

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

| <b>Date</b> | <b>Title</b>  | <b>Abstract</b>  | <b>Research By:</b>                           |
|-------------|---|--|---|
| June 2005   | Automatic Transport and Retrieval System for Power Wheelchairs                            | An Automatic Transport and Retrieval System (ATRS) is under development to automatically guide a power wheelchair to and from a power lift at the rear of a mini-van. The system uses computer vision and mobile robot navigation technologies to safely move the wheelchair between the lift and the driver's door. This system will allow a wheelchair user to travel independently in a standard passenger vehicle that needs only minor modifications.   | Carnegie Mellon University, Lehigh University |
| June 2004   | Characteristics of Wheelchair Users and Associated Motor Vehicle Transportation Usage     | Wheelchair transportation safety is a major concern, however little is known about the characteristics of wheelchair users who utilize transportation. This study is designed to examine and compare the transportation use of individuals using either power or manual wheelchairs. A survey completed by 282 wheelchair users was conducted to identify this information. The results showed little differences between the power wheelchair and manual wheelchair user regarding their transportation use, with private vehicles (driver/passenger) being the most frequently used form of transportation. These finding suggest that the private vehicle transportation domain may be a very important area of focus for future research and policy design initiatives.  | University of Pittsburgh                      |
| June 1998   | Testing and Evaluation of Wheelchair Caster Assemblies Subjected to Dynamic Crash Loading | Safe transportation is critical to the integration of wheelchair user into society. Many wheelchair users are required to travel while seated in their wheelchairs. Transportation conditions call for more stringent wheelchair design criteria since crash loads are dynamically applied and exceed loads encountered during normal mobility. This study utilized dynamic drop testing to evaluate the crash integrity of common wheelchair caster assemblies. Results suggest that current caster assembly designs may not be able to withstand forces associated with a crash. Five to seven evaluated caster assemblies failed when loaded to 1800 lb, or less. Wheelchair manufacturers intending to market wheelchairs as suitable for transportation should closely evaluate caster assembly strength to assure crashworthiness. | University of Pittsburgh                      |
| June 1998   | Status of Universal Interface Design Standard for Mobility Device Docking on Vehicles     | There has been work ongoing to develop a universal interface design standard to foster compatibility between wheeled mobility devices and the securement systems available to transport vehicles. Some of the results of this work have been reported in previous proceedings, as discussed below. This paper is an update on the state of this effort and primarily reports the work done to evaluate the potential designs for compatibility and dynamic strength, and the status of the development of the design standard.   | University of Pittsburgh                      |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |  |                                 |
|-----------|--|--|---------------------------------|
| June 1998 | Belt Fit Evaluation of Fixed Vehicle-Mounted Shoulder Restraint Anchor Across Mixed Occupant Populations | Occupant restraints, including shoulder and lap belts, are necessary to protect wheelchair occupants during motor vehicle transportation. It has been shown that proper belt fit is needed for effective occupant protection. In many cases, shoulder belt restraint systems incorporate a fixed vehicle-mounted anchor. The anchor is installed based upon a 50 <sup>th</sup> percentile (P50) male occupant. This study evaluates the influence of fixed shoulder belt anchor location on the belt fit of a 5 <sup>th</sup> percentile (P5) female and a 6 year old occupant. Belt fit is assessed using anchor guidance from SAE J2249 and WTORS manufacturer's instructions, as well as accounting for physical vehicle constraints. This study found that anchor configuration can lead to poor belt fit and compromised crash protection in smaller occupants.   | University of Pittsburgh        |
| June 1997 | Bicycle Modifications for Amputees   | In this day of heightened awareness of health and exercise, people have begun to realize the importance of participating in some form of athletic activity to promote a healthy lifestyle. Bicycling has long been known to provide a good workout with low impact, with the additional benefits of being outdoors, fresh air and scenery. For those cyclists with above the knee amputations cycling presents some unique challenges for safe and efficient riding.   | Georgia Institute of Technology |
