical Home, University of Rochester, October 20, 2001.

Rosen, M., Savard, L., Tran, B., and Trepagnier, C. Pre-Conference Half-Day Course on Tools and Techniques for Telerehabilitation in 2001, annual conference on Technology and Persons with Disabilities, CSUN, March 2002.

Trepagnier, C. (2001). Eye-tracking and virtual reality in investigation and intervention with autism: current projects. Presented at the Georgetown University Affiliated Program. February 27.

Trepagnier, C., invited participant in State of the Science Meeting (Demand Pull) of the RERC on Technology Transfer, State University of New York at Buffalo, Buffalo, NY, June 5, 2001

Trepagnier, C. (2001). A virtual playmate to train social attention in very young children with autism – Conceptual description. Robotic and Virtual Interactive Systems in Autism Therapy, University of Hertfordshire, Hatfield, UK, September 27-28.

C. Trepagnier, M. M. Sebrechts, C. Lathan, R. Ramloll, R. Peterson & L. Barker. (2001). VR and Autism: State of the Science & VR for Early Intervention. Presented at the State of the Science Conference, October 12-13, Washington, DC.

Stephanie Johnson has completed and presented her doctoral dissertation, Global vs. local perceptual bias in autism under the supervision of M. M. Sebrechts, Ph.D., with C. Trepagnier as a committee member. *Abstract:* Ms. Johnson found confirmation of expected impairments in configurational face processing and expected advantage in the Embedded Figures test. This profile did not translate into the predicted local-over-global advantage, however. Her results are consistent with the hypothesis of a developmental impairment related to failure to acquire configurational face processing in the early months of life. They are not fully consistent with the "Weak central coherence" model of autism, which predicts an advantage for local over global processing.

Proposals Submitted and Awarded Based on ATNRC Accomplishments

NSF Small Grant for Exploratory Research (SGER), C. Trepagnier and C. Lathan
"Development of an interactive virtual environment for delivery of rehabilitative intervention to children with social cognitive deficits."

Dr. Bleiberg participated in the preparation of supplementary funding requests to insert ANAM into existing studies, with funding successfully achieved for: a lofexidine dose-escalation study at NIDA (NIH intramural funding); a bupropion treatment efficacy study at NIDA (NIH intramural funding); an ANAM normative and validation study in lupus patients at University Of Texas at San Antonio Medical School (NIH supplement to existing NIH grant); and, adding ANAM to an existing CDC-funded concussion surveillance project at the University of North Carolina, Chapel Hill (supplement from CDC to existing CDC grant).

Conclusions

PLEASE NOTE:

All conclusions have been incorporated into each project's narratives in the previous sections.

Appendices

Appendix 1: Dr. Ramloll's resume

RAMESHSHARMA RAMLOLL
February 2002

1. GENERAL INFORMATION

Telephone 00 44 0141 3398855 ext 0983
Fax 00 44 0141 330 4913
Nationality Mauritian
Language English (Fluent), French (Fluent), Creole (Fluent), and basic Hindi
email ramesh@dcs.gla.ac.uk
Home Page www.dcs.gla.ac.uk/~ramesh (not current)
Address MedStar Research Institute, National Rehabilitation Hospital, 102 Irving St., NW, Washington DC 20010

2. EDUCATION

2000 Ph.D. in Computer Science, Lancaster University, UK
1993 B. Tech. in Computer Science and Engineering, Indian Institute of Technology (IIT), Kanpur

3. PROFESSIONAL EXPERIENCE

2001-to date MedStar Research Institute, National Rehabilitation Hospital, Washington DC, USA
2000- 2001 Post-doctoral RA, Glasgow Interactive Systems Group, Glasgow University, Scotland, UK

1999-00 Lecturer, University of Mauritius
1993-95 Lecturer, University of Mauritius

4. AWARDS

1992 Creative Design Award, Indian Institute of Technology (Kanpur)
1995 United Kingdom Commonwealth Scholarship for Ph.D. studies

5. RESEARCH INTERESTS

Multi-user Interface Analysis and Design
Multi-media Interfaces e.g. Visual, Auditory and Haptic
Assistive Technologies (Enabling technologies for sensory impaired people)
Multi-modal Interfaces, Gesture (e.g. gaze, hand) tracking applications
Voice recognition and Speech synthesis to implement Conversational User Interfaces
User Interfaces for Mobile Devices
Brain Computer Interfaces
Human Computer Interface Evaluation Methodologies and Practices
History of Scientific Ideas

6. RESEARCH

(Most publications available on-line)

6.1 Ph.D. Dissertation

"Supporting Cooperative Work Through Ubiquitous Awareness Filtration Mechanisms,'' Lancaster University, 2000. Advisor: Dr. J A Mariani,
Examiners: Prof. Thomas Rodden (Lancaster University), Dr. Wolfgang Prinz (Head of CSCW research group, GMD, German National Research Center for Information Technology)

6.2 Refereed Doctoral Colloquium Publication

1. Ramloll R. MICIS: A Multimodal Interface for a Common Information Space, ECSCW'97 Conference Supplement, ECSCW'97, Lancaster, UK, September 1997, pp.66, ISBN: 1 86220 037 8.

