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- A TOOL FOR EVALUATING AND INTERVENING IN THE AD'AGIO PROJECT
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RIVISTA ITALIANA DI ERGONOMIA

THE RIVISTA ITALIANA DI ERGONOMIA, *of the S.I.E. - Italian Society of Ergonomics, is a scientific journal that operates nationally and internationally for the promotion and development of ergonomics and the study of human factors, and the dissemination and systematization of knowledge and experiences related to the ergonomic approach, in close relationship with the social, environmental and productive realities where human beings, operate and live, coherently with the goals of the SIE.*

Supported by an international scientific committee and using a double-blind reviewing process, the journal publishes original contributions from research and applications on ergonomic issues, in its various aspects and related to the different contexts and human activities.

The RIVISTA ITALIANA DI ERGONOMIA *is aimed at ergonomic professionals and all those interested in applying the principles and methods of ergonomics / human factors in the design, planning and management of technical and social systems, in work or in leisure.*

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EDITORIAL

ERMINIA ATTAIANESE

Health and wellbeing in the framework of sustainability

Since the 2022 numbers, the Rivista Italiana di Ergonomia started a structured discussion to reflect on the synergies and intersections between Human Factors/Ergonomics and Sustainability. The topic is not new in the international debate; since 2008 the International Ergonomics Association endorsed the "Human Factors and Sustainable Development" Technical Committee, and "Designing a Sustainable Future" was the title of the 18th Triennial Congress of the IEA held in Recife, Brazil, in 2012. Since then, the interest on this topic has progressively grown and a large number of contributions fuelled the scientific debate at international level. However, in Italy the interest on the relations between Human Factors/Ergonomics and Sustainable Development remained sporadic. For these reasons, the Rivista Italiana di Ergonomia wanted to continue the initial discussions started in 2022 by focusing the journal on emerging issues that have international resonance, with the ultimate aim to look for potential convergences with the Sustainable Development Goals.

The Number 26 of the Rivista Italiana di Ergonomia addresses the ambitious goal of exploring the contribution of Human Factors/Ergonomics in the health and wellbeing sector, between the scenario of present and future demands of sustainabile interventions. As we know, health and wellbeing are two concepts that are well-known to ergonomists, traditionally connected to Human Factors/Ergonomics' theories and practices. But in a global perspective they assume new meanings related to multiple health demands, often conflicting: increasingly dynamic needs, life courses and multigenerational

issues that go beyond the personal dimensions by embracing the social, community and planet instances.
What is the role of Human Factors/Ergonomics in understanding the deep connections between health and the environment? How can the Human Factors/Ergonomics approach be more inclusive so that it can support the emerging health-related needs at both human and planet dimension? What role does Human Factors/Ergonomics play in conceiving technologies and services to support “healthy links” for all humans in a sustainable way? What are the most suitable person-centred models to improve health and wellbeing and to boost people autonomy and inclusion in a long-life perspective? These are only few of the main questions that the Volume 26 of the Rivista Italiana di Ergonomia intends to address at national and international levels. A special thanks to co-editors of this number, Alessia Brischetto e Mattia Pistolesi, for the competence and careful guidance with which they coordinated this Volume.

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Digital and physical ergonomics towards a new-old generation of self-driving cars

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Keywords: Design for the elderly, inclusive mobility, innovative vehicles, self-driving cars.

Abstract

In the context of the aging society and digitalization, this contribution aims to illustrate how a more inclusive and ergonomic approach can enhance well-being related to the daily mobility of the elderly. In the first part of the contribution the most important factors influencing the elderly's mobility needs are highlighted, and then are analysed with two significant cases of autonomous vehicles for older users. Autonomous cars have the potential to enhance the safety and efficiency of silver mobility with two types of intervention: digital ergonomics offers great flexibility with the potential to simplify functions and graphics layout, while physical ergonomics can explore new shapes and functions to make transportation technology more intuitive for seniors.

