

ADAPTATION OF PRODUCTION SYSTEMS ACCORDING TO THE CONDITIONS OF AGEING POPULATION

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Not only European population but also many countries in the world are being influenced by the population ageing. Regarding to those changes the actions have to be taken in areas like pension system or health care. The paper focuses on other very important area which is working environment and conditions. Adaptations of current schemes and limits valid for production planning in these days have to be done accordingly to the needs and capacities of older workers. Older workers may experience various age-related changes i.e. increased weight, reduced flexibility, mobility and strength, deteriorating vision and hearing, possible reduction in cognitive abilities and, in some cases, health complaints. If those facts aren't taken in consideration and companies don't respond appropriately they may face increased injuries and reduced productivity. However there is no 'one-size-fits-all' strategy so different sectors might face different challenges.

KEYWORDS

ageing, older workers, production planning, work rationalisation, ergonomics

INTRODUCTION

Population ageing is a phenomenon of the last decade. The first states which had to cope with issues connected with old population were Japan in the world scale and Italy within the EU. 1994 was the turning point for Italy at which the number of over 65 years old people overtook the number of children under 15 years old. Gradually all other states of EU faced the same scenario. This rapid and intense ageing of the population imposes a great strain on the capacities of EU's member states to make the necessary profound adjustments to social, economic, cultural and psychological structures. The biggest issues that have to be addressed are connected with longevity which is affecting in the first phase the pension system and healthcare. In order to avoid financial collapse in those systems many countries responds by lengthening the retirement age. However lengthening of the retirement age must be supported by adequate changes in legislature and working conditions. For people aged over 50 years it is currently problematic to search for new jobs or even maintain the present one. This is the first step that has to be taken, that has to change, in order to secure jobs for people who might retire in 65 or even longer.

2. DEMOGRAPHIC CHANGES IN EUROPEAN UNION AND WORLD

The population ageing will continue in next decades to be an important demographic trend in all countries of the European Union (EU). According to the statements by the European Commission [European Commission 2005], three basic trends are responsible for this development:

- 1) The continued rise in life expectancy owing to a significant improvement in the health and quality of life of Europeans.
- 2) The increase in the age group over 65 up to 2030 when the children of the "baby boom generation" reach retirement age.
- 3) A constantly low birth rate (low fertility) due to numerous factors.

Some studies eg. [Preston 1989] show that the mortality, which has fallen substantially since the 1970s among older people, is the main reason of population ageing, rather than low fertility.

Since 2000, fertility rates have slightly increased in several European countries, but they are expected to remain close to or below 2,1 child per woman, which is the rate needed for long-term replacement of the population. For the EU as a whole (EU 27), the total fertility rate is projected to rise from 1,59 in 2010 to 1,64 by 2030 and further to 1,71 by 2060. Fertility rate in Czech Republic is little bit below the average numbers as in 2010 the fertility rate was 1,5 and by the 2060 it is assumed growth to 1,61.

Furthermore, projected improvements in adult and old age mortality imply further population ageing throughout the EU. By 2060, mean life expectancy in the EU is expected to increase by 8 years for men (from 76,7 years in 2010 to 84,6 years in 2060), and by 6,5 years for women (from 82,5 years in 2010 to 89,1 years in 2060). Mortality gaps between new and old EU member states are expected to narrow.

The old-age dependency ratio (i.e., the ratio of people aged 65 years or older to people aged 15–64 years) is projected to increase from 26% to 52,5% between 2010 and 2060, so that for every person aged 65 years or older, there will be only two people aged 15–64 years (instead of four as previously). The largest increase is expected to occur during the period 2015–35, with year-on-year increases above 2 percentage points. [European Commission 2012]

As a result of these developments, there will be a sharp ageing of working population. The proportion of children (aged 0–14) is projected to remain fairly constant by 2060 in the EU 27 and the euro area (around 14 %), while those aged 15–64 will become a substantially smaller share, declining from 67 % to 56 %. This significant demographic change results from the increase in life expectancy and lower fertility. As a result, the workforce in Europe will be older than ever before. In many countries the percentage of older workers in the working population will reach 30 % or more. In concrete the population aged 65 and above will increase very markedly throughout the projection period. This group will almost double, rising from 87,5 million (17,4 %) in 2010 to 152,6 million (29,5 %) in 2060 in the EU 27. The number of older people (aged 80 years and above) is projected to increase by even more, almost tripling from 23.7 million (4,7 %) in 2010 to 62,4 million (12,1 %) in 2060. Czech Republic will belong to the countries with most quickly ageing population.

