DVN
Driving Vision News

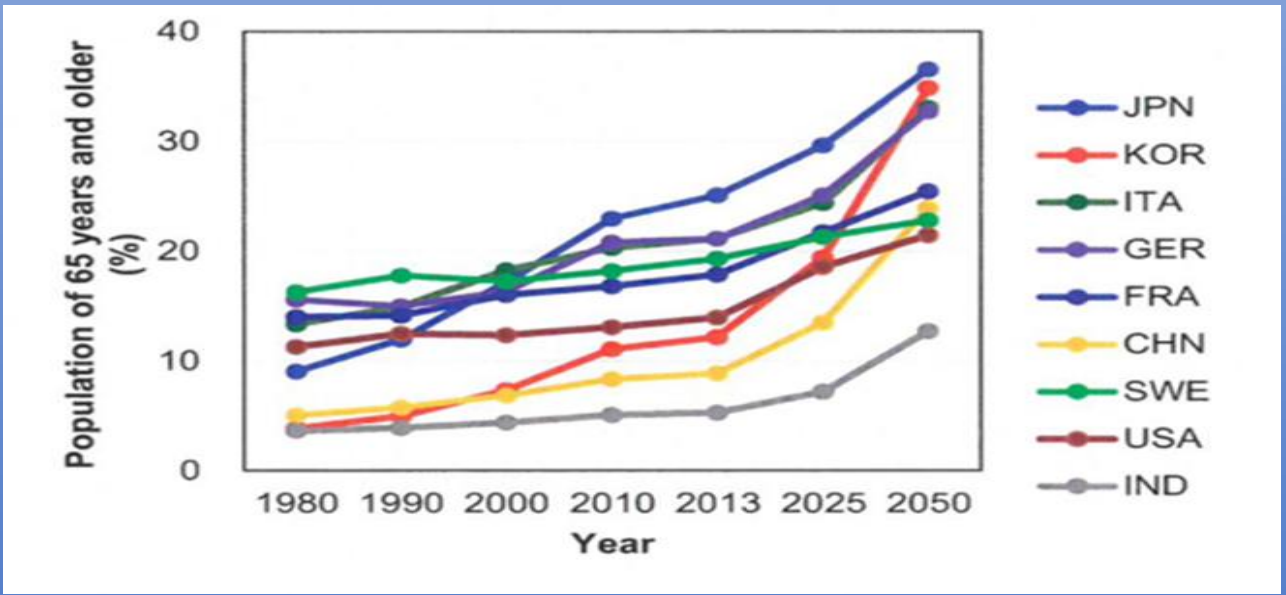
Worldwide Demographic Development

(Ageing Drivers and Mega-Cities)

REPORT

August 2022

Opportunities for Automotive Lighting Innovation



About the Authors and DVN

Geoffrey Draper

Former GTB President, Geoff Draper retired in 2009 after a 47-year career in the vehicle lighting industry, working for Lucas Lighting UK, Carello UK, Magneti Marelli in Italy and finally as Technical Director of Koito Europe based in Belgium. He was GTB President from 2008 to 2021. Apart from his "mainstream roles" Geoff developed an interest in international regulatory harmonisation and, in 1989, was elected chairman of the GTB Harmonisation working group and subsequently he led the GTB Front Lighting group, CIE TC-4-45 and the SAE Pedestrian Visibility Taskforce. Now, in his retirement, Geoff is a freelance advisor, DVN Senior Advisor for Regulatory Affairs, a regular contributor to Driving Vision News, and Honorary President of the ALE Forum (China). He was voted "DVN Personality of the Year" in 2017.

Driving Vision News

DVN is the vehicle lighting and ADAS industry's journal of record, dedicated to keeping the community informed and communicating about the latest progress and developments. DVN's three pillars are:

• LEARN from Technological watch on new emerging technologies, with weekly electronic newsletters bringing news, analysis, and crucial information on innovation in lighting, ADAS, and smart car interiors; there are also monthly technical reports with sharp focus on cutting edge technologies, company profiles, regulatory matters, and other relevant content available only from DVN

• NETWORK with high-level decisionmakers, researchers, innovators, practitioners, academics, and regulators to make new business connections with two workshops per year in rotating locations throughout America, Europe, China, Japan, India, and Korea. DVN Workshops gather over 300 participants.

• PROMOTE innovations from DVN's 180 member companies—we facilitate the promulgation of knowledge of innovation, which in turn paves the way for commercialisation, enabling to build new relationships through DVN Community to forge new business worldwide. The DVN Gold membership roster includes 180 companies including automakers; lighting and ADAS tier-1 and -2 suppliers, and a wide variety of universities; research organisations, and consultants. DVN Gold members receive all publications and attendance privileges at all DVN Workshops.

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Author's Foreword

This report has been stimulated by my personal experiences that provoked me to carry out a search of recent literature related to the development of lighting systems that can take account of the known worldwide demographic changes.

I am 76 years old, and have realised that I will soon be unable to drive safely at night. I have increasing difficulty to adequately see the road ahead and increasing problems with glare from oncoming vehicles. I initially thought that the performance of the 10 year-old HID headlights on my car was the cause, and I purchased the latest high performance HID light sources. Now I have the best HID headlights available (and correctly aimed!) but they haven't overcome my problem. I consulted my ophthalmologist who confirmed that I have the classic signs of ageing; high sensitivity to bright light (sunshine during daytime and glare from headlamps and signalling lamps at night) and slow adaption to changes in luminance and illuminance at night. Currently I do not have cataracts and I do have regular tests to ensure that my lens prescription is optimised.

Like many people, I have been vaguely aware of the issues that affect ageing drivers and their night driving capabilities, but until now I was unable to truly appreciate the reality of being an elderly driver, having to encounter the glare and visibility issues on busy roads. Now I understand the reality, that many elderly people are losing their mobility independence because they voluntarily decide to stop night-time driving as they realise that the risks are too great. These drivers are most likely to be successfully driving in daylight, even with their increased sensitivity to bright sunny conditions, because they can use good quality prescription sunglasses. At night-time such a solution to counter the effects of glare is not possible.

Until I became personally affected, I only had a passing interest in the subject of demographic change. Now I expect that with the new lighting technologies, based upon LED light sources and adaptive systems, the automotive lighting community may have the possibility to help ageing drivers to keep driving for longer. For many elderly drivers, their mobility is a key part of continuing their physical and mental wellbeing. There are many findings from government research that highlight this mobility issue, that is a significant factor of demographic change.

My personal experience of deteriorating sight, helps me to understand that there are two significant issues to be addressed, a) how to reduce the risks of disability glare experienced by ageing drivers, and b) how to provide more road surface illumination to help ageing drivers overcome some of their adaption difficulties. I know that my inability to adapt from the effects of the opposing glare, to being able to see the edge of the road and obstacles on the road, puts me in a dangerous situation. Recently I was confronted with sufficient disability glare from the flashing blue lamps of an approaching ambulance that forced me to stop with a long queue of vehicles behind me, until I could recover my vision to proceed.

The other consequence of the changing demographics is associated with the "mega-cities" that require a different approach to automotive lighting and light-signalling. In heavy traffic the requirements for visibility are different but glare and light pollution present problems for all drivers, and particularly for the ageing drivers.

This overview is intended to encourage debate with a view to developing technologies aligned to the general needs of the ageing driver and the specific needs for night-time driving in the "mega-cities"

Finally, I would like to emphasise that I am not a scientist and I am certainly not an expert on the human factors associated with ageing drivers at night-time. For this reason I have only selected some important extracts from available research to provide a background for my personal thoughts and conclusions that I am attempting to explain in this report.

Executive Summary

The changing worldwide demographics, relating to the developments of “mega-cities” and the ageing population of drivers, maybe well known to the automotive lighting community. However, there is no clear understanding of how this relates to the development of lighting systems and how it impacts on night driving.