6.3 Refereed Conference Publications

(Most papers are in conferences with acceptance rates of 0.14-0.3.)

1. Ramloll, R. and J. A. Mariani; Moksha: exploring ubiquity in event filtration-control at the multi-user desktop; Proceedings of the international joint conference

on Work activities coordination and collaboration, ACM conference, 1999, Pages 207 – 216

2. Ramloll, R. and J.A. Mariani; Do Localized Auditory Cues in Group Drawing Environments matter? in the International Conference on Auditory Display 1998 (ICAD'98 Glasgow) conference proceedings, 1998, Published by eWIC of the British Computer Society.

3. Ramloll, R., et al; Constructing sonified haptic line graphs for the blind student: first steps; The fourth international ACM conference on Assistive technologies, 2000, Pages 17 – 25

4. Beedasy, J. and R. Ramloll; User Interface Considerations to Facilitate Negotiations in Collaborative Spatial Decision Support Systems, in GISRUK 2000 proceedings, 2000, University of York, UK

5. Ramloll, R. et al; Using non-speech sounds to improve access to 2D tabular numerical information for visually impaired users, to be presented at IHM-HCI2001,10-14 September 2001, Lilles, France and to appear in the Proceedings of the conference published by Springer Verlag.

6. Ramloll, R. and D. Mowat; Wayfinding in Virtual Environments using an Interactive Spatial Cognitive Map, to be presented at the Fifth International Visualisation 2001 conference (London), July 2001 and to appear in the Proceedings of the conference published by IEEE Computer Society Press.

7. Yu, W., Ramloll, R., Brewster, S.A. and Riedel, B. Exploring computer-generated line graphs through virtual touch. In Proceedings of IEEE ISSPA 2001 (Kuala-Lumpur, Malaysia), IEEE, pp 72-75.

8. Yu, W., Ramloll, R. and Brewster S.A. (2001) Haptic graphs for blind computer users. Haptic Human-Computer Interaction. Brewster, S.A. and Murray-Smith, R. (Eds.), Springer LNCS, Vol 2058, pp 41-51.

9. Ramloll, R. and Brewster, S.A. (2002). A Generic Approach for Augmenting Tactile Diagrams with Spatial Non-Speech Sounds. To appear in Vol. II Proceedings of ACM CHI2002 (Minneapolis, MN), ACM Press.

6.4 Refereed Book Article Contribution

1. Beedasy, J. and Ramloll, R. User Interface Considerations to Facilitate Negotiations in Collaborative Spatial Decision Support Systems, (One of the best papers selected from GISRUK 2000) in 'Innovations in GIS 8', published by Taylor and Francis.

6.5 Refereed Workshop Publications

1. Ramloll, R. The Role of Reactive Typography in the Design of Flexible Hypertext Documents, Proceedings of the Workshop on Reuse of Web Information, held in conjunction with the 7th WWW Conference, 14 April 1998, Brisbane, Australia, Anne-Marie Vercoustre, Maria Milosavljevic, Ross Wilkinson Editors, CSIRO Mathematical and Information Sciences, pp. 91-97, Report Number CMIS 98-11.

2. Ramloll, R. Why Seek Ubiquitous Event-Filtration Control at the Multi-user Desktop? Implementing Tailorability in Groupware Workshop at the WACC'99 Conference 22nd Feb. 1999, San Francisco, California, USA

3. Yu W., Ramloll R., and Brewster S.A. Haptic graphs for blind computer users First International Workshop on Haptic Human-Computer Interaction, 2000, pp. 102-107.

6.6 Refereed Short Paper and Poster Presentation

1. Ramloll, R. Navigational Agents for Large Scale Virtual Worlds, ECSCW'97 Conference Supplement, ECSCW'97, Lancaster, UK, September 1997, pp.55-56, ISBN: 186220 037 8.

6.7 Refereed Conference Demonstrations

1. Ramloll, R. 'Demonstrating gaze driven auditory browsing' Demonstration at the International Conference on Auditory Display 1998 (Glasgow), 4th Nov 1998.

