New age philosophy

The jury is still out when it comes to the safety of older drivers. What's clear, however, is that auto-makers will need to find more ways of catering for an increasingly ageing population

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"COMPANIES ARE QUICKLY REALISING THAT BOOMERS HAVE THE HIGHEST CONCENTRATION OF DISCRETIONARY INCOME"

MIT's time-synchronised data-acquisition system allows for data capture for post-processing, real-time monitoring and evaluation of driver performance

Between 1946 and 1964, Europe and North America saw a boom in population that created the first generation to grow up with the car as king. The rise of the suburban neighbourhood brought with it a lifestyle that not only relied on the automobile but also viewed the car as a symbol of freedom and independence. As the first baby boomers turn 65, we are reminded that ageing populations will bring a host of issues into the car with them. Because they are likely to continue to live in places lacking strong public transportation infrastructure, to be able to work, travel and maintain a quality of life that requires the same mobility they had in younger years, the boomers will insist on staying behind the wheel longer and demand technologies that will enable them to safely and comfortably do so.

For the first time in history, there is a convergence of an ageing population and the promise of new assistive in-vehicle technologies to compensate for age-related changes in capabilities. Systems are being developed to improve comfort, confidence and competence in driving. Older adults may not have previously been seen as lifestyle leaders, but companies are quickly realising that boomers have the highest concentration of discretionary income and that older adults are the chief buyers of the most expensive vehicles on the market. These high-end vehicles are becoming increasingly intelligent, with systems such as collision warning, active brake assist,

(Above left) Measures of vehicle telemetry (CANbus link – e.g. velocity, wheel rates, etc, lane position) can be tracked as well as driver physiology (right) and eye tracking

blind-spot warning, lane-departure correction, automatic park assist and a myriad of infotainment features appearing in dealerships today. How will older adults react to and navigate these sophisticated systems safely and effectively?

Older drivers at risk

When we think of the ageing population, we would be wise to think of the little old lady. She's the one making marginally more driving trips than men and is very likely to outlive her husband and become a household of one. She's also in grave danger during a driving accident. This is not only because older adults are less likely

"WE MAY SEE AN INCREASE IN RISK AMONG THE OLDER POPULATION IN THE COMING YEARS"

Demographic demand

>> Demand for vehicles in China and Brazil is accelerating. According to Ward's Auto research, global registrations of vehicles increased from 980 million units in 2009 to 1.015 billion in 2010. China accounted for nearly half of this growth, increasing its own number of registrations by 16.8 million units in 2010.

Brazil's numbers grew by 2.5 million. To draw a comparison, the USA witnessed a less than 1% increase, although it still holds more registered vehicles than any other country in the world.

What do China, Brazil and the USA have in common with each other? Their populations are ageing. Based on year 2000 data, the US Census Bureau predicted the 65+ population would increase from 6.9% to almost 16% in 2050, and 2010 data seems to support these predictions. A Chinese census taken in 2010 showed the 60+ population jumped 3% in 10 years, and Brazil's 60+ population grew from 9.1% to 11.3% between 1999 and 2009.

Helping you drive into old age

>> Many studies of older drivers focus on people with dementia or other conditions that might impair their performance behind the wheel. A recent study conducted in Australia, however, comprised 266 volunteers age 70 to 88 who showed no signs of the condition, lived independently and drove at least once a week. As lead researcher Kaarin J. Anstey reveals, the results could have implications for the design of roads, signs and vehicles. Anstey, a psychologist who directs the Ageing Research Unit at the Australian National University, says the study found that normal ageing causes various declines in brain functioning and those distinct changes could affect driving skills, including the ability to focus despite distractions on the road, make quick decisions, and avoid other vehicles or pedestrians.

Participants completed a battery of cognitive tests and questionnaires about their driving history before they drove on a 12-mile route through city and suburban streets in Brisbane. A professional driving instructor rode in the car, which was equipped with an extra brake on the front passenger side for safety. An occupational therapist sat in the back and scored the drivers on various errors, including failure to check blind spots, speeding, sudden braking without cause, veering and tailgating.

"All types of driving errors increased with age, and the errors weren't restricted to a small group of unsafe drivers or those with a history of crashes," Anstey says. "It is important to note that there is a large variation in cognitive ability, so some people still have a high level of functioning in later life even if they have suffered some cognitive declines related to normal ageing."