Glare and Visibility issues are intrinsically linked, and over the years have been debated and researched by governments around the world, as a result of persistent complaints about glare. Although there is little evidence that the levels of glare being experienced are sufficient to constitute a safety risk, and there are clear arguments that increased visibility offers safety benefits, there is a significant body of public opinion that does not accept these conclusions.

One of the factors influencing the perception of glare and visibility may be due to the changing demographics. In his keynote speech at the DVN 2018 Tokyo Workshop, Dr Bodrogi concluded that, “the current regulatory requirements are written for young to middle aged observers, but elderly people need more light and more contrast with less glare. In comparison to young people (around 25 years), older subjects (60-66 years) need double contrast and double illuminance (in lx) and 50 % of glare load in order to have the same visual performance”. As an example to put this in perspective, the UK Government’s official 2022 statistics show that of all UK drivers holding a full license (total for all ages 17-85 years = 40.6 million), 30% (12 million) are aged between 60 and 85 years, with most being fit to drive and wanting to remain mobile! This could be an important factor to be considered.

Historically, it has been difficult to address the glare and visibility issue due to limitations in the lighting technology but, with the wide introduction of LED light sources and digital adaptive systems, such as Adaptive Driving Beam (ADB), it is time to focus innovation on the changing demographics and needs of the ageing driver.

This report presents the outcome of a review of recent publications, and awareness of the potential of new technologies to address issues experienced by the significant 30% of drivers over the age of 60 years. These drivers may benefit from customised lighting solutions to enable them to continue driving at night and retain their right to mobility, as long as they are remaining fit to drive on medical and ophthalmic grounds.

Although more research is required, this report attempts to identify how the lighting and signalling regulations may be adapted to meet the challenges posed by the changing demographics. Of course, the work to define the actual performance requirements will require considerable effort by expert organisations, including GTB, in conjunction with the UN Working Party on Lighting and Signalling (GRE).

1 Keynote speech at the DVN 2018 Tokyo Workshop

In his keynote speech at the DVN 2018 Tokyo Workshop, Dr Bodrogi emphasised that, “the current regulatory requirements are written for young to middle aged observers, but elderly people need more light and more contrast with less glare. In comparison to young people (around 25 years), older subjects (60-66 years) need double contrast and double illuminance (in lx) and 50 % of glare load in order to have the same visual performance”.

Dr Bodrogi’s presentation co-authored with Prof. Dr-Ing. habil. Tran Quoc Khanh, both from the Laboratory of Lighting Technology at the Technical University of Darmstadt, is available on request from DVN.

Age 20 **Age 60** **Age 75**

Dr Bodrogi’s presentation superbly summarised the human factors associated with ageing drivers at night-time by addressing the main issues of:

- The Ageing Population Worldwide
- The Number of Traffic Accidents with Elderly People
- How the Human Visual System Reacts to Light
- The Ageing Components of the Human Visual System affecting Visual Performance
- Visual Detection Performance of Young and Old Subjects in the Centre and in the Periphery

- Some first ideas for vehicle lighting technology were also presented.

The conclusion was that current regulations are written for young to maximum middle aged observers, but elderly people need more light and more contrast with less glare. In comparison to young people (around 25 years), older subjects (60-66 years) need double contrast, double illuminance (in lx) and 50 % of glare load, in order to have the same visual performance. Based upon this background, it is time for the automotive lighting community and regulators to consider how lighting technology can be adapted to the needs of the ageing driver.

2 Demographic Trends (world-wide) The Ageing Population

In Dr Bodrogi's presentation he referred to the graph below showing some startling variations in the ageing population of 65 years and over:

Source: Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017

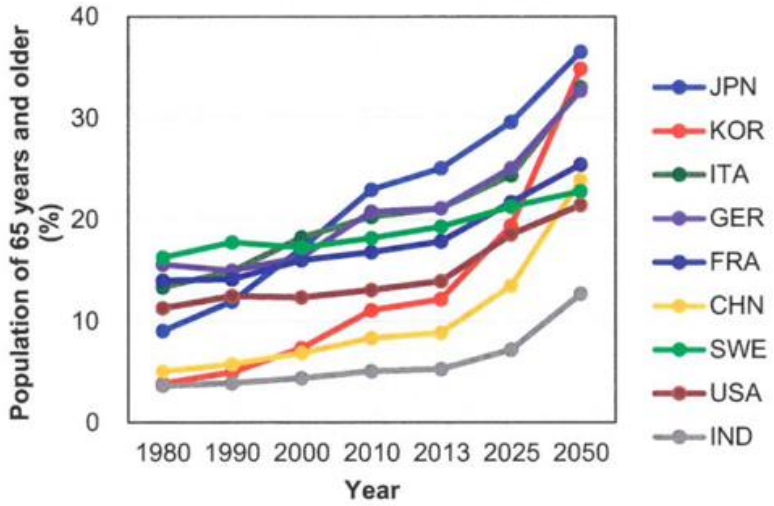
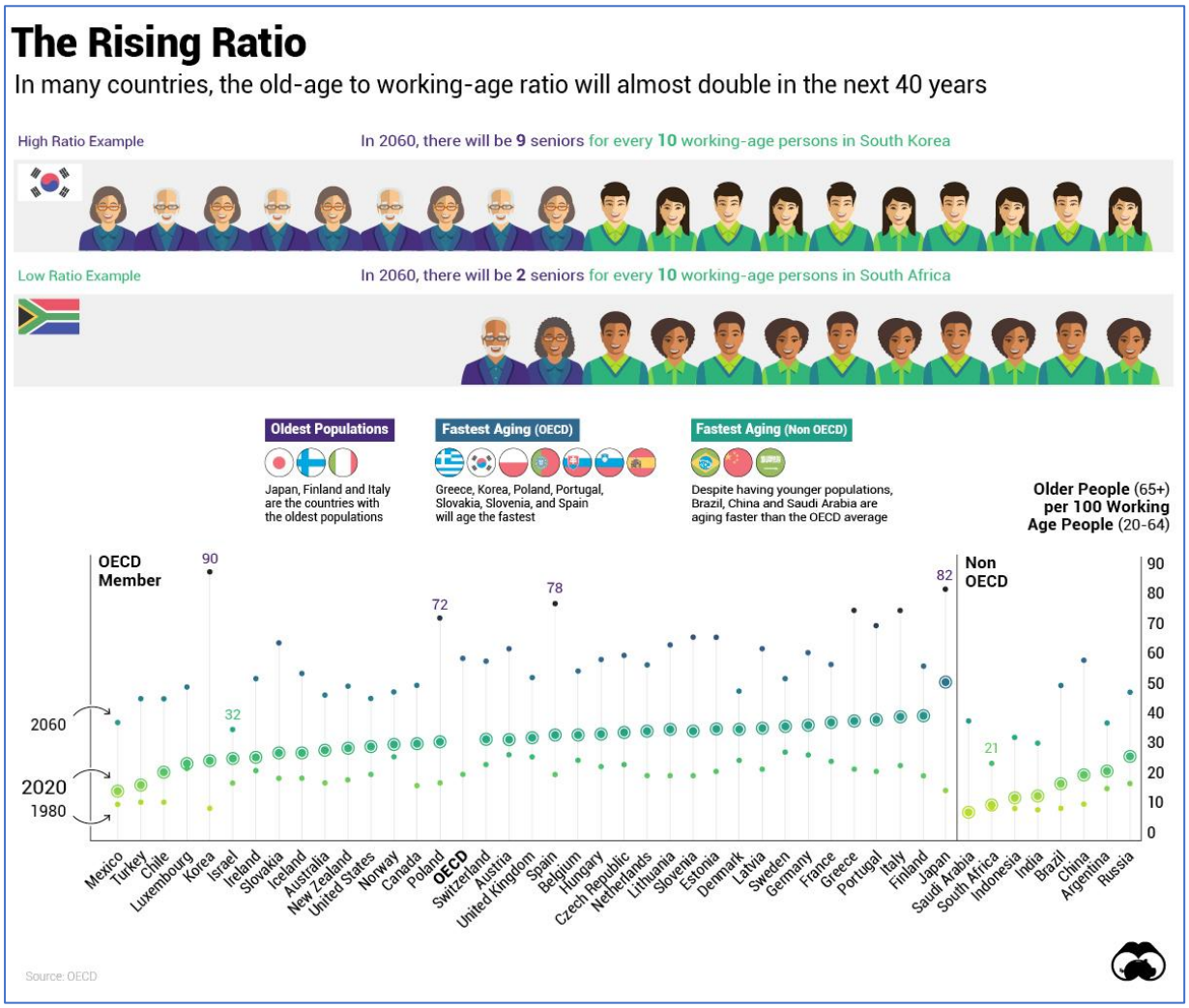


