

NEW TRANSPORT TECHNOLOGY FOR OLDER PEOPLE

An OECD – MIT International Symposium

Cambridge, Massachusetts

23-24 September 2003

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INTRODUCTION

On 23-24 September 2003, the OECD Working Group on Human Factors of Technology for Older Road Users and the Massachusetts Institute of Technology's (MIT) AgeLab co-sponsored an international symposium titled: "New Transport Technology for Older People" on the MIT campus in Cambridge, Massachusetts. The symposium's objective was to explore impacts of transport technologies on older road users' mobility, safety, and accessibility.

The program featured presentations by public and private sector professionals from over a dozen countries, representing a variety of disciplines including geriatric medicine and Public Health, technology development, safety research, public transport providers, the automotive manufacturing and insurance industries, and policy analysis.

The OECD Working Group, led by Dr. Joseph Coughlin, Director of the MIT AgeLab, produced a series of recommendations which includes those suggested by the symposium speakers. These are included in the symposium summary, followed by a synopsis of each presenter's key points.

This report is divided into three parts: Part 1 offers a thematic overview of the topics discussed, Part 2 discusses recommendations for policy and research that were gleaned from the two-day symposium and a follow-on meeting of the OECD Working Group on Human Factors of Transport Technology for Older Persons held on 25 September 2003, and Part 3 contains chronological speaker-by-speaker summaries of all of the symposium presentations. Selected papers that were presented at this symposium are scheduled for publication by the MIT Press in 2004.

PART 1: SYMPOSIUM SYNTHESIS

An aging population poses special challenges to transport systems. Issues of driver functionality, safety, and the frailty of older transport users all impact the health and well-being of a society. Mobility is crucial, both for our utilitarian daily needs as well as for the broader human needs of social contact and quality of life. Freedom of movement provides a myriad of social, functional, educational, medical, and recreational opportunities to do everything from visiting friends, buying groceries and attending classes, to just going out to get an occasional ice cream cone.

Yet older persons face numerous barriers to mobility across all modes. Driving, walking, climbing into a bus, reading a sign, lifting luggage at an airport, and navigating in a city all pose combinations of physical and mental challenges that daunt some older persons. Technology could help address some of these issues on a broad array of fronts. For example, in-vehicle drivers' aids, improved self-service kiosks, and more accessible, usable infrastructure would aid older persons' mobility. New policies and research are needed to ensure the happiness and well-being of older citizens, their caregivers, and society as a whole.

A. Reframing the Issue

Presentations at this symposium reiterated and reinforced the findings from the previous OECD report, *Ageing and Transport*. These views reframe the issue of older transport users.

A.1. Elderly Drivers: Not Risky, But At Risk

The OECD report, *Ageing and Transport*, stressed that older drivers are not so much risky as at risk. That is, older drivers tend to be safer than is commonly believed, but they are frailer, making them vulnerable to personal injury or death in the event of a crash. This symposium continued this line of evidence by noting that elderly drivers do not seem to be the traffic risk that current anecdotal evidence or medical functionality evaluations would seem to predict. This result is worth repeating, because many people would expect that age-related declines in functionality would lead to a higher rate of crashes per older driver. The reason why older drivers do not have more crashes is behavioural: older drivers self-regulate their driving. For example, they may choose not to drive at night to compensate for decreased night vision. Thus, older persons have similar rates of crashes as middle-aged people who drive a similar number of miles per year.

What is clear is that older persons are frailer. If an older driver is involved in an accident, that driver is much more likely to die. In public modes of transport, older users are especially vulnerable to injury. For older persons, public transport has the lowest rate of death, but the highest rate of injury of all transport modes. While this puts older people at risk, they are not a risk to others' transport safety.

Technology can play a role in reducing the effects of declining functionality and thus help to compensate for these age-related issues. Yet the fact that safety has a behavioural component means that the actual effect of technology may be different from the intended effect. Finally, technology such as advanced seatbelts could also reduce the chance of injury or prevent some injuries in the event of an accident.

A.2. Not Just Transport, But Public Health

The participants of the symposium agreed that mobility is much more than a transport issue. Driving cessation has both a personal and a societal impact that is poorly understood, but clearly present. Loss of personal quality of life, difficulty in maintaining health and nutrition, burden on caregivers and society, and loss of participation in the economic life of the society are just a few of the deleterious effects of a loss of mobility. Dr. Liisa Hakamies-Blomqvist presented a causal diagram that mapped the link between sustained mobility, good personal health, and lower burden on public funds.

Keeping older drivers safe behind the wheel and independent may be the best strategy for society and individuals alike. The mobile elderly are happier, healthier, and can contribute more to society than if they were homebound. Driving may actually be the safest mode of transport for older persons. Dr. Sandra Rosenbloom provided statistics that illustrate the potential reduction in safety of getting older drivers out of their cars. For example, she cited that being a pedestrian is 14-20 times more dangerous than being a car driver.

As a public health issue, elderly drivers present a more complex, multifaceted subject than one might think. Dr. Rosenbloom pointed out that elderly drivers tend to take shorter trips, that (on a per vehicle-mile-traveled basis) contributes to more automobile-created pollution as cold catalytic converters on short journeys are not as efficient in neutralizing pollutants.

This environmental issue highlights the need for more human-scale, environmentally-sensitive transport modes that suit the needs of the elderly. Devices like Neighbourhood Electric Vehicles (NEVs) or personal mobility devices such as the electrically-powered Segway could provide a reduced environmental impact solution that allows older persons to make short trips to run a local errand or make a social visit.

A.3. Not Just Drivers, But Passengers, Pedestrians, and Cyclists

Although much emphasis is placed on drivers, other modes of transport play a major role in life: such as walking, cycling, and use of buses, subways, taxis, and airplanes. However, getting drivers out from behind the wheel does not resolve the risk issue. As noted in the previous section, the elderly face greater safety risks when walking across the street than when driving on the road.

Several presenters noted the multimodal nature of all trips: even using a car involves walking. In addition, some transport modes, such as flying, involve a chain of modes to access the airport, including walking, and use of taxis, subways, and/or people-movers. The safety of a trip, not just the mode, is the key to a more holistic view of transport safety for older persons.

Non-driving modes of transport present safety issues for older people. Elderly pedestrians in particular face especially high risks, both because they are slow-moving and because their frailty makes even minor accidents more serious. Even use of public transit poses safety problems. As Ms. Ling Suen remarked, sudden stops, abrupt accelerations, and unexpected turns create numerous slip and fall risks. In combination with conditions like osteoporosis and a lower capacity for healing, a simple fall for an older person can become a life-threatening situation. On the one hand, statistics show that public transit has the lowest rate of fatalities for the elderly, making it the safest mode of travel for the elderly. On the other hand, statistics also indicate that public transit is the mode of transport with the highest injury rate for the elderly. With the prospect of falling, many older Americans choose not to ride buses: ridership by those over 65 has dropped from 2.2% to 1.3% of trips in the U.S between 1995 and 2001.

In contrast, many trips by elderly persons outside of North America are made on foot and/or on public transit. For example, in the United Kingdom, one-third of all trips are made on foot. Europeans have a tendency to use modes other than driving over the course of their life time and are more accustomed to them, whereas many North Americans have never taken a bus or a subway. Transitioning to use of public transit as one's primary transport mode for the first time as an older person may prove to be quite difficult, and create safety risks.

This issue reinforces the counterintuitive nature of the problem, that with reducing one type of risk, one might increase other risks. This is why both research and policy needs to focus on more holistic approaches--approaches that respect the interconnected effects of risks, behaviours, and realities. If policy makers want to maximise long-term societal performance, it may be better to help seniors stay behind the wheel longer than to create a large, disadvantaged population of homebound elderly.

In discussing his personal mobility invention, the Segway, Mr. Dean Kamen made the point that major metropolitan cities are unsuited to cars, with the average speed for all modes of transport in congested areas being a mere 8 miles per hour. If one can go no faster than 8 mph in cities, why not chose more human-scale, smaller-footprint modes of transport?

The Netherlands' intelligent urban designs that support and encourage walking and cycling suggest that there are viable alternatives to car transport. In addition, small, environmentally-friendly personal mobility devices may provide a solution for in-city, short distance transport.

A.4. Not the Person, But the Behaviour

Although many older drivers cannot see as well, think as fast, or move as agilely as younger drivers, they do not create the level of public safety risks that one might expect for a given degradation of functionality. The reason for this paradoxical finding is behavioural. At issue is self-regulation: most older drivers tend to recognise their limitations and drive accordingly. By driving less at night, avoiding busy roadways, and being more cautious, elderly drivers reduce their exposure to risk and thus reduce the chances of being involved in a crash.

This effect appears both in the data and in anecdotal observation of older drivers. Older drivers are underrepresented in the range of accident types associated with aggressive driving such as single-car crashes, accidents involving risky overtaking, and crashes involving drunk driving. Most elderly cease driving of their own accord. For example, in the UK, only a single-digit percentage of the elderly lose their licenses. When asked why they stopped driving, many respond that they feared failing a driving test. Most older drivers in current and prior generations seem to act responsibly.

At worst, it can be said that as we age and lose certain capabilities, we face increasing risks of some behaviours such as driving at night or in heavy traffic. But if elderly drivers compensate by reducing these now risky behaviours, they become no more risky than middle-aged drivers who do not drive very much per year. Dr. Blomqvist presented data to illustrate the point that older drivers are no more dangerous than middle-aged drivers who drive a similar number of miles per year.

The paradoxical data on senior drivers suggests that it is not age, per se, nor declining functionality that creates risk. Rather, it is behaviour that creates or reduces risk. The problem with self-regulation is that it is a behavioural trait and thus tied to cognitive and cultural factors.

Ms. Maureen Mohyde and Dr. Rosenbloom discussed how dementia sufferers who are driving present a special case. The malicious effects of dementia are such that they rob the victim of an awareness of their condition. Persons with dementia do not even realise they are losing the ability to drive safely. Thus, many dementia sufferers may not self-regulate and may even become combative or irrational if attempts are made to prevent their driving (*e.g.* dementia sufferers have been known to drive without a license or report their car "stolen" to the police because they had forgotten it was taken away.)

Cultural questions also arise. Do elderly drivers self-regulate appropriately in all countries? And will tomorrow's elderly self-regulate as well as the current generation? Dr. Rosenbloom noted trends that might increase the exposure of older drivers to risk and reduce their opportunities to self-regulate their driving. Specifically, suburbanised older people living in new retirement communities built on the outskirts of town face travelling long distances to access services and city centres. Rural and suburban senior citizens may be forced to drive whether it is risky or not.

The role of behaviour is crucial to understanding the impact of technology on older transport users. People's perceptions of the technology and its impact on risk will modulate their use of that technology, which will affect transport safety related to that technology. Technology may affect this risk in unexpected ways if it changes drivers' behaviours in unanticipated ways.

B. Applicable Technologies

Most of the symposium panellists mentioned one or more technologies that support the mobility of the elderly. While many are intended for installation in road vehicles, others provide infrastructure improvements, or enhance personal mobility.

B.1. In-Vehicle Systems

Many transport technologies target drivers in private automobiles. With cars as a dominant mode of transport and a high-value consumer durable good, research and development on new devices for cars is warranted and commercially viable. Automakers anticipate gains in market share and profits from adding new devices that enhance driver safety, confidence, and comfort. With abundant electrical power and burgeoning computing power, cars are an ideal platform for technology. Although many of these in-vehicle technologies are described in terms of private transport, public vehicles can also benefit from them.

Adaptive Speed Control

Many multi-vehicle crashes occur when traffic decelerates and the vehicles in the rear fail to react in time. Older drivers have reduced reaction times that make them prone to this type of crash. When additional distractions from new technology are added, rear-end collisions increase in frequency.

Intelligent speed adaptation (or advanced cruise control) would help drivers maintain safe following distances even as the traffic ahead changes speed. Safe following distances reduce the chance of a rear-end collision if the driver is momentarily distracted or is reacting slowly. Preliminary studies, described by Mr. James Langford and Dr. Christopher Mitchell, suggest between a 2-40% reduction in crashes with intelligent speed adaptation technology. The large range of estimates reflects the varying assumptions used by different studies and the overall need for more research.

Intelligent speed adaptation technology raises acceptability issues with regard to how the system operates. Like many driver safety aids, this system can operate with three levels of intervention: an alert to get the driver's attention, an adjustment of the throttle to regulate speed, or the application of the brakes to more abruptly slow the vehicle. Traditional cruise control, which regulates the throttle, is widely accepted. But survey results suggest that drivers might be reluctant to let the car take over more active driving roles, such as braking.

Night Vision Displays

Declining night vision affects most people from age 40 onwards. Many older drivers report that they avoid driving at night. This self-regulation threatens mobility to many social events and decreases quality of life. Moreover, an older driver might be forced to drive at night, creating risks. With a specialised camera and a Heads Up Display (HUD), night vision systems project an intensified image of the forward scene to either augment reduced nocturnal acuity or to extend the range of sight. In fact, the specialised cameras can see farther than healthy young drivers, thereby providing an extra margin of safety to drivers of all ages when driving at night. HUDs also offer a natural way to present additional information to the driver. For example, HUDs could have overlays or iconic annotations that help the driver interpret the scene.

Navigation Systems

Navigation systems are a good example of a technology that provides value to people of all ages and situations. Most drivers have experienced the frustration of trying to find an address in an unfamiliar part of town. Other users who benefit include travellers in rental cars.

Navigation systems could provide special benefits to older drivers, compensating for declining functionality, making them prone to getting lost. Navigation systems could help older drivers reach their destination more easily, efficiently, and safely. In particular, older drivers could set navigation preferences to avoid left turns (or right turns in the UK and Japan) and to avoid especially busy roads or more complex routes. Navigation systems could also provide drivers with advance warning of lane changes, providing extra time in anticipation of an up-coming turn.

Navigation systems do, however, raise issues with human-machine interfaces that can have an impact on safety. If older drivers are to use these systems, the drivers must be able to control them. Drivers must be able to enter their desired destinations or to configure their navigation preferences. Moreover, concerns over the fluster-factor arise: will elderly drivers have crashes while trying to obey their navigation systems? Driver distraction is another issue, although the results might not be as detrimental as drivers who try to read a map while driving or who make belated mergers into the lanes that they need to be in. Finally, accuracy is a major concern: obsolete data could put the driver going the wrong way on a newly converted one-way street or route them through a major construction zone.

Gap Estimation Aids

Turning across oncoming traffic is a critical driving skill. Estimating the timing of gaps in oncoming traffic is difficult as it requires the ability to assess distances, speeds, and gauge one's own timing needs to safely complete the turn. Declines in vision, cognition, and physical reaction times make left turns (in left-hand drive countries) or right turns (in right-hand drive countries) hazardous for some elderly drivers. The importance of the issue is underscored by older driver's over-representation in intersection crashes. Older drivers have more crashes in which they report not having seen the other vehicle.

Technology aids would help drivers estimate the gap by measuring the distance and speed of oncoming traffic. A visual or auditory alert would signal when it is safe to go. In Sweden, simulated tests of such a system suggest that the systems can increase driver confidence. Test drivers used the system in different ways. In daytime simulations, drivers tended to watch the traffic themselves, but glance at the system for confirmation when they thought they saw a suitable gap. In night simulations, when drivers have a harder time personally judging distances to the bright headlights of oncoming traffic, drivers tended to watch the alert for the "OK" indication and then glance at traffic for confirmation.

Workload Management Systems

Dr. Judy Gardner from Motorola described technology that can help meld all the data available to drivers to help them make informed decisions, without overloading them. Currently, each device in a car competes for the driver's attention. Dashboard instruments, turn signals, cell phones, and audio equipment all vie for the attention of the driver. Future ITS might only exacerbate the situation, adding navigation services, traffic alerts, collision warnings, e-mail, etc. If the driver is changing lanes as the phone is ringing, the navigation system is providing directions, and the CD changer wants another disk, something is likely to go wrong as the driver tries to wrestle with the competing demands on his or her attention.

Motorola and other companies are developing workload management systems that help integrate and regulate the myriad of in-vehicle systems that could appear in cars. Thus, an incoming cell phone call might automatically turn down the audio system. One could even set variable priorities on incoming calls – a call from the boss could get through, but a call from an acquaintance would only get through if the system detects that the driving conditions are favourable.

The key to workload management systems is a cognitive model of driving and the use of vehicle data to infer the level of cognitive loading present. If the windshield wipers are set to maximum, the system might infer that heavy rain is occurring and that sending a reminder to check tire pressure would be inappropriate. Such a workload system would prioritise the activities of the in-vehicle systems and ensure that different systems don't make too many demands on the driver at the same time.

Protection Systems

The frailty of older people puts an increased burden on protection systems. Brittle bones, older joints, and weaker musculature make many older transport users prone to serious injury in even minor crashes. Reduced recuperative powers lead to longer hospitalisations, prolonged convalescence periods and an increased fatality risk.

