Theme 4: Looking toward future wheelchair transportation—What should be our vision and how do we realize it?

Linda van Roosmalen & Douglas Hobson

Introduction

Theme 4 is a departure from the preceding three themes because it challenges us to stand back from where we are today and conceptualize wheelchair transportation as it should be in 10 to 15 years. First, we summarize the current status and key points found in the other three white papers. To these we add provocative observations on the need for change. Finally, we challenge the Theme 4 panel to recommend the steps, resources, and system changes that will be required to make this vision for the future into a realizable goal.

Where Are We Today?

At this point in the review of the State-of-the-Science (SoS) documents, the reader should have acquired a working familiarity with the details of the status of WTS as documented in the preceding three white papers. Since a common understanding of where we are and how we got here is a necessary prerequisite to productive discussions on future directions, this introductory section attempts to summarize the previous papers from the “where we are today” perspective. Hopefully, this summary will serve as common resource for the two following sections, which are the main focus of this fourth theme: “Where should we be going and how do we get there?”

Theme 1 Summary: Barriers to Transit-Safety Technologies

As of January 2005, voluntary US standards for WTORS will have been in existence for nine years and WC-19 wheelchair (WC-19) standards for nearly five years. There can be little doubt that travelers seated facing forward in a transit-tested wheelchair secured with a compliant four-point, strap-type tiedown and using a three-point occupant belt are at significantly reduced risk of injury compared to wheelchair-seated travelers who are not using standards compliant devices. Despite a notable increase in the marketing and use of transit-safety technologies, and particularly of WC-19 wheelchairs, the widespread availability, purchase, and use of compliant products and WTS principles (e.g., forward facing; use of a three-point belt restraint) are
under used in the real world. Thus, the potential impact on improved safety and reduced injury risk for wheelchair-seated travelers is yet to be fully realized.

The barriers to increased availability and use of SAE, ISO, and ANSI/RESNA compliant products are summarized as:

Concerns for legal liability (i.e., lawsuits):
Reluctance to producing transit-option products
Restricted marketing due to concerns about occupant size
Restricted marketing due to concern about seating system crashworthiness
Lack of knowledge/understanding/awareness of standards, safety issues, and availability of transit-tested products and procedures
Cost of and payment for, transit-tested products
Design and performance requirements of standards are too high and/or are in conflict with federal standards and policies (e.g., ADA, FTA, etc.)

Theme 2 Summary: Wheelchair Seating Systems for Transportation

Motor vehicle travel while seated in a wheelchair, whether a driver or passenger, presents additional challenges to mobility. Individuals who use their wheelchair as a vehicle seat need a seating system that meets their needs in and out of the vehicle. Design characteristics that make a wheelchair suitable for mobility may differ from characteristics that define a motor vehicle seat. Work remains to bring the safety of persons traveling in a wheelchair to the level of persons traveling seated in regulated motor vehicle seats. Improvement is needed in the design and performance of wheelchair seating systems and associated postural supports. Seating must be designed to ensure safety in normal driving, emergency maneuvers, and crash events, as well as meet the daily needs of the user.

A summary of the key points related to seating systems used in transportation include:

- Wheelchairs and their seating systems are key to providing adequate protection to wheelchair users in a crash,
- Voluntary industry standards to evaluate seating systems independently of specific wheelchair frames are in development. These ISO and
ANSI/RESNA standards include test methods, design criteria, and instructions to users to assure seat integrity during a crash,

- Additional design guidelines are needed for wheelchair seating manufacturers to develop and provide consumers with transit-safety products,
- Preliminary guidelines for wheelchair seating were developed using computer simulation and limited sled impact testing,
- Design guidelines and test methods are needed to provide crashworthy secondary supports or PSDs,
- Future standards must include effect of rear and side impact on seating,
- Transit-tested wheelchair seating design criteria (frontal, rear and side impact) are needed for pediatric wheelchairs,
- Educating consumers, clinicians and manufacturers is key to standards implementation.

**Theme 3 Summary: Wheelchair Securement for Use in Public Transport Vehicles**

A study [1] involving 270 paratransit and transit agencies, mainly in Florida, with 95 respondents highlighted deficiencies related to wheelchair securement such as:

- Excessive time required to secure a mobility device,
- Both common and un-common mobility devices are often difficult to secure,
- Problems in particular with 3 and 4-wheeled scooters,
- 40% reported injuries to driver, attendant or passenger in past three years associated with mobility device securement,
- Alternate strategies had to be developed by many agencies to deal with above the deficiencies and so comply with ADA,
- The intent of ADA will not be fulfilled until these deficiencies have been resolved [2].

Most wheelchair users want to use public transit vehicles without help from the driver or an attendant—even if it means not using securement at all. Transit agencies want to improve services and reduce costs through use of rapid transit services (BRT) and reduced dependence on paratransit. Transit drivers and managers would like securement technology that reduced time and effort. Strap-type tiedown devices are
cumbersome, misapplied, often dirty and are over-designed for buses since the potential crash loads are lower due the larger vehicle mass. Two alternatives with promise for addressing these problems are on the horizon: an automated docking-type securement mechanism and a rear-facing, passive securement compartment for LATVs.