Introduction

The overall current scenario can be considered as an antinomy: on the one hand, the current context is characterized by an increas-

ingly rapid (but not always positive) technological and economic development; on the other hand, society - as it grows older - demands a slowdown, greater comprehensibility, acceptability and inclusiveness of technology. This is particularly true for the technology helpful in traveling and enabling the elderly population to maintain its independence, in their daily and weekly routine activities. In today's market, there are already specific solutions for the elderly, such as four-wheeled electric scooters, but very often this high specificity on the product - although it allows the elderly to move around independently - leads to stigmatizing the elder person as a weak person, not up to date, slow, unfit for social and working life.

Designing suitable mobility for the elderly is not only an ethical requirement but a concrete issue for the mobility of the future. This conviction is also supported by the Nielsen Norman Group (Experience, n.d.) which not only considers older people an important part of the next society but also emphasizes their ability to spend on products and services that can solve their real problems, especially when it comes to maintaining their daily routines and their health.

For these and other reasons, it is, therefore, necessary to begin to consider mobility, no longer exclusively linked to the traditional values of speed, power, and success but also to values more related to a cooperative space, no longer the domain of the driver alone, but an amplifier of social interactions especially for elderly people which normally are excluded to the driving tasks due to their natural muscular and cognitive decline.

Aiming to include elderly people in the travel population, it is worthed to focus on three kinds of issues when involved in the design of artifacts, services, and interfaces for older people: sensory, physical, and cognitive limitations (Young et al., 2017).

Older people naturally show a progressive decline in all 5 senses but particularly in sight, hearing, and touch. Considering vision, elderly people often have problems reading very small texts and distinguishing colors, especially in non-optimal visibility conditions. Within a vehicle, these difficulties could be overcome through adequate use of font size, the correct frequency and quantity of information presented, and by using more than one sense the communication between vehicle and user. Messages and actions could be sent with a combination of visual, auditory, and tactile stimuli always taking into account possible problems with high-frequency sounds (Corso, 1981) and the lower sensitivity to touch and vibration that the elderly

usually present (Gescheider et al., 1994).

Elderly people are also likely to suffer from physical decline that can affect their mobility while using private or public transport. As a consequence, the elderly present reduced flexibility and coordination which have a negative influence on the proper use of the car equipment. Several research projects carried out with the intent to improve elderly mobility have been focused on the facilitation of the vehicle interface including slower steps and clearer pauses to compensate for muscle weaknesses, slower comprehension, and stiff joints.

Last, but not least, there are difficulties related to the elderly comprehension and their slower information processing (Eby et al., 2016; Johnson & Finn, 2017; Salthouse, 2010; Yang & Coughlin, 2014). These difficulties are particularly significant when it is necessary to stay focused on several tasks all at once like normally it occurs while driving. In fact, in the common driving experience, the attention is split between the standard car movement operations - normally, the pedals and steering wheel usage - and the information processing from the inside or the outside of the vehicle. Therefore, while designing interfaces or vehicles for frail people like the elderly, it is crucial to design proper information flows that take into account the slower cognitive process of the elderly. Hence, an interface design with an inclusive intent should consider the correct information timing aiming to reduce distraction, confusion, or mental overload (Koppel et al., 2009).

After having introduced the aging society trends and the relative influence on the design of services, products, and interfaces it is worth it to dive deep into the factors that influence the needs of the elderly about mobility.