| June 1997 | Universal Interface Hardware Design Standard for Mobility Device Transport Docking Systems               | Docking-type securement devices for mobility devices and their occupants offer several advantages over the more commonly used belt-type technology. One large limitation of the proliferation and success of docking technology is the requirement for specific wheeled mobility device (WMD) hardware to interface with compatible vehicle-mounted hardware. Current interface hardware designs have shortcomings and require that the vehicle have specific docking hardware or it is rendered useless. This paper discusses the efforts that have been made to facilitate the development and adoption of a trans-industry universal interface design standard. The goal is to foster seamless compatibility between the WMDs, their securement devices, and the transport vehicles. Industry design criteria and potential hardware configurations. In addition, the optimal location for placement of the hardware on WMDs has been investigated. | University of Pittsburgh        |
| June 1997 | Wheelchair Transit Safety<br>A Conceptual Case for a Low "G" Securement Approach                         | Securement and release of wheeled mobility devices (WMDs) by their occupants on public transit vehicles is essential to realize the desires of users and the spirit of ADA. Currently used belt type technology and the lack of a universal docking approach are two major obstacles to this goal. This paper makes the case for an alternative solution that can be developed and applied in the short term for use in larger transit vehicles. Results of preliminary testing of a prototype design further support the feasibility of the proposed concept.   | University of Pittsburgh        |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |   |                          |
|-----------|--|---|--------------------------|
| June 1997 | The Need to Establish Appropriate Levels of Crash Protection for Wheelchair Riders in Public | Lack of information regarding accident frequency and severity has resulted in national wheelchair safety standards that are too stringent for larger buses and trains and too lenient for public transit vans. Research is needed to provide: (1) accident injury risk and appropriate vehicle crash pulses; and (2) wheelchair tiedown and occupant restraint systems (WTORS) loads. It is anticipated that the resulting findings will acknowledge the inherent safety of the large public transit bus and stimulate the development of wheelchair restraints that are less cumbersome for the operator and less intrusive for the wheelchair user.   | University of Virginia   |
| June 1997 | Survey of Wheeled Mobility Device Transport Access Characteristics                           | In support of the ANSI/RESNA WC/19 Standard for Wheelchairs Used as Seats in Motor Vehicles development, a survey of various types of wheeled mobility devices (WMDs) was undertaken to identify ranges of select transport access characteristics. A subset of this study, including statistical analysis of WMD weights, overall dimensions and turning radius is presented. Information related to these characteristics can be used for comparative purposes by consumers, WMD prescribes and designers of WMDs, securement systems and other WMD transportation accessories.   | University of Pittsburgh |
| June 1996 | Seated Postural Stability of Wheelchair Passengers in Motor Vehicles                         | The seated postural stabilities during driving maneuvers of quadriplegic, paraplegic, and able-bodied individuals were compares. Testing, conducted with the subject seated in a wheelchair in a 22-ft. van, consisted of left turns performed at two different speeds resulting in sustained centrifugal acceleration levels of either 0.2 g or 0.4 g. Subject response was captured in video recordings while vehicle acceleration was measured with a triaxial accelerometer. The quadriplegic subjects lost stability for all test rungs, while the paraplegics withstood all the 0.2 g and some of the 0.4 g runs. The able-bodied subjects maintained balance for all runs. Better stability in the driving maneuvers correlated with an ability to withstand greater center of gravity displacement in static testing. For this small study seat cushion type had no significant effect on response. | Ohio State University    |
| June 1996 | The Affects of Securement Point Location on Wheelchair Crash Response                        | ADA has led to an increase in disabled travelers, many of whom are required to use their wheelchairs as vehicle seats. Proper securement of the wheelchair is crucial to the safety of these wheelchair users in a crash. To promote proper wheelchair securement, the ANSI/RESNA Transportable Wheelchair Standard currently under development will require that all transportable wheelchairs be equipped with four securement points, compatible with belt-type tiedowns. Through computer simulations, the location of these securement points has been found to influence the response and loadings of a wheelchair in a frontal crash. Accordingly, placement of securement as a strategy to control crash response, and may eliminate the failure of critical wheelchair components in a crash.  | University of Pittsburgh |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |  |                             |
|-----------|---|--|-----------------------------|