To summarize the status of wheelchair securement:

- **The four-point strap tiedown with three-point lap and shoulder belt occupant restraint are the industry standard,**
- **Although it protects the occupant, this system has limitations: requires assist from others, misuse or non-use of WTORS, and time spent to apply properly.** [1,3]
- **Using docking technology and rear-facing or passive wheelchair securement stations, resolving today’s problems and user concerns seems possible** [4],
- **Developing voluntary standards is creates industry-wide collaboration and agreement and the assurance of meeting nominal product safety.**

**Summary Statements**

If one now stands back and attempts to draw some conclusions from the information presented in these white papers, the following begins to come into focus:

- Prior to the advent of the voluntary industry standards wheelchair transportation safety had evolved more or less haphazardly with essentially no industry-wide collaboration and little concern or understanding of the occupant–injury protection, necessary for wheelchair-seated passengers traveling in motor vehicles.
- Today, the four-point strap tiedown with three-point lap and shoulder belt occupant restraint is the universal or industry standard.
- There is little doubt that people seated in a WC-19 wheelchair secured by compliant four-point, strap-type tiedown facing forward and using an compliant three-point occupant restraint are at significantly reduced risk of injury.
- Although providing effective occupant protection during a nominal frontal
crash event, the four-point strap tiedown system does have operational limitations; mainly related to user issues such as requiring an attendant or driver for their application, misuse or non-use of the devices, and the time required for proper application.

- More wide-spread use of standards-compliant wheelchairs will help alleviate a number of the problems, mainly those attendant/driver-related, such as, more proper securement and reduced time requirement.
- Additional design and standards guidelines are needed for wheelchair seating manufacturers to develop and provide consumers with transport-safe products.
- There has been little coordination between enabling federal legislation and resulting mandatory regulations and voluntary industry standards. This disconnect now presents an impediment to future problem solving.
- To date, the industry standards development has been driven by concerns for user safety and less by usability or product ease of use.
- Several new standards development activities (i.e. seating, rear and side impact) activities are underway and will focus mainly on remaining safety concerns.

The problems being encountered today, in practice, are driven largely by our history of unguided product development, confusing or outdated federal mandates, and products or concepts without adequate “user friendly” features required to meet current user needs and expectations.

Two prospects for wheelchair securement considered more “user friendly” (i.e. docking and rear-facing securement) are on the horizon but they also have limitations that will require time and effort before wide-scale application can be expected in the US.

The voluntary industry standards forum has been an effective mechanism for facilitating industry agreement and guidance on both a national and international scale. In the US, this process now needs to be more effective in reaching out to include collaboration with government policy makers, transit providers, transit users and other stakeholders, as we look forward to future problem-solving.
Wheelchair Transportation in the Year 2020

The purpose of this theme is to conceptualize where we need to be heading, i.e., our vision for the future, based on our general understanding of where we are today and the rather haphazard manner by which we got here. One-way to arrive at an answer to the question of where we should be heading is to conceptualize the features of an ideal wheelchair transportation system 10 to 15 years into the future. This discussion should not concern itself with how, but should focus more on creative speculation about what might be possible. It will be the work of the BOG for this theme to articulate a vision for the future. The features of an ideal US wheelchair transportation system, in say 2020, are intended as a springboard for discussion rather than as a definitive list of ideas or concepts:

- All wheelchair users enter and exit all public transportation vehicles with the same level of independence as other non-wheelchair using passengers on the vehicle,
- Wheelchair users can expect this level of accessibility on any public transit system in the US,
- Enabling federal legislation and voluntary industry standards are mutually supportive in their goals and requirements,
- All wheelchair products offer the option of being safely used as a seat in a motor vehicle.

How do we get there?

Assuming that discussion has resulted in a vision for an ideal future, let’s speculate on how to best get there. In other words, what needs to happen between now and 2020 to realize the vision? The following thoughts may suggest some resources, tools or activities that may facilitate a productive ‘how to get there’ discussion.

The needs, desires and expectations of the population of persons with disability is constantly changing (i.e. more social involvement, increased need for transportation). In response, products produced for use by individuals with disability are also constantly changing. While people and products have been changing, Federal regulations that affect wheelchair transportation have, for the most part, remained the same [5-9]. This
has led to incompatibility between wheeled mobility devices and federal regulations for vehicle safety. One way to facilitate moving towards an ideal wheelchair transportation system may be to examine existing Federal regulations and identify the barriers they create to implementing the state of the art in wheelchair transportation safety knowledge and technology. A partial list of modifications to the regulations follows.