Figure 1 – Ageing population of 65 years and over by country (UN (2013.6) World Population Prospects: 2012 Revision)

Another more up-to-date graphic, published by Visual Capitalist clearly shows the ageing global population status of 1980 and 2020, with a prediction for 2060.
(https://www.visualcapitalist.com/aging-global-population-problem/)



The conclusion concerning the ageing demographic is that the increasingly high proportion of the population aged 65 and older cannot be ignored and their needs must be taken into consideration when defining safety performance requirements to be incorporated into regulation.

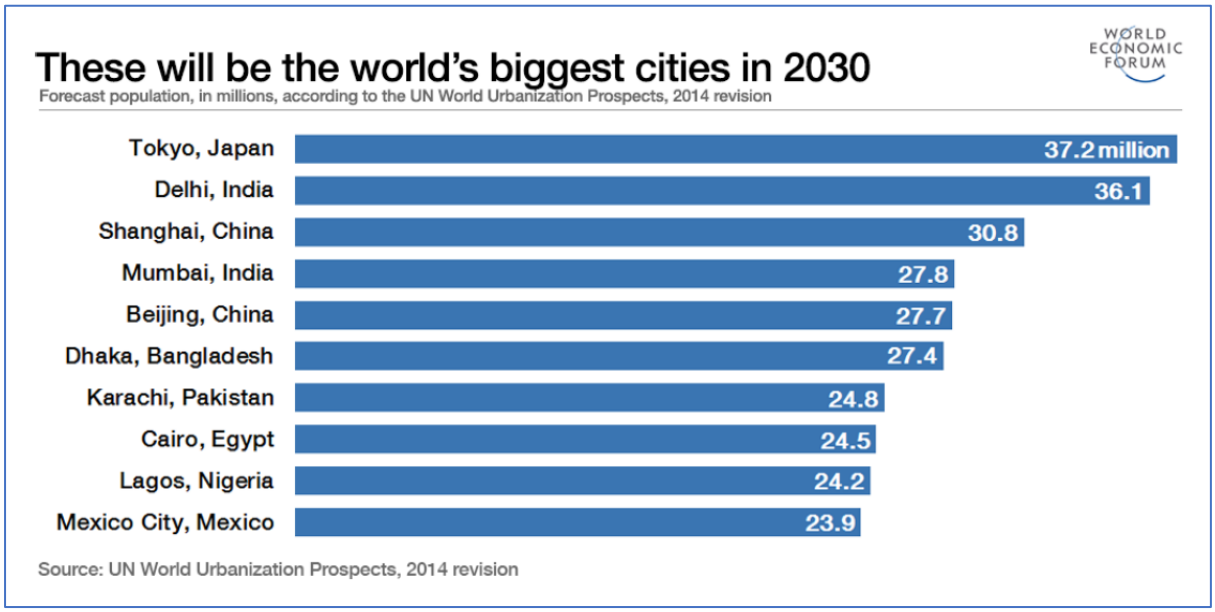
Most research relating to automotive lighting performance has been focussed on young to middle aged observers and, in view of the demographic changes, this is not sufficient as it ignores the ageing drivers who need to retain their autonomy for many years after reaching their 65th birthday.

3 Demographic Trends (world-wide) The growth of the Mega-Cities

A megacity is a metropolitan area with a total population in excess of 10 million. It can be a single metropolitan area or two or more metropolitan areas that converge

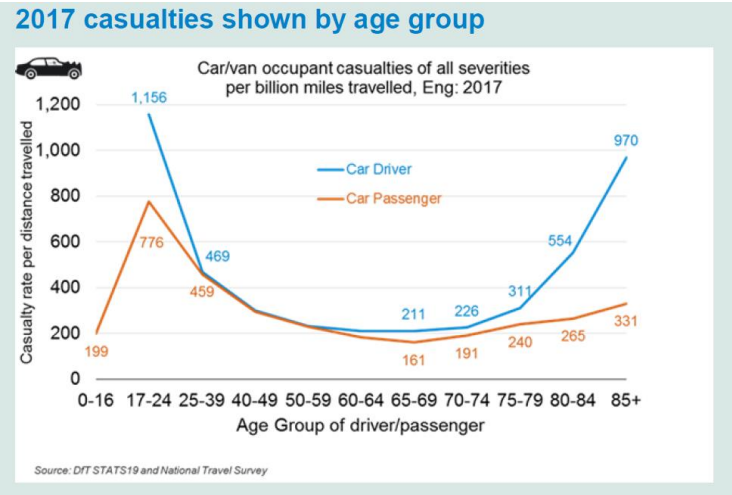
By 2025-2030, it is estimated that around 630 million people will live in close to 40 megacities around the world. Megacities are an invention of the West and have become a reality in the East. Japan's capital Tokyo will still be the largest of them all, followed by Delhi and Shanghai. The list is dominated by cities in Asia, but several in Latin America and Africa will grow rapidly as well. In addition to these megacities, about 400 million people will live in cities of 5-10 million people, and just over 1 billion

people are expected be living in cities of 1-5 million. (source: ESPAS Ideas Paper Series Global Trends to 2030 : The future of urbanization and Megacities)



4 Accident Rates according to age

The following graph is taken from the UK Department for Transport (UK DfT) road safety statement published in 2019.
(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/817695/road-safety-statement-2019.pdf)



This graph follows a similar trend experienced in many countries that show that numbers of casualties of ageing drivers do not differ significantly from the rest of the population. The 25-75 age group shows the lowest figures and outside this group the young and older drivers casualty rate increase.

In its " Road Safety Statement 2019" the UK DfT states:

> "Road users' knowledge, experience and skills develop with experience over time. But they can also deteriorate based on age, experience and declining cognitive and physical capability. As

the UK's population ages, **it is crucial that older people are able to maintain the skills and confidence required to remain safe and effective drivers**.