Factors influencing the elderly's needs for mobility

Providing a transportation system able to meet the needs of older people is a complex aim, especially considering differences in people's health status, social and cultural background, and travel requirements (Luiu et al., 2018). Scientific research about gerontological mobility shows that the use of transport decreases with the deterioration of health status, causing a reduction of accessibility to transportation (Haustein et al., 2013). Understanding which specific factors impact the fulfillment of the elderly's needs can influence

stakeholders as service providers and policymakers in providing those users with better ways of accessing and using transport.
The worsening of health conditions diminishes the elderly outdoor activities, especially leisure ones. In particular, health issues can affect the ability to board the vehicle and drive it, making necessary the assistance of another person, and causing the shift from driver to passenger, with a consequent limitation of independence and the feeling of being a burden for others (Musselwhite, 2017).
According to Luiu et al. (2018), the fulfillment of the elderly's needs for traveling is related not only to the transportation environment but also to other elements creating a complex framework, and providing useful information to analyse different specific situations. The analysis of those elements can provide a great amount of details and data useful to properly describe the chosen group of older users, and then design specific solutions.
Identified impacting factors are:

- *Demographics*: It provides some data useful to assess a background profile, some characteristics, human factors, and daily habits of the involved category of users. Examples of individual peculiarities and living habits are data are age, gender, weight, origins, education level, occupation, place of residence, cohabitants, and relationships with the community.
- *Health and well-being*: It concerns personal health conditions and the impairments that could affect mobility and transportation abilities. This element includes even qualitative information such as the individual perception of well-being, satisfaction with one's lifestyle, and feelings about the personal quality of life.
- *Built environment*: It provides information about the urban living context, the urban transportation public services, transportation infrastructure quality, and availability of facilities without using transport.
- *Activities*: It regards the personal attitude and abilities of the user related to transportation and the consideration given to proposed activities. It also regards the destinations and frequency of their journeys and frequently encountered difficulties in traveling.
- *Transportation*: It regards traveling options and the physical access to transport modalities, the personal attitude towards traveling, the ability to drive and plan journeys, and the options for non-driving people. Examples are car availability, presence

of driving license, frequency of use and typology of used transportation means, issues in public mobility services, and attitude in planning travels.

Among the analysed factors, several scientific research analyses demonstrated that the elements most influencing the relationship with out-of-home mobility are the person's health conditions and access to transport (Kim, 2011; Luiu et al., 2018).

In particular, health conditions greatly influence access to transport, limiting the independent use of the personal car in favour of other solutions like involving another person as the driver, using public transport (not always accessible), and moving by walk (not always physically possible). In these cases, the restricted access to transport causes a significant reduction of outdoor activities for older people, contributing to their isolation and need for personal assistance.

Influencing factors like demographics, built environment, and activities, have a lower impact on the usability of artifacts, services, and interfaces for aging people.

These elements make it evident that the design of new typologies of vehicles is a key research field to ensure aged drivers have appropriate solutions for their instances. Sensory, motor, and cognitive issues can be partially overcome by ergonomic solutions improving the physical and digital accessibility of designed solutions.

Future perspectives for self-driving cars addressed to older users

Considering the worldwide aging trend, the growing number of aged drivers will exponentially increase in the coming years. Compared to nowadays drivers, they will be healthier and hold more resources to preserve their favourite ways to live their everyday lives. These people will be highly automobile-dependent and used to moving on their own more than the previous generations of drivers, who have given up the independence of autonomous driving with less suffering (Alsnih & Hensher, 2003).

Following this perspective, one of the current potentially disruptive innovations characterizing the automotive industry is the advent of self-driving cars. This change could affect not only the shape and functions of the vehicle but even the design of cities and infrastructures, beyond the interaction between the user and the automobile. Besides, the potential removal of drivers from driving would avoid