2. Ramloll, R. 'Demonstrating an auditory enhanced Collaborative Drawing Tool' Demonstration at the International Conference on Auditory Display 1998 (Glasgow), 4th Nov 1998.

6.8 Invited Talk and Demonstration

1. Tactile and Multimedia Tools for Young Visually Impaired People, BrailleNet 2001 Thematic Day, 5th April 2001 organized by The BrailleNet Association, The Cite des Sciences et de L' industrie de La Villette, The University of Pierre & Marie Curie, French National Institute for Health and Medical Research.

6.9 Software Systems

Design and implementation of following experimental software systems (implementation language: Java, Visual C++, Perl, Visual Basic, Macromedia Flash, Microsoft Access) relevant to published work.

1. ALET (Auditory Localisation Evaluation Tool § 6.1, 6.7(1))

2. Moksha (Application demonstrating awareness filtration mechanisms presented in § 6.1, 6.3(1), 6.5(2))
3. ACDT (Auditory Collaborative Drawing Tool § 6.3(2), 6.7(2))
4. ReactType (Demonstrating the concept of reactive typography § 6.5(1))
5. AudioTable (Making information in 2D tables accessible by visually impaired people using synthetic speech and non-speech sound § 6.9(1))
6. CoSpaME (Horizontal prototype of a Collaborative Spatial Decision Support System § 6.3(4))
7. Computerized version of the NASA Task Load Index § 6.9(1)
8. TouchMelody § 6.3(9)
9. AudioCave § 6.9.1(1)

6.9.1 Papers under Review

1. Ramloll, R. and S. Brewster: A Shareable Audio Environment for Studying the Effectiveness of Spatialised Sonified Graphs, IEEE Information Visualisation 2002, London UK

6.9.2 Technical Reports

1. The Comic Spatial Model: A Critical Study, Technical Report CSEG 32/97 (Lancaster University).
2. Ramloll R. and J. Mariani: Taking a Fresh Look at Auditory Displays: Gaze Driven Auditory Browsing, Technical Report, 1998, (Lancaster University).
3. Ramloll, R. 'Seeking Alternative Resources for Context Building in Common Information Spaces'
4. Ramloll, R. Revealing Awareness Information through Intuitive Direct Manipulations

7. TEACHING and other academic duties

7.1 University of Mauritius

1993-95, 1999-00 (courses taught)

1. FoxPro (MBA part time students)
2. Data Communications and Networks (year 4, B. Tech Computer Science)
3. Data Processing (year1, B. Tech Computer Science)
4. Design and Analysis of Algorithms (year 3, year 4, B. Tech Computer Science)
5. PC maintenance and Networking (Short Course)
6. Information Technology Foundation Course (year1, BSC Accounting)
7. Robotics and Automation (year 4, B. Tech Computer Science)
8. Software Engineering, Object Oriented Analysis and Design (year 4, B. Tech)
9. Data Base Design (year 3, B. Tech Computer Science)
10. Software Engineering, Object Oriented Analysis and Design (year 4, B. Tech)
11. Data Base Design (year 3, B. Tech Computer Science)

1993-95, 1999-00 (projects supervised)

1. Design and Implementation of a Program Visualization System (year 4, B. Tech Computer Science)
2. Design and Implementation of a Computer Aided Traffic Control System (year 4, B. Tech Computer Science)
3. Database design and implementation projects (year 2, B. Tech Computer Science)

7.2 University of Lancaster

1995

1. Tutor for ADA and Prolog programming course (year 1, B. Sc. Hon. Computer Science)

7.3 University of Glasgow

2001-to date (project supervised)

1. Designing Navigation Aids for Large-Scale 3D Virtual Worlds (year 4, B. Sc. Hon. Computer Science)

8. VIRTUAL REALITY TECHNOLOGIES

I am familiar with the following VR related hardware:

1. Polhemus, FASTRAK, mid-range motion tracking and digitizing system which can track (position and orientation) up to two
receivers over a range of 5 feet. I used it to experiment with hand gestures to modulate a MIDI stream.

2. Polhemus, LONG RANGER, mainly used to extend the range of the FASTRAK. I used it in conjunction with the Huron CP4 (a Digital Audio Convolution Processor) to experiment with real time rendering of virtual sound sources while tracking the head position and orientation of a listener.

3. Huron CP4, Lake technologies, which is a high performance multi-processor DSP engine for audio applications. I used the CP4 mainly to simulate 3D audio for virtual 3D environments. It also provides extensive functionality for room acoustic measurements and can in principle be used for the measurement of Head Related Transfer functions (essential for the production of convincing 3D sounds through head phones).