This motivates the use of more intelligent protection systems in vehicle--for example, seat belt tension regulators that might reduce the forces on the belt. Mr. Jeffrey Pike from Ford Motor Company presented several alternatives for better belt design, such as 4-point harnesses, X-belts, or in-belt airbags that could help distribute crash loads and reduce the chance of injury.

Dr. Elisa Braver from the Insurance Institute of America presented results from a study of the safety of side-impact airbags on the elderly. Full head and torso airbags offered the most protection. The good news is that it appears that the elderly do benefit (or at least are not harmed) by side airbag systems. Unfortunately, the greater range of variability among the elderly and lower rates of new car ownership among older drivers means that the results of this study were not statistically significant, and that more data is needed.

New technologies can also improve the survivability of collisions with pedestrians and cyclists. Innovations such as external airbags could save the lives of cyclists and pedestrians.

B.2. Personal Technologies

Personal technologies can also enhance mobility.

Smartcards

One reason that older citizens might eschew public transport is the concern of having correct change. Fumbling at the fare box while the bus is accelerating is both uncomfortable and dangerous for older riders. Smartcards offer a more convenient way to pay for rides. In particular, RFID-based smartcards offer the added human factors advantage of being contactless. The cards do not even need to be removed from a purse or pocket – a boon for arthritic hands or for people whose eye-hand co-ordination makes it difficult to insert a card into a slot.

Smartcards can have many applications beyond the public transit system or paying for paratransit taxi rides. Some localities in the U.S. are using such cards for administering government benefits. In Europe, smartcards have broader acceptance in a range of applications. Universal standards and

ubiquitous card readers promote the broader application of this technology, including uses in transport-related applications.

Smartcards could even help with technological customisation of drivers' ITS. A personal smartcard could automatically reconfigure in-vehicle systems to suit each driver's preferences. If such smartcards are based on widely-implemented standards, they might even work in rental cars. This would help older travellers navigate in unfamiliar cities.

Screening

Although mandatory age-based functional screening is of dubious value, personal self-testing may help older drivers make responsible transport decisions. Many elderly and their families worry about driving: how/when will a person know that they are becoming an unsafe driver or that they should make allowances for declining abilities when they drive? Some drivers, especially women, even cease driving prematurely with the fear that they can no longer drive well.

Self-testing at a kiosk in a retail outlet might help older drivers check their skills and either gain confidence in their abilities or confirm that they should reduce driving or reduce particular types of driving. Such self-testing might be simulation-based or involve a simple set of timed visual-cognitive tests. Privacy would be implicit and guaranteed. Post-test information could even guide the test-taker in regulating driving or in choosing in-vehicle technologies that would best extend their driving lifespan.

Personal Navigation Aids

Navigation issues extend beyond driving as all trips are multimodal. At the very least, one must walk to and from the car. In congested cities and multi-story parking garages, navigating to and from the car can be a challenge. Moreover, pedestrians, cyclists and public transport users face some of the same navigational challenges as the motoring public. Declining costs of GPS/Galileo and telecommunications, along with increased penetration of simple personal digital assistants offer an opportunity to add personal navigation services. These services could even be integrated with public transport information systems or tourist information services. Thus, they could help provide information on the arrival of the next bus or train. They could also help older riders in locating the right stop.

Personal Security Devices

The elderly are vulnerable to crime. Even when the actual risk is low, the elderly often perceive there is an elevated risk. Personal security devices such as Personal Emergency Response Systems improve confidence in leaving the house, increasing the sense of security that older persons may feel; thereby enhancing their comfort and mobility.

B.3. Physical Infrastructure

Public infrastructure technologies provide the greatest public benefit because everyone can use them. Issues of affordability and general delays in technology adoption mean that many older drivers will not gain much near-term benefit from private-sector technological innovation.

Design Innovations

Technology is more than just microprocessors and software. Technical innovations in road design, crossing areas, and public transit vehicles all help older people move safely. Simple ideas, such as the offset left-turn, can improve visibility and safety for all drivers. Mr. Rob Methorst from the Ministry of Public Works in the Netherlands, showed a wide range of crosswalk designs that are deployed in the Netherlands to improve safety. For example, in-pavement flashers or raised crosswalks help ensure that vehicles see the crosswalk and decrease their speed. Raised crosswalks have the added benefit of providing a curb-free, ramp-free walking surface for pedestrians, electric scooters, and wheelchairs.

Improved Public Vehicle Designs

Some public vehicles pose daunting obstacles to older transport users. High steps make ingress and egress problematic. Although public transport is the safest mode of transport for the elderly in terms of deaths, it is the most dangerous in terms of injuries. Low-floor designs, kneeling buses, and lifts can help older riders use public transport. Smoother acceleration and deceleration profiles would also reduce the risk of slip-and-fall injuries for older riders. Making “Stop-request” buttons easier for patrons to reach from a seated position would also reduce chance of injury.

People-movers in large public spaces, like airports, also need improved design for expanded use by older transport users. Mr. Harry Wolfe of the Maricopa Council of Governments, Arizona, suggested that the lack of seats on people-movers poses accessibility problems for those with limited endurance or arthritic joints.

Signage

Signage plays a major role in all modes of transport. Mobility depends on reading and following signs, be it a stop sign at an intersection, a route number at a bus-stop, or an airport sign for baggage claim. Even pedestrians depend on signs to locate different streets to find an entrance to a subway station. Many elderly users with declining vision are frustrated with quirky sign designs, non-standard sign placement, or an insufficient numbers of signs. Improving signage visibility means better sizing, location, colouration, density, and consistency of signage.

The problem of signage is especially acute when signs contain a lot of information. Although the bright red octagon of a stop sign is easily seen and understood, many modes of transport include more intricate signage. Typically, bus schedules, subway route maps, airport maps, and train platform listings are designed with denser type, more information, and greater cognitive loading. Finding airport departure screens (not arrivals screens), looking up the flight by destination and time, remembering the terminal letter and gate number, cross-referencing the terminal and gate information with an airport map, and navigating through concourses is something that stresses even young, seasoned travellers. Older travellers may face such high frustration with the situation that they avoid flying altogether.

Signage can also provide real-time information. For example, some bus and subway systems provide countdown timers showing the next arrival time. France and Singapore have signs on major highways displaying the driving time to various destinations. These alert drivers of upcoming congestion and may motivate some drivers to take alternate routes. Singapore also makes its traffic cameras available on the web, allowing drivers to check traffic conditions before they even get on the road.

Automated Public Warnings

Other upgrades to public infrastructure can help provide warnings to drivers or adjust traffic signals to meet the needs of older transport users. “Extra Time” buttons on crosswalks or sensors on crosswalks could respond to slow-moving pedestrians and adjust the signal changes accordingly. Other systems might incorporate sophisticated sensing and traffic analysis logic. Dr. Thomas Granda aired a video simulation of intersection warning systems that alert drivers to the presence of speeding cross traffic. Such systems would reduce crashes at dangerous intersections where cars routinely run red lights or where poor sight conditions make it hard to judge cross-traffic or on-coming traffic.

C. Issues in Technology Application

Applying technology to the mobility of older transport users raises numerous issues. The wide range of variations among older people affects how they use technology and which technologies are appropriate. Technology adoption is a complex issue, yet it is critical if investments in innovation are to have their intended benefits. Finally, we must be cognisant of the downsides of technology.

C.1. High Variability Among Older People

Variations among people, cultures, and geographies imply variations in the application of technology to the improvement of mobility of older persons. Below are categories of variation that affect transport and mobility issues.

Functional Ability

The elderly vary in their level of functional abilities on a host of dimensions. These include:

- Vision:
 - Night vision.
 - Daytime visual acuity.
 - Sensitivity to glare.
 - Changes in colour vision.
- Cognition:
 - Slower reaction times.
 - Reduced short-term memory.
 - Difficulty navigating in unfamiliar settings.
- Tactile sensitivity and dexterity.
- Hearing.
- Physical mobility:

- Arthritis.
- Endurance.
- Reduced range of motion.

Each of these medical changes in functionality has a different impact on driving and mobility. Each type of functional deficit can be addressed by different technological augmentations. For example, night vision displays can help seniors with poor night vision. Side collision warning systems can assist older persons who cannot turn their necks to look beside the car when changing lanes. People with reduced peripheral vision might prefer auditory prompts, while those with diminished hearing might choose tactile alerts or visual messages. People with arthritic knees might prefer low-floor or kneeling buses and eschew mass transit modes that involve stairs or long-distance walking.

Senior citizens also vary in total driving experience, both in total and in each driving year. In two-driver families, one member may drive far fewer miles than the other. Often the husband drives, while the wife is a passenger. As a low-mileage driver, this less experienced driver tends to be more prone to crashes. When the main driver of the family becomes infirm or dies, then their less-experienced partner must take over the driving task. Easy-to-use technology could reduce the experience gap, while poorly designed ITS (Intelligent Transportation Systems) could exacerbate the problem.

Cultural and Personal Preferences

Value systems and personal interests vary between seniors both within and across cultures. These values and interests impact mobility preferences and the application of technology to enhance mobility. As one example, consider the Calvinist culture of the Netherlands vs. the consumerist one of the U.S. – the Dutch enjoy their heavy, black, 3-speed bicycles while the Americas prefer their Sport Utilities Vehicles. Such factors impact the application and acceptance of technology. The Dutch might adopt technology based on its utilitarian performance, while the Americans might buy it for its novelty. Even the scope of the technology may vary. For example, it was noted that the Japanese are much more comfortable with in-car technology that actually controls the car (*e.g.* applying the brakes if a potential collision might occur) while most Western drivers are wary of the notion of the “car taking control.”

Personal preferences play a major role in mobility and mode selection. For some, driving is a utilitarian function that provides an ends to a mean, while for others, it reflects a lifestyle and represents personal freedom. Personal levels of gregariousness or extroversion as well as interests outside the home also impact mobility needs.

Geographic Variations

Geography and climate impact transport and the mobility modes of older people. Mr. Methorst from the Ministry of Public Works in the Netherlands noted that his country’s flat terrain and mild climate is a partial reason accounting for the high percentage of cyclists and pedestrians. In contrast, Dr. Coughlin mused that the gritty urban environment of Bridgeport, Connecticut is a reason why the elderly would prefer to stay safely in their cars. The movement of some retirees to the Sunbelt of the United States and the heat-related deaths of elderly people in Europe in the summer of 2003 highlight the heat sensitivity of the elderly and provide additional reasons why this population might prefer the safety and comfort of their own air-conditioned vehicles in hot climates.

Land Use Variations

Mr. Methorst made the point that rather than grafting bike lanes onto busy roads, new communities have an opportunity and an obligation to design transport networks that support a range of transport modes. Land use policies also impact the demand for transport, the costs of the transport, and the impact of mobility impairments. Higher-density living arrangements and mixed-use buildings help ensure that the elderly are near the services and social outlets that they need. As appealing as rural life can be, it is untenable for the less mobile.

Dr. Rosenbloom stressed the need for partnerships between housing planners and economic development councils to either place retirement communities closer to essential services (doctors' offices, grocery stores, recreation centres) or to build an adequate infrastructure that will support the retirement communities as their population ages. New technology such as the Segway can provide solutions to provide personal mobility in congested cities.

Income Levels

Seniors' income level also widely varies, thus affecting their mobility. Ms. Jane Hardin noted that some non-driving seniors lack cars for financial reasons. Increasing pressure on public and private pension programs suggests that in the future, the population of restricted-income seniors will only grow. Creating affordable mobility will be a challenge. Advanced information systems and telecommunication systems can help transit authorities create better service density at lower cost.

Senior citizens only benefit from in-vehicle technologies if they can afford to buy the latest model cars or pay for optional add-on technologies. One approach to this issue, as Dr. Granda suggested, is to build intelligent systems into the infrastructure, such as intelligent intersections or beacons that communicate to the car, minimising the amount of technology that has to go into the car itself. Such infrastructure technology aids all drivers.

Technology Response: Customisation

Technology can cope with the inevitable variations in driver preference across countries, ages, genders, levels of ability, and personal predilections. To do so, the technology must offer opportunities for customisation. For example, individuals could carry personalised Smartcards that could be inserted into any car to configure that vehicle to their preferences (seat distance, steering wheel angle, display size and navigation system characteristics, driver alert configuration, etc.). Other customisation options include pre-set preferences for each driver of the family car, or adaptive systems that learn how each driver drives and conform to their preferences.

Customisation, as attractive as it is, raises its own human factors issue. Who sets up these systems and how do they know how to configure them? Car dealers and aftermarket service providers might be logical providers of such services.

Moreover, such customisations should never compromise safety by overloading the driver or obscuring needed information. Drivers should not be in traffic toying with the layout of their instrument panel. Some notion of safe and appropriate configurations is needed.

C.2. The Five A's of Technology Adoption

In order for technology to be adopted by older people, it must be affordable, accessible, adaptable, acceptable and available to them.

Affordability

When evaluating the costs of a new technology, it is important to consider the cost to the individual as well as to society. Some of these costs can be measured in hard currency while others have an impact on quality of life. Moreover, the costs may be indirect. As Dr. Hakamies-Blomqvist remarked, mobility impacts activity, health and autonomy. People need mobility to lead an active life. Active old people stay healthy longer, which means that they stay autonomous longer and do not require institutional support. Thus, keeping older people mobile saves public funds because it supports their autonomy.

Ms. Hardin cited case studies demonstrating how agencies can collaborate to afford new technology that separately they could not afford, while reducing overall costs for agencies and users alike. The Cross-County Transit program in North Carolina (U.S.) is a joint program between Human Service providers and Transit providers. The program is available to users in North Carolina based on income. The program has not only extended healthcare by giving low-income people access to medical care outside of their own county, but it has also resulted in hard-dollar savings.

The Taxicard in Baltimore, Maryland (U.S.) replaces paper vouchers that low-income people use for taxis. The Taxicard not only reduces costs of the original service, but it can also be used on public transport. As Ms. Rosemary Mathias and Ms. Carol Schweiger remarked, paratransit is very expensive: the average USD1 cost to ride on general public transport costs between USD10-65 when paratransit services are used. Providing technology that enables an older person to use general transport rather than paratransit can yield dramatic cost savings.

The St. John's Council on Aging is a co-operative effort that reduces the need for door-to-door paratransit by making a general transport solution easier for seniors to use. Many seniors do not need demand-response systems, but use them because they cannot use a traditional fixed-route system. The St. John's program uses eight buses, all painted a bright sunshine yellow colour. The buses run on a fixed route, but stop at any corner for anyone who signals them. The program has been especially successful in situations such as bringing dialysis patients to their regular doctor visits several times a week, and for bringing people home from the hospital.

Accessibility

Technology can help make existing transport options more accessible and usable. Accessibility has both physical and mental dimensions. Elderly who have difficulty walking or climbing stairs can be helped by low-floor or kneeling buses with handrails, as speakers Dr. Bella Dinh-Zarr and Ms. Suen suggested. New technology should be based on the principles of universal design. For example, electronic displays at airports provide information, but are useless to seniors if they display information in small type sizes, poor colours or confusing arrangements.

Although it has been said that the elderly do not use new technology, evidence shows that they will adopt new technology if it is demonstrably useful and easy to use. As Dr. Mitchell mentioned, in-vehicle navigation systems are used when they give helpful prompts. Often the key to adoption of new technology is user transparency.

Indeed, many technologies are transparent. That a car uses sophisticated software to improve handling, or infrared cameras to project an enhanced night view, or artificial intelligence to create a navigation plan, is irrelevant. What matters is that the person can drive safely, comfortably, and confidently. Research into human factors will help ensure that new technologies are accessible to all.

Adaptability

Given the personal variations described in the previous section, technology must be adaptable to individual preferences and needs. In addition, mobility means more than just transport to the doctor's office or grocery store. Mobility and transport options need to be adaptable to the needs of the elderly for their variety of purposes, whether it be for emergency transport to a hospital, a pleasure trip to get an ice cream cone, or a heavily-laden journey from the store.

Acceptability

Technology must be acceptable to the older person if it is to be adopted. Mr. Wolfe cited an example of an elderly woman at the airport who refused the wheelchair offered her: "I don't need a wheelchair, I just want to be able to walk the distance," she said. Mobility choices that preserve individual dignity have the highest chance of acceptance. Similarly, many older people do not want to buy the "old man's car," so design of new technology should be inclusive of all age groups.

Technology also has acceptability dimensions in terms of control and rights. Invasive screening technology or programs that tap into automobile blackboxes to monitor driver behaviour may be deemed unacceptable by the Public. Automated systems that exert too much control of the vehicle may be unacceptable. Individuals and policy makers will need to explore and understand the appropriate limits of acceptability.