issues deriving from human factors, like age-related ones, and consequently improve key aspects such as safety, journey planning, fuel efficiency, and other issues related to mobility (Ahmed et al., 2022).
Generally, there is a lack of empirical evidence of the most important requirements from the users' point of view, focusing the design process on technicians' inputs, rather than orienting it to the customer's acceptance (König & Neumayr, 2017). When new self-driving cars were initially widely presented to the public, the more sophisticated the car level of automation, the more users were skeptical about it (Bekiaris & Petica, 1997). In recent years, a more positive opinion of self-driving cars and related technologies has been detected, even if some perplexities and concerns remain (Kyriakidis et al., 2014).
Older users' resistance and caution to radical innovations are crucial for the development of new products and services. They often show a sort of irrational distrust towards everything unknown and unfamiliar. Especially with cars, the driving experience is conceived as something "adventurous, thrilling and pleasurable" (Steg, 2005), and for many expert drivers, this makes it difficult to grant the driving task to the car.
Understanding instances and requirements of future aging drivers can support the development of technological and non-technological solutions able to innovate the sector of elderly mobility by introducing new typologies of artifacts, providing safe and satisfying experiences to this category of users. In particular, individual health conditions and the vehicle's accessibility should be priority factors.
Car designers are now thrilled to seize the opportunity of revolutionizing the concept of mobility with self-driving vehicles, considering consumers' preferences and behaviours. Re-thinking the car's design and interaction model, avoiding traditional constraints such as the passenger's visibility, the seating position, and the control panels, opens new possibilities for solutions improving ergonomics and accessibility by exploring new form factors accommodating an innovative user experience.

Case study

The advent of electrical and autonomous vehicles has opened a new scenario for automotive designers which has to deal with new needs especially coming from an aging society together with the removal of the traditional interface. Among the numerous projects all over the world about Autonomous vehicles for elderly people here are

presented two significant case studies.

The first case study is Flourish, a three-year research project recently developed in the United Kingdom (2015-2019) by many automotive industries and the Centre for Connected and Autonomous Vehicles (CCAV). Based on autonomous driving systems technology, the project focused on developing new mobility alternatives for older adults that can enhance their accessibility and inclusivity to transport services.

The project is based on creating a mobility service for older adults that uses autonomous two-person pod vehicles that enable users to travel in urban contexts safely and inclusively.

The vehicle itself has special morphological aspects that are different from the forms of traditional vehicles. For example, the horizontal plane of the electric vehicle allows greater accessibility of the vehicle ingress and egress for people with reduced mobility. The orientation, the decentralized arrangement, and the orientation of the seats offer greater space for movement and dialogue between older people, fostering greater sociability inside the vehicle (Figure 1).

Figure 1. *The Flourish autonomous pod during a demonstrative public test. More information at http://www.flourishmobility.com/about-flourish.*

The peculiarity of the Flourish service lies in the design of its interface. The project has used a human-centered and participatory approach with users to foster interactions and configurations that are understandable and accessible, suitable for the elderly who may have reduced abilities or physical and cognitive impairments.

Flourish reduces driving-related interactions by using an essential dashboard with a single large screen that offers simplified functions and clear information on the status of the journey to maintain an intuitive use of the transport service. The interface allows either tactile interactions with the touch screen or conversational dialogue through a user voice interface for blind people or older adults with limited hand movement. The long and complex “planning a journey” function is broken down into many manageable steps and guided through simple questions such as "Where would you like to go?" or "Would you like to add a stop to your journey?", which allows users to complete the task of selecting the destination place calmly and efficiently.

Furthermore, the system keeps users informed and aware of where they are in their journey by viewing their journey information at a glance via a map or as a timeline. While notifications on screen, or voice messages communicate what is happening around the urban environment, making the vehicle behaviours visible and transparent to the passengers.

Finally, the artificial intelligence of the driving system offers a flexible system that adapts to users' preferences, learning not only from their needs related to the appearance of the interface itself, such as appearance, information, and interaction but also from their regular destinations. This allows the service to provide users with tailored experiences about their more frequent trips, suggest new recommendations of places to visit, and events to go to, or offer information about the surrounding area according to their needs (Figure 2).

***Figure 2**. An elderly person is interacting with the Flourish interface. The option “planning journey” is visually simplified and broken down in easy steps to make the selection of the destination place easier and accessible to older adults More information at http://www.flourishmobility.com/about-flourish.*

The second case is the "Elliot" trial a three months research project conducted in South Australia in 2019 by the Global Centre for modern aging (GCMA) in collaboration with the AURRIGO autonomous vehicle company, the e Government of South Australia Department of Planning, Transport & Infrastructure (DPTI) and the Alexandrina Council and the Regional Development Australia.