Although population ageing is a well-known phenomenon and challenge in the EU, it is not an exclusive facet of Europe. Similar trends are presents also in other parts of the world, but to varying degrees.

Life expectancy rate		2003	2010	2060
at birth, man/woman		EU 25 – 75/81	EU27 – 76,7/82,5	EU27 – 84,6/89,1
at 65 years of age, man/woman		EU 25 15/19	EU27 – 17,2/20,7	EU27 – 22,4/25,6
Proportion on 65+ year olds	1992	2003	2010	2060
	EU 25 – 14,3	EU 25 – 16,1	EU27 – 17,4	EU27 – 29,5
Fertility rate	1960	2000	2010	2060
	EU 15 – 2,5	EU 15 – 1,5	EU27 – 1,59	EU27 – 1,71

Table 1. EU population statistics

Scientific and technological advances, industrialization, socioeconomic development, improved communication, better hygiene and increased food intake have helped to increase life expectancy and reduce mortality rates in recent decades. Since 1840, global life expectancy has indeed risen in a linear fashion for both sexes, with an increase of almost three months per year for women. The most dramatic gains have been in East Asia.

Fig. 1 shows the old-age dependency ratio in the world. The projected old-age dependency ratio of 52,5 % in the EU in 2060 will be much larger than in the rest of the world with the exception of Japan, where it is projected to reach 69,6 %. The EU of today had the highest old-age dependency ratio already in 1950, slightly higher than in the US, but its increase has been faster over the period 1950 to 2000 (up by 10 % in the EU compared with only about 6 % in the US). Everywhere, sharper increases in the old-age dependency ratio are projected during the period 2000–2050 than between 1950 and 2000. The largest increases are projected to take place in Japan (by almost 45 %) and in China, the EU and the euro area (by about 30%). [European Commission 2012]

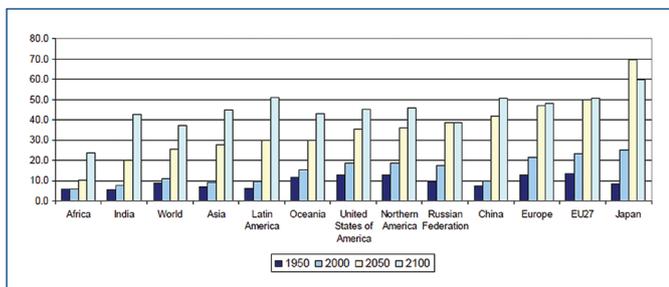


Figure 1. Old-age dependency ratios by main geographic areas and selected countries (in percentage) [European Commission 2012]

3. CHALLENGE FOR COMPANIES

The demographic changes in the population are leading to far-reaching consequences and challenges for the world of work. Europe has been undergoing a dramatic decline in the employment of older workers since the end of the 70s. The general problem in these days

is the employment of people over 50 years old. The employment rate for older workers (aged 55–64) in EU 27 is currently less than 50 %. Only 15 countries around the world have the employment rate of older workers higher than 50 %. As a key solution to deal with the increasing proportion of older workers the EU policies have aimed to increase participation in the labour force at late ages and also to increase the retirement age. The Lisbon Strategy for Growth and Jobs, which was launched by the EU in 2000, and re-launched in 2005 was a very important EU policy initiative associated with ageing. This strategy envisaged rising of the mean age of retirement by 5 years to 65 years and an increase of workforce participation at age 55–64 years to 50 % by 2010. Although these goals were not quite reached, progress was made, and workforce participation in people aged 55–64 years was 46 % at average in 2010. Graphs on Fig. 2 show the comparison of older workers employment rate in years 2000 and 2010. The data were gathered from OECD statistics [OECD 2010]. Countries included are European OECD member states. These employment rates vary substantially across Europe but general development toward higher rates can be seen. Rates of participation are generally higher in men than in women.