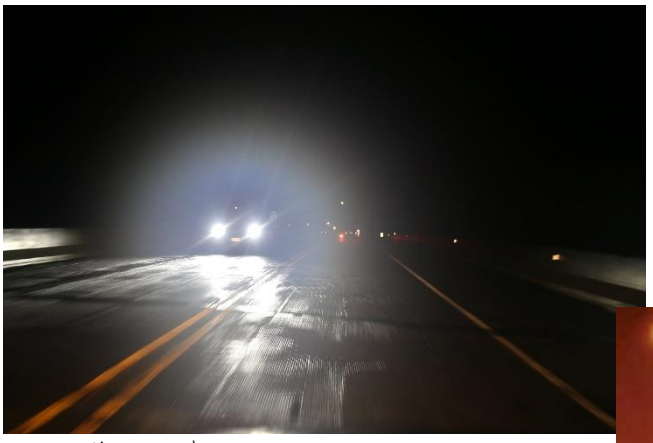
It is important that people live an active and healthy life into older age. For that, people of all ages need the knowledge, skills and confidence to use a wide range of travel options safely. **Age should not be a barrier to any mode of transport,** be it driving, riding a bicycle or horse, or walking. And age itself does not give an indicator of how fit a person is to drive**. There are many older drivers who self-regulate and drive only when they feel comfortable to do so, for example, they may only drive on roads they are familiar with, and/or restrict themselves to daytime driving only."**

5 Ageing Components of the Human Visual System affecting Visual Performance

Older people often experience noticeable changes in visual performance and task object appearance originating from:

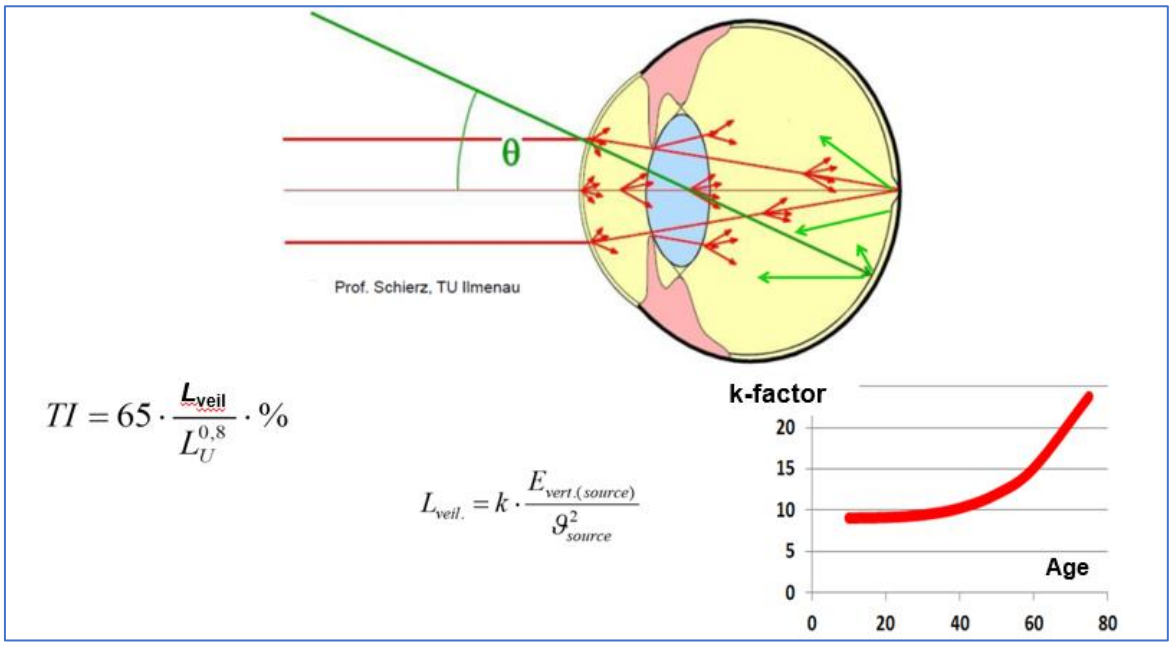
5.1 Reduced accommodation: the lens becomes more rigid and flatter with age, making it more difficult to focus on short-distance objects (farsightedness due to age)

5.2 Increased intraocular light scatter results in more glare



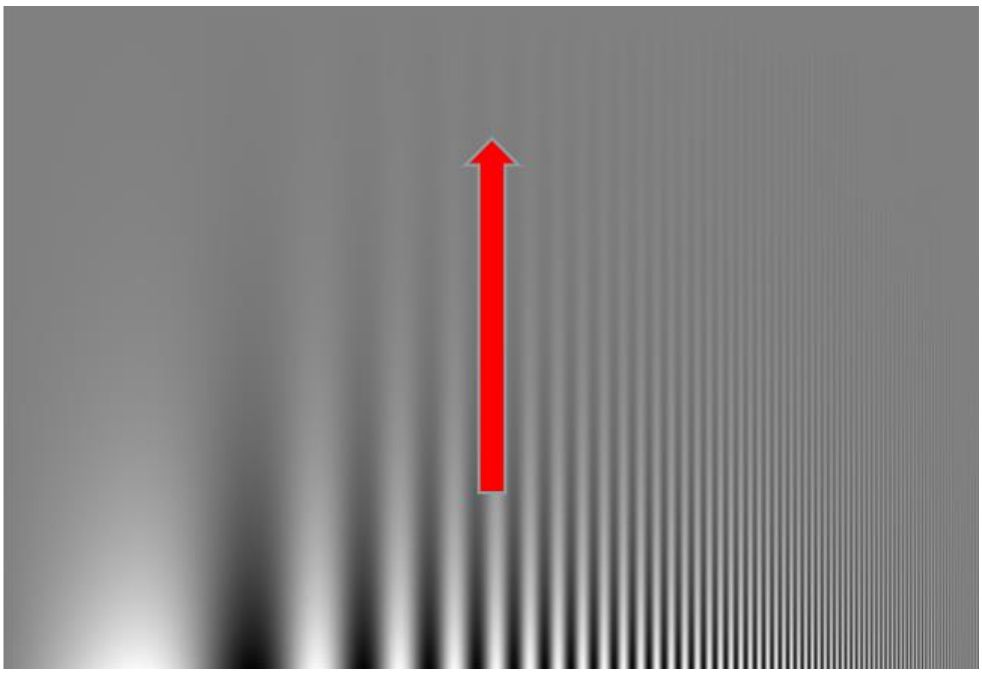
(source nytimes.com)

(Source insightvisioncenter.com)



Source :Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP

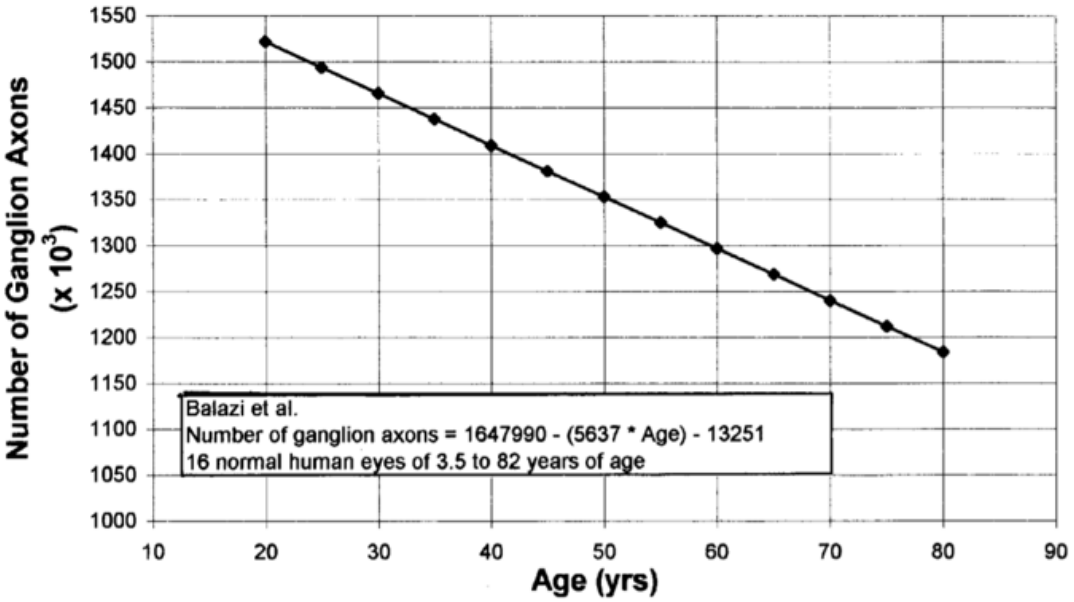
5.3 Increased intraocular light scatter results in less contrast and less contrast sensitivity of the elderly