| June 1996 | Transportation Needs: Survey of Individuals with Disabilities             | In order to evaluate the transportation needs of individuals with disabilities, a survey was distributed to the mailing list of the local independent living services organization. In addition to basic demographic data, respondents were asked to report their modes and frequency of travel, fatigue information, seat belt use, driving frequency and accident rates. The results of the survey showed that all respondents use personal vehicles as drivers or passengers for transportation, while two-thirds use public transit. Respondents had a greater tendency to travel while seated in their wheelchairs when using public transit, and reported having difficulty with wheelchair securement and occupant restraint systems in all vehicles. The ability to leave the vehicle in the event of an emergency was also a major concern. Additional attention to comfort, ease of use, and emergency egress is necessary for wheelchair securement and occupant restraint systems, particularly for public transit vehicles. | Cleveland Clinic Foundation |
| June 1995 | Whiplash Injury Risk to People with Disabilities Traveling in Wheelchairs | A large number of studies have been conducted examining the mechanisms resulting in whiplash injury as a result of automotive accidents. Despite that fact that many of these mechanisms are still not clearly understood, very little has been documented concerning the possible risks that rear impacts present to wheelchair users. As it stands now, there is no existing U.S. Standard regarding protection of mobility aid users from rear collisions. This paper will discuss the importance for these issues and outline the research which will be performed in the Spring of 1995.  | University of Virginia      |
| June 1995 | Change of Handling and Rollover Stability of Van due to Body Raise        | Computer simulation and accident data analyses were used to study the effect of raising the body of a van on handling and rollover stability. Preliminary results suggest that a six inch body raise may result in unsafe handling characteristics in accident avoidance maneuvers and will increase the rollover rate.  | University of Virginia      |
| June 1995 | Universal Tiedown and Occupant Restraint System for Mobility Aids         | In response to the long expressed need for a universal system to safely secure wheelchair van and bus riders, an innovative wheelchair tiedown and occupant restraint system (WTORS) prototype has been developed that is crash safe, easy to use, and adaptable to commonly used mobility aids. The design has several advantages over one ore more present systems including easier, more reliable operation and lighter hardware that can accommodate common lightweight folding wheelchairs. Further assessment and design refinements are required in order to produce a system suitable for universal application.   | University of Virginia      |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |   |                                 |
|-----------|--|---|---------------------------------|
| June 1995 | Evaluation of Powered Lifts for Commuter Railcar Access                          | The Commuter Railcar Accessibility Study was conducted to guide California Department of Transportation (Caltrans) in designing accessibility into existing and planned commuter railcars. Three different lift types and two lift locations were studied, as well as other accessibility issues; this paper highlights the lift evaluations. The study emphasized the consumer perspective, involving 53 people with disabilities in testing and evaluation of mock-up equipment. A set of design criteria for new and/or improved lifts were created, which expands upon guidelines in the Americans with Disabilities Act (ADA). Many of the study's conclusions are also relevant to the accessibility of other rail systems, non-rail transportation, and buildings.   | San Francisco State University. |
| June 1995 | Wheelchair User Stability during Simulated Driving Maneuvers                     | The stability of individuals seated in wheelchairs during driving maneuvers is difficult to measure consistently. Acceleration profiles of a large transit bus were measured on the floor at the wheelchair position during five severe driving maneuvers performed under test conditions. Simulation of these vehicle maneuvers was then performed in a laboratory environment, and the displacement of the test subject's center of gravity was measured relative to the wheelchair seat. It was shown that the center of gravity shifts in the direction of the simulated lateral acceleration with a human subject without trunk support, and with an anthropomorphic test dummy. The shift in the test dummy's center of gravity during the maximum acceleration was significantly less than that of the human subject. When the human subject uses trunk muscles alone or in combination with arm support to stabilize himself, the center of gravity is shifted in the opposite direction to the simulated lateral acceleration. | Cleveland Clinic Foundation     |
| June 1995 | Securement of Wheelchair in Motor Vehicles: Is it Time for a Universal Solution? | This paper discusses the multitude of issues involved in arriving at a universal solution to securement of wheeled mobility devices in motor vehicles. A proposal for the development of a universal interface standard that will integrate the involved technologies is made. A time schedule for completion of the work and a discussion of the unique window of opportunity that exists to successfully carry out this activity is also presented. The potential benefits to WMD users are outlined and a request for their participation is the process is also made.   | University of Pittsburgh        |