Availability

Ms. Audrey Straight from the American Association of Retired Persons (AARP) described the results of research comparing people's opinions about public transport. Study subjects resided either in the city or in the suburbs. People in suburbs stated that they felt trapped at home, whereas people in urban, transport-rich environments were pleased with their transport options. The difference is that the transport options that existed for users in the suburbs were limited. The suburban dwellers could not use the existing transport system to go where they wanted to go when they wanted to go.

Similarly, new transport technology needs to be available to users if it is to be adopted. Navigation systems are only useful if accurate maps are available. Intelligent infrastructure that is too limited in its availability may confuse drivers more than it helps them.

C.3. Downsides of Technology

Although many technologies show great promise in enhancing the mobility of older people, such technologies are not without risk. Three such risks include over-reliance, distraction, and information abuse.

Over-reliance on Technology: Risk Homeostasis

When faced with an invention that increases safety, people can react in one of two ways. They can live with the increased safety or they can increase their risk-taking behaviour by either increasing exposure or increasing aggressiveness. This behaviour modulation strategy is called risk homeostasis. It is a widespread phenomenon in which people tend to maintain the same level of risk, regardless of the application of risk-abating technologies.

For example, some evidence suggests that people with airbags and antilock brakes drive more aggressively on the presumption that these inventions reduce their chance of injury or death. Risk

homeostasis operates in both directions. An excellent example of risk homeostasis is the fact that many elderly self-regulate their driving to reduce risks in the face of declining functionality

Risk homeostasis alone is not a problem. Problems only arise when people underestimate the risk. If people are overly confident of the risk-reducing properties of a technology, then they may drive with excessive aggression or exposure to risks. For example, Dr. Kuchar presented research from the AgeLab where the risk of having a car crash actually increased when a collision avoidance system was used. Drivers were found to drive more aggressively because they believed that the warning system would protect them to a greater degree than it actually did. Similarly, adaptive cruise control that regulates following distances might enable people to follow more closely at higher speeds, thereby increasing their risk. Risk homeostasis combined with erroneous risk models explains why a safety-promoting technology can actually increase injuries and fatalities.

Drivers can also misinterpret the meaning of signals from technology. For example, Dr. Mitchell noted a simulated study of a driver decision aid that showed some inappropriate assumptions made on the part of some drivers. The particular device helped drivers make turns across on-coming traffic by measuring the speed and distance to on-coming cars. When a safe gap developed, it signalled the driver. Unfortunately, a green “safe-to-turn” dashboard signal was treated more like a green “legal-to-turn” traffic signal. Consequently, some drivers made slower turns as if they expected oncoming traffic to stop for them. In promoting driver’s aids, both government and industry must ensure that drivers understand the limitations, legalities, and liabilities associated with the technology.

Distraction Potential and Cognitive Overload

Of greatest concern is the potential for distraction – that the cognitive load imposed by the technology will compete with the cognitive load required to safely operate the vehicle.

Two factors further increase the safety threat posed by driver distractions. First is the growing number of complex in-vehicle systems. At its core, a car is simple: a throttle and brake for controlling speed and a steering wheel controlling direction. Safe driving requires little more than avoiding collisions with other cars, objects, and people while progressing toward an intended destination. Over the years, however, cars have become progressively more complex with turn signals, windshield wipers, climate control systems, and audio entertainment systems. Each new system adds to the cognitive load of the driver. Failure to turn-off a turn signal which continues blinking is a sign that a driver has reached his/her cognitive limit.

Recently, the number of new in-car devices has grown both in number and in complexity. Cell phones, navigation systems and more complex audio entertainment systems add to the cognitive loading and impose spontaneous demands for attention from the driver: cell phones ring, CD changers require changing, etc.

Distraction is not just an issue for vehicle operators. Pedestrians and public transport users can also be overwhelmed. A distracted pedestrian might inappropriately step into the street or collide with other sidewalk users. Public transport users can miss their stop or neglect crucial safety messages.

Training on the new devices is also lacking. As Dr. Coughlin remarked, consumers can purchase an USD 80,000 automobile equipped with all of the latest features and drive it out of the showroom having received no training whatsoever.

Finally, safety-enhancing technology that provides warning alerts could potentially fluster an older driver or cause confusion as to the correct procedure to follow. Improved cognitive models,

appropriate human-machine interface design principles, education programs, and automated workload management systems could all help to ensure that distraction does not pose an excessive safety risk.

Information Abuse

Information is a double-edged sword. Many older persons fear that information about their declining abilities could be used against them in driver licensing decisions. Yet information is the key to responsible driving habits. Speakers Mohyde, Braver, Staplin, and Sheridan suggested the potential for using private self-tests. For example, The Hartford Financial Services Group publishes a paper test to help drivers and their families recognise the warning signs when dementia is degrading driving performance.

Many senior citizens fear testing and may in fact cease driving rather than face an upcoming test. People do not always trust published privacy policies. For example, even when the testing is clearly labelled as being 100% private, seniors fear that an unfavourable assessment could end up in the hands of licensing authorities.

Privacy issues arise from the deployment of the technology itself, not just from testing. For example, if an in-vehicle ITS system is to adapt to the driver, then it needs to store data on the person's driving behaviour and habits. For example, data on accelerating, braking, and turning might influence how and when the system provides alerts or information to the driver. But, some fear that this data could be used against the driver. If a driver tends to accelerate briskly, brake rapidly, or turn quickly, such data could be interpreted as evidence of risk-taking behaviour. Even data that the driver drives slowly, turns slowly, and brakes often could be used as evidence of caution, self regulation, and that person's self-awareness that they cannot drive normally.

This concern that the car has data providing evidence that can be used against its driver is not just a theoretical future risk. Today, the "blackboxes" of many new vehicles save the last several seconds of car behaviour in the event of an airbag deployment. Such data can be used to determine if a driver was speeding, when they braked prior to a crash, etc. Future systems might even be able to provide more details about the driver's behaviour. The driver workload system described by Motorola might even detect that the driver was on a cell phone or adjusting the heater when a crash occurred. These blackboxes do help to create smarter ITS, to diagnose car troubles, and to reconstruct the causes of crashes. Yet, they can also be construed negatively as a source of evidence against the driver.

RECOMMENDATIONS

A. Policy Recommendations

Preliminary policy recommendations were synthesised from two sources; recommendations suggested by the presenters and audience members of the two-day OECD – MIT International Symposium, “New Transport Technology for Older People” and additional recommendations suggested by the OECD Working Group on Human Factors of Transport Technology for Older Persons, following the symposium.

In summary, the top-level recommendations are:

- Pursue an integrated approach to mobility and safety of the elderly.
- Create and promote standards that enhance the mobility of older citizens.
- Improve information systems in transport systems.
- Encourage education for lifelong mobility.
- Pursue infrastructure technology improvements.
- Create a regulatory framework for adopting novel modes of transport.
- Collect better data to assess the relationship between technology, safety, and mobility for older citizens.

A.1. Pursue an integrated approach to mobility and safety of the elderly

Mobility is more than a transport issue – it impacts public health and economic health. This suggests that a more holistic approach to managing the mobility of the elderly will result in better societal outcomes. This concept of integration extends to policy making processes, to relationships between governmental and nongovernmental entities, and to integration within the technologies themselves. If the goals of government are to promote sustainable societal well-being, then policy makers need to consider the widespread impacts of their decisions beyond the narrow confines of their own department’s jurisdiction.

Use systems models for the societal impacts of mobility policies

Systems models provide policy makers with tools to understand the complex relationships between technologies, user behaviour, and societal outcomes. In many situations, coupling between variables leads to counterintuitive impacts from well-intentioned policies. Holistic approaches reduce the chance for such unintended side effects.

For example, most people assume that as a person declines in functionality, the person first gives up driving and then gives up walking. But in fact, the reverse is true: those who cannot walk well rely more on driving. This perverse effect also manifests in other ways: those who cannot walk well are often the ones who must walk the most, because their condition may also preclude them from driving or riding the bus. Thus, they are forced to walk even if it is very difficult for them.

Another example of coupled effects and the potential for unintended effects of regulation comes from the Netherlands. The Netherlands is a nation of cyclists, with 46% of all trips being non-motorised. Yet, the country does not require bicycle helmets. The reason cited is that helmet laws may discourage people from cycling. As this example illustrates, well-intentioned laws could lead to adverse changes in behaviour that do not serve the greater good.

Facilitate multi-disciplinary communication between agencies, NGOs, industry, other stakeholders.

Improved co-ordination and cooperation between transport ministries, health and human service ministries, local authorities, NGOs, industry, and stakeholder groups can both improve the quality of mobility and reduce the cost of service. Ensuring the mobility needs of an aging population requires co-ordination between authorities governing land use, infrastructure, driver licensing, and public transit. Disjointed planning results in retirement communities constructed far from urban service centres with poor mass transit linkages, resulting in decreased accessibility and mobility for older persons.

Co-ordination improves the quality and cost of services. For example, many mission-specific agencies provide purpose-specific transport services for the elderly. With each agency or NGO providing its own paratransit services, volunteer drivers, or flex-route transit, the potential for duplicated effort, underutilised assets, and gaps in services exists. Shared centralised scheduling, dispatching, and communications help maximise the service provided while minimising the costs. Co-ordinated action also aids patrons who are confused by a patchwork of disjointed service providers.

Encourage integrated approaches to in-vehicle technologies

With their potential for distraction or confusion, an array of disconnected technologies poses special challenges for older drivers. Given the low or non-existent level of user training for new vehicle owners and aftermarket vehicle solutions, it behooves regulators and industry to pursue common, easy-to-use human-machine interfaces. A more integrated approach based on open standards would help ensure a more intuitive interface to in-vehicle technologies.

A standardised, integrated architecture also reduces the potential for distraction that arises when independent devices compete for the driver's attention. If every device is connected into the shared system, workload management systems can mediate between various in-vehicle technologies and the driver. Workload management with integrated systems help manage the cognitive load created by proliferating technologies, which is a critical issue if older drivers are to safely use and benefit from these new technologies.

A.2. Create and promote standards that enhance the mobility of older citizens

Fully adopt universal design principles for all modes of transport

Universal design principles improve users' accessibility to and uniformity of transport systems. New technologies in transport should be accessible to all, especially since many of the technologies

could be especially valuable to older transport users. Accessible, legible, intuitive man-machine interfaces are the key to widespread adoption of technology in both private vehicles and public transport systems.

Define multimodal standards

Recognising that transport is multimodal means that barriers in one mode can curtail mobility in other modes. Uniform standards that apply across modes can improve ease-of-use and mobility. For example, signage standards should be the same across all modes, with common standards for road signs, pedestrian signs, mass transit information, and airport terminals.

Enforce and integrate guidelines that already exist

Well-established standards exist in many regions, but implementation and enforcement of these standards is lacking. More widespread adoption of existing standards would improve the usability of the existing infrastructure for older transport users. For example, enforcing proper design and maintenance of walkways would improve pedestrian safety, security, and mobility. Well-lit walkways that are clear of hazards such as snow and ice would minimise slip and fall hazards for older citizens.

A.3. Improve information systems in transport systems

Advances in information technology help to improve levels of service to transport users and to improve cost efficiency. Government policy makers should consider human factors in all facets of transport policy recommendations, to improve the usability of new technologies for older transport users.

Ensure technology equity through technological investments in public infrastructure

Policy makers should ensure technology equity so that the largest number of people can afford and gain enhanced mobility and safety. Encouraging public infrastructure investment is one way to increase public safety. Warning systems embedded in infrastructure provide a wider public benefit than technologies limited to luxury cars.

Create data synchronisation initiatives for data about infrastructure status

Many transport technologies depend on accurate and timely data on the status of critical infrastructure. These include paratransit dispatch schedulers, route planners used in private-vehicle navigation systems, and bus-stop displays with expected arrival times of buses. Changes in the road system (such as the pattern of one-way streets or traffic light cycles), construction zones, and crashes all impact the utility of these technologies. Inaccurate data means inaccurate decisions will be made, which will lead to frustrated users and inefficient transport operations.

Data synchronisation is more than a convenience issue. It is a safety issue, especially for older transport users. For example, a navigation system that lacks timely data might send a driver the wrong way down a street that was recently made one-way. Inaccurate data could also increase the chance of drivers getting lost. Once misdirected, older drivers might become flustered and might be more likely to have a crash.

The key is to share data on current and upcoming changes to the infrastructure in a timely way, to integrate data from different sources, and to disseminate this data to users. This involves better co-ordination of information from all agencies that affect road usability – from municipal transport

planners, to construction contractors, to special events planners (e.g. road closures for marathons or parades) to emergency response personnel (e.g. diverting traffic from a chemical spill on a highway). It may also require co-ordination with companies that provide telematics to private vehicles (services that distribute updated data and alerts to in-vehicle navigation systems). With real-time data synchronisation systems, transport managers could also help reduce congestion by sending real-time alerts on traffic flows.

Improve the usability of self-service systems

Increasingly more service interactions occur at self-service kiosks, be it at an Automated Bank Teller, a subway ticket machine or an online booking of air-travel. Human factors determine the accessibility of these service outlets to the older citizens, whether the service is a zone-map at a subway ticket machine, or an airline's website. Government has a role in creating and encouraging standards that improve the accessibility of these self-service systems for the elderly. As a further benefit, usable self-service systems can reduce the cost of service.

Integrate and deploy a seamless information system for transit trip planning and transport.

Many trips, especially those involving public transport, require multiple segments on different modes. Accessing the airport might involve walking to the subway station, transferring to a bus, and boarding a Peoplemover through the various parts of the airport to reach the boarding gate. End-to-end transit trip planning systems would help elderly transit users navigate a multi-segment, multimodal trip. Such systems would help travellers budget their time, so that they can leave at the right time to arrive at the right time. The information would enhance older people's feeling of security, minimise their confusion, and minimise the physical demands of time spent standing and waiting.

Leverage IT and communications for enhanced transit/ demand-response services

By coupling vehicle tracking systems with automated telecommunications systems, a variety of public transit services could provide timely alerts on the expected arrival times of rides. In paratransit services, especially, timely phone calls ("the van will arrive in three minutes") will allow older patrons to remain safely inside until the van or bus arrives at their doorstep. These technologies also improve service by more effectively managing the real-time deployment of assets.

A.4. Encourage lifelong education for lifelong mobility

The advent of new technologies in transport brings a need for ongoing education. New in-vehicle technologies must be mastered. Moreover, as the needs and abilities of people change as they age, education on how to maintain mobility can be useful. For example, training or tips on safe driving for older drivers can help the elderly compensate for any deficits without requiring them to relinquish their driving license.

Encourage driver training in conjunction with technologically-advanced new vehicles

As new car buyers adopt ITS, training may be recommended to ensure safe and effective operation of innovative vehicle systems. Currently, car buyers can purchase a new vehicle and drive it out of the showroom with no training. As carmakers deploy ever-more complex technology, more education may be useful.

Training would ensure that drivers know how to appropriately interpret any alerts, warnings, or safety-related recommendations made by in-vehicle systems. Even easy-to-use, intuitive technology

might require some training, helping the driver make safe use of the system or understand how to cope with the limits of the technology.

Drivers using advanced technologies such as collision avoidance systems must understand the appropriate level of trust to place in the system. Early research has shown that people sometimes place more trust in a collision avoidance system than the system is designed to handle. The unintended result is that an accident may be more likely to occur because the driver has abdicated vigilance or has started to drive more aggressively given the presence of the collision avoidance system. Training could also be done in the guise of a customisation or configuration process – a service in which the driver’s preferences are entered into the system.

Mandatory training might be ill-advised if it reduces the adoption of technologies that do improve safety. Car makers might eschew new technologies that spoil the buying experience, and consumers might avoid the technologies that come with strings attached. Incentives (*e.g.* on taxes or insurance) – rather than mandates – can encourage training. Public information campaigns could promote responsible use of transport innovations and infrastructural upgrades.

Create a “smart advisor” that helps older drivers chose appropriate technologies to suit their individual needs

New in-vehicle technologies applied in conjunction with appropriate driving strategies can enable older drivers to drive safely and compensate for age-related declines in functionality. The notion of an ability/disability dichotomy is overly simplistic. Rather, mobility-impacting changes in functionality occur on many dimensions of visual, auditory, cognitive, and physical function. Some people can walk well, but cannot see far. Others find walking hard but have perfect vision, while still others may have difficulty remembering their way around.

Rather than mandate that all cars have some well-intentioned set of driver-aids, government can help consumers make wise choices. Information about what to look for based on particular disabilities or preferences would help drivers choose the vehicle most appropriate for their needs and preferences. The resulting recommendations or “smart advisor” would be offered as a public service to help ensure the safe mobility of the elderly.

Government would work with industry to characterise the performance of alternative in-vehicle systems and the recommended driver strategies associated with these systems. Insurance companies and advocate associations might participate as needed in assessing risk, setting insurance premiums or representing the needs of their constituencies.

