Human Age and Vehicle Speeds Affect on Vehicle Ingress Motion Pattern

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The vehicle ingress and egress are important issues for the automotive industry, both for minimizing assembly work load and for maximizing end-users' comfort. Digital human modeling tools are used for evaluating and visualizing these issues. The assembler and end-user are more or less performing the very same entering task if the vehicles have identical geometrical prerequisites. The major difference is the vehicle speed; an assembler is entering a vehicle slightly moving forward on the assembly line with a speed of 5 meter/minute whereas the end user's vehicle is standing still. The human motion when entering a car is a complex biomechanical process, which affects many different body parts. Car ingress techniques, such as flopper, swiveler, and glider vary among humans; for which humans' agility may be one affecting factor. Agility is affected by joint diseases, which is more frequent among older people. There are several studies regarding ingress motion patterns[1,2], but studies on the differences in car ingress motion between car assemblers and end-users, or older and younger people are rare. Thus the purpose of the present study was to compare the ingress motion between younger versus older persons, and assemblers versus end-users.

A Saab 900 s and a treadmill were used in the study. The treadmill was used to simulate the forward moving vehicle. The car was elevated to not change treadmill-vehicle ingress height from normal ground vehicle ingress height. The motion pattern of the subjects was recorded with a ShapeWrapII motion capturing system[3,4]. In total, 40 subjects participated. The subjects, all holding a valid driving license and healthy with respect to joint disease diagnose, were divided according to their age into two groups: 20 – 25 years old and 60 – 65 years old; each group containing 20 persons. Each group performed ingresses twice, both as end-users, from a stable ground, and as car assemblers, from a moving treadmill.

The procedures of the test were divided in five steps: initial part, mounting the ShapeWrapII system, warming and calibrating ShapeWrapII, performing the ingress, closure part. In the initial part, the subjects were introduced to the procedure and asked to answer a questionnaire about age, driving experience and joint disease history. The closure part included a questionnaire, in which the subject described and rated his/her experience of ingress. In the closure part, subjects were rewarded for their participation (as fig.1).

From the ShapeWrapII motion capture system, joint angles and angles velocities were calculated and plotted (graph.2 -graph.5). Joint angles were also used in the ergonomic evaluation tool REBA. The total time to perform ingress motion was also

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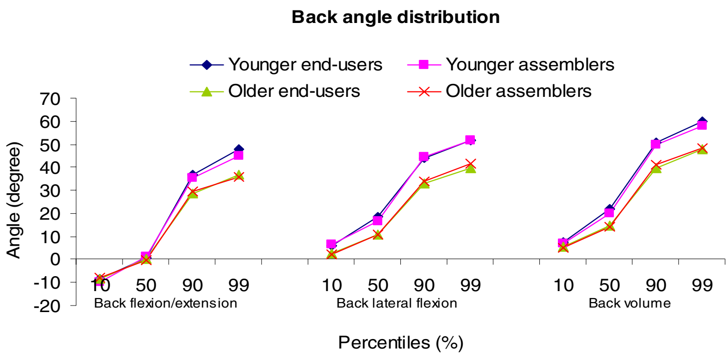
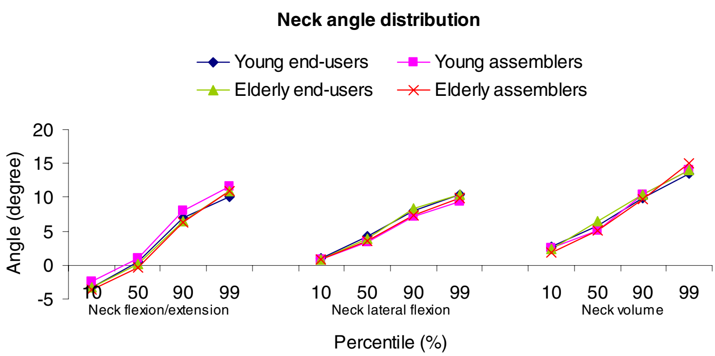
Fig. 1. Start and ending position