| June 1993 | Performance Testing of Wheelchair Lifts for Personal Licensed Vehicles           | This paper presents some of the findings during testing that are of importance to wheelchair users, prescribers and lift manufacturers. The proposed test procedure establishes minimum performance requirements and only lifts satisfying all the tests are considered in compliance. While most lifts manufactured today may not pass all aspects of the proposed standard, most conform to a significant number of the specifications. Some of the requirements of the proposed standard are very stringent and are still in the evaluation process. It is expected that through the acceptance of these standards, the reliability and performance of the van lifts will improve and benefit the thousands of disabled people who rely on personal vehicles for transportation.   | University of Virginia          |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |  |                             |
|-----------|---|--|-----------------------------|
| June 1993 | Testing Procedures for Wheelchair Securement System Standards                 | The development of wheelchair securement system performance standards requires the development of standard tests to ensure reliable and consistent information. Questions have been raised regarding the significance of variations in the crash pulse, and important test parameter which helps to define the severity of the collision. To investigate the effect of crash pulse variations on securement system loading, a series of dynamic crash tests was conducted. Preliminary results indicated that variations of the pulse produced insignificant changes in securement loading. Additional work is needed to improve test sensitivity. | University of Virginia      |
| June 1993 | Factors Affecting Wheelchair Occupant Injury in Crash Simulation              | The kinematic response of the wheelchair seated body to a simulated crash event has been previously described in qualitative terms (1). This paper presents a more detailed analysis that has been performed on data from crash simulations. The relationship between the injury criteria of the occupant and the mechanics of the restraint system was investigated. It was found that when hip flexion was restricted by restraining the torso with a shoulder belt, there was an increase in neck flexion which correlated with an increased level of head injury.  | Cleveland Clinic Foundation |
| June 1993 | Determining The Transportation Safety of Chest Supports and Pelvic Restraints | Many wheelchair users require postural supports to insure functional stability. The performance of these supports in dynamic transportation environments is unknown. Postural supports may provide protection or pose a danger to the user. Static testing procedures based on federal testing guidelines were adapted to judge the integrity of postural supports. None of the commercially available supports were able to meet the strength requirements necessary for an occupant restraint, but should withstand the forces experienced during non-impact driving conditions.   | University of Virginia      |
| June 1993 | Static Testing of Commercial Headrests to Evaluate Transportation Safety      | Commercially available head rest systems were evaluated to determine their static strength under test conditions similar to motor vehicle tests of head restraints. Certain head rest designs surpass the static strength requirements of vehicle headrests and may be appropriate for transportation use. Dynamic tests should be conducted to validate the static methodology.   | University of Virginia      |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |   |   |
|-----------|---|---|---|
| June 1993 | Toward Understanding Consumer Concerns About Transporting Children with Physical Disabilities in the Family Car | A major issue that concerns parents when preparing for travel in the family car is transferring their disabled school-age child to and from the vehicle. Research is presently underway to develop a transfer system that will assist them by providing a more effective method of ingress and egress. To determine whether specific issues could be raised that would assist in the development and eventual evaluation of such a device, a focus group of eight parents was organized. In addition to discussing issues of concern, the parents were asked to identify the criteria they would use to evaluate the appropriateness of a transfer device if one was available. Twenty three criteria were identified during the meeting. A follow-up survey was conducted to rate the criteria. Participants identified the safety of their children and themselves and the cost of the device as being of primary importance. Furthermore, innovative policy schemes for creating a device that was affordable were also proposed. The ability of the consumer to repair the device if it breaks and product versatility were rated to be of lesser importance. | Hugh MacMillan Rehabilitation Centre, Thames Valley Children's Centre |
| June 1993 | Wheelchair Aviation: Case Studies and Survey of Adaptive Engineering Needs                                      | Although aviation offers significant opportunities for freedom, transportation, employment, and recreation among disabled persons, potential wheelchair pilots often may not be aware of resources within their communities to assist with these goals. The purpose of this paper is to raise awareness within the rehabilitation community of the feasibility of training disabled persons to become licensed airplane pilots and to describe some of the medical and engineering considerations appropriate for patients interested in such an endeavor. Results of a survey of members of the International Wheelchair Aviators suggest potential areas for future engineering design of adapted aircraft to further assist disabled pilots, particularly spinal chord injured pilots.   | Mayo Clinic and Mayo Foundation                                       |