The new Europe 2020 strategy, which was launched in 2010, does not have specific targets for people aged 55–64 years, but an EU employment rate of 75 % for those aged 20–64 years is one of the five headline indicators.

In order to support the employment of older workers (aged 55–64) flexible working patterns must be applied. Several European countries have experimented with different models. France and the UK have enabled health workers who reach the statutory retirement age to continue to work part time while preserving pension entitlements. In France, doctors older than 60 years can be exempted from night and weekend shifts. In Belgium, many hospitals have allowed nurses aged 55 years or older to work 32 hours per week and still earn a full-time wage and the retention of nurses has improved. Different part-time models have been tried in German hospitals, including part-time employment, job sharing, flexible working hours, and partly working from home. [Rechel 2013]

If the companies will be able to ensure adequate working conditions, there will be no problem in employment of older workers. It is already proved [Heron 2013] [Suhrcke 2006] that promotion and investment

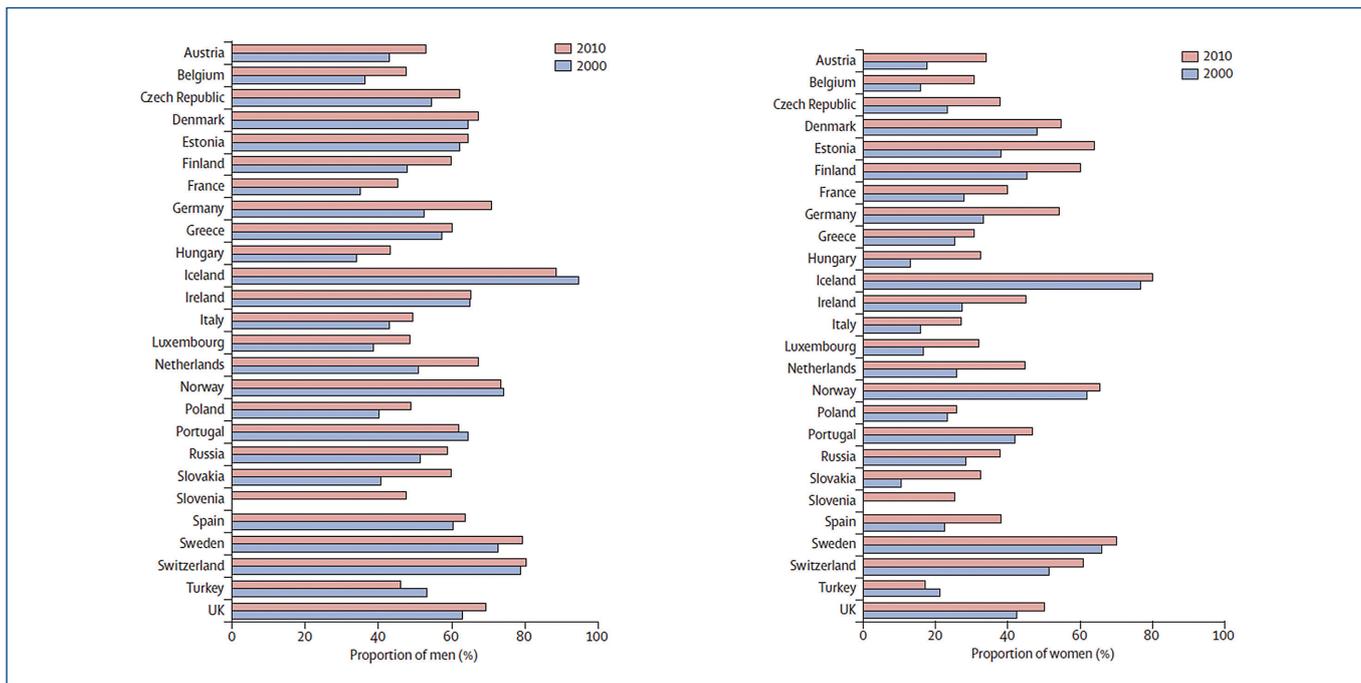


Figure 2. Labour-force participation by European men and women aged 55–64 years in 2000 and 2010 [OECD 2010]