Men didn't in fact fare any better in the tests than women, Anstey reports. Blind-spot errors were the most common mistake, followed by veering across lanes and failure to use turn signals. During the tests, 17% of the drivers made critical and potentially hazardous mistakes that required the

instructor to hit the brake or grab the steering wheel.

The rate of critical errors during the driving test quadrupled from the youngest group, age 70 to 74, which had an average of less than one critical error, to the oldest group, age 85 to 89 with an average of almost four critical errors. There were no crashes during the tests, although participants who had reported an accident during the five years before the study also had a higher rate of critical errors.

Overall, Anstey feels that older drivers could remain safe on the roads longer with training on checking blind spots and other driving skills that might decline with ageing. The participants had their vision checked before the test, although she admits that more research is needed to determine if visual ability contributed to the high rate of blind-spot errors.

MIT's AwareCar is instrumented with methods of monitoring driver state through physiology, visual attention, driving performance, as well as environmental sensing

to survive impact than a 30- or 40-year-old driver but also because airbag deployment can be fatal to a frail, 5ft 1in driver. For this and other reasons, a basic demographic analysis suggests that we may see an increase in risk among the older population in the coming years. Because of older adults' greater tendency to rely on established behaviour patterns, difficulties in managing multiple demands at the same time – and their comparable ease of distractibility – they are also more easily confused and uncertain when technologies attempt to warn or assist them. Take, for example, the introduction of automated brake assist (ABS) in motor vehicles a number of years ago. Prior to the introduction of this technology, drivers were trained to pump the brakes to come to a safe stop. After ABS, old habits died hard for many drivers who continued to pump the brakes despite the presence of the assistive technology

The AwareCar includes sensors to record data about the current state of the operating environment

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or, even worse, reacted to the vibration and sound of the ABS system engaging and completely released the brakes. Today's new car models are equipped with a dizzying array of alarm lights and sounds intended to draw attention to a perceived risk. However, improperly designed, these alarms will likely follow the path of ABS, distracting and hindering the older driver in many instances more than helping them. In the case of other systems, the need to learn a new, complex or multistep interface – or the struggle to read an unfamiliar digital dashboard while driving – will place an even greater burden on an older adult.

New safety lessons

Technology drives design and marketing, which means more novel warning systems and more shared control between the driver and the

New in-vehicle systems create particular challenges for older drivers. Paradoxically, even though older drivers may find it more difficult to use these devices, they are likely to be the first to encounter them because innovations are often initially introduced into high-end cars usually purchased by more affluent (and often older) customers. Thus the more mature driver population is very likely to be the first to encounter

still immature systems. When well designed, technology can limit the effects of age-related changes. For instance, a major problem for many older people is decreased flexibility – stiff necks, etc. Alerts and visual aids such as rearview camera systems can help alleviate these problems. In-vehicle displays and devices should also be designed so that those with presbyopia can still use them. Some evidence has shown

that older drivers particularly benefit from multimodality displays that combine visual and auditory information. Distraction is also another issue. With age, the ability to focus and divide attention tends to decrease. In-vehicle devices often require that a driver divide attention between driving and using the device. Overall, then, technology should be designed for people, which includes considering ageing drivers.

"IMPROPERLY DESIGNED, THESE ALARMS WILL LIKELY FOLLOW ABS, DISTRACTING AND HINDERING THE OLDER DRIVER"

vehicle. Already on the market are preventative safety technologies such as radar systems to alert the driver if they are too close to another object while in reverse, night-vision display systems (with age comes delay in dark adaptation, making it more difficult for older adults to see in the dark), and cameras that provide images from around the vehicle.

The issue with these new technologies is that they are most effective when the driver both comprehends and trusts them. Older adults (or any driver, for that matter) driving high-end vehicles from the dealership often have little understanding of how to use the preventative safety technologies or how their car will react in an emergency. We don't often learn how to use new technology from the manual or from the car dealer. We might receive help from friends or family, but it is most likely we'll learn through experience, on the go or in the car park. Auto parking assistance, forward and reverse proximity warnings and rearview cameras have the potential to reduce stress associated with low-speed manoeuvring (particularly as we reach that age when turning to look out the rear window becomes difficult), but how are we ensuring drivers are trained to use these technologies properly and actually benefit from them in the way designers intended? A recent MIT AgeLab study of Ford's Active Park Assist (APA) parallel parking system found that when drivers were unfamiliar

Platform for change

≫ The MIT AgeLab AwareCar is an instrumented experimental vehicle platform designed to monitor the major variables that influence driver state. By combining measures of the driver's physiology, perception and driving performance along with vehicle telemetry and information about the operating context, a comprehensive picture of the driver's engagement with the roadway can be developed. This integrated approach to understanding driver behaviour has been used in the assessments of cognitive, visual and manipulative in-vehicle demands among drivers

across the lifespan and a variety of health conditions.