A.5. Pursue infrastructure technology improvements

Infrastructure technologies offer a means to provide technological benefits to all transport users. However, current and future infrastructure design needs to be reviewed in light of older persons’ needs. For example, the timing logic on standard traffic crossing control devices may need adjustment to accommodate older pedestrians. Other infrastructure technologies that provide warnings to drivers (such as collision avoidance systems at intersections) may require education programs to prevent differential behaviour (in which some drivers ignore a warning or ignore a signal that it is permissible to cross).

Many trips on public transport involve carrying additional objects. Such trips include coming from the grocery store with parcels on a bus or moving through an airport with luggage. Level-changes with baggage, lifting the carried objects, and balancing on moving vehicles can be

uncomfortable or dangerous for older transport users. Large transport hubs, such as airports, train stations, and bus depots often force travellers to stand in queues for long periods or walk long distances with their baggage. Improved infrastructure would facilitate older person's use of such facilities.

A.6. Create a regulatory framework for adopting novel modes of transport

In addressing the issue of mobility for the elderly, innovators may create new transport modes. Small electric-powered vehicles, power-assisted limbs, and variations on the electric scooter or NEV (neighbourhood electric vehicle) could provide some solutions to mobility for the elderly. But if these innovations are stymied by outdated regulations, then top-level policy goals will be thwarted.

Devices like the Segway exist in a regulatory "no-man's-land", being potentially illegal for both street and sidewalk usage. Yet this device, or others like it, could reduce urban congestion, improve total mobility, and reduce the environmental impact of transport. Improved regulatory frameworks would consider not just the potential dangers, but also the potential benefits of the new technology. For more controversial technologies, staged trial-and-review processes could ensure a fair test of the new technology while minimising the threat to public safety.

A.7. Collect better data to assess the relationship between technology, safety, and mobility for older citizens

Encourage more thorough data collection to track the impact of technology on safety and mobility

Assessments of the impact of technology on the mobility of older drivers often suffer from a paucity of real-world data. Although surveys, instrumented vehicles, and simulated testing provide powerful insights of how technology impacts safety and mobility, many crucial effects to society only emerge once the technology is in use by everyday people. Real-world data is needed to validate simulations and survey results, and uncover unexpected relationships between technology and transport patterns.

Governments and researchers lack crucial data about what technologies are deployed in private and public vehicles, both in the aggregate and in specific events. Current crash data lacks much information about in-vehicle technologies that are already in use. For example, police reports from crashes fail to report whether the vehicles involved had any of a range of in-vehicle technologies such as navigation systems, night vision, anti-lock brakes, or even an automatic transmission.

This lack of data occludes analysis of the potential impact of the technologies on safety and mobility. To assess how antilock brakes or night vision systems affect crash outcomes, data is needed on the portfolio of technologies installed in each car. Assessing the long-term impact of technology on safety and mobility implies collecting sufficient data on the deployment of technology, who is using which technologies and what is happening to them.

Better databases can help track what equipment is installed on cars. Interestingly, new technologies can be used to aid in the collection of such data. For example, RFID technology can be deployed to store vehicle information numbers and provide access to information on everything that is inside the vehicle. Databases that enable policy makers and researchers to look up detailed vehicle configurations would help improve the analysis of accident statistics.

Collect comprehensive data on injuries in the context of a multimodal mobility model

Currently, there is no data on the number of people injured or killed getting to or from the bus or subway system. What is known is the number of riders injured, and separately, the number of pedestrians injured. The availability of such accident data would help transport policy and health and human service ministers make informed decisions about the relative risks of mobility using different modes. Estimating the total trip risk across the multiple modes involved provides a more holistic view of the risk. Public transport managers should care about the safety of their riders. If the elderly perceive that getting to and from the bus stop is dangerous, they may cease to ride the bus, ridership will fall, and public support for public transit will continue to decline.

Moreover, some technologies might reduce some categories of crashes while increasing others. For example, night vision technology could increase slip and fall accidents as elderly drivers alight and disembark from cars at night. If government policy makers wish to improve health and welfare, they need more encompassing data on who is using which technology and what health events they are experiencing. A better understanding of all injuries within the context of a multimodal model of mobility will help policy makers estimate the true risks of different mobility strategies and the technologies that affect them.

Ensure that testing includes both younger and older participants

Current standards and policies often reference research data collected on younger test subjects. Because so much research is done by universities, college students are over-represented in the data. But adding elderly subject data to the data set is not easy. The high degree of variability between elderly individuals creates greater variability in the results.

Given an aging population, some existing standards may need adjustment. For example, the timed crossing signal presumes a faster walking speed than some elderly can maintain. Ergonomic recommendations also may need to be adjusted in order to reflect differences in physical agility and range of motion.

Although Bernard Isaacs said that “If you design for the old, you include the young, but if you design for the young, you exclude the old,” neither half of this aphorism may be true. For example, in-vehicle alerts and over-sized road signs that help older drivers to drive confidently might irritate younger drivers. Similarly, the Twingo car was designed as a fun first car for younger drivers, but its large dashboard displays and easy ingress and egress features have made the vehicle popular with the elderly.

The point is that testing a broader range of drivers ensures that recommendations derived from that research will apply to the broader population. In cases when the research applies to critical safety-related issues, a more representative sampling is especially important. Longitudinal studies will help us understand the natural progression of aging and its impact on mobility. Deploying a transport technology that is dangerous to 25% or more of the population is not acceptable. Without data on elderly populations, sound policy decisions cannot be made.

B. Research Recommendations

Further research will help resolve the complex interplay between technology, mobility, and safety of older transport users. The tendency for people to modify their behaviour in response to changing conditions means that first-order arguments about the impact of technology can be incorrect. Better models, research related to human factors, and a better understanding of the aging population will help

policy makers, technology designers, and individuals make more responsible decisions that maximise mobility for older people without sacrificing the safety of society.

PART 2: CHRONOLOGICAL SUMMARY OF PRESENTATIONS

Symposium Purpose and Overview

Joseph F. Coughlin, MIT AgeLab

Dr. Coughlin introduced the symposium with three “R’s”: Reason, Rules and Recommendations. The symposium’s objective is to address a vital concern that transport is about freedom, independence and life. Dr. Coughlin highlighted this point with a dramatic example of a man, 75, who was found dead in his home due to starvation. Earlier that year, the man had failed the eye test associated with his driver’s license and had therefore lost his right to drive. When the coroner examined the scene, he saw that the man had eaten everything in his home, including all the condiments like relish and ketchup. He starved to death because he lived too far away to access the grocery store without a car and had no other transport option.

Given this dramatic need for answers to the topics about to be discussed, Dr. Coughlin charged the group with devising a set of recommendations. These recommendations would not only define the problem, but would also provide a range of solutions that are affordable, accessible and adoptable. The need for new transport technology for older people is not just a research issue, but an issue to help people as they age. It applies to all of us as we age.

Panel 1: Moving in Older Age: Patterns, Problems & Possibilities

Annie Pauzié, INRETS (Moderator)

Ms. Pauzié introduced the panel that would set the stage for discussing mobility for older adults.

Liisa Hakamies-Blomqvist, University of Helsinki, “Greying Road Users: the Challenges and Opportunities for Traffic Safety”

Dr. Hakamies-Blomqvist began by framing aging and transport as a public health issue. Mobility impacts society and societal costs because mobility affects activity, health and autonomy. People need mobility to lead an active life. Active old people stay healthy, which lets them lead an autonomous life longer. When people are no longer autonomous, they require public support. Therefore, countries can save public funds if they can keep older people mobile and autonomous for longer. She stressed that mobility is therefore a public health issue, not just a safety issue. It is also not just a safety issue because actions such as revoking licenses from older drivers impact their quality of life for the rest of their life.

Taking measures to ensure the safety of older adults is different from taking measures to ensure the safety of children. With children, we mandate that they be in child harnesses for their own safety, and we know that they will be compensated later in life for this increased safety now. In the case of the

older person, however, their quality of life will decrease for the rest of their life. Therefore, the older person's needs must be balanced against the needs of other target groups. For these reasons, mobility is more than just a safety issue.

Dr. Hakamies-Blomqvist presented a number of studies on older drivers and crash rates. Most strikingly, she presented data that showed that older adults are much more often killed as pedestrians or bus passengers than as car drivers or passengers. Therefore, taking their license away does not improve their own safety. Similarly, Dr. Hakamies-Blomqvist showed that the most important risk factor for older persons in traffic is their physical frailty, not their driving ability. Driver aging does not cause higher crash rates per kilometre. Rather, because older people are more frail, they are more likely to be injured in any accident and more likely to die from an injury than a younger person. Any mishap will hurt an older person more than a younger person because of the older person's frailty. Data from the UK and Sweden (*i.e.* from countries where walking is a viable option to driving), showed that the main source of safety problems for the older person is their physical frailty, not the quality of their driving.

Furthermore, traditional crash and injury data overestimates older drivers' risk because of the frailty bias and the low mileage bias. That is, older drivers drive fewer miles than younger drivers. But when one compares crash rates adjusting for low mileage drivers of all ages, older low-mileage drivers are no more likely to have a crash than younger, low-mileage drivers.

Dr. Hakamies-Blomqvist's conclusions about age-related risk in drivers were that we know that older drivers face an increased risk of injury and death in car crashes, but that the evidence is not conclusive that they present a greater risk of causing crashes. Taken together, these facts stress that older people are "at risk, not risky."

Predicting future developments in crash rates for older drivers is difficult because there will be cohort effects, gender effects and time effects. Baby boomers as a cohort rely heavily on private car driving for their daily travel, and according to a VTT survey, baby boomers expect to still be driving at age 80.

Recommendations

- Well-informed policy makers need to work with a sound problem definition.
- Broad collaboration between different areas of policy making, such as land use, healthcare, and transport planning.
- Involve "the targets" and engage new actors.

Sandra Rosenbloom, University of Arizona, "The Implications of Socio-Demographic Trends for the Safety and Mobility of Older People"

Dr. Rosenbloom described socio-demographic trends and the policy issues these trends raise. First, socio-demographic trends show the growth of the aging population, not just in absolute numbers but also as a growing part of the population. Traditionally, demographic profiles of a population had a pyramid shape, with the oldest members constituting the smallest percentage of the population (the top of the pyramid). But with the aging of the baby boomers and increasing longevity, that traditional pyramid is becoming more box-shaped. Moreover, in some countries such as Japan, the pyramid is actually inverting, with the largest subgroups of the population being the old. Moreover, many of these

older persons are not living in cities or high-density areas, but rather in rural areas where there are few public transport options.

Data from the US show that older people rely more on driving as their primary mode of transport than on other modes of transport. Indeed, use of public transport in the US has fallen by half between 1996 and 2001. What's troubling about this trend for policy makers is that typical planning efforts assume that older people will continue to drive less as they age. This assumption, however, is not being borne out by the data. Older people drive shorter distances, but that simply means that their short trips cause a greater environmental impact (catalytic converters don't have time to warm up). Older drivers also drive at all periods of the day, so road congestion does not just occur only at peak driving times.

Dr. Rosenbloom, reinforced Dr. Hakamies-Blomqvist's statement that mobility is not just a transport problem. Rather, we need partnerships with housing planners and economic development councils. Currently, economic development councils seem to be encouraging retirement communities to be built on the outskirts of towns, where land is inexpensive, but where infrastructure and services are lacking or nonexistent. This will cause a problem as the retired community ages and faces lack of access to doctors, grocery stores and the like. Co-operation among housing planners and transport planners is needed to ensure that the adequate infrastructure exists as the retirement community population ages.

Dr. Rosenbloom also described certain myths that the public holds about older drivers which are erroneous and affecting policy decisions. The first myth is that as people age, they give up driving first, then bus usage, then walking. In fact, the opposite is true. Older people stop using public transit first, then stop walking, and stop driving last. The reason is that older people feel safer getting into their car and driving a block than walking that block.

Another myth is the belief that policy should tackle driving issues first. In fact, it is land use policy that affects driving. If people live in communities where they have a short distance to travel to access doctors and food and recreational facilities, they will need to drive less to reach these facilities. Therefore, our policy efforts should begin with the source of the problem – land use policies – not with the transport symptoms that arise from poor land use policies.

Recommendations

- Recognise and respond to diversity. For example, elders from different racial backgrounds have different issues. Hispanic, Asian and Native American communities tend to have family networks that take care of elders better, providing models we can learn from.
- In addition to family networks, cooperation is needed between public, private and non-profit groups to collaborate to devise options that address the mobility needs of older persons.

Bella Dinh-Zarr, American Automobile Association, "International Synthesis of Recommendations for Improving Senior Safe Mobility"

Dr. Dinh-Zarr offered a synthesis of mobility recommendations for older persons which were divided into three categories: the person, the road and the vehicle.

Recommendations for the Person (driver and non-driver)

- Do not stop people from driving too soon: older drivers are less likely to speed, less likely to drink alcohol, and more likely to wear a seatbelt. They self-regulate their driving to compensate for the declining abilities, such as by not driving at night, not driving in inclement weather and not driving on unfamiliar roads. Therefore, older drivers may actually be safer drivers than we think or than they themselves think they are.
- Promote older driver training programs.
- Develop screening and assessment tools to help drivers determine their driving competence levels.
- Provide insurance discounts for taking driving “refresher” classes.
- Offer more in-person driver’s license renewals, more frequent renewals, and better vision testing.
- Identify and restrict high-risk drivers.
- Support transport options such as non-traditional or subsidised transport.
- Create and evaluate supplemental transport options.
- Improve public transport options and usability of these options (such as extended hours, provision of seating and shelters at bus stops, and kneeling buses).
- Develop mobility manager programmes.
- Support safe mobility action plans, land-use plans, and funding.
- Educate the public and promote mobility as a public health challenge.

Recommendations for the Road

- Promote senior-friendly road signs (larger signs and improved contrasting colours).
- Improve infrastructure to support non-automotive travel options such as walking or cycling.
- Incorporate the Federal Highway Guidelines for Older Drivers into existing state guidelines and local guidelines (US).

Recommendations for the Vehicle

- Improve occupant protection systems for ease of use and comfort.
- Make vehicles easier to operate for older drivers (non-glare headlights, wider windshield wipers, and fewer blind spots).
- Increase safety standards for vehicles to compensate for the increasing frailty of older age.

- Make vehicle exteriors less harmful to pedestrians (such as external airbags).

Panel 2: Identifying Older Adults' Functional Capabilities

Claude Marin-Lamellet, INRETS (Moderator)

Richard Marottoli, Yale University Medical School, "Older Adult Function and Mobility"

Dr. Marottoli presented a new perspective on how to view what we traditionally see as functional impairments. Rather than seeing a decline in a capability as an impairment, we can view it as a potential area of intervention, an area which we can address to enhance personal safety and mobility. The entire array of functional capabilities should be viewed in context. Each area affects driving performance, so a decline in one single area does not mean that the person is unable to drive.

Dr. Marottoli suggested that an array of factors be examined for older drivers – driving history, environmental and vehicle conditions, medical factors, functional abilities, and awareness – which all affect driving performance. In terms of driving history, how often does the older person drive? (How many days per week, how many miles) and under what circumstances? (At night, in inclement weather?) Typically, older drivers self-regulate and do not drive under these conditions. Likewise, in the area of functional abilities (sensory, cognitive and physical) there is a broad array of measures for each capability. We tend to focus on vision, but even there, what is the most important aspect of vision for driving? Likewise, in cognitive domains, some areas are more important than others. Where on the spectrum does one draw the threshold beyond which a person can't drive? Finally, conditions like dementia are progressive, so a person with dementia may pass a test now, but is that level of performance still valid six months later?

In terms of mobility, people tend to drive because walking is harder for them than driving. Therefore, driving is one of the activities they give up later, not earlier. We need to be aware of this fact when considering policy regarding older people's mobility.

Preliminary data are showing that some of the underlying functional capabilities can be improved, reducing crash risk. Therefore, assessments such as driving tests may need to be reframed in more positive terms: not as an assessment that revokes one's license, but as an avenue for improvement, to identify areas that will help people keep driving safely longer.

In short, older adults have an array of functional capabilities and are very good at compensating for a deficit in any particular area. Technology in vehicles can provide assistance as well, from ergonomic comfort to crash-avoidance systems (anti-lock brakes, traction control) and crash protection (airbags, crumple zones, padded interiors). Therefore, it is important to keep in mind the whole context when assessing driving and mobility.

Desmond O'Neill, Trinity College, "Using Gerontology and Technology to Maximise Mobility for Older People"

Dr. O'Neill explained that sound gerontological principles should be considered when planning transport. One needs to think not only about risk, but also about preserving mobility. Geriatric medicine provides us with mechanisms to preserve older adults' independence. Therefore, one needs to look not only at the adverse effects of medications, but also at the fact that medications can improve older people's mobility.