in healthy or active ageing not only increases life expectancy and postpones health expenditures, but also has wider economic benefits. People who live a long and healthy life have a strong incentive to invest in skill development and usually stay longer in the productive life, in the work. In addition to healthy lifestyle preventive and proactive measures taken in the context of occupational health care, as well as the proper treatment of acute health problems, plays an important role in achieving good health during working life.

For example study performed by [Tsai, 2005] points to the fact that early retirement is not associated with better survival. There is a widespread perception that early retirement is associated with longer life expectancy and later retirement is associated with early death. The study shows that the reality is just the opposite. Early retirement at 55 or 60 is not associated with increased survival. Employees who retired at 60 had similar survival to those who retired at 65. In summary, employees who retired at 55 had a significantly increased mortality compared with those who retired at 65. This difference may be caused by poorer health status of some early retirees. Survival for employees who retired at 60 was similar to that of employees who retired at 65. Retiring at 65 was not associated with a greater risk of mortality than retiring at 55 or 60 years. Very similar results have been also obtained in the following study on Swedish workers [Hult 2010]

4. LIMITATIONS AND BENEFITS OF OLDER WORKERS

With the age the long-term health problems and chronic diseases increase. That's why approximately 30% of men and women in the age group 50–64 years need due to their health problems urgent work adjustments in order to prevent the risk of early retirement and disability. Serious health problems are musculoskeletal and mental disorders. Also a depression is one of the most common causes of work disability and early retirement.

The capacity for physical work generally seems to diminish before mental capacities. After the age of 45 cardio-respiratory capacities may fall by more than 25 % in the space of four years and muscular-skeletal capacity seems to diminish just as quickly, which affects, among other things, overall speed of movement. A parallel decline has been observed in mental capacities: not only in sensorial-motor tasks but in perception, problem-solving and other situations requiring mental exertion. Many studies have found that changes in performance are directly caused by the effects of ageing on the central nervous system. [Golini 2001]

Strength

Much of the strength data used in ergonomics for task design are based on static strength measurement protocols during which a subject exerts a volitional maximum effort against an anchored load cell for generally 1 to 3 seconds. Many sources report that static strength is peaking between 25 to 30 years then decreasing slowly till 40, with a more rapid change after the age of 50. About 25 % of strength is lost over the adult lifespan. This is at best a simplification as significant variations exist across individuals. Exercise, habitual activity and genetic endowment all play a role in how much or how little strength changes with age.

According to statistical evaluations the maximum muscle strength of a 60-year-old is roughly only 75 % of the comparable values for a 30-year-old [Morschhäuser 2006]. It is also very important which muscle group are we talking about. A study performed by [Sinaki 2001] measured among other the grip strength and knee extensor strength. The grip strength felt quite linearly. Men's grip strength decreased 45 % on the dominant side from a peak in the fourth decade of life to the lowest level in the ninth decade. Women's grip strength decreased 47 % on the dominant side from a peak in the third decade to the lowest level in the ninth decade. Regarding the knee extensor the strength decreased by 36 % on the right knee in men from a peak level in their seventh decade to the lowest level in their ninth decade, and 35 % on the left knee. In women the decrease was 38% on the right knee from a peak

level in their fifth decade to the lowest level in their eighth decade, and 42 % on the left knee. From these two results we can see that different muscles strength decrease differently within different periods of life. Also the strength decrease is more rapid by women than men and it unfortunately occurs more sooner.

The authors also found a higher muscle strength in older subjects in their study compared with that in other studies. This is a positive result which could be attributed to the lifestyle changes that have occurred in our society over the past couple of decades and may reflect the increased level of physical activity in our older population.

