Usability of the Graphic Information, Navigation Systems and Cars for Seniors and Disabled

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USABILITY OF THE GRAPHIC INFORMATION, NAVIGATION SYSTEMS AND CARS FOR SENIORS AND DISABLED

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Authors conducted survey and conversion of information on space and aviation ergonomics to the car, computer, navigation and communication systems design. These achievements and methods are particularly important for the fast growing needs and market of special solutions for elderly and disabled drivers.
New principles ("laws") of automotive ergonomics and methods of individual adaptation of human-computer dialogue were developed based on theory of ergodynamics (Venda and Venda, 1995). They were applied to usability analysis of navigation systems for vision and hearing impaired and other drivers who need a customized car and driver-computer dialogue. We studied experimentally perception of navigation maps by drivers with different vision disabilities (anomalies).
45 people of the ages of 20-30 and 60 subjects of the ages 55-75 with different types of astigmatism participated in the experiment. We displayed information by projecting slides on a screen, with a computer display, with a TV display, LCD panel and with various point lighting matrices. We changed the shape of the symbols, the distance of perception, vision angle, general lighting on the work station, brightness and contrast of the symbols on the screens.

INTRODUCTION

This study was initiated by R. Trybus, N. Venda and V. Venda on the contract with Honda of Americas R&D. The main goal was to survey, convert and use information on space and aviation ergonomics for car design. We summarized a huge body of achievements in the space, aviation and military ergonomics and psychology directly or potentially applicable to the car, on board computer and navigation and communication systems design. These achievements and methods might be particularly important for the fast growing needs and market of special car solutions for elderly drivers. To expand these and other our studies in human factors, work safety and usability, we have organized an International Institute (Network) of Ergonomics and Work Safety. We are interesting in cooperation with international telecommunication, car and navigation systems makers.

SEARCH FOR AND CONVERSION OF ERGONOMIC SOLUTIONS

1. Aviation and space ergonomics in application to the car navigation systems.

The survey is directly applicable to the following tasks:

1.1. Ergonomic Assessment and Design of GPS Driven Maps.

1.2. Individual Adaptation of Driver's Task and Navigation Map.

1.3. Interactive route guidance systems (RGS) for GPS.

1.4. Route Guidance Destination Entry Methods.

1.5. Ergonomic assessment and design of displays for the advanced traveler information system (ATIS).

1.6. Use of infrared based night vision systems in cars.
1.7. Methods of driver's voice analysis to predict stress, fatigue, and prevent emergency situations.
1.8. Methods of recognition of driver's (human operator's) psycho-physiological state.
1.9. Multi-parameter assessment of human psycho-physiological state.
1.10. Design of individually adaptive visual and voice driver-computer dialogue.
We have developed an international computer database on studies in space, aviation and military ergonomics applicable to the car design and other ergonomic projects.

2. Car and Navigation System for Senior and Disabled Drivers.

2.1. Objectives of our International Program: To find out: What do seniors dream to have in their cars? What psychological innovations and ergonomic design of cars we may offer seniors?
2.2. Analysis of psychological, physiological and ergonomic characteristics of elderly driver.
2.3. Ergonomic design: Functional data for the older population
2.4. Sensory changes with age
2.5. Acuity, contrast and color
2.6. Visual field
2.7. Cognitive changes in aging
2.8. Questionnaire on a senior dream car
2.9. Concept of the Senior Dream Car.
For the usability study we developed a questionnaire and questioned 890 senior drivers of the age of 65-80. The questionnaire consisted of 112 questions. So far only preliminary processing was made. The questionnaire is used by our colleagues at InterInErgo in several countries.

SPECIFIC USABILITY FUNCTIONS OF A SENIOR DREAM CAR

Here are examples of usability features of the high priority that were found important to attract elderly customers:
1. Easier to get in and out of the car.
2. To have adequate presentation of safety, navigation and driving information. To communicate automatically in emergency.
4. To have pleasant audiovisual communication.
5. To have a car more visible when it stalled in darkness.
6. Easy to operate controls.
7. Navigation maps adapted to individual perception.
Some other functions:
1. The senior dream car may play role of a friend, personal counsel-coach and nurse in order to:
1.1. Advise senior on ability his/her to drive safely today. For this purpose a questionnaire presented on a touch screen, or through interactive voice recognition system, or in a combined visual-audio system, may ask senior questions and analyze her/his answers about: 1.1.1. Health; 1.1.2. Mood; 1.1.3. Stress, 1.1.4. To compensate psychological consequences of the post-traumatic stress to assist elderly driver in correction of behavior, information and psychological support of drivers and who had severe car accident.
1.2. Test the senior sensory systems:
1.2.1. Vision: acuteness
1.2.2. Vision: color sensitivity
1.2.3. Vision: astigmatism
1.2.4. Hearing: check of sensitivity
1.2.5. Hearing: check of loss in comparison with previous time.
1.3. Test the senior reaction time and ability to process information and predict dynamics of the road situation
1.4. Test the senior motion coordination
1.5. Test the senior mental abilities
1.6. Test the senior memory, attention concentration and distribution
1.7. Measure the senior:
1.7.1. Blood pressure
1.7.2. Tremor
1.7.3. Strength of hands and feet
1.8. Record the senior report how she/he was driving and analyze her/his previous errors, dangerous situations and accidents
1.9. Advise on safety actions, for example: Have a rest, or Do not drive today, or Call your doctor, etc.
Elderly (as well as any other) customer must have a choice what type of communication is desirable, helpful, and not annoying. For that we will create a software for questionnaires offered to the elderly customers at every dealer outlet

and for all flexible characteristics of the senior dream car..