Dr. O'Neill shared a quote from Bernard Isaacs who said: "If you design for the old, you include the young, but if you design for the young, you exclude the old." This design principle becomes even more important as one considers the phenomenon of the population pyramid's inversion. If designers want to reach older consumers, they are going to have to design for older people.

Dr. O'Neill identified key research areas to be explored:

- Improve vehicle design and crashworthiness.
- Improve assessment and rehabilitation of older drivers.
- Determine the societal benefits of safe mobility (The World Health Organization has stated that activity and participation were a part of health and active aging).
- Enhance land use planning and sustainable communities.
- Use international research and sources.
- Include a gerontological perspective in the context of mobility.
- Balance mobility and safety considerations.

The strengths of geriatric medicine can be leveraged for mobility research:

- Gerontology training tells us that driving is important to being active.
- Gerontologists are skilled at functional assessments.
- Gerontology has a tradition of rehabilitation (not just getting older drivers off the road).
- Gerontologists have skills in risk assessment.
- Gerontologists are accustomed to balancing client and family perspectives.
- Gerontologists play an advocacy role for aging in society.

Certain principles of aging need to be kept in mind when considering mobility for older people. For example, we should stress the positive aspects of aging: older drivers have more years of driving experience. Another principle is that advancing age increases inter-individual variability (two 80 year-olds are less similar than two 8 year-olds).

Technology can be used to maximise mobility for older people. Just as car seats save children's lives (young people are not forbidden to ride in cars), technology can offer safety features that save older adults' lives. Technology offers wide-ranging options. The key is to apply human factors research to the effective deployment of technology. Just as MRI technology is useless without skilled practitioners who can interpret MRI results, people skilled at listening to the issues of older drivers and being aware of the potential negative impacts of technologies on driving (such as the distraction potential of driving while talking on a cell phone) are needed. The wise application of technology is critical. Currently, driving simulators are being used primarily for assessment, but airlines use simulators primarily for training. Their goal is not to prevent pilots from flying, but to train them to fly better. Similarly, simulators for training older drivers and for rehabilitative use should be considered.

Medications are often perceived to have a negative impact on driving, but in fact medications such as anti-depressants, anti-Parkinson's, and anti-inflammatories all have a positive effect on driving. If people have better general functioning, they can drive better. Moreover, many tests that have been conducted on use of medications while driving have been conducted in low-income areas among disadvantaged populations where alcohol or recreational drug use may have been confounding factors. Other confounding factors are the underlying medical condition, not the medication. For example, when testing a new anti-Parkinson's drug, eight of the test subjects fell asleep, so manufacturers concluded that people taking that drug should not drive. But in fact people with Parkinson's disease are prone to falling asleep. So, it was the disease – not the medication – that led to the sleep. A more accurate instruction is that if people with Parkinson's do not have a habit of falling asleep, then they will not have a habit of falling asleep while taking that anti-Parkinson's medication. Finally, new medications (such as newer versions of anti-depressants) do not have the side effects of their predecessors.

Loren Staplin, TransAnalytics, "Practical Applications for Driver Functional Screening"

Dr. Staplin discussed characteristics of screening tools to identify high-risk drivers. He then described the venues where these tools can be applied and outlined the potential advantages and disadvantages when the screening tools are used in these venues.

The goal of driver functional screening is to identify high-risk drivers. Thus, we want tools to be validated against at-fault crash involvement, have high sensitivity and specificity (that is, few "misses" of high-risk drivers and few "false alarms" on safe drivers). The screening tools should have cut-offs which are tied to empirically-derived estimates of relative risk and encompass the full range of abilities that significantly predict risk. Finally, the tests should be standardised, reliable and cost-effective to administer.

It is important to remember that "screening" is a performance measurement to detect a decline in the essential capabilities needed for safe driving. It should not be used to assess underlying medical conditions or be an endpoint in a process to evaluate driver qualifications. Rather, it is the lowest, entry-level tier in a multi-tier system and should be used as a trigger for other actions, but not as a basis for taking someone's license away from them.

Dr. Staplin discussed four venues where screening tools can be used. First, screening tools can be used by regulatory agencies such as Departments of Motor Vehicles (DMVs) for license renewal purposes and for referral evaluations. The problem with DMV as a venue for screening is that DMVs face severe budget constraints that hinder the reliable delivery of tests. Also, changes in license renewal requirements typically require new legislation, which is not easy to obtain. Finally, false positives pose a threat to the DMV. On the other hand, a cost analysis of an effective screening tool puts the cost at USD 5 per screening. This cost would likely be offset by savings from the added information that these tools would provide, reducing the need to perform road tests (which are much more expensive) to assess borderline cases. Finally, DMVs can address the threat of false positives by providing more information and training programs to the public or linking more closely with alternate forms of transport.

A second screening venue is in a clinical setting, namely the specialised setting of driver evaluation [OT/CDRS] and non-specialised settings (consultations with private physicians). In clinical settings, unless the screening is medically required, insurance will not cover the cost of the screening. Nonetheless, the screenings are already in place, although techniques vary widely across practitioners. Forecasts show a dramatic increase in the need for driver evaluation services as a key to injury protection for the aging population. Professional associations such as the American Occupational

Therapy Association and the Association of Driving Rehabilitation Specialists have recognised the need for standard, valid and reliable assessment tools.

Use of screening tools by personal physicians brings two major obstacles. First, people may choose to go to a different physician, which means that physicians may lose their patients if they perform these screenings. Second, liability concerns increase if physicians are too involved in evaluating fitness to drive. On the other hand, testing by doctors could be incorporated as part of a medical evaluation, making it a procedure covered by insurance. Perhaps the biggest advantage of using screening tools in the physician setting is that seniors trust their doctors.

Third, social service agencies could offer screenings as part of an educational service to seniors. On the positive side, these agencies are positioned to help older adults, but on the negative side reliable administration of the tests could be difficult (especially if staff consists of volunteers). Nonetheless, social service agencies have been receptive to this idea, as have seniors at venues like the CCRC and AAA Senior Centers.

Finally, screening tools could be offered directly to the consumer. The disadvantage here is that the ROI may not be large enough to justify staff or kiosk space to perform the screening (using kiosks similar to blood pressure seen at grocery stores). Also, the tests may not work well in an unsupervised setting. On the other hand, they could provide early warnings. Most important, the private sector is skilled in developing new products and marketing them, which means that companies are well positioned to sell consumers on the benefits of a new tool such as this.

In closing, Dr. Staplin remarked that demographic pressures and safety statistics may influence public opinion such that driving while functionally-impaired is seen as an injury prevention/public health issue. If so, the public will demand practical tools to identify (older) drivers who are at greatest risk to themselves and others. Functional screening tools that identify high-risk drivers but do not penalise on the basis of age alone, will proliferate.

Recommendations

Modal

- First-tier (entry-level) screening tools for decisions on functional abilities are needed to drive safety. The tools should screen evaluate visual, mental and physical abilities, not just one of these abilities.
- Focus broadly on measurement constructs as well as narrowly on specific tests. Because we do not have one true test yet, we need to stay at the functional ability domain and develop specific protocols.

Policy

- Address screening applications to as wide a segment of the population as possible, not just older adults. These tests should be used to identify any high-risk driver, not just older high-risk drivers.
- Emphasise the positive aspects of screening – the early warning of risk factors and injury to self and others – not just the “get them off the road” aspect.

Research

- Use within-subject (longitudinal) designs, not just snapshots. Continuing validation studies that look at the change in functional status over time can identify a change in that individual's level of risk.
- Apply transport data summary and analysis techniques to add credibility. Transparency is the key: showing number of subjects, raw events, how many crashes, etc.

Dean Kamen, DeKa Research and Segway, LLC, “Introducing Technological Innovation to Transport & Mobility”

We often think about the existing paradigm of transport opportunities, but what happens when the range of options expands? Can policy makers think of viable alternatives and accept a truly new paradigm that challenges the existing ways of providing transport?

Dean Kamen is a medical equipment innovator who has built specialty medical equipment for babies and dialysis patients, but is perhaps most well known for his invention of a personal transport system, known as the “Segway.” Mr. Kamen saw that the wheelchair (patented by Benjamin Franklin) has not really been improved upon for 200 years. Just because a person has trouble walking doesn't mean they have to be in a chair. Mr. Kamen partnered with the world's largest medical equipment company to design and build a personal mobility device based on the concept of walking and balance, a device that would help people walk faster without getting tired.

Mr. Kamen saw this new device not as a recreational toy like a jet-ski, but as a way to improve transport in cities and suburban areas. As cities have grown, distances have increased and traffic has increased, impairing mobility. In a typical metropolitan area, the average speed to go from one address to another in the city is 8.1 mph, whether the person takes a cab, a subway, or a private car. Furthermore, 43% of pollution in cities is created from idling cars. Mr. Kamen's Segway product gives people a clean way to walk 8 mph, reach their destination, and even avoid parking problems by taking their Segway with them into the building. In fact, Mr. Kamen made his presentation while riding on a Segway.

One of the challenges Mr. Kamen faced when introducing the Segway was whether, as a motorised vehicle, it could be permitted to travel on sidewalks. Mr. Kamen received clearance from the U.S. Department of Transportation that the device did not need a license or headlights and was not to be considered as a motor vehicle on the road. Next, he met with the Consumer Products Safety Association to determine whether the device could travel on the sidewalk. He then appealed to each individual state in the U.S., and within one month secured permission from 30 states that the Segway should be allowed on the sidewalk because of the potential advantages that this new technology could bring.

Mr. Kamen stated that although his colleagues predicted that the Segway would not be accepted well among the older population, their prediction has failed to come to fruition. Indeed, older adults are among the most enthusiastic supports of the Segway because the device gives them a new mobility option.

Panel 3: Industry Activities to Improve Older Persons' Mobility

Maureen Mohyde, The Hartford Financial Services Group, (Moderator)

Ms. Mohyde introduced the panel, which discussed American corporations' actions to help older drivers enjoy lifelong, safe mobility.

Jeffrey Pike, Ford Motor Company, “The Role of Technology in Protecting Older Vehicle Occupants”

People experience physical changes when they age that may increase their likelihood to have automobile crashes. These changes include decreased mobility of their joints and changes in the distribution of their weight and their posture. They also experience degradation in their visual acuity, losing the ability to adjust for glare and to see at night. How, specifically, do these changes affect driving, and what technology can be put in the car to protect older persons?

Ford Motor Company researchers have designed a “Third-Age Suit” that provides young designers with a taste of what it is like to drive with some of these physical changes. Specifically, the suit has stiffeners at the joints on the neck, elbow and knees, mimicking the decreased freedom of movement that older drivers experience. The suit includes gloves that reduce tactile feedback and goggles that are high glare, yellowed and scratched, mimicking older eyes with poorer eyesight that do not compensate for glare. Young designers have an immediate experiential understanding of the challenges that older drivers face.

Ford also uses a simulator in its research to assess the cognitive changes in reaction time and processing time that occur as we age. The simulator is used to test drivers under fairly realistic driving conditions without the risk of actual collision. A platform moves on a hydraulic motion system and the view inside the dome is 180 degrees for the front view and 120 degrees for the rear field of vision. The simulator provides realistic sound cues and steering wheel feedback.

Ford is also researching how to protect all older occupants in the car, not just drivers. Older drivers are more frail (Mr. Pike showed an X-ray of a person with osteoporosis that dramatically illustrated the decrease in bone structure that makes older persons much more susceptible to crash injuries). Ford is looking at all aspects of crash avoidance, car crashworthiness and post-crash assistance. Some of the technology that Ford is using for crash avoidance includes “tracking headlights.” Unlike traditional headlights, these headlights do not just face forward. Rather, they are linked to the steering column, so that when a driver is going around the turn, the headlights shine along the curve, not straight ahead. The headlights also produce less glare.

Ford is also exploring its smart speed control, which warns a driver if he or she is getting too close to the car in front of them. Such technology could also potentially disengage the accelerator if the car gets dangerously close, and potentially even apply the brake. But, the question remains whether consumers will accept this kind of technology. Consumers seem to find warnings acceptable, but fewer people think it is permissible for the car to disengage the accelerator and fewer still want to cede braking control of the car.

Other technology which Ford is researching can help older drivers compensate for age-related declines. Decreased range of motion, slower reaction time and decreased ability to turn one’s head to see obstacles make older drivers more susceptible to running into obstacles on the road. Technology such as back-up warning alerts warn drivers when they are getting too close to something behind them. The question with this technology is when to raise the warning: if it goes off too early, it may be ignored. Likewise, how loud should the warning be? The same questions apply to technology that helps with lane changes. This new technology can alert a driver if someone is in the lane next to them. In this case, should warnings go off only when someone is already in the lane, or should the system calculate the speed of an approaching car and inform drivers if they have time to move into the lane?

As Mr. Pike’s presentation made clear, technology can address certain problems that older drivers face, but at the same time it raises new issues. Technology such as in-vehicle signage makes it easier

for older drivers to read signs. It also removes the problem of not seeing signs at night. But, should all signs be shown? Should some signs be larger than others? And how should signs be displayed? Heads-up displays project information onto the windshield, so drivers do not have to look down on a dashboard and change focal lengths to view information.

The question, however, is how much information to display so that it does not create cognitive overload. Virtual gauges, navigation guides and in-vehicle signage would all compete for attention. One of the important design considerations will be to let each individual driver adjust the display to the size, colour and characteristics that suit them best. Another alternative is to provide not only visual displays, but also auditory or tactile ones. For example, if a system detects the driver is falling asleep, the steering wheel could move a bit to wake them up. Research into age-related changes in the way we combine input could help determine the mix of audio, visual and tactile input.

Technology can help not only in preventing crashes but also in protecting older bodies from injury if a crash does occur. Given the frailer bodies of older persons, traditional seatbelts put too much force across too small a body area. Older persons also have a lower tolerance for seat belt forces on them, so adjustable D-rings on seat belts and load-limiters that spool additional belt length are helpful here, but they are not as effective in a crash.

In the event of a crash, new types of airbags provide better protection for older drivers. Several types of airbags are already available, including front airbags, side airbags that protect the head, chest and pelvis, and curtains. Other airbags could be placed in the foot-well, in the headrest, and inside the seatbelt. Airbags may also need to deploy differently based on the age of the occupant, their posture, height, size, etc. Mr. Pike also raised the option of external airbags that deploy outside the car to protect pedestrians or cyclists in a collision. Futuristic developments include cars that inflate with foam inside and out to protect occupants, or “prescription cars” that change the way headlights are reflected in rear-view mirrors

Finally, technology can help in the post-crash environment to bring assistance to crash victims. Automatic locators can signal the exact location of the car or send the vehicle’s location automatically. Systems could also have medical information about the driver such as whether they are diabetic, allergic to common medications, etc. While this information can save time in bringing aid and quality medical care, it raises privacy concerns. Some people do not like information about themselves being given out, even if they have had a crash.

Recommendations

Modal

- Develop “smart” intersections that reduce left-turn (US) and intersection crashes.

Policy

- Determine if current testing can be scaled to reflect the elderly, or if unique procedures/devices/criteria are needed. Can current criteria be used for older persons with some adjustment (such as that only half the force on the seatbelt is acceptable) or do we need completely different crash-test dummies with different postures and characteristics that more accurately mimic elderly persons?

Research

- Determine which factors of aging are associated with fatal crashes and which are associated with injury-producing crashes. For example, do visual acuity factors play a bigger role than other factors? This information will help prioritise which factors automakers should design for first.
- General research: investigate which technology concepts will be wanted or accepted by the public.

Maureen Mohyde, The Hartford Financial Services Group, “Safe Driving for a Lifetime: Helping Older Drivers Balance Safety and Independence”

Maureen Mohyde described the role that an insurance company can take in the education of older drivers. Education, self-awareness and family support can improve the driving performance of older adults.

The Hartford, a multi-line insurance company, speaks with tens of thousands of older drivers every day. (The company has been a provider of automobile insurance for AARP members for the past 20 years). The company uses its direct link with older drivers to identify the issues of greatest concern to them. The Hartford’s goal is to keep drivers on the road, but keep them safe. Toward this end, the company has created a series of public education programs and conducted research to help older drivers assess their driving skills. The company also works with the media to change the negative image of older drivers often depicted by the media. That tone affects the way the public thinks about older drivers, and we need to balance the “get them off the road” mentality with the need for preserving people’s mobility and independence. A more balanced view will help lead to solutions that will keep older drivers on the road safer and longer.

One of the concerns expressed by The Hartford’s customers was how to cope with relatives who had Alzheimer’s dementia and continued driving. Traditionally, the advice offered in such cases was for family members to simply take away the keys, but that is not necessarily the best or the only solution. The Hartford conducted a study on persons with dementia and their caregivers. Caregivers need systematic guidance to help them make the driving cessation decision, but even professionals disagree on approaches. (The Alzheimer’s Association, the American Psychology Association and the Academy of Neurology all have differing views on the subject.) Therefore, The Hartford developed tools for families to help caregivers in making the driving cessation decision.

