

# Chemnitz Age Model – an interdisciplinary research basic approach to characterize age critical performance factors

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The central basis for an age appropriate design of products and processes lies primarily in the adaptation of the altering performance factors of aging people. Results about the changing performance of people are available for several research areas. The “Chemnitz Age Model” as an interdisciplinary approach has got the explicit aim to collect present research data, to review this data with regard to its usability and its eventual transfer to a comprehensive age model. Furthermore, the results will be represented in the “Chemnitz Age Database” in a systematic way. The profound basis of knowledge allows an age appropriate development and adaptation of products and processes.

## INTRODUCTION

### Demographic Development in Germany

The extent of the demographic development in Germany is characterized by three trend-defining factors: Firstly, the development of the fertility and secondly, the development of the mortality. Thirdly, the influencing factor refers to the development of movement of people across German borders, the so-called migration (Dickmann, 2004).

Forecasts of the 11th coordinated statistical projection (Statistisches Bundesamt, 2006) for the year 2030 indicate that the general population development in Germany is most widely sketched out. Due to an approximately constant fertility rate of an average of 1,4 children per woman and an increase of the mortality, the number of inhabitants will drop by more than 5 million people (-6,4%) until 2030, compared to 2005. Moreover, the trebling of the fertility deficit until the year 2030 will unbalance the natural population-balance. Only that the balance of migration, the gap between immigration to Germany and the emigration to foreign countries, under the supposition of an annual average of 100,000 persons, will not compensate the rising population deficit.

The decrease of the German population goes hand in hand with a perceptible structural change of the population composition (Figure 1). Among other factors, the rising life expectancy, which will increase the age for newborns by approximately 4 years to 80,6 years for boys and 85,5 years for girls, is responsible for this trend. A serious problem poses the fact that most likely 25% less children and adolescents (group of the under twenties) will live in Germany until 2030. The group of people in the working age (group of the 15-65-year-olds) will also clearly decrease by 15%. In comparison, the age group of the 65-year-olds will increase by 40% until 2030.

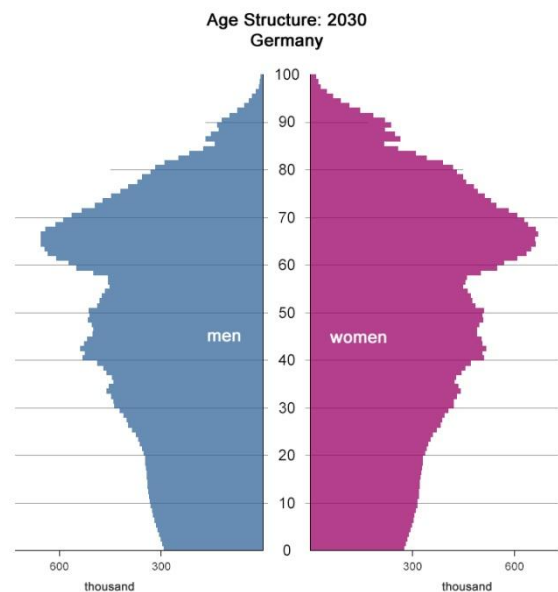


Figure 1: Age Structure Germany 2030

The central problem of the demographic change lies in the shift of the age-group of the working people, starting in the year 2010. The age-group of the 35-49-year-olds will be replaced by the 50-64-year-olds as the numerically strongest group (Richter, Schmidt-Lehm, & Krenkel, 1996; Statistisches Bundesamt, 2008). This so-called change of cohorts of this development leads besides the fundamental decrease of the number of working people and the tough competition for junior staff to the circumstance that many enterprises have to face an increasing mean age of their work members (Johnson, 2002).

## **Consequences for Enterprises**

Age represents an important factor for the state of health, as with increasing age an increase of medical conditions is noticeable (Statistisches Bundesamt, 2008). Occupational health screenings provide evidence for a clear and constant increase of medical documented disturbance of health in working employees beginning with 45 years (Enderlein, et al., 1998). Statistics about the age-dependent increase of sick leave support this assumption. In spite of the decrease of the number of cases of unemployability, sick leave, due to the increase of the mean duration of the cases of unemployability, strongly increase with age (Vetter, 2003; Statistisches Bundesamt, 2006; Gesundheitsberichterstattung des Bundes, 2008). The rising of the average age of the staff by one year has the effect of a "natural" increase of the sick leave by 0,2 till 0,3 percentage points (Brandenburg & Domschke, 2007).