This work aims to form the foundation for an integrated vehicle safety/wellness system, which would monitor driver state and detect when a driver's performance is less than optimal. The AwareCar concept would then display

information to the driver about their performance, vehicle systems, and the evolving intelligent transportation system infrastructure. Features could then be triggered to alert or calm the driver as needed to adjust their functional state and improve performance.
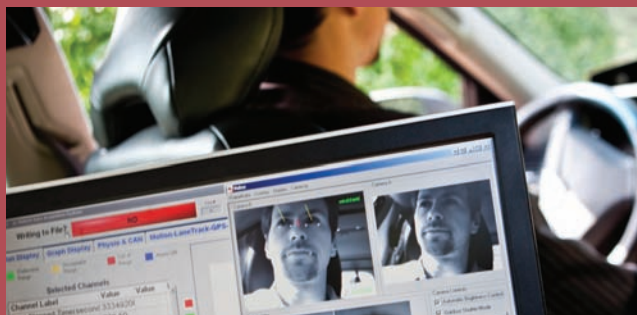
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As we grow older, we find it harder to discern pedestrians, cyclists and other cars while driving. It's a side-effect of ageing, yet it isn't a diminished capacity for perceiving moving objects but a heightened awareness of the backdrop against which they're moving.

Evolutionarily speaking, moving objects are the most important visual features to detect quickly because they could be your lunch or they could want to eat you for lunch. Unsurprisingly, our brains have a number of different mechanisms for processing moving objects, one of which is suppression of irrelevant background motion. When we're young, our visual processing supresses any backdrop motion so we can focus on, say, a kid on a bike. Earlier studies have shown the elderly are unexpectedly more adept at perceiving background motion. However, that comes at the expense of seeing what really matters – things in the foreground.

Using a technique known as transcranial magnetic stimulation, we have discovered the brain's middle temporal (MT) is responsible for this effect. In our research, we placed magnetic coils on each subject's head and used electrical signals to stimulate the MT for 15 minutes, briefly inhibiting it. Then we measured how effectively subjects identified the movement of small and large objects on a monitor. With an inhibited MT, subjects found it easier to discern the motion of large, background-like objects, which suggests a malfunctioning cortical area MT may be why seniors experience superior perception of background motion.

Knowing this could help train the elderly to be better drivers.

with the technology, they were quite neutral in rating their expectations about APA. After being educated on the system and being provided with an opportunity to experience using it, participants significantly increased their rating of the value of the system. One has to wonder to what extent changing the typical experience at the dealership to be more informative and educational would benefit the relationship between industry and driver, and driver and vehicle.

What's good for older drivers is good for you too

Automotive industry leaders, as well as public policy-makers, should have a vested interest in determining how older adults will learn to properly use assistive technology while also learning to ignore all the distractions that come with today's driving environment. We should not be quick to assume driving cessation as the easy answer for the older driver. Around 79% of adults over 65 live in suburban and rural

Empathising with the baby boomers

» AGNES is MIT AgeLab's 'Age Gain Now Empathy System' developed by researchers and students and calibrated to impose the limitations in motor skills, vision, flexibility, dexterity and strength one might feel in their late-70s. Worn by students, engineers, product designers and developers, architects, and physical therapists to gain a first-hand understanding of the challenges an older adult faces in completing everyday or complex tasks, it often provides an 'aha' moment that other traditional research

methods cannot provide. Developed in 2005, AGNES has since been featured in the *New York Times*, the *Financial Times*, countless other major publications, as well as television programs. Now, AGNES 2.0 has been improved upon to better replicate the effects of ageing and the onset of chronic diseases such as diabetes and arthritis.

The many aspects of the system include braces limiting joint mobility and creating stiffness, leg straps shortening gait and decreasing hamstring flexibility, a helmet and band attachments simulating spinal

compression, and custom shoes to cause the imbalance we develop due to changes to our musco-skeletal system and inner ear.

AGNES has allowed users to gain an understanding of the difficulties associated with completing tasks that were once second nature. In one AgeLab project 'AGNES Goes for a Walk & Ride', students and industry researchers obtained a personal understanding of the 'friction points' older adults encounter in the transportation system. Metro

maps were more difficult to decipher, buses were a challenge to board and exit and streetscapes were daunting to navigate.