The tools are based on data collected about warning signs of dementia and driving. The tools describe the warning signs to observe and suggest looking at the warnings as a pattern (not a one-time event) and seeing if the pattern escalates. The tools are available in a workbook, *At the Crossroads: A Guide to Alzheimer’s Disease, Dementia & Driving*, published by The Hartford and available for free to the public through the company’s Web site or call centre. The workbook also offers a way to begin early discussions of the issue of driving with the person with dementia, thereby including them in the decision. By starting the conversation earlier, the family can make plans to ensure mobility before it is too late. Research has shown that when caregivers take unilateral action to stop a person’s driving, they feel very guilty about it and often delay making the decision for up to nine months – a long delay that presents risks to the individual and to other road users. Early planning is also better than a unilateral action that is taken at a point in time when the person with dementia does not comprehend it.

The Hartford also conducted a web-based survey among families with a driver with dementia, asking them who was in the best position to make the driving cessation decision and how that decision was made. Fully 62% of respondents said that families were in the best position to make the decision, but interestingly 74% of them made the decision without directly observing the demented person’s

driving, and only 30% had spoken with the driver about the decision. The Hartford created news releases on this topic as another way to raise awareness of these issues and help families to discuss the topic.

In the future, The Hartford will be establishing databases on numerous topics related to the older driver, such as self-perceived health and the older driver.

Recommendations

- There needs to be far more work to reach out directly to older drivers and their families.
- Enlist older drives as partners to ensure their safe driving for a lifetime.

Judy Gardner, Motorola, “Technological Assistance for Aging Drivers: Motorola’s Approach”

Ms. Gardner described technological assistance solutions that Motorola is using to help aging drivers. Research shows that with increasing age comes declining ability, namely slowing reflexes, decreased visual acuity, diminished ability to adjust to distances, and hearing loss. But these changes happen at different rates and in varying ways to different people – drivers of the same age may have different abilities. Permanent or temporary disability can happen to any of us at any age (*i.e.* sprained wrist can slow down a person’s response time at any age). Driving conditions can also “disable” the driver – heavy rain can impair the vision of even younger drivers. Therefore, the assistance systems that Motorola is exploring apply to many drivers, not just older drivers.

The first assistance system which Ms. Gardner described is called the Driver Advocate. The Driver Advocate is a workload management system that orchestrates the presentation of information to the driver. Its key feature is the Advocate’s awareness of the driver’s estimated level of activity (cognitive workload), driving environment (*e.g.* whether the windshield wipers are set to their highest level) and condition of the vehicle (*e.g.* speed, acceleration, turns or degradation of any internal system). The Driver Advocate monitors all of these data streams and then presents information to the driver one at a time in priority order. For example, if the Driver Advocate perceives that the windshield wipers are set to their highest level and that the headlights are on, the system can infer that bad weather and night driving are causing the driver to work harder to see well. The driver won’t be able to see as well as they could on a sunny day. This combined information provides the system an indication of the potential problems that could occur. In addition, if the system is connected to a vision system or a radar system in the car that can identify traffic in the driver’s vicinity, the Driver Advocate can combine this information and alert the driver to potential problems. At the same time, the system can limit the number of lower-priority messages that might distract the driver during difficult driving conditions.

Motorola has been working on the Driver Advocate system for several years and has a first-generation prototype that is in the on-road testing phase now. The system uses the existing sensors in the car and does not require any new interfaces to the driver. (Therefore, the system is not intimidating and requires no additional skills that the driver has to learn.) The system helps the driver maintain focus by avoiding excessive cognitive loads. By prioritising information, the system helps drivers avoid the confusion that can arise from multiple inputs. The system is particularly appealing to older drivers because it works behind the scenes and requires no training to use. Therefore, it isn’t intimidating to older drivers who may be leery of new technologies.

Second, Ms. Gardner described the second generation of the Driver Advocate system. This second generation incorporates Advanced Driver Assistance Systems (ADAS) such as crash avoidance

systems that have forward collision warnings, lane departure warnings, and side object detection. The ADAS also incorporates navigation and other off-board communication systems. Navigation systems are of particular interest, because they can help older drivers avoid getting lost. The concern with these systems for older drivers, however, is whether the systems might startle the driver with an unexpected or hard-to-execute command. By deploying them along with the Driver Advocate system, however, the Driver Advocate workload system can prioritise the information. Therefore, the system can determine that a forward collision warning is more important to convey than the navigation system's notification of an upcoming turn. The Driver Advocate system thus minimises the potential distractibility that other on-board systems (and off-board systems like cell phones) could create.

The third generation of the Driver Advocate will personalise features to the individual driver, learning their habits and preferences and adjusting to these preferences. For example, some older drivers may wish to avoid making left-hand turns – a fact that the Driver Advocate can learn just by observing the driving habits of the driver. The system can provide navigation routes that avoid left-hand turns. With machine learning, the system can also “learn” that the driver always takes the same route to work, the average speed they travel, etc. On a particular day, the system could detect that the driver is going faster than usual that day. The system could detect that instead of keeping his usual distance from the car ahead, the driver is tailgating and making frequent lane changes. The system can therefore infer that the driver is in a hurry and alert the driver with a low-priority notification.

Other developments which Motorola is exploring include a Driving Coach that can help older drivers maintain their driving skills. The coaching system would provide private, optional, objective feedback to drivers about their driving. This system is aimed at aging baby boomers, that are receptive to technology and self-help, and they would value feedback from a system that is objective. In addition, the information would be provided only when requested, (not forced on the driver), and there would be no fear of losing one's license. The feedback would include both positive as well as negative information, which means that it could boost the confidence of older drivers who might otherwise mistakenly think that they can no longer drive safely.

These new systems all require more research on human factors. As Human beings vary, more research will help elucidate the range of human behaviour with the proposed driver-assisting technologies. The research will also help adjust the human-machine interfaces to meet the particular needs of individual drivers.

Panel 4: Intelligent Transportation Systems Applications to Highways & Transit

Ragnhild Davidse, SWOV Institute for Road Safety Research (Moderator)

Ms. Davidse introduced the purpose of the panel, which examined whether intelligent transport systems can address the needs of older persons. These systems can be applied to private cars as well as to public transport.

James Langford, Monash University & Christopher Mitchell (UK), “Older Person's Response to In-Vehicle ITS”

The presenters mentioned the OECD report, *Road Safety: Impact of New Technologies*, which considered ITS as a potential technology for improving the safety and mobility of older drivers. The report recognised that the interfaces to the new technologies had to be safe for older drivers and the parameters had to be suitable to older driver needs.

Intelligent Transportation Systems (ITS) are the application of computing, communication, design and control to the driver-vehicle-highway system. Most of the advances in driving technology are ITS, and a surprising number of ITS services are already in service: route guidance and navigation systems, warnings of traffic congestion, emergency systems, seat-belt reminders, airbags, rear obstacle warnings, advanced cruise control, etc. Some of the new ITS technologies in development include night vision enhancement, intelligent speed adaptation, front and back collision warnings, and driver condition or fatigue monitoring. Emerging technologies include automatic lane changing and merging. As these technologies take control away from the driver, public acceptance of them may be of issue.

The value of ITS to older drivers lies in helping them to compensate for some age-related impairments. For example, reaction time decreases with advanced age, and ITS systems give advance notice to drivers of potential obstacles, hazards or conditions, providing them with more time to react. Older drivers also have greater difficulty when driving in unfamiliar or congested areas. In principle, navigation systems can inform older drivers where they are and provide them with advance notice of road signs long before they become visible. Finally, older drivers experience deteriorating vision at night; night vision enhancement and in-vehicle signage can help address these impairments.

Older drivers have distinct crash patterns which ITS systems could help address. For example, older driver crashes are more likely to involve a failure to see the other road user (25% of the time). Collision warning systems could help alleviate this problem.

Safety is one concern with older drivers, but safety concerns must be balanced with mobility needs. The need to have maximum mobility for older drivers is an OECD issue. Loss of a driver's license lowers self esteem, and walking and cycling are more dangerous than driving. Older drivers reduce the number of car trips they make as they age, which may negatively impact their mobility. ITS systems that help older drivers stay driving safely for longer can positively effect their quality of life.

One of the questions raised is whether ITS will be accepted by older drivers. An earlier (1990) study showed that there was reluctance to accept new technology, especially if the older driver had to give up control of the car to the technology in the car. Later and more in-depth evaluations found that ITS such as route guidance which were comfortable to use and were not distracting were welcomed by older drivers. ITS such as gap assistance was viewed positively, but the technology must be suited to individual preferences. (Older drivers were found to prefer larger gaps than the technology was providing them.)

In summary, for ITS to be accepted by older drivers, it has to be demonstrably useful. Drivers want evidence of the technology's effectiveness, and they want the technology to have good human-machine interface design. Affordability of the technology is also important. Finally, drivers do not want to give up their control of the car to the technology.

To date, no research has empirically established the safety benefits of ITS on the road. A 2002 study by Regan *et al.* examined the types of crashes in which older drivers were involved and found that a small percentage of crashes could be reduced if ITS were introduced. But, the overall verdict was cautious. The most beneficial application of ITS was in speed reduction, but other applications resulted only in single-digit percentage-point improvements in crash rates.

Recommendations

- If ITS is carefully selected and implemented, it can keep older drivers more mobile, but it is not clear that ITS will keep them safer.

- ITS is but one arrow in the safety arsenal.
- If we are going to spend time on ITS and human-machine interfaces, we need to be doing it at very specific levels and on specific subgroups of age, gender and cohort membership, because each group will need its own specific solution.

Ling Suen, International Centre for Accessible Transport, “Transit-Related Issues for Older Users”

“The freedom to move is life itself,” according to the Ontario, Canada government. It is clear from the literature on aging that mobility is a key element of a healthy, active life. To age well is to be able to live a vital and connected life, which means having access to commercial, medical and social activities.

Mobility for seniors most often means being able to drive. In North America, baby boomers are dependent on their cars for access to stores, doctors and recreation. A decrease in access to private cars results in severe problems. Mobility alternatives (public, private and personal) are needed. In the US, research has shown that bus usage decreases for people over age 60. (It increases for people in the UK, which may be due to land use.) Three key factors affect mobility: the abilities of the individual (their health, knowledge of choices and ability to pay); the geographical location; and the availability of transport services and infrastructure.

Transit options include fixed-route options such as the subway, or flexible route options such as route deviation, request-a-stop, or a community route concept (paratransit). Factors that may improve the fixed-route option for seniors include low-floor buses and priority seating for older users. Also, access to transit options, including egress considerations, need to take into account motorised vehicles such as powered wheelchairs, scooters, electric bikes, golfcarts, Segways, and NEVs (neighbourhood electric vehicles) as well as non-motorised options such as bicycles, tricycles, assisted walkers and wheelchairs. Furthermore, access to transit means providing the opportunity to park some of these vehicles and to provide for safety and security. For older users, the primary crashes associated with transit vehicles are slips and falls (primarily during boarding or when the vehicle accelerates and decelerates). Another issue is what to do in emergency evacuation situations.

Finally, street crossings pose a danger to transit users when they don’t allow enough time for slower walkers. Solutions include audible crossings, countdown timers that provide a level of comfort through information (seniors can determine if they have enough time to cross the street) or adaptable crosswalks that let seniors press a button for more crossing time.

Crash rates on public transport are low for all age groups, but 69% of older transit users’ non-collision accidents are due to falls. Security issues are more of a perceived problem than an actual problem, but seniors do experience anxiety waiting at the bus stop. They fear being pick-pocketed or dealing with unfamiliar technologies or surroundings. Seniors also dislike handling fares and fumbling with coins. Physical agility issues may pose a problem when seniors have to handle fare payment or lose their balance as vehicles accelerate. Non-technology solutions to these problems include pre-purchased tickets, Smartcards or bus passes, and having handrails on buses.

Information provides security and power. Knowledge about the trip and where to go allays many seniors’ fears. The trouble is that most older transit users have problems reading maps and schedules because the print is often too small and/or difficult to read. Computerised reservation and dispatching systems could provide real-time information and booking, and electronic information systems such as those in Sydney provide bus arrival information as well as city information. Such information can also be provided inside the subway through electronic billboard systems.

Recommendations

Modal

- Uniform and disaggregated data sets are needed that record the purpose of the trip and provide details about transit use for different age groups.
- Provide mobility counselling: counselling should be provided before a senior loses his/her license. Counselling can help seniors to gradually ease into giving up the driving option.
- Provide mobility training.
- Provide personal mobility alternatives such as the Segway or independent transport networks or sharing rides with friends and family.

Policy

- Implement information and guidelines that already exist.
- Adopt universal design practices (Japan, for example, is adopting universal design practices that go beyond personal transport to include infrastructure — *i.e.* a comprehensive plan)
- Clarify licensing issues of mobility alternatives such as the Segway.

Research

- Conduct studies on ITS, both in-vehicle ITS, transit ITS, and pedestrian systems
- Identify ergonomic guidelines for ITS equipment for transit applications.
- Identify enhanced audio and visual systems to improve upon the incoherent public announcements that currently exist on public transit.

Rosemary Mathias and Carol Schweiger, TransSystems Corp., “Improving Public Transport for Older Adults using ITS and Other Technologies”

ITS can be used as a tool to collect public transit information and to information on the number of passengers using a transit option, the number of trips made, vehicle condition, and vehicle location. ITS can be applied to financial transactions as well, including tracking information for funding sources, tracking older persons' eligibility for reduced or reimbursed fares, and providing a means for electronic payment mechanisms.

ITS can improve paratransit and public transport because providers are asked to provide a lot of data, such as how many passengers used the system and how many trips were made. Much of that information is currently handwritten, often illegible or not systematically gathered. ITS can gather data through Smartcards, automatically calculating how many trips were made by individual passengers. In addition, Smartcards can collect information that can be compiled in different ways (Public Transit may count trips, while Human Service may count the number of people). By tracking a variety of kinds of information, ITS can help drivers do their jobs more easily. Automated systems can also capture information about the vehicle itself (how much fuel is used, how many miles were travelled, when preventative maintenance was performed, etc.) Finally, automatic vehicle location can inform

dispatchers or users where the driver and vehicle actually are. Automatic vehicle location provides accurate information on a bus' arrival, which can help seniors plan their trips and minimise the time they spend waiting at bus stops or waiting for the van to arrive at their door.

Smartcards can also solve many of the different payment difficulties faced by older transit users. Smartcards can be programmed to recognise if a fare is to be paid or if the senior qualifies for a program that reimburses the cost of the trip. These Smartcards enable seniors to use general-use transit options rather than on-demand systems, thereby lowering the costs of these trips.

Case examples of ITS use in public transport include the SMART system used in suburban Detroit, Michigan (US). SMART (Suburban Mobility Authority for Regional Transportation) covered four regions with a fleet of 430 vehicles from social service agents. The system uses paratransit scheduling and dispatching software to eliminate duplication of service. The social service agencies tap into the scheduling software by phone from their agencies and use the scheduling tool to get information on the trips, reducing the cost to provide the trip service. The SMART agency provides 100 vehicles (supplementing the agencies' own 330 vehicles) and provides IT support to the agencies.

The CARTS program in Austin, Texas (US) provides tremendous benefits to customers, not just agencies. CARTS (Capital Area Rural Transport) serves a 7500 square mile area with 15 fixed-route vehicles and 65 demand-response vehicles. Previously, three dispatch centres were needed, with each region managing its own routes and having a separate phone number. In 1995, the region became a customer of the Lower Colorado River Authority Communication System, which provides communication across the whole 7500-mile region. CARTS became the first customer to use the Lower Colorado River Authority communication system, which took on the burden of handling the communications and enabled CARTS to deploy vehicle technology to communicate with drivers. As a result, the region was able to consolidate the three dispatch centres into one, which provided tremendous cost savings, and improved efficiency and productivity. Service also improved, because customers can use a single toll-free number from anywhere in the region, rather than having to contact three different numbers that were previously in use. In addition, the communication system improves safety, because all the agencies share the same network. In any emergency, all agencies are on the same channel.

The CRAFT system in rural New Mexico (US) tackled the challenge of how to track passengers and correctly bill for transport services when participants are eligible for subsidies by a federal program. At first agencies were reluctant to co-ordinate their efforts because they feared that non-eligible customers would be funded by the wrong program. CRAFT developed web-based software to authorise and schedule trips, track riders, bill for the trips and generate reports. The CRAFT system keeps the records and standardises reporting. The system also uses an electronic payment scheme based on the farecard system used in New Mexico.

In summary, these case studies illustrate the benefits of ITS applied to public transport for older adults. ITS can integrate human service transport referral and service delivery with public transit. It can improve the co-ordination between transport providers and agency programs as well as customers. ITS can improve data collection and accountability, enabling more flexible service and improving predictability for customers.