Range of motion

Joint flexibility and range of motion quite often show decreases with age. The neck and the trunk show quite often the most decrease as described in [Doriot 2006]. Within this research a total of 44 subjects were measured, divided in half into two age groups (25–35 and 65–80 years). The highest loss in range of motion was observed in the neck and trunk, especially for neck extension, lateral flexion and axial rotation as well as for trunk lateral flexion and axial rotation. Another study performed by [Chung 2009] examined 28 joints range of motions at 1134 Taiwanese workers (698 males and 436 females). Data were sorted by 3 age groups (16–30, 31–45, 46–64 years of age) and by gender. The results showed that age-induced decline in range of motion were more apparent in cervical spine and wrist joint than the other joints. The largest decline was about 26%. Although the range of motions of the other joints also showed reduction with the increase of age, the level of reduction was not significant. Moreover, a significant gender difference was found in most of the joint motions. In general, females showed greater range of motions in cervical spine, upper extremity, and lower extremity joints than those of males. Joint ranges of motion are very important references in job and workplace design. Those range of motion values need to be considered in the ergonomic design of the workplace, equipment, tools, material handling and systems for an ageing population to decrease the risk of injury or cumulative trauma disorders.

Sensory functions

The sensory functions change during a work biography. With increasing age vision diminishes (accommodation capacity and adaptability, sharpness of vision and contrast sensitivity). The lens of the eye becomes more opaque, and people become more vulnerable to glare and need more light for adequate visual conditions. Also, onset of presbyopia occurs with age and is commonly seen after age 40. The hearing threshold, especially in the high frequency range, decreases. [Morschhäuser 2006]

Need for recovery

Another point of view on older worker performance level is from the need for recovery. Generally people think that older workers need more time to refresh and recover. The study performed by [Kiss 2005] on 717 subjects younger than 45 and 383 subjects of 45 years or older employed in the public sector was carried out by cross-sectional questionnaire study. The results from this study showed that ageing workers had a significantly higher need for recovery than the younger workers, within comparable occupational exposures. In both age groups negative affectivity and work pressure significantly increased the risk for a high need for recovery to a similar degree. In the younger group, support from colleagues and satisfactory relationships with close relatives significantly reduced the risk for a high need for recovery. In the older group monotonous work, presence of chronic musculoskeletal disorder and number of children at home significantly increased the risk for a high need for recovery, while satisfactory social contacts significantly reduced that risk. For both age groups these results indicated that social factors tend to have a positive effect on the need for recovery: relationship with close relatives in the younger workers and social contacts outside the family in the older workers. Another more detailed study [Mohren 2010] reports that the highest levels of recovery were observed in the age group of 46–55 years. However

while the need for recovery increased with age until the age of 55, it was followed by decreased recovery levels among older employees. Explanations for the decreasing levels of recovery needs in the highest age group can be found in several domains such as the work environment, private situation and compensation strategies.

Strengths of older workers

Although the health and physical fitness is getting worse with the age some other abilities improve. The positive side of ageing is improving mental abilities. With age, for example, the strategic thinking, wit, courtesy, wisdom, prudence, ability to think logically, holistic perception and language skills improves. Certain characteristics, such as empirical knowledge, work morale/discipline or quality awareness, tend to be viewed as strengths of older workers.

Generally speaking, it can be stated that the level of performance does not change in the ageing process but the spectrum of performance. Many skills, such as empirical knowledge, practice, safety awareness or linguistic skills only develop over the course of time. Others, such as co-operation and communication skills or creativity, scarcely change. And others such as muscular strength, good vision and hearing or mental agility tend to diminish.

In summary, due to the ageing the older workers are in many ways becoming better and stronger than before. An important positive-acting element of active ageing is therefore active involvement in working life. Every generation has its strengths and weaknesses. The older people tend to differ more from each other than from younger people. It is necessary to better define and utilize the strengths of older workers so that they become a valuable asset on workplaces. The needs of older workers can be satisfied also by flexible working time arrangements which result in improved reconcilability of working and private life. Going into retirement should not be a single event but a process. Part-time retirement is one option which deserves more attention than it currently receives.