| June 1990 | A Portable Driver Measurement System  | The authors have developed a device to assist them in determining the physical parameters of potential drivers in order to compare them with the available adaptive driving equipment and with the configuration of various vehicles. The prototype described here was designed to fit the following criteria: 1) measures position/operational range, size, and force capability of a subject using simulated steering, hand brake and throttle controls while allowing the use of interchangeable control grip interfaces; 2) allows and assists with the measurement of all relevant body parts, range of motion, and personal equipment (i.e. wheelchair) components in three dimensional space in the driving position; 3) is portable, with no single component weighing more than 30 lbs. and the total weight not more than 65 lbs.; and 4) is easy to assemble, adjust and use without special training.   | N.C. Division of Vocational Rehabilitation                            |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |   |                                 |
|-----------|--|---|---------------------------------|
| June 1990 | Appropriate Development of Vehicle Modification Protocol for Maximizing Traffic Safety of Disabled Drivers | Many of the individual U.S. States and Canadian Provinces have some means of identifying and prescribing adaptive driving devices. The past several years have been a progressive refinement of early vehicle modification guidelines and standards developed by the states of Massachusetts and California. In many instances clinical rehabilitation engineering has been called upon to assist in the development and implementation of systematic procedures for procuring appropriate adaptations for the disabled driver. The independent operation of a motor vehicle is potentially one of the most hazardous consults that the rehabilitation engineer is faced with. Inappropriate identification and prescription of specific driving devices can jeopardize the safety of the user and the motoring public, and in many cases is avoidable. A system of describing appropriate generic equipment has been developed by the Department of Human Services of the State of Indiana and is based on sound clinical practices used in several rehabilitation programs around the state.  | Metro Health Medical Center     |
| June 1989 | Automatic Wheelchair Inboard Storing   | Many disabled drivers using a wheelchair find it possible to install themselves behind the steering wheel of a vehicle but are then faced with the formidable task of trying to bring the wheelchair inboard! This paper describes the design of a device that will automatically bring a folded wheelchair inside the boundaries of a vehicle. The device was successfully adapted to a variety of cars and the paper will review the design objectives and the detailed operation. Researchers at Ecole Polytechnique de Montreal have participated in the design and development of a low cost device that can be installed in most vehicles. This device allows handicapped people to bring their own wheelchair inside a vehicle, without any exterior help, any special strength or any special movement nor requirement as long as they can transfer, by themselves, from the wheelchair to the automobile seat and back. Operation of the device is through a simple switch located on the instrument panel of the vehicle. The device was designed with flexibility, low maintenance, low cost and ease of operation in mind. It is intended for disabled people who have use of their upper limbs even if their lower limbs are not mobile. | Ecole Polytechnique de Montreal |
| June 1989 | Unistik Vehicle Controller: Clinical evaluation and Prediction of Driving Ability                          | The Unistik vehicle controller is an adaptive control system added to the inside of a motor vehicle, which allows a driver to control all movement of the vehicle at highway speeds using only one hand (or other limb) on a single joystick. This study tested efficacy of driving for 22 subjects with various types of disability, with emphasis on prediction of driving ability by common clinical methods. Psychological testing, wheelchair skill evaluation, upper extremity sensory, muscle strength and performance measurements were done, and the results were correlated with driving test scores.   | University of Washington        |



**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |  |   |
|-----------|---|--|---|
| June 1987 | The Carchair Story  | Historically, in the UK, if a disabled person wanted vehicular mobility, their choice of transport was limited to entering the rear of a small van, with dramatically restricted vision, or physically transferring from their wheelchair to the front seat of a car. Traveling in the rear of the van the disabled person was isolated from the driver, and the requirement put to me was to design, and ultimately produce, a method for a disabled person to enter the standard car and travel in the front seat position without the physical effort of transferring from their wheelchair. Any system would, of course, have to be safe, beneficial, reliable, durable and easy to use.   | Car Chair Ltd.  |