AGNES was also used by a German car-maker to understand the challenges older adults face in entering and exiting vehicles, as well as how dashboard interfaces may be difficult to see and interact with. Representatives of a consumer products company and retailer have also used AGNES to 'age test'.

AGNES is designed to help product designers better understand the physical toils of old age

Bryan Reimer
research scientist, AgeLab/associate director, New England Transportation University, USA

One problem is the lack of continuous driver education. We learn how to drive as late teens, but technology is moving so quickly that continuous education – perhaps every five to 10 years – needs to become the new norm. Many older adults, for instance, hold the steering wheel at 10 and 2 [on the face of a clock], yet students today are often taught to hold the wheel lower to minimise the risk of having their arms broken by airbags.

And a perfectly health 75-year-old is far more capable of driving an car than a 55-year-old managing multiple chronic conditions and taking a series of medications. For most, it's not about how many birthdays you have had; it's about how well you are managing your diabetes or hypertension, how distracted you are, and whether you have taken your medication today.

With age we know that people generally make more appropriate decisions in the vehicle. They self-regulate and take themselves out of situations where they perceive the risk is high, such as not driving at night, avoiding left turns, driving during non-rush-hour periods. In essence, they make themselves safer by taking less risk. Younger groups feel 'invincible', per se, but they don't necessarily have the performance and skill to make the decisions as to when and when not to drive. One thing that's incredibly interesting, though, is with age we become more distractible. So how does the influx of technology into the vehicle distract individuals differently as they age? That's something we're really interested with at the AgeLab.

Machine vision cameras and a faceLAB eyetracking system keep a watchful eye on their subjects

Thomas Broberg
senior safety advisor, Volvo Cars Group, Sweden

Accident statistics prove that older drivers are underrepresented in crash involvement as a whole, although this is not true in some traffic scenarios. Intersection and turning manoeuvres are overrepresented accident types when it comes to older drivers. But there are a lot of myths about older drivers. They are not involved in more crashes than younger drivers; they just have different reactions. It's also about taking risks and understanding the consequences of those risks. One recent study we undertook looked at senior drivers who are healthy when compared with drivers aged 35-45. We checked their neck flexibility; we tracked their eye movements at intersections. What we thought we would find was – based on the circumstances – you take fewer risks if you have more experience. But we actually found that there's just a strong difference in what drivers look at: senior drivers focus on lane markings and roadsigns, while younger drivers focus on moving objects. We have to consider this huge behavioural difference as we design safety technologies. The solution is to build cars with senses. We have cars today that can recognise a potential collision, feel if the driver is responding or not, and automatically apply the brakes if necessary. We prioritise the issues that are the most common and dangerous in real-life traffic. Focusing on intersections is logical as this research shows that older drivers would benefit from support in these situations. The positive spin-off effect is that safety systems that take care of the special needs of older drivers will also be useful for younger drivers.

communities with limited or no options for public transportation. For this and other reasons, research has shown that older adults who no longer drive make significantly fewer trips to the doctor, to shopping centres and restaurants, and to visit family and friends less often. As a result of this isolation, driving cessation is linked to higher rates of depression, reduced social engagement and an overall reduced quality of life.

Objectively validated user-centred design is the most important aspect in easing the learning process for interaction with new technology. If the dashboard is designed in a way that is intuitive to the driver, interactions will be less of an effort. Of course, this would not only benefit the older adult; any simplification of functionality will make it easier for drivers of all ages. Each age group brings its own challenges to safety behind the wheel. Whether you are the young adult who has less driving experience, the middle-aged driver with hyperactive kids in the back seat, or any driver with less than optimal health or physical mobility, keeping the car driver-friendly will be far more successful in providing increased comfort and safety than overloading it with confusing and distracting intelligence systems.

As we move forward, shifting demographics and the needs of drivers across the lifespan will increasingly demand that vehicle designers and engineers consider the capabilities of the older consumer. Although no-one will buy the old man's car, we need to strive to disguise older driver-friendly features with intuitive, easy-to-learn mental models and interfaces that make new cars universally friendly. ❮

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"THE AUTO INDUSTRY SHOULD HAVE A VESTED INTEREST IN DETERMINING HOW OLDER ADULTS WILL LEARN TO PROPERLY USE ASSISTIVE TECHNOLOGY"