1.10. Record a selfreport on today driving (after return home)

2. Senior dream car may help as a secretary:

3. Senior dream car must be a navigator-advisor:

3.1. Help to return home from any point by giving detail advice on every turn;

3.2. Advise how to reach a place needed, what is a better rout and how to ride it (by giving detail advice on every turn);

4. Automatic SOS-communication:

5. Driver (and passenger) seat must be much more individually adjustable and dynamic than existing seats.

5.1. Seat must turn left and move out when senior is getting out; seat must turn left, go out, then turn right and go in when senior is getting in; or

5.2. Ceiling must be high enough or partly open to allow easier in and out; car roof might be partly open when senior is getting in and out (with special handle blocking this automatic connection in rain and other circumstances);

5.3. Driver (and passenger) seat shape must be individually adjustable much better than luxury cars provide now.

5.4. Dynamically inflating, deflating and vibrating on various individual programs seat cushion and back support may help to massage muscles and improve blood circulation.

It is desirable to make seats wider and more flat, and as a rule to avoid bucket seats for seniors.

NAVIGATION SYSTEMS FOR VISION AND HEARING IMPAIRED DRIVERS.

We studied experimentally perception of navigation maps by drivers with different vision disabilities (anomalies).

45 people of the ages of 20-30 and 60 subjects of the ages 55-75 with different types of astigmatism participated in the experiment. We displayed information by projecting slides on a screen, with a computer display, with a TV display, LCD panel and with various point lighting matrices. We changed the shape of the symbols, the distance of perception, vision angle, general lighting on the work station, brightness and contrast of the symbols on the screens.

1. Reliability of map perception depends on type of vision anomaly.

2. Astigmatism complicated with myopia is a widespread eye anomaly.

3. Many people are not aware of their astigmatism.

4. Three groups of subjects with different types of astigmatism participated in the experiments.

5. People with direct astigmatism had difficulty perceiving horizontal lines on map, they often lost these information elements.

6. People with reversal astigmatism had difficulty perceiving vertical elements, they often cannot see vertical lines on map.

7. People with oblique astigmatism had troubles perceiving incline lines with different slope angles.

8. All three groups and some specific anomalies in a depth and distance perception, strongly depending on lighting types and levels, vision angles, subject head positions etc.

9. The subjects' drawings of the maps showed what elements they are missing.

10. Changing the subject's head position or that of the map often changed the subject's perception of different elements on the map.

11. Additional head motions to change the position and perception lead to higher muscle strain and fatigue.

12. The visual keenness of astigmatic people decreased much faster than for those with normal vision when the lighting level dropped.

13. Perception of navigation map by the astigmatic person takes much more time than by person with a normal vision and leads faster to fatigue.

14. The size of the symbol perceived depended on the person's type of astigmatism. For example, subjects with direct astigmatism usually saw the symbols as much higher than the normal subjects saw. People with reverse astigmatism saw the symbols as lower than in reality, but much wider.

15. There are some models for the astigmatic perception distortion that might allow to create principles to design and adapt the navigation maps to the drivers with vision disabilities. We found that for 80% of subjects with direct astigmatism, the main elements on map should have angles between 80-130 degrees.

The subjects with reverse astigmatism perceive elements best between the angles of 0-15 degrees. For subjects with oblique astigmatism, the angles

in the intervals 40-50 degrees and 100-110 degrees were the best.
These our preliminary studies led us to the conclusion that individual adaptation of navigation maps and other information to the drivers with astigmatism and other visual deficiencies will decrease their visual and muscle strain, fatigue and errors in the navigation map perception.

ERGODYNAMICS PRINCIPLES OF CAR USABILITY

The First Principle of car usability:
A car criterion (safety, comfort, driving satisfaction, or attraction), Q_i, for a driver is a bell-shaped function of any factor F_j of mutual adaptation between driver and the car, $Q_i(F_j)$.

The Second Principle of car usability:
Driver may use different strategies in perception and processing information, making decisions, in physical interaction with car. For each strategy the car ergonomic quality criterion, Q_i, will be presented with a particular bell shaped function $Q_i(F_j)$.

The Third Principle of car usability:
Transformations between two different driving strategies Q_1 and Q_2 go through a state common and equal for both strategies presented as an intersect point of two bell-shaped characteristic curves $Q_1(F_j)$ and $Q_2(F_j)$.
One of many corollaries of the third law is: when emergency occurs and driver transforms his/her normal strategy into emergency strategy, first efficiency and reliability of driver's actions go not up, but down until the strategies are transformed. Car design and driver training must be directed specifically to help drivers to expedite the transformations. This may be a key point in increase of traffic safety.

CONCLUSION

1. Conversion of information on space and aviation ergonomics helps to find quick effective solutions particularly for elderly and disabled users.
2. Principles ("laws") of ergodynamics are applicable to usability analysis of navigation systems and driver-computer dialogue.
3. Usability of navigation maps for drivers with different vision disabilities (anomalies) require special experimental methods and solutions.
4. Individual adaptation of navigation maps and other information to the drivers with astigmatism and other visual deficiencies decrease their visual strain, fatigue and errors in the navigation map perception.

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