The project aimed to test local elderly attitudes and perceptions towards autonomous vehicles (AV), the reason behind the use of the AV, and the user experience with a special focus on the space perception of the inner part of the vehicle.

Several key insights revealed an overall positive attitude towards AV with the majority of the elderly users considering the experience as useful and trustworthy and a convenient replacement of their vehicle (Figure 3).

Figure 3. *One of the "Elliot" autonomous trials in South Australia while tested by three elderly users and 1 chaperone. More information at https://rdahc.com.au/wp-content/uploads/2019/04/Aurrigo-Elliot-Autonomous-Vehicle-Trial-Summary-Report-FINAL.pdf*

Nevertheless, the research project also highlighted several points of improvement related to physical and cognitive ergonomics.
Regarding the physical ergonomics, the considerations that came out of the project were related to: the user request of having greater accessibility to the vehicle with better support of ramps, the need for different types of vehicle accordion to the size of the group, and the need for a larger space available for their animals, their walking aids or wheelchairs.
Considering the cognitive ergonomics, besides the fact the perception of the vehicle as safe, new, quiet, and useful several suggestions were made to improve the understanding of the overall functions. Suggestions were made about the possibility of having a phone application to guide the elder through the trial experience as well as the possibility of customizing the interior with some entertainment such as music or the regulation of the temperature inside the cabin.
Furthermore, the service could have been more enjoyable if it was designed door-to-door to accomplish their daily travel in the surrounding community, including shops. Margins of improvements were also related to the weather and availability of the pods which can be a valid alternative to walking especially during winter or in particularly rainy periods. Finally, the autonomous vehicle was perceived as the optimal vehicle to accomplish the last mile between the main route connections and the most remote locations (Figure 4).

Figure 4. The cabin inside the "Elliot" autonomous vehicle. More information at rdahc.com.au/wp-content/uploads/2019/04/Aurrigo-Elliot-Autonomous-Vehicle-Trial-Summary-Report-FINAL.pd

Conclusions

Considering the progressive increase of aging people, giving a new usability perspective to the mobility sector is an incoming and inescapable necessity. Current technologies can provide innovative mobility solutions for older users, giving them a more efficient and safe transportation system increasing comfort, well-being, and social inclusion.

Exploring the elderly's needs is a fundamental activity to understand which requirements can be satisfied by Design Research in the transportation field. Designing mobility for older people is a challenge regarding how it is possible to overcome issues related to motor or cognitive impairments by creating digital and physical solutions able to enhance vehicle accessibility in all phases of the journey.

The paper presents two case studies regarding autonomous vehicles where a highly automated system allows the complete redesign of the passenger's user experience and the vehicle shape, supporting the person in maintaining autonomy and increasing the quality of the traveling experience. The case study is a significant example of autonomous driving because it allows the user to practice non-driving-related activities during the journey, with the only task of selecting the chosen destination. The different relationships between humans and machines can make the mobility experience less stressful and more comfortable due to safety and accessibility improvements. Cars presenting self-driving features seem to be an effective solution to make transport more inclusive for aged drivers; these peculiarities can be divided into two main groups: the digital and the physical ones. The first group regards mainly the service aspects related to digital technologies, characterized by a high level of automation, providing inclusive interfaces with simplified functions and graphic layouts that can easily guide the user through a facilitated and pleasurable non-driving experience. The second group is about the physical features of the vehicle that, free from traditional constraints, can explore new shapes, such as wide screens or boarding platforms, to physically facilitate the user in accessing every aspect of the vehicle. Self-driving cars represent nowadays a great chance to provide efficient solutions to older drivers, opening an innovative design field where experimenting with new useful and meaningful technologies, solutions, strategies, and interactions can produce a more age-friendly future for the elderly.

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