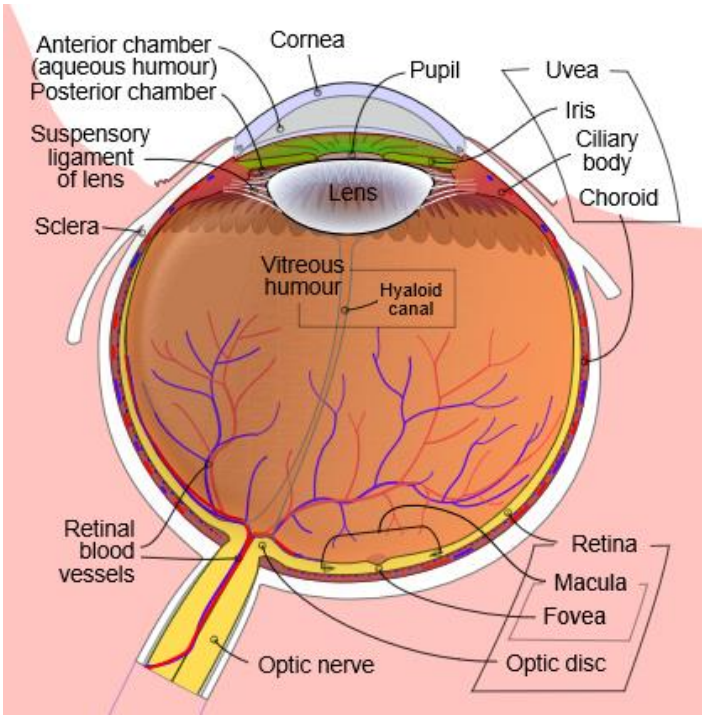
This is caused mainly by the cellular structures of cornea, crystalline lens and fundus. The light scattering in the crystalline lens dramatically increases with age

Source :Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP

5.4 Reduction of the number of neural axons with age



Source :Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP

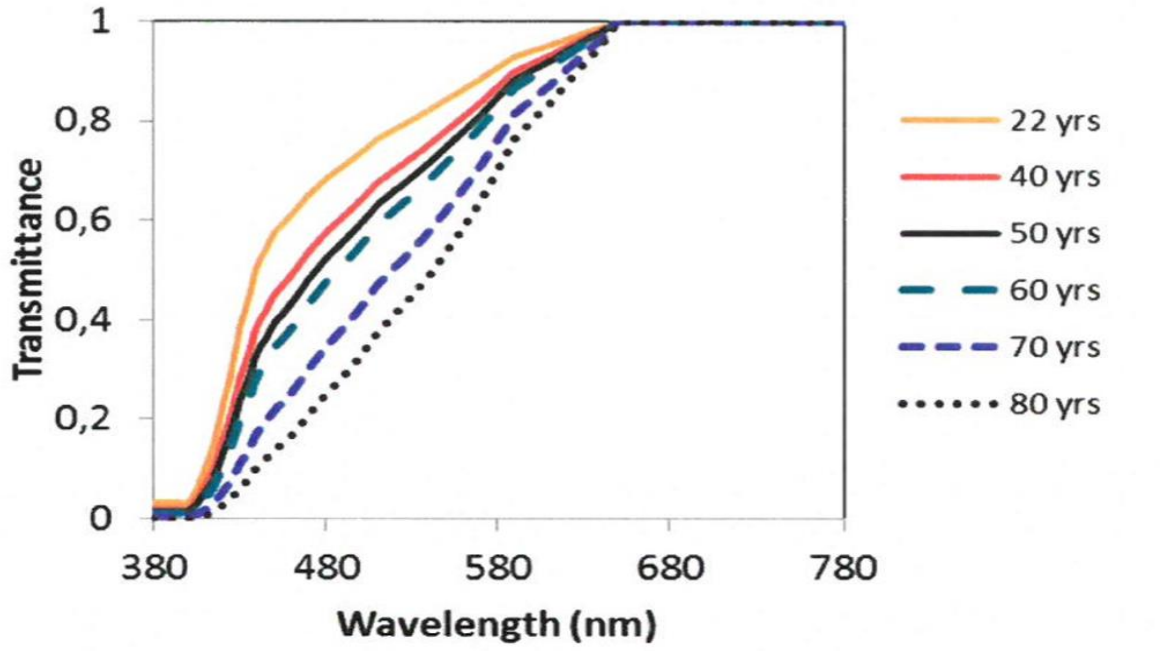


The Axon, also called nerve fibre, portion of a nerve cell (neuron) carries nerve impulses away from the cell body. *Source: Britannica.com*

Ganglion cells are the major output cells of the retina. Their axons gather at the optic disk, where they become myelinated (enclosed in a myelin sheath) and form the optic nerve. As their message is conveyed over a significant distance, it is encoded as trains of spikes

Source: Wikipedia

5.5 Decreased retinal illuminance with less blue content



Spectral transmittance of the human crystalline lens with different age groups

Sources:

- *lens photos: S. Lerman, 1980*
- *Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017*
- *Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP*

5.6 Slower dark adaptation

Older people experience substantial delays in adapting to darkness as they need longer photo-stress recovery time to allow the retinal pigments to recover after they had been bleached by a bright light source e.g. looking into a glare source. During this longer recovery time, the visual system is in a transient state of insensitivity in which after-images of the glare source are being seen, deteriorating night-time traffic safety.

Sources:

- *Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017*
- *Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP*

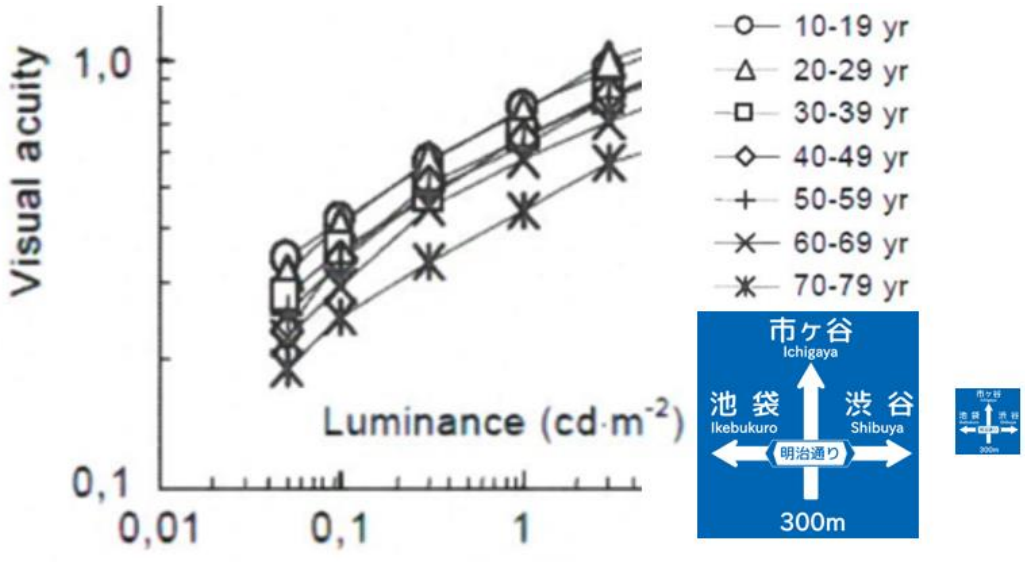
5.7 Reduced spatial contrast sensitivity (young people)

Source :Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP

5.8 Reduced spatial contrast sensitivity (old people) due to increased intraocular light scatter and neural factors

Source :Worldwide Demographic Development... | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP

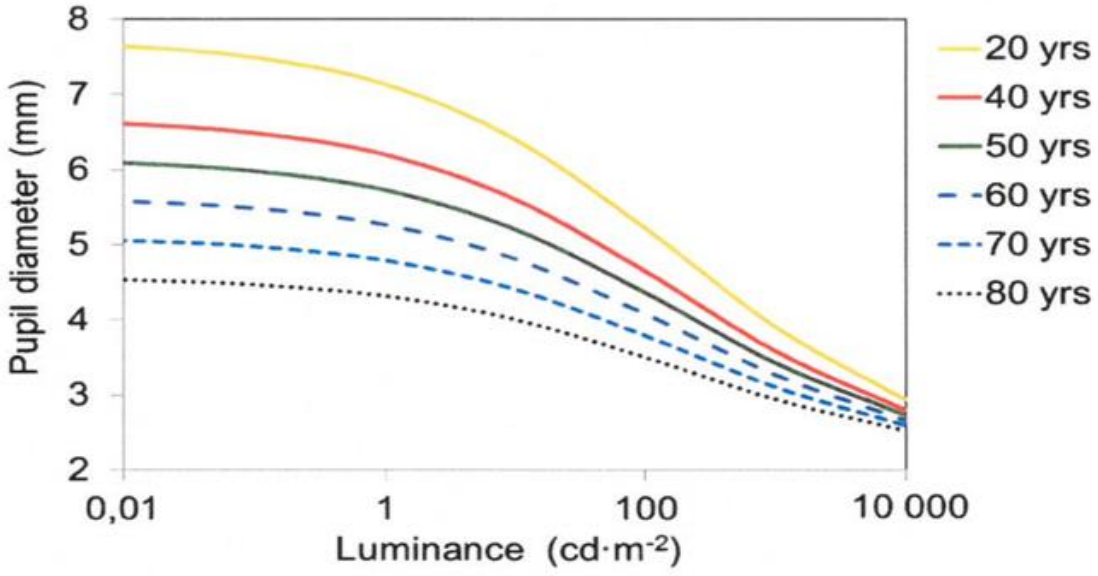
5.9 Reduced visual acuity



Sources:

- *Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017*
- *Worldwide Demographic Development… | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP*

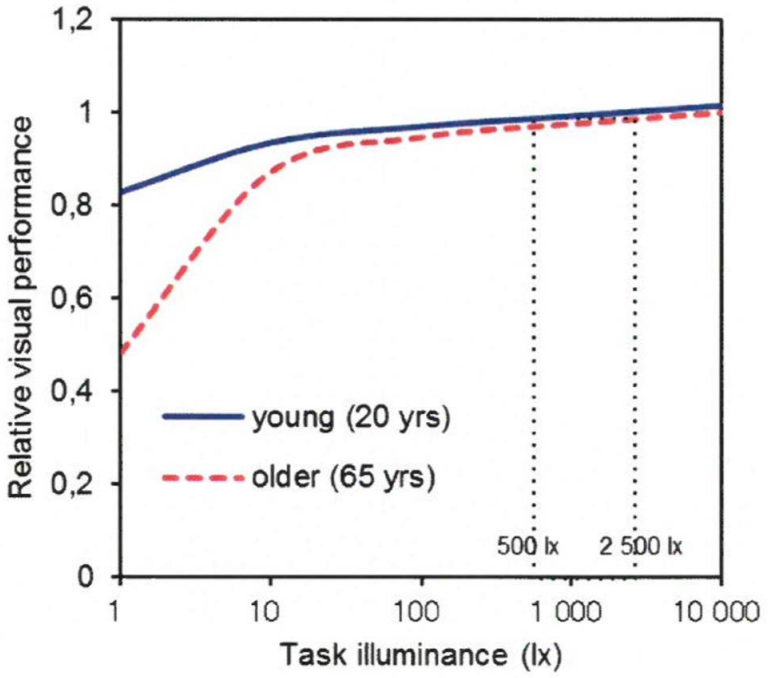
5.10 Age-related pupil reduction



Sources:

- *Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017*
- *Worldwide Demographic Development… | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP*

5.11 Relative visual performance



Relative visual performance (RVP) model:

Input: Adaptation luminance and CCT, target size and shape, target contrast (chromatic, achromatic)

Output: Contrast Sensitivity, Detection Probability, Detection Contrast Threshold, visual acuity, search performance, reaction time visual performance

Sources:

- *Lighting for Older People and People with Visual Impairment in Buildings; CIE Publ. 227:2017*
- *Worldwide Demographic Development… | Bodrogi, Khanh | 2018 DVN TOKYO WORKSHOP*

6 The issues of Glare and Visibility The 2018 GTB Forum – UN GRE Geneva

The closely linked issues of Glare and Visibility have been extensively discussed and researched but no clear conclusions have resulted.

In conjunction with the October 2018 session of the UN Working party on lighting and light-signalling (GRE), held in Geneva, the International Automotive Lighting and light-signalling expert group (GTB) organised a forum to assist the GRE experts to understand the many issues surrounding the global debate relating to glare and visibility, Experts from academic research institutes of universities in Asia, Europe, and the USA were invited to present their findings. The emphasis was focused on the scientific issues and the forum was deliberately arranged to exclude presentations from representatives of industry.

The forum was organised by Dr Rainer Neumann and Gert Langhammer, chair and secretary of the GTB Safety & Visual Performance (SVP) Working Group (respectively) and was moderated by Dr Bart Terburg, GTB Vice-President. The speakers and their topics were:

Elderly People, General Visibility Versus Glare and Headlamp Cleaning in Automotive Lighting
(Jonas Kobbert, M.Sc. • TU Darmstadt, Germany)

Recent Study on Benefits of ADB
(Prof Dr Dirk Meyer • THM Gießen, Germany)

Visibility Under Adverse Weather Condition in Automotive Lighting
(Prof Chan-Su Lee • Yeungnam University, Korea)

Importance of Visibility Improvements for Safety in Automotive Lighting
(Dr Michael Flannagan • UMTRI, University of Michigan, USA)

Headlamp Light Performance Evaluation
(Dr John Bullough • Rensselaer Polytechnic Institute Lighting Research Centre, USA)

Glare and Visibility by Headlight for Pedestrian and Elderly Driver
(Dr Yoshiro Aoki • National Traffic Safety and Environment Laboratory, Japan)

Glare and Visibility by Headlamps with Different Control Strategies
(Prof Yandan Lin • Fudan University, China & Chinese Technical Committee of CIE)

The main takeaway points were:

- Although governments receive many complaints, glare is a very complex subject, discomfort glare is difficult to quantify and includes psychological factors.
- There are no data to indicate that glare is a major cause of crashes.
- Headlamp misaim and road geometry are the overwhelming factors that provoke complaints about glare.
- New adaptive technologies such as ADB (see paragraph 7) offer the potential to overcome the compromise between glare and visibility.
-

Other factors that provoke complaints about glare

A quick search of the internet shows that there is an enormous amount written about headlamp glare and also many references to the effects of glare on elderly drivers. However, it is not easy to find any specific data to indicate that glare complaints increase with driver age, although this could be reasonably expected.

7 Adaptive Driving Beam (ADB)

The adaptive driving beam (ADB) works by projecting as much light as far ahead of the vehicle as possible, except where other road users could be glared by it. The objective is to provide the driver with the forward vision of the driving-beam whilst maintaining the regulated glare levels to other vulnerable road users.

The ADB is a system comprising a camera, image processing technology and software to control the LED matrix and adapt the beam pattern to the road and traffic scene ahead of the driver's vehicle.

ADB benefits all vulnerable road users. The driver of a car equipped with ADB experiences increased visibility distance during meeting and overtaking while other vulnerable road users meeting, or being overtaken by, a car fitted with ADB will experience no additional glare.

The following images briefly illustrate the operating principle of ADB:

The camera is used to detect and keep track of the positions of other road users, so one of the first difficulties was to achieve a reliable identification of road users and features, and to distinguish among them to allow an appropriate response to leading cars, oncoming cars, retroreflective signs, and so on.