4. Phantom, from Sensable Technologies, hardware providing precision positioning input and high fidelity, force feedback output. It was used to produce grooves in a 2D surface to represent line graphs for the visually impaired. Related publications are in the CV.

5. Vision Control System, a lightweight (less than 100g), and compact and flexible eye tracking system. This product was promoted as a "look-and-click" control device. I demonstrated that it could be useful as a "look-and-listen" device to browse spatially dense soundscapes. I had the opportunity to use one of the first prototypes made by Ferranti a subsidiary company of British Aerospace. More information about this research is available in PhD thesis available on-line. Detailed information about the product is available in the appendix.

9. DETAILS of first degree in Computer Science and Engineering (B.Tech.) at the Indian Institute of Technology, Kanpur.

Courses: Chemistry (I, II), English Language and Composition, Mathematics (I, II, III), Physics (I, II), Thermodynamics, Mechanics of Solids, Electrical Science (I, II), Earth Science, Manufacturing Processes (I, II), Fluid Mechanics and Rate Processes, Probability and Statistics, Data Structures, Introduction to Logic, Indian Art and Civilization, Graphics, History of Scientific Ideas, Discrete Mathematics, Computer Organization, Algorithms, Artificial Intelligence Programming, Engineering Design-Creativity Concepts and practices, Principles of Database systems, Principles of Compiler and Translating Systems, Theory of Computation, Parallel Semi-Numerical and Non-Numerical Algorithms, Philosophical problems, Introduction to Natural Language Processing, Robotics and Robot Applications, Computer Network, NLP Semantics, Dynamics, Construction and Programming of Robots, Social Psychology.

Cumulative Point Index Obtained: 7.3/10

Appendix 2: Abstract of the human studies protocol for the composite brace project

Four subjects with paraplegia, selected based on their previous experience with Knee Ankle Foot Orthosis (KAFO) walking, lack of skin ulcers and abnormalities on their legs, good health with no active medical problems or comorbidities, and ability to get to NRH, will participate in a study to examine a new composite full-contact long leg brace system called the NRH Brace. It is anticipated that these new braces will be lighter and cosmetically superior to traditional long leg braces, potentially allowing additional users and persons already using braces to ambulate further with less effort and wear on the rest of the body. Whereas some of the components are already in use in some bracing systems, this will be the first time they are used together for a full contact brace specifically for persons with paraplegia. The trial will consist of two phases. In the initial phase subjects will demonstrate their current brace use, be fitted for the new full-contact brace, and then receive training and supervision at NRH by a physical therapist and orthotist until such time as their function in the new braces is similar to that of their old braces, at which point they will begin phase two. During phase two of the project, subjects will use the full-contact braces in their home environment over a four-week period. During this period the subject will be in regular contact with the project physical therapist (who will collect data on the use of the full contact brace) and will make several trips back to the hospital for visual inspections of his/her skin and the full-contact brace. At the conclusion of the study, subjects will complete a brief questionnaire on their satisfaction with the brace.

Appendix 3: Job description for recruiting new PhD engineer

Human-Machine Systems Engineer

Job Description, December 31, 2001
Assistive Technology and Neuroscience Research Center
National Rehabilitation Hospital
Washington DC

Required skills, knowledge and experience

- ***Doctorate*** in mechanical or electrical engineering (or other undergrad degree and Ph.D. offering equivalent background)
- Knowledge and experience in
  1. human motion analysis and related experimental methods
  2. human-machine systems modeling from a control-theoretic and information-processing perspective
  3. robotics: mechanical design and control
  4. development of digital and analog control systems
  5. design of haptic systems and tangible interfaces
  6. digital signal processing
  7. experimental design and evaluation of human-machine systems
- Demonstrated ability to publish research outcomes in refereed proceedings and journals
- Programming proficiency in C/C++, VC++, Visual Basic
- Familiarity with data analysis using tools such as Matlab, LabVIEW
- Experience as part of multi-disciplinary r&d teams
- At least two years of professional experience in industry or academia

Preferred skills, knowledge and experience

- Experience in medical or rehabilitation applications desirable
- Demonstrated ability to conceptualize R&D projects in these fields, prepare successful proposals for funding, and lead and execute funded projects.
- Intended career path in biomedical applications of technology and engineering methods

Prospective candidates are required to email (1) their CV and (2) a cover sheet describing their motivation for choosing this career path to the director of ATNRC, Michael J Rosen, Michael.J.Rosen@Medstar.net., phone 202-877-1932, fax 202-723-0628.