5. WORKPLACES ADJUSTMENTS

So far we have explained that ageing of the workforce is inevitable. This means that companies must be prepared for this future and adapt to it. If we are talking about employment of older people issues like monetary incentives, improved workforce organisation, better working conditions, education, career opportunities and social support must be addressed. Workplace ergonomics, proper tools and equipment, job redesign or task shifting are concrete answers how to solve these problems.

The state of health and efficiency of older workers is frequently the result of concrete work processes. Ilmarinen [Ilmarinen 2005] describes three groups of risk factors:

- High physical work demands, e.g. static muscle work, lifting and carrying heavy loads, repetitive work, bent or twisted body posture.
- Stressful and hazardous working environment, e.g. dirty or wet ambient conditions, risk of accident, heat, cold or rapid temperature changes.
- Badly organised work, e.g. role conflicts, fear of poor performance, lack of degrees of freedom and possibilities of influence, lack of career prospects or insufficient recognition by supervisors.

According to the results of the European Foundation survey in 1995 and 2000, it must be noted that, on the contrary, the above-mentioned risk factors are firmly established or have even increased, especially from the point of view of ageing workers [Ilmarinen 2005]:

Environment influence

Exposure factors of employees over 45 years of age in the physical environment remained relatively the same between 1995 and 2000. Over 20 % of men are exposed to noise or vibration or both for at least half of their working hours, and fewer than 20 % are exposed to air impurities. The exposure and stress factors in the work environment

are virtually the same for employees of all ages. Similar exposure may, however, be a bigger risk for the work ability of an ageing employee because the exposure may have continued for several decades.

Working postures

Physical work demands increased among ageing employees, except for repetitive work, during 1995 till 2000. Approximately one-third of ageing men and women are exposed to poor work postures for at least half of their working hours and 45 % are exposed to repetitive work. Exposure to poor postures at work has even increased.

Material handling

About 24 % of ageing men and 17% of women handle heavy loads. Ageing employees work more often in physically demanding occupations than younger ones, usually because they have less education. Physical workload and the resulting musculoskeletal disorders are still a significant cause of work disability among ageing employees. About 40 % of ageing men and women report that their work affects their musculoskeletal syndrome. Because physical functional capacity decreases with age, an extended career in physically demanding occupations is neither reasonable nor possible without a significant lightening of the workload.

Diseases and accidents

According to Eurostat the number of new cases of occupational disease increases significantly with age. Whereas there were 39 new cases of occupational disease among people aged 45–54, the respective number among people aged 55–64 was 69 for every 100,000 employees. Most occupational diseases were caused by physical factors in the workplace. Notifiable work accidents in Europe occur most frequently among younger workers. The rate declines with age and ends with a slight rise in the age group of the 55 to 64 years. However, when accidents happen, they are more serious and result in longer periods of incapacity to work than among younger employees. Fatal accidents at work also occur most frequently in the age group 55 to 64 years.

The above mentioned areas are among the most frequent causes of health problems. Within the ergonomic optimization the most attention is devoted just to the material handling and optimal working postures. In the future, it is necessary to continue with the positive trend so called proactive approach when it is necessary to prevent negative effects of the working environment and to effectively reduce the excessive workload. It should be noted that the improvement of the working environment should be carried out for all workers regardless of age. By older workers however needs to be taken into account their specific needs and requirements.

6. COMPANIES GOOD PRACTICES

Although many organizations are aware that they will face challenges related to global ageing in the coming years, they either do not perceive the potential magnitude of the problem or are too consumed by shorter-term imperatives to act. As a result, far too few companies are taking sufficient steps to prepare for the impact of demographic realities. Indeed, whether global ageing patterns truly represent a risk or an opportunity has a lot to do with how soon companies recognize the changes to come and take steps to mitigate potentially negative consequences.