The first ADB was a mechanical system introduced in 2010 and was considered one of the most important breakthroughs in the history of vehicle lighting. Very quickly, everyone involved in automotive lighting began striving to improve ADB performance and functionality.
Four years later, in 2016, another significant milestone was the presentation of a lighting system with

84 LED pixels; the multibeam system on the Mercedes E-Class. A very special approach by Mercedes was the introduction of the LED pixel light source module, an optical interface, and a separate electronic module, out of the headlamp. In the next generation the headlamp manufacturers further improved ADB with the arrival of µLEDs

ADB is becoming a standard fitment in premium cars and an option on lower-segment vehicles. This is resulting in increasing volumes, further development, and decreasing prices. As a very effective safety system which can save lives, ADB has the potential of becoming mandatory across the world.

During the next five years, the competition for high-definition modules will be mainly between micro-LED and DLP* technologies, each now have clear cost reduction perspectives. Despite their handicap of lower pixel definition, µLEDs will take a major part of the market thanks to their better energy efficiency and better cost and packaging.

**(DLP) Digital Light Processing, is chipsets based on optical micro-electro-mechanical technology using a digital micromirror device*.

8 The issue of light-pollution

New lighting technologies provide opportunities to use lighting to create appealing designs, as marketing features attractive to the customer. This was the subject of the DVN 2021 Study "Lighting under Pressure – Leveraging Tensions Between Design, Marketing, and Engineering". However, some

of these design features may add to the difficulties for elderly drivers by increasing the disability glare and reducing the ability to see the road surface and obstacles in the forward path of the vehicle.

Now, based upon my actual experience, I can understand how “light pollution” can affect the ability of elderly car drivers to retain their mobility and independence. Industry has reached the stage where almost any lighting function is possible. We all see many instances where lighting is used, not only in automotive applications but also for street advertising, illumination of buildings and for external solutions for domestic security. This adds to the light pollution that can affect a driver’s ability to detect objects and hazards. There is even a glare hazard produced increasingly by lamps mounted on the humble bicycle. LED cycle lamps certainly make the bicycle more visible and improve forward vision for the cyclist but, at the same time they create disability glare if not correctly aligned and most cyclists are not even aware of the discomfort they are causing for other road users.

The new adaptive technologies, and in many cases the regulations, are available to address the issues of light pollution that affect all drivers, but particularly the ageing drivers. The lighting installed on vehicles needs to have a performance adapted to its surroundings. For example:

1. A rear foglamp is indispensable in conditions of low visibility to signal the presence of a preceding vehicle, but as soon as the vehicle immediately behind has noticed its presence the high intensity of the rear foglamp becomes disturbing.
2. A high performance headlamp is very necessary on the open road but in heavy traffic and particularly in built-up areas and particularly in mega cities it becomes disturbing.
3. Automatic switching of headlamps is a very useful feature provided the driver is educated to its advantages and disadvantages. However we all see many cases where a driver is sitting in a parked car with the engine still operating and not realising that his headlamps are causing serious discomfort to opposing traffic.
4. Lighting systems, creating designs that emphasise a vehicle brand identity, are attractive and cause no problems in daytime but they should be carefully considered when activated at night time because they can add to the overall light pollution in heavy traffic. Maybe it is necessary to be clear that the busy roads should not be used as a night-time showroom!

These examples are offered to illustrate the point that good lighting is essential when used correctly but it can also have its disadvantages if abused. This is a nightmare for regulators who want to avoid barriers to trade but at the same time have to ensure that safety is not compromised.

9 The Dilemma and Challenges for the Regulators

The task of the regulators in respect to road and traffic safety is to lay down in national legislation minimum standards and requirements for road infrastructure, vehicle construction, performance and use, and human performance and behaviour for both drivers and other road users. Road infrastructure includes layout, and lighting where appropriate, and these aspects become more important with the increasing age of the driver and other vulnerable users. Human performance encompasses cognitive and visual aspects that lead to requirements for verification of driver health , vision and physical ability.

The UK Department for Transport published its “ Road Safety Statement 2019” that provides a very good insight into the thinking of regulators and contains an interesting section concerning “Third-age adults: safety as you get older”. Here are a few points extracted from the statement:

- “Road users' knowledge, experience and skills develop with experience over time. But they can also deteriorate based on age, experience and declining cognitive and physical capability. As the

UK's population ages, it is crucial that older people are able to maintain the skills and confidence required to remain safe and effective drivers".

- "It is important that people live an active and healthy life into older age. For that, people of all ages need the knowledge, skills and confidence to use a wide range of travel options safely. Age should not be a barrier to any mode of transport, be it driving, riding a bicycle or horse, or walking. And age itself does not give an indicator of how fit a person is to drive. There are many older drivers who self-regulate and drive only when they feel comfortable to do so, for example, they may only drive on roads they are familiar with, and/or restrict themselves to daytime driving only."
- "Both regulators and consumer information providers, such as Euro NCAP, recognise the need for safety diversity, and this means encouraging vehicle manufacturers to deliver safer vehicles for all occupants, irrespective of gender, age or stature."
- "Regardless of age, drivers have a legal duty to ensure that they are medically fit to drive, to make sure that they have good eyesight to enable them to do so, and to notify the Driver and Vehicle Licensing Agency (DVLA) of the onset or worsening of a medical condition affecting their capability to drive. While we know that visual abilities and cognitive functions which impact on reaction times decline with age, the relationship between age and functional decline is not linear. The process of licence renewal at age 70, and then every three years thereafter, serves as a timely reminder for older people to consider their driving choices. However, further research is required to understand the extent to which vision issues pose a risk to road safety for drivers of all ages.
- "The fitness required for driving is not just about good eyesight - manoeuvrability and reaction time are also essential. But good eyesight is important. We are minded to consider that there may be a case for mandatory eyesight tests at 70 and at three-year intervals thereafter, to coincide with licence renewal. We are launching a research programme and literature review, in partnership with DVLA, to assess how far poor vision is or may itself become a road safety problem in the UK, and if there is a requirement for a new vision test to identify drivers who pose a collision risk. In parallel, older drivers will be a permanent agenda item on the appropriate Secretary of State's Medical Advisory Panel, facilitated by DVLA, to ensure expert advice feeds into the research.

This reference to the thinking of the UK Regulators is taken as a good example of the considerations of regulators in many governments worldwide. Other examples are easily found by searching the internet.

10 Can new technologies provide an answer?

This chapter attempts to identify some ideas for utilising the new lighting technologies to assist elderly drivers in night-time conditions and all drivers in urban areas, including megacities where streetlighting is present. It is assumed that the elderly drivers are not suffering with cataracts or other eye conditions that can be successfully treated.

10.1 Technologies to address glare issues for all drivers in urban areas, including megacities

In general driving conditions, with the exception of ADB (Adaptive Driving Beam), new technologies to address the general issue of glare are not available as discussed in Chapter 10 above. ADB is proven to offer significant advantages for the driver's forward visibility, while maintaining existing regulated

glare levels. The effectiveness of ADB to reduce collisions has been confirmed by analysis of accident data.

In urban driving, regulators have searched a headlamp beam pattern that moves the emphasis from long range forward vision to a pattern that produces significantly less glare to other vulnerable road users and, in theory this is possible because of higher traffic densities and street lighting is present.

In 1975, the Commission Internationale de l'Éclairage (CIE) recommended that a 'town beam' be introduced, having an intensity between that of the currently used low beam and side lights. The CIE committee, working on automotive lighting and signalling, recommended that all relevant organisations should consider introducing requirements for a town beam as an essential part of the lighting systems for road traffic. It believed such a beam would provide conspicuous and glare-free front lighting on vehicles and suggested the beam could be simply realised by using the existing dipped beam headlamp operated at a lower voltage. The UK was the only country to incorporate requirements in its national legislation requiring dim-dip to be installed on all cars, buses and trucks first used after 1 April 1987. This mandatory requirement was to satisfy strong lobbying to address glare complaints from various organisations, but it was opposed by manufacturers and was not supported by other European countries. In 1988 the UK accepted to fall in line with the EU regulations and in particular, the requirements for accurate headlamp aim.