Recommendations

Modal

- Use ITS to facilitate intermodal transfers and provide real-time information. (People often transfer from one mode to another, and ITS can be of help here.)

Policy

- Use universal design to accommodate people with disabilities

Research

- Provide people with flexible, affordable, real-time information. This information can be delivered in ways that accommodate people with disabilities, and it can be delivered automatically through devices like pagers, informing older adults when the next bus or train is scheduled to arrive, to avoid waiting long periods of time outdoors.

Summary and Adjourn Day 1 Joseph F. Coughlin, MIT AgeLab

Dr. Coughlin concluded the day with the observation that technology is one of the themes of today, but that technology by itself is not the answer. Rather, better business, service and organisation are needed to integrate that technology, to prevent cognitive overload, and to address the human issues. We also need to look at how we fund transit systems. He pointed out the irony that for USD 10, one can send and track a package anywhere in the world, but a local mass transit dispatcher cannot locate a USD 250 000 bus with 60 people on board somewhere in the neighbourhood.

Day II Overview & Panel Discussions

Martine Micozzi, OECD

Ms. Micozzi recapped some of the highlights from the first day's presentations. First, from Panel 1, Dr. Hakamies-Blomqvist stated that older drivers are at risk, not risky, in car crashes. Frailty makes older persons more vulnerable to injury and death from crashes, and it is this frailty rather than their driving behaviour that accounts for older people's over-representation in crash statistics. Aging baby boomers will not produce a linear increase in the number of accidents. The panel also made the point that the older driver issue may be best served by being framed as a public health issue and brought to the public health arena. Third, technology can be deployed in innovative ways to protect older drivers, such as through the use of external airbags to reduce a crash's impact on pedestrians and bicyclists.

In Panel 2, Richard Marottoli made the point that just because an elderly person is impaired in one area does not mean that they are unfit to drive. Desmond O'Neill shared the quote, "If you design for the old, you include the young; if you design for the young, you exclude the old."

With the lunchtime speaker, Dean Kamen, we explored a new paradigm shift in personal transport and learned the reactions of various governmental agencies to addressing this innovation.

In the afternoon, Jeffrey Pike from Ford raised the research challenge of determining which aspects of aging are associated with fatal crashes and which with injuries, to help prioritise the potential technology interventions we make, and that we need tools to prevent drivers' cognitive overload, not add to it. Maureen Mohyde suggested the need to change the tone and accuracy of the media when reporting on older drivers, to avoid myths such as those created by the Santa Monica Farmer's Market accident. Judy Gardner from Motorola cited how a 94-year-old neighbour learned about in-vehicle navigation systems from an episode of the American talk show hosted by Oprah Winfrey. In short, we can use the media to educate the public about older drivers.

Finally, from the concluding afternoon panel we learned that intelligent speed adaptation yields the greatest reduction in car crashes. Other ITS technologies did not lead to dramatic reductions in crash rates. Technology can keep drivers mobile longer, but it is not yet conclusive if it keeps them safer.

Panel 5: Design Tools and Frameworks to Address Human Factors, Aging and Transport

Elisa Braver, Insurance Institute for Highway Safety, “Methods of Exploring Crash and Injury Risk Among Older Vehicle Occupants”

Dr. Braver used a variety of data sources to examine questions such as whether older drivers have elevated involvement in crashes related to deaths and fatalities. Her results did show elevated involvement (although the youngest drivers pose the highest risk to all age groups). One of her key findings was that it was frailty, rather than excessive crash involvement, that was the key reason in explaining the elevated deaths per mile among older drivers. Frailty was the overriding factor leading the death and injury for all older adults, although for those age 80 years and older, excess crash involvement does play a role.

Dr. Braver also examined whether older drivers gain safety benefits from airbags. She examined the value of side airbags in nearside collision and death ratios. She found that for the 60-64 year old age group, there was a 44% fatality reduction from nearside collision when side airbags are used. For the over 64 year old age group, there was a 41% fatality reduction, but the results are not statistically significant (the problem being the small number of drivers studied). Given the small sample size and relative newness of side airbags, Dr. Braver concluded that more research needs to be done on the problem of increased frailty, both for older adults as drivers as well as passengers. Nonetheless, improvements in vehicle design and restraint would help all ages.

The special circumstances of frailty call for an improvement in occupant restraints, namely to cover broader areas of the body. New advances in this area include seatbelt force limiters, inflatable seatbelts, 4-point belts, and advanced airbags for both the head and torso support.

Bryan Reimer, MIT AgeLab, “Eye Tracking as a Method of Identifying Age-Related Changes in Driver Behaviour”

How do age-related declines (such as in visual and cognitive performance) and the increased flow of information to drivers (from traffic congestion and from devices such as cell phones in the car) impact the older driver? Methods to study these age-related changes have been limited to date. These cognitive impacts could be studied by someone sitting next to the driver with a checklist, inferring driving behaviour, or by videotaping the driver and observing their behaviour. These methods, however, are limited in how much the observers can observe and infer.

Dr. Reimer is building models of driver behaviour using eye tracking technology that follows the drivers' eyes in terms of where they are looking and for how long. Eye movements can tell us what the driver is paying attention to, be it the road, the rear-view mirror, the dashboard, etc. There is a link between visual attention and saccadic eye movement. The eye fixates on something to perceive it, and we don't transfer our attention as efficiently when we have directed our attention to one particular thing. Eye tracking shows how we devote attention to tasks. Using fixed mounted systems in the vehicle and head mounted systems, scientists can process where the driver's eyes are looking and what they are looking at.

Dr. Reimer found that drivers do not focus off the roadway for more than 1.6 seconds, on average. That seems to be an intuitive, human-set amount of time. Older individuals have a harder time handling a lot of input quickly and performing tasks like turning knobs on a radio dial. Many devices in the car are designed with some minimum amount of time required to adjust them, but that amount of time is age-dependent. Eye-tracking research can capture how much time it takes for an older driver to switch between tasks or to adjust a device. In this case, technology can act as a tool to evaluate what is best for different populations.

Recommendations

Modal

- Promote industry innovation in systems for older drivers.

Policy

- Increase the use of on-road and simulated driver evaluations for older drivers.

Research

- Improve our understanding of age-related changes that occur in a driver's gaze path.
- Improve human factors evaluations of ITS and in-vehicle devices (that is, the cognitive costs of how much attention has to be focused on these devices).

Matthias Roetting, Liberty Mutual, "Feasibility of an Augmented Reality-Based Approach to Driving Simulation"

Liberty Mutual, an insurance firm, has a research institute that studies how to reduce driving injuries and disabilities. The goal is to use a real vehicle on a real road (rather than simulations) to research human responses to various conditions and technologies. Testing in a real car improves the driver's sense of operating the vehicle—providing realistic sounds, vibrations, and accelerations. With a highly-instrumented but otherwise standard car, the researchers can assess how drivers handle new technology in realistic driving scenarios. For example, the Institute can study human responses to safety-enhancing technology features, to distractions such as cell phones, and to physical conditions such as the effects of medications or age-related deterioration in vision.

In support of this research, Liberty Mutual is building a system with optical see-through and head mounted displays. These systems allow experimenters to overlay synthetic images onto a natural scene while the driver is operating a real motor vehicle on a roadway. The researchers can test the driver's reaction to a pedestrian stepping in front of the vehicle without endangering anyone. Optical see-through systems are simpler than video see-through systems and they provide a closer match to reality. Video systems are restricted by the resolution quality of the camera.

New vehicle technology can be both a cause and a cure to some of the problems faced by older drivers. On the one hand, technology can cause problems when it contributes to cognitive overload, but other the hand, technology such as collision warning systems might reduce the occurrence of accidents and injuries.

James Kuchar, MIT Lincoln Laboratories, "Collision Avoidance Systems for Automobiles: Prospects and Pitfalls"

New technologies are emerging that provide drivers warnings of potential threats or hazards that they may face on the road. These systems contain their own logic and displays. They give information to the driver or signal an alert or alarm. Potentially, such systems could take actions of their own, such as decreasing the speed of a car. These technologies offer a way to improve safety, but they may raise safety concerns of their own.

Collision avoidance systems offer several advantages to the driver, whether old or young. First, they operate independently of the driver, which means that they are always watching the road situation, whereas the driver's attention may shift elsewhere. Given the processing speed of computers, they may have sensors that are superior to the human eye, that see better at night, or that can calculate complex quantities like the time-to-impact. They can also react very quickly, with no delay in sending signals to take action. In aviation, while such on-board alerting systems have saved aircraft from crashes, they have not proven to be 100% effective. In one case in July 2002, the systems actually induced an aviation crash that would not have occurred had the warning systems not in been place. Therefore, the systems raise numerous issues.

Some of the issues raised by collision avoidance system include: who knows best, the human or the computer? How sensitive should the system be? Systems that are too sensitive create a lot of false alarms that may decrease a person's attention to the system overall. On the other hand, if the system is not sensitive enough, it may miss detecting a dangerous situation. Another issue is that of the salience of alerts: should the alert be a gentle warning or a loud alarm? Which modality is best: visual, auditory or tactile? Finally, if an alert does go off, will the driver know what action to take in response? Airplane pilots undergo extensive training in how to respond to various emergency situations and what actions to take, but car drivers are unlikely to have this kind of training in proper procedures to follow in response to alerts.

Such new technologies also raise new challenges. A system optimised for a 20-year old driver won't be suitable for a 70-year old, and visa versa. The system will need to be adapted to users to take into account their experience level, age, health and other factors.

Maintenance of the collision warning system is another issue of vital concern. Aircraft are very highly maintained, and if a system is not functioning properly the aircraft is not allowed to fly. Such high maintenance standards are not in place for cars. Finally, the issue of standardisation will come into play. Currently, cars have standardisation of pedals and steering wheels, but devices like windshield wipers are not standardised. Standardisation among collision avoidance systems among all car models will be important to accommodate situations such as car rentals.

Dr. Kuchar also reported the results of a small study on responses to collision avoidance systems. The study was performed on six subjects: three young drivers and three old drivers. The study took place under simulated driving conditions in the MIT AgeLab facility. The study found that in most dangerous situations, the drivers took actions that resolved the situation. In the case of younger drivers, the warning system only had to go off 5% of the time. With older drivers, the collision warning system went off in 20% of the cases.

Perhaps the most surprising result of the study was that with the warning system, driving performance worsened. That is, the near-collision rate increased when the alerting system was present, and in one case a collision actually occurred with an older driver and the warning system. Why did driving performance decrease with the warning system in place? When drivers had the alerting system,

they drove more aggressively. They drove faster and came closer to other drivers than they did without the system. The drivers were in fact overcompensating for the safety they thought they had gained from having the warning system activated. They placed a higher level of trust in the system than the system actually provided.

Whereas airplane pilots are trained on the appropriate level of trust to place in a system, drivers are not. Therefore, warning systems, if they work well, may give drivers a greater sense of security than they actually provide, causing drivers to increase their risk behaviour to the point that their risk exposure equals or actually exceeds the risk they had without the system in place. If collision avoidance systems work poorly, then they will raise false alarms or miss detections, and people will distrust them and turn them off.

More advanced warning systems are being investigated that take control of the car, but that opens up new issues of its own. Should the car have more control than the driver driving it? What happens if the system does not work correctly and it induces a crash? Who decides when the car should take control? The new technologies raise design issues of how much risk should be taken by the car, and whether consumers will even accept giving control over to the car. The issues of control also raise liability issues. Currently, when a crash occurs, unless it is entirely mechanical such as a defective tire blowing out, drivers are at fault. But if the crash occurs due to the collision avoidance system, whose fault is it? It becomes less clear where to draw the line: did the driver over-trust the system?

In summary, automated systems can improve safety, but they can also significantly change how people drive, and these changes are not always beneficial from a safety standpoint as drivers may increase their risk behaviour. Therefore, these technologies are not simply a new technology like a radio: their impact on driving must be studied.

Recommendations

Research

Significant research is needed on human factors issues. Aviation has been spending millions of dollars (US) on human factors research for decades, but the research for warning systems in cars is different because response times are so much shorter in cars than in airplanes: there is simply less time to react to an emergency situation.

Policy

- Don't automate simply because you can. Putting a new technology into a car may cause new problems.
- Collision warning systems need to be standardised across cars and be intuitive to use.
- Driver training on collision warning systems or yearly safety inspections of these systems may be need.
- Be prepared for shifts in liability for accidents.

Panel 6: Current and Future Infrastructure Plans & Technologies and Their Implications for Older Users

Patrick Hasson, US Department of Transportation, (USDOT) (Moderator)

Mr. Hasson began the panel with a description of some of the recently published guidelines now available regarding older drivers. For example, the U.S. Federal Highway Administration's *Guidelines for Older Drivers and Pedestrians* describes older driver issues and the current technologies available. In addition, he noted the upcoming release of the OECD's report, *Road Safety: Impact of New Technologies*. This report includes the conclusions of a working group that examined intelligent transport systems technologies, synthesising the current knowledge and safety implications of these technologies. The report provides a fairly optimistic view of the technologies available to save lives. Although the report is not specifically about older drivers, it did highlight a few facts applicable to older drivers, namely that the biggest issue facing the technology for older drivers is acceptability and usability by the older driver.

Thomas Granda, USDOT, Federal Highway Administration, "Roadway Infrastructure and In-Vehicle Technology and the Elderly User"

Dr. Granda's presentation focused on the topic of roadway infrastructure. Currently, the elderly are disproportionately represented in road fatality rate statistics, but technology will continue to advance and be applied to all road users, including the elderly. Dr. Granda described some of the technologies available.

Conventional infrastructure technologies include intersection design, interchange design, road curvature, and pedestrian crosswalks. *Advanced infrastructure* technologies include intersection collision warning systems, highway speed differential information, and adaptive pedestrian crosswalks.

In-vehicle advanced technologies include ITS, advanced cruise control, forward collision warnings and user profile cards.

Co-operative systems include collision warnings, pedestrian sensing systems, and redundant infrastructure information. Few people are looking only at infrastructure in isolation.

Older-driver handbooks provide information on older drivers' limitations, and infrastructure can be designed to minimise the impact of these limitations. For example, older drivers have a more limited sight distance, which requires a longer length of highway that needs to be visible to them. Similarly, older drivers require eight seconds of visibility to turn left when stopped at a major intersection. In conventional left-hand lanes, an eight-second sight distance is quite long, but offsetting the left-hand lane provides a much better view of the lane of approaching traffic, giving older drivers (and indeed all drivers) a better view of what is happening ahead.

At street crossings, older drivers need 2.8 feet per second timers. Staggered crosswalks can help in this situation. Countdown signals help older pedestrians make the determination if they have enough time to cross the road. Adaptive crosswalks let anyone who needs more time adjust the crosswalk for a longer time-count. Well-lit crosswalks at night increase both pedestrian and driver visibility.

Intersection collision warning systems may help older drivers who have a slower reaction time, but drivers don't need this kind of assistance at every intersection. Older drivers have diminished

contrast sensitivity, so raised pavement markers help accommodate this limit. At interchanges, merging and weaving all come into play. Here, larger interchange signs give all drivers more time to merge or make lane changes. Finally, providing differential speed information helps older drivers who are merging, weaving and making lane changes.

The deployment of these technologies, however, requires human factors research: how to give information to drivers that they will heed and comprehend. Research is also needed to inform us whether we need to approach older drivers differently than other drivers.

Recommendations

Modal

- Greater use of traditional systems engineering and human factors tools: task analysis, user requirements analysis and workload analysis. We have to identify how to help older drivers and how to form models of their behaviour.

Policy

- Require that all proposals for roadway systems provide research results that show that the system is safe. The roadway systems have to take into account drivers, transit users, and pedestrians, and they must demonstrate that benefits will exceed the problems. Currently, every system in the U.S. military is required to demonstrate how the human being will be taken into account in the system. This approach could serve as a model for civilian agencies as well.

Research

- We need to study the adaptation of older drivers to advanced technologies. A new technology may look good, but people may become too dependent on it and pay less attention or believe that the system will make them safer than it actually does.

Rob Methorst, Ministry of Public Works, The Netherlands, “Adequate Road Facilities for Elderly Pedestrians and Cyclists”

Mr. Methorst described the Netherlands’ approach to facilities design for pedestrians and cyclists and explained his cascade philosophy of land use policy, network policy and site policy.

Because nearly every journey is composed of walking, facilities for pedestrians are a basic utility and make mobility possible. Facilities for walking and cycling also have important health benefits and support “growing old in place.”

Conditions in the Netherlands make it ideal for walking and cycling: the flat terrain, moderate climate, compact cities and Calvinist culture (emphasising sobriety and functionality) have led to excellent pedestrian, bike and public transport facilities. Fully 46% of all trips are non-motorised. In the Netherlands, the car is not a status symbol and cycling is a common activity.