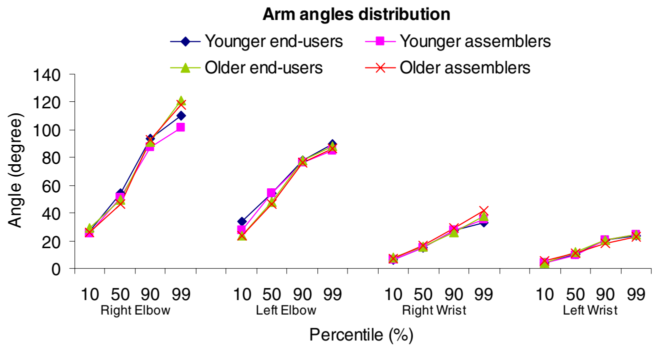
calculated from motion capture data. Descriptive statistics were used to summaries the ingress motion pattern and Friedman's test to investigate differences between young and old as well as assembler and end user.



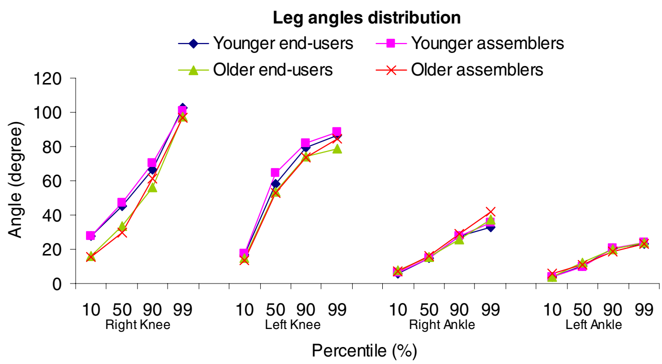
Graph 2: Back angle distribution



Graph 3: Neck angle distribution



Graph 4: Arm angles distribution



Graph 5: Leg angles distribution

All the above experimentation, calculations and data analysis gave the following results: there was a significant difference in the car ingress motion between older and younger people. The joint in which the differences were most significant was the back. The younger people's ingress motion was more risky according to REBA evaluation. Furthermore, the older needed a significantly longer time to perform the ingress motion. No significant difference in motion pattern was found between assemblers and end-users, and the slow forward motion of the car on assembly line had no effect on the ingress pattern.

These differences and similarities found in this study lead to the following conclusions:

1. There is a need to introduce age as a parameter in digital human modeling tools, due to its affect on motion behavior. With age as a parameter, similar to nationality, anthropometrics motion pattern predicted, reach envelopes generated and vision cones generated can represent also an older human.

2. Within the automotive industry, responsibility for assembler and end user is normally divided into two departments. The communication and sharing of information between these are normally limited. However this result shows that ingress information from digital human modeling analysis could be shared between them and facilitates an effective and efficient design process.

References

1. Menceur, A.E., M. O., Pudlo, P., Découfour, N., et al.: An experimental protocol to study the car ingress/egress movement for elderly and pathological population. AM'06: In: European Annual Conference on Human Decision-Making and Manual Control, alenciennes France (2006)
2. Kazmierczak, K., Mathiassen, S.E., Forsman, M., Winkle, J.: An integrated analysis of ergonomics and time consumption in Swedish 'craft-typ' car disassembly. Applied Ergonomics 36, 263–273 (2005)
3. Hignett, S., McAtamney, L.: Rapid Entire Body Assessment (REBA). Applied Ergonomics 31, 201–205 (2000)
4. Measurand_Inc_2.: ShapetapeTM Manual (2004) (Retrieved August 22, 2006) ftp://ftp.measurand.com/shapeware/ShapeWare_Release_II/ShapeWare_II_manual_only/help_shapeware%20II.pdf