| June 1987 | Transfer of Current Technology to Adaptive Devices and its Impact on the Driving of Public Both Able Bodied and Physically Challenged | This paper outlines the basic criteria that should be applied to the design of adaptive equipment for the physically challenged.   | General Motors Corporation  |
| June 1987 | Performance Standards for Adaptive Equipment in Personally Licensed Vehicles Used by Persons with Disabilities                        | A Society of Automotive Engineers (SAE) Subcommittee has been established to develop SAE voluntary performance standards, recommended practices, and information reports relating to adaptive equipment in personally licensed passenger vehicles used by persons having a disability. The Subcommittee, composed of manufacturers and other experts from the rehabilitation community, is working on SAE documents for (a) adaptive driver controls, (b) wheelchair lifts, (c) wheelchair occupant protection systems, and (d) related terminology. Additionally, test templates and a computer program (with user's guide) have been developed for predicting wheelchair storage capability in the trunk or behind the seat of passenger vehicles. | Electronic Industries Foundation, SAE Adaptive Devices Subcommittee |
| June 1987 | Driver Assessment, Education and Training for the Disabled  | The Louisiana Tech University Center for Rehabilitation Science and Biomedical Engineering sponsors a comprehensive driver assessment education and training program for persons with disabilities. The program uses a multidisciplinary team approach, with the team members being determined by the individual needs of each client. The program is organized into three major components, Driver Assessment, Adaptive Device Prescription, and Driver Education and Training. In addition, a Mobile Assessment Laboratory has been developed in an effort to solve the problem of providing assessment services to individuals who find it difficult to travel long distances to rehabilitation facilities.                                       | Louisiana Tech University   |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |  |                           |
|-----------|---|--|---------------------------|
| June 1987 | An Assistive Mobility Device for Independent Living   | Traditional shopping devices do nothing to remove the loads and stresses from the shopper's joints. In addition, the loading and unloading of goods and parcels to and from an automobile trunk is a difficult task in itself. However, for the elderly and arthritic, the removal of loads and stresses is a requirement for their health, safety and comfort. It is proposed that the use of a cart and lift mechanism could virtually eliminate the load from the user.   | Arizona State University  |
| June 1987 | A Mobile Assessment Laboratory for Evaluating the Driving Skills of Disabled Individuals  | A mobile facility has been designed and equipped with the components of a laboratory-based driver assessment system for use by disabled individuals. Its ergonomically planned layout provides wheelchair access to areas for reaction time and visual search abilities, range of motion, manual muscle tests, and strength of other functional movements needed for driving. In addition, space is provided for paper-and-pencil assessment tasks and computer controlled tracking with interchangeable steering and control modules. Assessment results obtained in the mobile assessment laboratory (MAL) parallel those obtained with similar equipment in the stationary laboratory.  | Louisiana Tech University |
| June 1987 | Psychometric Predictors of Driving Ability Among Able-Bodied and Disabled Individuals   | Twenty five subjects (7 SCI, 10 TBI, 8 able-bodied) received a battery of psychometric and performance tests. Their ability to drive a full sized vehicle on the closed course was also evaluated. This study examined the relationship between the psychometric predictors and actual driving ability. Results indicate that the able-bodied subjects drove better than the spinal cord injured subjects. Excellent inter-rater reliability in evaluating driving performance was obtained, with two raters reaching perfect agreement on 86% of their shared observations. Correlations ranging from .38 to .85 were observed between the predictor variables and the driving criterion. Multiple regression indicated that 81% of the variance in driving could be accounted for by two composite predictors, and knowledge of group membership added nothing to the predictive accuracy. These results offer promise toward developing a simple screening battery for identifying client's who can progress directly to in-vehicle assessment. | Louisiana Tech University |
| June 1987 | Computer Programs for Cognitive Rehabilitation; Usefulness in Predicting Driving Skills Among Disabled and Non-disabled Persons | The Computer Programs for Cognitive Rehabilitations (Vol 1) is a set of computerized tasks that are used in assessing and retraining cognitive abilities among brain injured individuals. Two of these, Visual React and Visual Search were used in an assessment battery for predicting driving skill among disabled individuals. This paper describes two studies of potential use of these tests in evaluating a driving candidate.   | Louisiana Tech University |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |  |   |
|-----------|--|--|---|