A rising mean age of the staff members may have economically wide-ranging consequences for the enterprises. Consequences of the demographic development for the enterprises may result in the rise of costs for employees, the increase the time of absence due to illness, the enhancement of employees with a loss in performance, a reduced flexibility of deployment and the pending loss of innovation skills (Brandenburg & Domschke, 2007). Considering this development, enterprises will be urged more frequently to initiate measures which can guarantee the maintenance of the earning capacity and the employability against the backdrop of changing health conditions until 67 years (Wolters, 2004). Enterprises, which do not have developed a sustainable approach for dealing with an aging workforce, jeopardize to lose performance and innovation (Buck, 2003; Baase, 2007; Brandenburg & Domschke, 2007).

## **CHALLENGE OF A COMPREHENSIVE AGE MODEL**

### **Demands of an Age Model from a Human Factors and Ergonomics Perspective**

The process of aging is totally differently characterized by various authors. Bäunig, Kubicki and Quandt (2006) describe aging as the sustainable decrease of survivability effected by intrinsic processes. In contrast, Cremer (1994) defines the process of aging as a dynamic process with continuous biological, structural, and psychological changes. In turn, Domres (2006) links her definition of age to the process of aging in the working environment. Domres does not regard aging as a general loss of performance but as a continuous transition in which the quality-profile and the work capability change but working and performance ability remain constant. Due to the diversity of possible age-definitions, it becomes apparent that, indeed, dealing with terms of age and the process of aging in the field of science leads to partially controversial and complete different statements. One reason for this fact originates from the multidisciplinary and also from the range of perspectives on the subject of age. The question is from which point of view the field of Human Factors and Ergonomics has to be interpret the term and process of aging.

Knowledge of the way and the extent of the changing performance factors with advancing age, especially the ordinary shifts in performance, are essential for an efficient and age appropriate design of processes and products. Established models of aging constructs, for example Yerkes' (1921) approach of the deficit model or the competence model (e.g. Olbrich, 1987), do not succeed in presenting a comprehensive and adequate image of aging which meets the enterprises' demands and requirements to deal successfully with the problem of demographic change (Keil & Spanner-Ulmer, 2008).

### **Definition of the Process of Aging**

Ziglinicki & Nikolaus (2007) characterize the process of aging as follows:

Aging is the ordinary physiological process of development, taking place in every human and is consequently universal. The process is a result of morphological and functional changes of almost every humans' organ and organ system.

Age-related shifts in performance are intraindividually variable, meaning that different impairments of function, for instance vision and power, depend on a specific temporal distribution across the lifespan.

The possibility to get various (chronic) diseases with apparent functional impairments (Polymorbidity) is consistently rising across the lifespan.

The variance of functional impairments with age is, due to different genetic dispositions and environmental conditions, interindividually diverse, meaning no human ages in the same way as another. Age-dependent changes of the performance ability of humans can be positively influenced with the help of physical and mental training as well as adequate nutrition.

To develop a comprehensive age model, the presented characteristics of aging have to be taken into account.

## **THE CHEMNITZ AGE MODEL**

### **Objective**

To apply the entirety of all processes and outcomes of aging for an age appropriate design of product and processes in an understandable manner, all age-related changes of the performance factors of humans have finally to be identified and presented in a clear way with regard to their development with advancing age. For this, an approach has to be developed, which identifies age-related performance factors in terms of an interdisciplinary research of present data from fields of medical science, sports science, gerontology, ergonomics as part of engineering science, psychology and sociology, review their applicability and combine them to a comprehensive age model.

### **Structure**

According to the model of human work by Schmidtke (1993) and also the rough structure of the system element man by Bubb (1993) age-dependent performance factors were integrated in the stress-strain concept (Figure 2).