**ADA requirements for securement system floor area vs. common wheelchair dimensions:**

Currently ADA states that the “(wheelchair) securement station shall have a clear floor area of 30 in. by 48 in.. The ADA also states that the maximum dimensions of a “common wheelchair” are 30in. by 48in. [5]. Therefore, the existing space allowance does not provide sufficient space for maneuvering the wheelchair or accessing securement systems within the station, especially with a larger wheelchair. Proposed changes are:

- Increase the minimum floor size to be more consistent with the length of today’s common wheelchairs, including scooters, and to allow room within the wheelchair envelope for maneuvering into and out of the securement station.
- Restrict “over-sized” wheelchairs from boarding transit vehicles. Although this restriction is partially in place (overweight wheelchairs are prohibited from boarding) further study and development of options should be explored along with public education about the definition of a reasonable weight/size limits.
- Add a clearance space around the maximum common wheelchair area to increase access and make attaching wheelchair securement systems easier.

**ADA requirements for rearward-facing securement station:**

ADA states that in larger vehicles the required securement device may fix the wheelchair or mobility device in a rearward facing direction and specifies height and width requirements for a padded barrier [5]. Specifying the dimensions of a padded barrier and requiring it to be “centered immediately in the back of the seated individual” restricts wheelchair securement system manufacturers in their design and product development. Also, with the existing variability of wheelchair designs it is extremely
difficult to get a padded barrier “centered immediately in the back of the seated individual”. Proposed changes are:

- Reconsider the necessity of dimensional requirements for a rearward facing barrier and thereby allow manufacturers to be innovative,
- Reconsider the phrase “immediately in the back of the seated individual” since a flat barrier may not be able to make that happen, nor may it be required in certain transit environments, such as large fixed-route transit vehicles.

**Adoption of a “User Centered” design approach**

The WTS focus to date has been primarily on safety and less on how people use the existing safety technology. Universal design (UD) is defined as creating products and systems designed with all users and their capabilities in mind [10]. Adapting a universal design approach when developing WTS technology, can encompass technology that is designed for and evaluated by all potential end users. This means that from the early stages of the design process, the wheelchair occupant, transit agency, manufacturer, etc. are involved in the design and evaluation process either as focus groups or early product/concept evaluation sessions. By using such a design approach, WTS solutions that better meet user needs can be generated. Universal design of WTS technology can serve as another tool to help developing the wheelchair transportation system. Additionally, innovative technologies such as wireless communication, computer-steered components and ultra light materials like plastics, carbon fibers etc. can be explored as to their effect on crash protection, as well as wheelchair weight and esthetics.

**Communication Plans**

A communication plan can be another important tool to help move us toward our vision of an ideal wheelchair transportation system. Actively disseminating our current knowledge, explaining the safety risks for wheelchair-seated travelers and informing stakeholders shown in Table 4.1 about the available transit-tested wheelchair technology will improve awareness of the options available. Educating the wheelchair
user and wheelchair prescribers about the importance of WTS, will likely increase the demand for WC-19 wheelchairs.

Table 4.1: Important “users” who are stakeholders in an improved transportation system

Additionally, since the stakeholders involved in wheelchair WTS each have their own primary need, communication should occur in ways that best respond to these individual needs. For example, handbooks specifically developed and written for wheelchair manufacturers, wheelchair users, transit providers, or clinicians may be one solution to better communicate the aspects of wheelchair design, transportation safety and accessibility.

**Capacity-building**

Progress to date in standards development and the manufacture of related compliant products has occurred in a mostly haphazard fashion. A few people with the interest and background that enabled them to provide the early leadership and secure the research support necessary to yield productive outcomes, just happened to be available. If a new vision is to be realized, a more coordinated effort at coordinating human efforts, not only at the research level, but also throughout the network—wheelchair user, manufacturer, clinician, transporter and transportation regulator—will be required. Coordination of this network is essential to transferring new concepts and related technology into everyday practice. We must assure that there will be educational programs that will attract and motivate individuals to take up the cause of WTS and so provide the leadership and expertise for future problem solving. The RERC on WTS and related research programs should create partnerships with affected sectors at the
highest policy levels. Ideally, an inter-jurisdictional coordinating body guides both research and policy development. Appropriate lead roles for such an effort need to be identified to ensure clear lines of authority and responsibility.

Summary

This paper summarized the status of WTS to create a point of departure for establishing a framework for creating a vision for the future. Hopefully, working within this framework, panel participants can “fill in the blanks” and crystallize a vision that can be embraced as our goal for the future. Of course, realizing this goal will not be simple. It will entail significant systems-change to foster the technological innovations needed to overcome barriers meet the expanding needs and expectations of stakeholders, without sacrificing the important principles of user safety that have been gained in recent years.

Suggestions of possibilities that may yield positive outcomes have been offered. These included modifying federal regulations, promoting a “user-centered” design approach to manufacturers of both transit vehicles and wheelchair safety technology, improving our communication resources and using capacity building to solve wheelchair transportation problems. Additional recommendations will surely follow from the panel deliberations.

References