| June 1987 | Wally's Trolley  | Accessibility to private residences poses a very real problem in extremely hilly cities like Pittsburgh. Wally's Trolley is an individual passenger cable car designed to transport a person with limited mobility up and down a slope. It was designed for use at a senior author's residence when his wife's arthritis limited her ability to walk. It permits the user to transfer from the flat surface of the back porch to the cable car and transfer again to a flat surface at the street level. The entire system was designed to be constructed of materials easily available from local sources and at a reasonable cost. Construction of the cable car system has permitted an individual with limited mobility to continue to reside in a home with grades beyond her ability to negotiate.   | The Rehabilitation Institute of Pittsburgh. |
| June 1987 | A Small-Scale Vehicle for Assessing and Training Driving Skills Among the Disabled | A Small-Scale Vehicle (SSV) was developed for the purpose of assessing and training skills of disabled individuals who wish to become licensed to drive. The SSV is an electric golf car that has been modified to accept various types of adaptive driving controls. This vehicle allows the driving evaluator the opportunity to evaluate the client's performance in a dynamic situation. It allows the potential driver the opportunity to practice basic vehicle maneuvers in a safe, low-anxiety environment.  | Louisiana Tech University                   |
| June 1987 | Development of a Compact Lift and Transfer Device                                  | A portable lifting machine has been developed for moving quadriplegics without sling insertion under the buttocks, while maintaining dignity and preventing undesired rotation or jack-knifing of the body, as can occur with traditional lifters. The device is especially helpful in the transfer of spastic quadriplegics; the subject is lifted to a semi-standing position with upper back and thigh slings while braced against knee and foot supports. The device folds easily for storage without disassembly.   | Design Mobility Inc.                        |
| June 1987 | Driving Task Evaluation and Training Vehicle for the Disabled; Small Scale Vehicle | One of the tools for assessment and training of disabled drivers being developed at the Center is the Small Scale Vehicle (SSV). The SSV is a common golf car that has been outfitted with power steering, improved seating, automotive type foot pedals and modular accelerator/brake controls. The steering system can accept several different sizes of steering wheels which can be placed in many different positions. Accelerator/brake control is accomplished through device accelerator/brake controls physically configured to simulate an assistive driving device. All controls are easily reconfigured so that the SSV can be fitted to a client quickly. The Center's first SSV has been used to evaluate about 50 clients and has proved useful as a tool for developing a driving device prescription. This paper examines the design and technical aspects of the SSV. Engineering criteria, trade offs, and design philosophies are discussed. | Louisiana Tech University                   |
| June 1984 | Driver Assessment Unit for Disabled Persons  | A 1982 Omega was modified and instrumented to provide objective measurement of the forces applied to the brake, accelerator and steering wheel by disabled persons as well as their reaction time. The Driver Assessment Unit augments an established driver training programme.   | Queen's University at Kingston              |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |  |   |  |
|-----------|--|---|--|
| June 1984 | Quantitative Assessment of Residual Capabilities as a Method of Predicting Disabled Driver Performance | An evaluation system was developed at the NIHR Louisiana Tech University Rehabilitation Engineering Center for personal licensed vehicles that gives a quantitative measure of the residual physical capabilities of the handicapped subject and predicts the subject's potential to successfully complete a driver education program. The evaluation system is described and the results of two sampled subjects that have been evaluated are discussed quantitatively.  | Louisiana Tech University                                |
| June 1983 | Validation of Simulator Evaluation of Disable Drivers  | In an ongoing program, a part task driving simulator has been used for the training and evaluation of individuals with perceptual and psychomotor disabilities. Decisions made based on simulator evaluations need to be validated by a testing of driving performance on the road. As such, an instrumented automobile was used to evaluate the same individuals who had been previously evaluated on the simulator. This paper describes the method used.   | The University of Michigan                               |
| June 1983 | Driver Readiness Training for Persons with Brain Damage  | Persons after head injury often exhibit residual cognitive/perceptual deficits which affect safe operation of an automobile. A training program was developed utilizing a modified AMIGO electric wheelchair to simulate some actions of driving an automobile to teach brain injured persons driver readiness skills in a safe and controlled atmosphere. Skills trained included visual-motor tracking, perceptual-motor planning and divided attention. This training program is viewed as one component which can be added to standard training programs to teach brain injured persons safe driving skills.  | University of Michigan                                   |