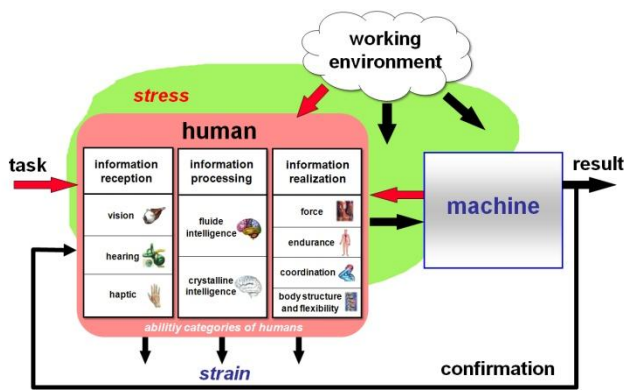


Figure 2: Structure scheme of human work with ability categories

Age relevant parameters can be found in all factors of the structure model of human work. The age-dependent physical and mental features of performance in individuals can, based on nine ability categories of humans, be structured. In doing so, one ability category includes all age-dependent factors of performance ability, which either negatively or positively influences the concrete ability across the course of aging. For example, the ability of accommodation, acuity, and depth perception would represent the ability category vision. In addition, with the term of working environment age-dependent physical (e.g. noise, vibrations, climate, lighting) and social influences (e.g. work motivation, shift work) can be detected during task processing. The classification of the subsystem man in information reception, processing and realization and also the modularization in ability categories enables one to separately examine and eventually evaluate the age-dependent abilities for a task.

### Identification of the Changes in Performance in the Ordinary and Pathologic Age Process

On the basis of a division between normal and pathologic aging, an examination of age-related changes of performance factors was made (e.g. Lang & Arnold, 1991). The aim of "The Chemnitz Age Model" is the analysis of scientific based studies of normal aging to detect physical and mental changes, which appear in the sense of typical developments in "healthy aging" male and female individuals between 20 and 70 years. The ascertained performance data of normal aging will be completed by pathological data, meaning occurring (chronic) diseases, which reduce the performance ability though not necessarily have to appear with age. Furthermore, creative work possibilities for influencing the performance and also adaption for every ability category will be detected. Through the division in normal and pathologic aging, interindividual differences with advancing age are taken into account (at least to some extent). The quality of the examined studies will be ensured by the comparison with concretely defined test criterion, for instance, the number of subjects. All scientific documents and their results will be reviewed and edited in a well-structured manner in the "Chemnitz Age Database" developed by the Professorship of Human Factors and Ergonomics. With the help of the "Chemnitz Age Database" more than 700 scientific based studies of various age differentiated performance features of man could be viewed

and brought together to a comprehensive age model – the "Chemnitz Age Model" (Figure 3).

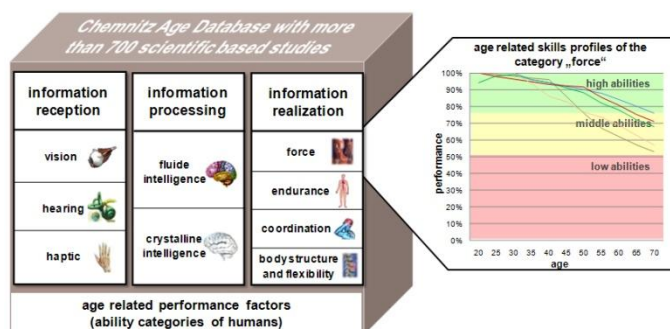


Figure 3: Chemnitz Age Model with age related skills profiles

The change of performance factors across the lifespan can be presented via skills profiles. The data of the analyses classified as valid studies will be categorized by normalization to the size of the performance ability over age.

First results show that aging processes of the single performance factors proceed very dissimilarly, which means that different performance factors in their performance process age intraindividually diverse in extent and speed. The acquisition of the standard deviation from representative studies points out the interindividual range of the respective performance features. Through the determination of performance limits for high, middle, and low abilities at interfaces of performance curves with the threshold for every ability category, the so-called "Ability Classification", can be established. With those "Ability Classifications" on the basis of present research data, scientific based statements can be made about the age at which the "healthy aging" man, in terms of the particular performance feature, possess high, middle or low abilities.

### RESULTS AND FURTHER RESEARCH

The "Chemnitz Age Model" with the collection of quantitative and qualitative age data provides the necessary basis for an age appropriate development, design and adaptation of products and processes. Results from the "Chemnitz Age Model" have already been used for the development of a modular age explorer (M A X) which allows the scientific based simulation of age for the most diverse user (Scherf & Spanner-Ulmer, 2008). A current study examines the present effects of the demographic change on the requirements for new technologies.

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