Facilities in use in the Netherlands include elevated crossings whose function is to focus attention on the intersection and reduce vehicle speed (speed being one of the main causes of crashes). Elevated crosswalks also enable pedestrians to cross the street without stepping off a curb, making them

beneficial for older people. Crossings are made as narrow as possible to minimise cyclists and pedestrians' exposure to traffic, thereby reducing the risk of crashes.

The mobility and safety of elderly pedestrians is an extensive problem that is hindered by a lack of statistics: most statistics don't show the importance of walking because the research does not take into account the fact that most trips are multimodal and involve walking. The lack of statistics gives a false sense of security to the elderly (who, as Dr. Hakamies-Blomqvist said, are more at-risk than risky). The future will only worsen the situation, with increasing traffic congestion and a growing aging population. Better approaches to the problems are needed, approaches that use the cascading approach of optimising land use, optimising networks and optimising site design. Universal design, namely designing economically for as many people as possible at once should be the guiding principle.

When tackling problems, land-use should first be addressed, then design criteria should be used, such as locating schools and shops close to home, and then finally design should be addressed on a network level, making roads and paths as effective and as safe as possible. The site level is geared to creating better infrastructure, such as by designing bike lanes that are separated from car lanes. In contrast, poor infrastructure designs cannot be eliminated by good measures taken at the site level. To improve safety, facilities should only be employed for their intended use. For example, cars should not enter the bike lanes.

Structure-level principles include large walk-able neighbourhoods with essential destinations being located as close as possible to the home. There should be clear distinctions between traffic lanes. Key locations should be centrally located and accessible by public transport. For example, the town of Houten in the Netherlands has designed car roads that operate completely separately from bike lanes. Consequently, people in Houten cycle 50% more often than do people in other cities simply because of this key structural feature.

At the road network level, routes should be connected, identifiable, safe (from traffic and personal safety perspectives) as well as being comfortable and attractive.

At the site level, research into task analysis is needed. What are the tasks involved in riding a bike, and how critical are those tasks? Most design assumptions assume a healthy young person, not an elderly person. Gaps in site-level include: which competencies are needed to cope with common traffic situations? Which people cannot fulfil the implicit demands and competence? What are the consequences for present road design?

Recommendations

Modal

- Promote walking and cycling through traffic calming in neighbourhoods.
- Provide adequate facilities for walking and cycling along the most important routes (at the very least). Tackle the weakest links: arterial road crossings.

Policy

- Use a cascade approach. Focus on structure first, not technical "gadgets".
- Take an integral approach: don't think only about pedestrians but about living and mobility.

- Don't wait until countermeasures become unaffordable.

Research

- Human factors research is greatly needed about the relationship between competencies and design.

Harry Wolfe, Arizona Maricopa Association of Governments, "Adapting Airport Terminals for an Aging Population"

Most research on senior travel is focused on intra-urban travel, but there is a desire for intercity travel as well, and most intercity travel is by air. Therefore, airport design is important for older travellers. In the US alone, by the year 2020, there will be 54 million people over age 65. In 2000, seniors made 13-14 million trip miles, and this figure will likely increase by 21 million in the year 2020. Therefore, travel by seniors could bring significant additional revenue to airports, airlines, and the tourism sectors of the economy. But, most airports are not designed from the perspective of the older person.

Mr. Wolfe's research has shown that the older person does not want to be considered disabled, and that they cherish their independence. "I don't want a wheelchair, I want to be able to walk it" is their attitude. Accommodating their needs means making adjustments in the three primary tasks required in airports: way-finding, walking, and waiting. Improving way-finding entails improving signage, making signs larger and easier to read, clearly marking where the person is on the map, placing signs at comfortable heights, and using contrasting colours. Use of volunteers to help with way-finding, and standardisation in the appearance of maps and signs across different airports, are also good ideas.

In the area of walking, the primary issues of concern are related to distance, (moving sidewalks can be of help here, although they present their own challenges), change of grade, (elevators can help, if they are clearly designated) and availability of carts. Walking long distances can be problematic for older travellers.

Waiting requires strength, and waiting is required at security lines, baggage check-in and boarding. To alleviate these problems, availability of seating and the assignment of numbers could reduce the time spent standing and waiting. Also, devices that help lift suitcases to conveyer belts, and rails to help older persons walk through security, would be beneficial for older adults.

Recommendations

Policy

- Develop airport terminal design standards for older persons and ensure government support for these standards.

Modal

- Evaluate airport terminals in terms of standards and identify enhancements. Develop an airport inventory form and a process for working through the enhancements.

Research

- Apply ITS to airport terminal way-finding. Also, regularly survey intercity modal splits by age to assess how we are doing in improving way-finding.

Panel 7: Policies & Strategies to Facilitate Mobility Across the Lifespan

Irja Vesanen-Nikitin, Ministry of Transport, Finland (Moderator)

Ms. Vesanen-Nikitin introduced the topic of this panel and how transport policy is not an isolated issue. Rather, transport policy should be in line with the goals of other policies. Modern transport policy must take into account social policy and the promotion of public health and sustainable development.

Audrey Straight, AARP, “Facilitating Mobility through the Lifespan: Policy Options”

Ms. Straight, a senior policy analyst for the AARP (American Association of Retired Persons) Public Policy Institute detailed five policy options for facilitating mobility through the lifespan.

1. Invest in expansion and improvement of transport options. The recommendation here is to target needs and preferences and to manage the transport options that are currently available. This option is the top recommendation because it improves the quality of life for everyone. Drivers are currently getting around safely, so the need is to expand other options and to target investment to those needs. People are not going to use options that do not meet their preferences. As focus group research has borne out, people in suburbs feel isolated at home, whereas people in urban, transport-rich environments are pleased with their mobility options. The difference is that the transport options that existed for users in the suburbs were not tailored to what users wanted in terms of acceptability, adaptability, affordability, availability and accessibility. The people could not use the existing transport system to go where they wanted to go when they wanted to go.
2. Promote private investment in safety and mobility. The action here is to provide incentives for planning for retirement from driving. Currently, public subsidies are provided to people for services which they could afford to pay for themselves. Indeed, 17% of the U.S. gross domestic product goes to transport, which is more than out-of-pocket healthcare costs. The opportunity is to better direct what people are already spending. This can be accomplished by looking at incentives, such as giving people tax breaks for buying transit passes. Incentives for performing self-assessments or to take non-regulatory driving evaluations that could help them plan for their retirement from driving could also be provided.
3. Invest in tools for enhancing driving safety. In the short-term, this involves targeting investment to the development of tools. In the long-term, the goal is to employ the tools we have and to enforce existing evaluations. As the research from earlier presenters has shown, older people are causing fewer car crashes than expected, so it is possible that older drivers are already doing self-assessments and self-regulating. Activities such as participation in driver safety programs should be encouraged at a much higher level. Existing laws should be enforced and police officers should be educated to citing older people for traffic violations. In actuality, not citing older drivers puts them at a higher risk by not alerting others to the problem and inadvertently helping some at-risk drivers deny that they are having trouble driving.
4. Regulate drivers to prevent crashes. The intervention should be based on evidence of risk. Functional screening can be done on age-related impairment, but it should also offer an

opportunity for remediation. Failing a functional screening should lead to a driving test to determine if driving capabilities are in fact impaired, and the DMV should give advice or provide remediation options. Only when there is evidence of continuing impairment should a driving test be given. As we have seen, many people can accommodate functional impairments, so the test should be used to determine when they are no longer able to compensate for their impairments and are at risk of hurting themselves or others.

5. Guarantee adequate and reliable financing for public investment in mobility for older persons and individuals with disabilities. Capital costs of infrastructure are high, and the size of the aging baby boom population is large. If we are going to build infrastructure that enhances mobility of the baby boom population, we have to assure financing for that infrastructure now. The priority focus of the funding should be on older people with disability conditions that compromise their safety or mobility.

Recommendations

Modal

- Assess customer/consumer/user needs and use public relations and marketing to reach diverse audiences and the diverse needs of aging individuals. The goal is mobility, keeping people mobile as they age.

Policy

- Make community mobility a high priority and invest accordingly.

Research

- What does it really cost to make sure that the older population can maintain mobility? What does it cost if we don't keep them mobile? We need to work with economic information.

Jane Hardin, Community Transit Association of America, "Tools for Co-ordinating Senior Transportation"

Ms. Hardin described three case studies of programs that co-ordinated transport services for older citizens.

Cross-Country Transit in North Carolina: This program provides non-emergency transport service that is accessed through a website. Human service providers, transit providers and the public all use this website. The program is available to users in North Carolina based on income. The program has been very successful in extending healthcare. Traditionally, it has been hard to get transport outside the county in which one lives. This program has cut costs dramatically through voluntary co-ordination.

TaxiCard in Baltimore: The Taxicard is a reusable card that replaces paper vouchers used by low-income taxi patrons. The Taxicard provides users with access to six cab companies in the area. The City of Baltimore provides the equipment and trains users and participants on its use. Participants like the cards because the savings realised through the program have brought them additional benefits, namely additional subsidies on the card as well as a customer service number to call. In addition, the card not only works for taxis, but also can be used in public transport. Surveys have shown that older people say the biggest barrier to their using public transport is having change for the farebox. Money

for the bus can be added to this Smartcard. Therefore, the Smartcard offers a great opportunity for public transport to reach out to older passengers.

St. John's Council on Aging: This cooperative effort provides door-to-door demand response, with priority for medical situations. It is a balanced transport program that combines a medical paratransit program with public transport. Seniors are best served when the transport option is not just aimed at seniors, but is a general transport solution that takes into account the needs of seniors. Many seniors do not need demand-response systems but use them because they cannot use a traditional fixed-route system. The St. John's program uses a fleet of eight buses, all painted a bright sunshine yellow colour. The buses run on a fixed route, but stop at any corner for anyone who signals them. They serve the entire public, from commuters who need a connection to commuter buses to seniors going to visit the doctor. The program has been especially successful in situations such as bringing dialysis patients to their regular doctor visits several times a week, and for bringing people home from the hospital. Programs like Medicare pay to take people to the hospital in an emergency, but they do not pay in non-emergency situations such as hospital discharge. That has led to situations of people paying USD 700 to get home, or frail elderly persons riding in the backs of pickup trucks. The St. John's busses provide return home service and can accommodate a stretcher.

Recommendations

- Application of dispatching and scheduling techniques to general public transport.
- Increased government funding for co-ordinating human service transport and public/community transport.
- Research into how aging persons respond to new technologies: how do they use the technologies? Do they use a Web site? Are they turned off by voicemail? What can they be trained on?

Esther Wagner, US National Highway Transportation Safety Administration, "DOT and the Older Road User: Programs and Activities to Promote Safe Mobility"

Ms Wagner described current U.S. Department of Transportation (DOT) activities, its connections with outside agencies and what the future holds for programs for older road users. (Road users include drivers, occupants, pedestrians, bicyclists, and motorcyclists – in short, anyone on the road.) The DOT's mission regarding older road users is to enable people to drive as long as they are safe and to encourage the development and availability of affordable and accessible transport options. A number of government agencies are addressing older road users, including the Office of the Secretary of Transportation, which is the main policy agency. The Office of the Secretary co-ordinates departmental policy and is working on a report titled: "Safe Mobility for an Aging Society: Challenges and Opportunities" that will be published shortly.

Other U.S. federal agencies involved in older persons' issues include the National Highway Traffic Safety Administration, the Federal Transit Administration, and the Department of Health and Human Services (through its Administration on Aging, the AOA). The AOA has a memorandum of understanding with the Federal Transit Administration to build a bridge to public transport. The goal is to generate economies of scale and save money. Another agency, the Access Board, provides rulings for accessibility guidelines in terms of how to implement the American Disability Act (providing a very wide range of guidelines from the curb cuts for sidewalks to the width of passageways on cruise ships). Thus, the Access Board has a large impact on all infrastructure and affects the mobility of seniors.

Ms. Wagner identified some gaps in three areas that need to be addressed: co-ordination, training, and outreach/communications. In the area of co-ordination, agencies need to know what other agencies are doing and what projects they can perform jointly. Identifying and implementing joint projects will reduce the problem of duplicated efforts. The area of training impacts everyone from engineers to transit providers and drivers to licensing authorities and medical personnel down to families and consumers. For example, law enforcement officers need training to help them identify potential problems, such as a lack of citations given to older drivers. (In a study of 50 000 citations given in the last five years, only 2% were given to seniors. That figure should be much higher, so it is clear that training needs to be given to help police officers help seniors more effectively.) If officers aren't educated on the importance of citations to help seniors assess their driving, and to help family members make those decisions, seniors will be at greater risk. In the area of communications, agencies need to work with each other, with non-governmental agencies, and with the public to provide information. The agencies have come a long way, from wanting to get older drivers off the road to helping keep them safely mobile.

Richard Pain, National Research Council, Transportation Research Board "Opportunities to Make Things Happen: Using Organisational Development to our Advantage"

Mr. Pain explained how organisational design principles could improve the effectiveness of organisations to make an impact on older driver and mobility issues. Currently, federal, state and local agencies operate in silos, taking actions that are often duplicated or unknown to other agencies or other disciplines. Each agency carries out its own projects and optimises its own performance of duties without regard to the impact on other agencies.

By using the structure of a consortium, previously separate agencies and disciplines can be brought together and work together toward a common purpose. Mr. Pain used the example of the Maryland Consortium to illustrate this principle in action. The Maryland Consortium brought together agencies such as the DMV and the DOT as well as law enforcement, education, and the medical board to create an integrated safety management process. The Consortium created an integrated, strategic highway safety plan.

The result was a comprehensive plan to substantially reduce fatalities and injuries on the nation's highways. The consortium brought new insights through the interrelationships of organisations. It pooled existing resources and came up with a co-ordinated plan of action. The meetings created new lines of communication between different agencies to improve co-ordinated action or to facilitate effective hand-off of problems.

Consortiums such as this can be replicated at the local level (because delivery is local) and succeed best when they bring together both personal and institutional ownership. Mr. Pain's recommendation was to look carefully at organisational structures to be able to provide older persons safe mobility and to improve the effectiveness with which we deliver those results.

Symposium Summary & Adjourn Joseph F. Coughlin, MIT AgeLab

Dr. Coughlin concluded the symposium by reinforcing the importance of policy in shaping the actions that will address the issues raised by this symposium. The symposium raised important research issues, highlighting that older persons face limits due to the aging process. But the symposium also made clear that we don't really know what the natural aging process is. How old is old? Night vision begins to fade at age 40, is that old? Transport safety issues arise not just with age-related impairments but with other impairments such as the use of medication. Currently, 110 million Americans are managing one chronic disease, and others are managing two or more. What is the effect

of medications on driving performance? As we explore some of the safety issues raised, we also have to take into account new demographic trends such as cohort effects and gender effects.

Solutions to some of the problems raise new issues of their own. If everyone drives an SUV with ITS, do they feel invincible, making the car a tank? Or, as various ITS systems present more information to the driver, issues of display legibility and cognitive overload become critical.

The question of transport is broader than just the car: if people choose not to drive, are the alternatives adequate and acceptable? From Rosemary Mathias and Carol Schweiger's presentation we learned that paratransit is very expensive: the average USD 1 ride on general public transport is a USD 10-65 ride when paratransit is used, with many "I forgot you" incidents. Therefore, policy decisions need to evaluate the cost to the consumer.

Policy decisions also need to remain flexible and open to new ideas. As Dean Kamen's presentation about the introduction of the Segway highlighted, when we create a new technology, do we have a political system that can think about how to accept a new idea "on my road"?

Harry Wolfe's presentation about adapting airports for an aging population demonstrated the need to think about a comprehensive definition of mobility. "Travel" doesn't simply mean going to the grocery store; it means going on vacation as well. Travel to and within airports is a key aspect of quality of life, and it represents an economic opportunity as well: senior travellers represent the largest market for airports and airlines after business travellers.

The recommendations resulting from this symposium can be considered by governments in setting their policy agenda. Transport and mobility for the elderly is an important issue that we need to get everyone thinking about and planning for. People talk about 401Ks and planning for retirement, but they need to think further about their mobility in retirement: where should they live? How will they get around?

Governments can help guide industry and guide the new technologies going into the car and into transport systems. Governments can look at standardisation and get auto companies thinking about designing cars that will not only *help* older drivers but will be *acceptable* to them.

Because transport and mobility encompass a range of issues, we need cooperation and collaboration among various stakeholders to plan land use, bike paths, walking paths, roads and alternative transport systems that make sense for the older population.

Finally, transport for older people isn't just a technology issue. Rather, it is an issue that needs a political definition so that it generates political power. Just as a particular legislator says "healthcare" or "education" is his or her issue, we need to have senior elected officials who make mobility for older drivers their main issue. The result will bring not only health and safety but also improved quality of life.