The ideas to introduce “dim-dip” or a new “town beam pattern” have not proven successful because such a town beam with a simple on/off switch do not provide a solution because they would depend on a driver’s judgement about when the should be activated, according to the ambient conditions; presence and quality of street lighting, presence of other traffic, etc.

The growing installation of ADB systems now provides an opportunity to develop an automatically adaptable feature to produce the correct road illumination according to the urban conditions. This should be primarily a technological challenge with only minor regulatory amendments.

10.2 Technologies to reduce the glare load of signalling lamps in heavy traffic

For many decades it has been recognised that the luminous intensities of signalling lights necessary for daytime can be excessive in night-time driving conditions and the regulations initially allowed two-levels, for daytime and night-time. More recently, adaptive signalling lights have been introduced into the regulations but, so far, there are only few such systems installed on vehicles.

In heavy night-time traffic, for the benefit of all drivers and not only ageing drivers, there seems to be a logical argument that the glare load of a mass of bright position and stop lamps can be reduced. The problem of drivers of vehicles with automatic transmission keeping their foot on the brake-pedal certainly needs to be addressed.

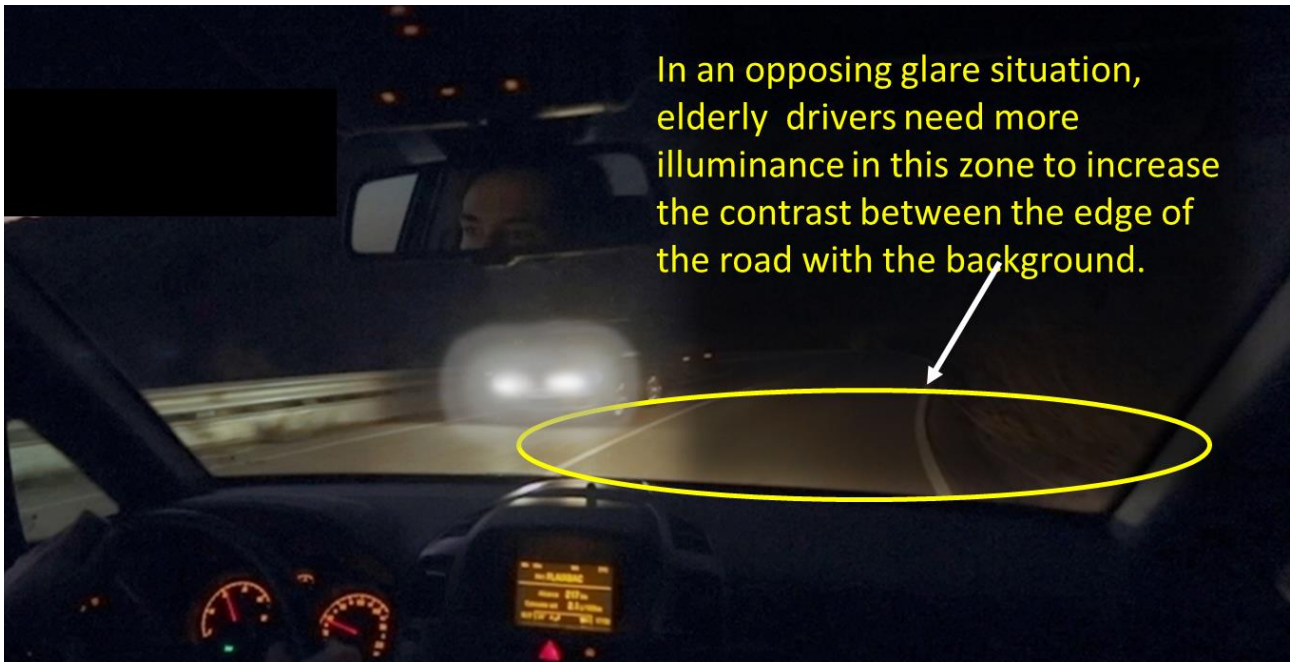
Maybe it is time to exploit the extensive capabilities of adaptive signal-lighting systems to adjust their luminous intensities according to many varied conditions, including ambient lighting conditions, vehicle proximity, traffic speed, traffic density, etc. This would obviously be dependent upon sensors to make these adaptations automatic, taking the decision out of the responsibility of the driver.

This discussion is closely connected with Chapter 11, discussing "light pollution" issues.

10.3 Technologies to assist elderly drivers in night-time conditions

As Dr Bodrogi concluded, "the current regulatory requirements are written for young to middle aged observers, but elderly people need more light and more contrast with less glare. In comparison to young people (around 25 years), older subjects (60-66 years) need double contrast and double illuminance (in lx) and 50 % of glare load in order to have the same visual performance". This implies that a headlamp beam distribution should be capable of adaption to these special needs but it is unlikely that technology will be able to satisfy the requirement of a 50% reduction in glare load.

The current the UN AFS (Adaptive Front-lighting System) regulations have a provision for a town lighting function but this option has not been exploited. Under the context of ADB systems it should be possible to provide an elderly night driver the option to choose an alternative beam distribution biased toward the wide angled foreground. This means significantly more illuminance to improve their ability to follow the nearside edge of the road by increasing the contrast. For drivers having difficulty to follow the road because they are unable to identify obstacles there is no value in offering more illuminance in the 50m-plus range, they need more light in the foreground to help them move their focus away from the glare source. When faced with glare causing disability, the driver's instinctive reaction will be to slow down and to concentrate on holding a safe position and trajectory, so more illuminance in the foreground becomes essential.



11 Conclusion

a) There is a need for the automotive lighting community to consider how to address the demographic issues of ageing population and mega-cities. It is a question of industry willingness to add new functionalities for all vehicles and there are no major regulatory barriers.

b) Adaptive technologies will be the key and should be available for all vehicles.

c) ADB is likely to provide the platform, and it should be relatively easy to add additional functionality to new vehicles equipped with ADB and perhaps also existing vehicles in circulation. There are arguments that ADB should be mandated, or more likely, included in NCAP ratings to encourage uptake.

d) The question remains, concerning how technology can be made available to address the specific problems of the ageing drivers. This is not straight-forward because many ageing drivers will not be buying new vehicles, or will be buying small cars that do not have ADB installed.

e) To address the problem of the ageing driver, an “additional visibility” function should be introduced to provide more contrast and overcome adaption issues in oncoming glare situations. In addition to incorporating this function as part of and ADB system, there may be an opportunity to develop a retrofit headlamp or other device to provide the extra foreground illuminance that can be optionally activated as required by the driver. However, a good driver education initative would be required to

f) To overcome glare from signal lamps, smart adaptive systems should be considered and perhaps more attention to the effects of “light pollution” is necessary.

g) There are research findings from the USA concluding that the problems of the high intensity of emergency lamps can be addressed and our automotive lighting community should takes these into consideration.

h) It should be stressed that the vehicle lighting community should focus exclusively on finding lighting solutions to assist elderly drivers who meet all the requirements to hold a license to drive. The task therefore is to focus on the means to reduce the glare load, increase contrast and increase road illumination. It is the role of governments to regulate the requirements for frequent eye tests to ensure that drivers have regular corrections to their lens prescription (when cataracts are not present!)

Final Comment

This report is an attempt to provide an overview of the issues of demographic change associated with automotive lighting. This report is not pretending to propose specific solutions, but is intended to provoke discussion in our lighting community, including the NGO's having an advisory role at the UN working parties in Geneva.

Regulatory barriers are not foreseen in regards to the issues discussed in this report and, to the contrary, it may be advantageous to end users and manufacturers to develop requirements to be introduced into NCAP rating systems.

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