| June 1983 | Improved Driving Performance Following Perceptual Training of Persons with Brain Damage                | Brain damage often results not only in physical impairment but in perceptual deficits as well. Sivak et al. (1) have shown that driving performance of persons with brain damage is directly related to the extent of their perceptual impairment. Specifically, persons with brain damage who scored well on certain perceptual tests tended to show good driving performance as well. Furthermore, the results implied that the driving-related problems encountered by some of the persons with brain damage were due primarily to impaired perceptual skills. These findings suggest that therapeutic techniques capable of improving the impaired perceptual skills might improve driving performance as well. This hypothesis was tested in the present study.  | University of Michigan Transportation Research Institute |
| June 1983 | Modified Steering Systems for the Severely Disable   | In adapting conventional steering systems to the needs of drivers with severe physical limitations, the required effort and range of limb motion must be both reduced. Reduction of the range of limb motion increases the overall gain of the steering system which reduces the margin of stability of the system. Interactions between the driver and vehicle acting as a closed loop control system are studied using McRuer's "Cross-over" model. In particular, the effects of different driver parameters on maintaining stability at high speeds (80 km.hr) are investigated. Results show that increased driver time delay which characterizes persons with disability and increased steering gain which is a must for severely disabled drivers are detrimental to stability. The results also indicate the steering gear ratio must be variable with speed for stable regulation at all speeds. | University of Michigan                                   |

**A Brief Summary of Personal Transportation Issues Researched and Reported at RESNA Meetings**  
**RESNA Special Interest Group 02 – Personal Transportation**

|           |   |  |                        |
|-----------|---|--|------------------------|
| June 1983 | A Testbed for Vehicular Control Systems   | A need currently exists for technology that will allow severely handicapped persons to drive. Studies have shown that the mobility provided by personal transportation can be a very positive factor in the rehabilitation process. Under recent contracts from the Veterans Administration, the Rehabilitation Engineering Program at Texas A&M University studied the relative merits of several van modifications. These modifications ranged from low effort steering wheel and mechanical hand controls for driver input to servo systems which used various types of joysticks, levers, and wheels. These studies showed that the technology exists to construct very low effort steering and braking systems which can quickly and accurately position the wheels or apply the brakes in response to a driver input. However, despite excellent control hardware most high gain (low range of motion) systems could not be safely driven at highway speeds. | Texas A&M University   |
| June 1980 | A Mechanical Device for Triple Amputee Drivers  | The object of this study was to design and fabricate a mechanical device for a triple amputee driver. The device is fastened to the vehicle dashboard and connected with the amputee's left leg stump. The motion of this stump commands vehicle acceleration and braking mechanisms. The normal left hand is used for vehicle steering. A slip-proof leg harness was designed and fabricated. This leg harness fits over the subject's left leg stump and connected with the mechanical device. Extensive accelerated life-cycle tests were conducted and the device was found safe for a minimum of five years operation. The subject is presently driving the device-equipped vehicle and has obtained her Texas Vehicle Driver's License.  | Texas A&M University   |
| June 1980 | A Wheelchair Restraint System for Handicapped Drivers and Passengers  | A motorized wheelchair tie-down system has been developed for use in vehicles by the wheelchair bound driver or passenger. This system provides for automotive securement of the wheelchair to the vehicle by operation of an electrical switch. The design also provides a way of anchoring the seat belt to the wheelchair without loading the wheelchair frame with occupant restraining forces during a crash. Sled impact tests using a 50 <sup>th</sup> percentile male crash dummy demonstrate that this device provides effective restraint of the wheelchair even when all the occupant restraint is provided by lap belt only. More effective occupant protection is provided is upper torso belt is used in conjunction with this system.   | University of Michigan |
| June 1980 | Driver's Training Program: A Methodology for Determining The Training Needs of Individuals with Perceptual Disabilities | This study examines the potential of interactive driving simulators for assessment and training purposes. The results indicate that simulators do not adequately asses every individual's driving skills. However, the simulator does have the strong correlation with on-the-road driving performance. It is concluded that simulators may be useful for (1) appropriately placing an individual in training programs and (2) providing individualized training.  | University of Michigan |