Some examples of good practice shows that giving more time-off to workers or reducing the workload proportionally to advancing age increased time of actual retirement about three years. One manufacturing company introduced the program „Master of ageing“, where workers over 58 years were provided with more days off. This gives them more time to rest and regenerate after performing precise and demanding manual work of door locks assemblies. Another energy company introduced the „80-90-100“ program and allowed its workers to reduce their working hours by 20 %, while their salary reduced by 10 %, but retirement benefits remained at 100 %. The advantage of this solution was adopted by 25 % of employees and workers. The actual retirement age increased by 3 years to 64 years.

These innovative examples show that older people are able and willing to work longer if they can better cope with the workload or the length of working time.

The most proactive companies have grasped the situation and taken appropriate steps. Several examples from production environment are described below.

BMW – Designing production lines to facilitate healthy and productive ageing

The German automaker BMW was determined to proactively face the challenges of an ageing workforce. In order to identify potential difficulties and devise ways to mitigate them, the company set up a pilot project – staffing a production line in its Dingolfing plant with a group of workers whose average age was 47, which was the forecast average age for the plant's workers in 2017 (8 years older than the average age in 2007). As part of the project, the company's ergonomic specialists, human-resources personnel, and physicians collaborated with employees, who had been asked by managers to suggest ways to improve working conditions. Most of the proposed changes were quickly adopted. They included the following:

- New equipment such as special ergonomic chairs, magnifying lenses, and wooden flooring.
- Job rotations across workstations to minimize fatigue.
- Development of special stretching exercises to compensate for physical strain during work hours.

With only a minimal investment by the company, the results were impressive. The “older” production line maintained the same level of productivity as other lines and achieved even better quality than comparable lines. Absenteeism was not significantly higher. BMW integrated the findings from the pilot projects when setting up a new production facility in the Dingolfing plant in February 2011. This initiative made the new facility the first in the automotive industry that was designed from the start to address the issue of ageing workforces. [Loch 2010]

Ford, Audi, Volkswagen– Exploring physical limitations with ageing suits

In an attempt to better understand the physical limitations of older drivers, as well as learn how to design automobiles that are both more comfortable and more functional, Ford Motor Company developed a jumpsuit for car designers to wear that simulates the effects of ageing. The outfit adds up to 30 years to the wearer's age by stiffening the movement of the knees, elbows, ankles, and wrists. The suit also simulates a thicker midsection by adding material around the waist. Finally, thick gloves reduce the sense of touch, and scratched, yellow-tinted goggles simulate eye cataracts. [Kuenen 2011].

Similar suits are now being used by other automobile manufacturers and by other industries. The Modular Age Simulation Suit (MAX) was developed by Chemnitz University of Technology based on an initiative by the AutoUni, Audi AG and Volkswagen Group Research. The suit was developed using knowledge from over 200 scientific studies in the fields of medicine, gerontology, sports science and ergonomics. It enables users to experience the everyday realities of older people by limiting their ability to see, move and hear, making them weaker and reducing their sense of touch. MAX is able to offer this simulation in three different levels of difficulty and is therefore the only suit of its kind in the world. Volkswagen company was using this suit to design workplaces according to limitations already known from different research papers. With this suit it is now possible to simulate reduced range of motion during work processes, count with reduced strength of the workers or even decreased vision and hearing and adjust workplaces to fit those limitations.

SSAB Tunnplåt – Better organisation as an answer to workers ageing

SSAB Tunnplåt (SSAB Strip Products) is part of Swedish Steel (SSAB) and consists of two steel plants located in Luleå and Borlänge. SSAB

Tunnplåt's interest in ageing employees began over 15 years ago. The company focused their attention on how to improve health and well-being of older workers. SSAB Tunnplåt's initiatives addressed three main areas [European Monitoring Centre on Change 2015]:

Improvements of work environment and individual health check-ups:

Workplace lighting was improved, sight examinations were provided and employees were given spectacles for specialised work. Conference rooms were equipped with hearing loops for the hearing impaired and ergonomically unsuitable workplaces were rebuilt. Special devices for packaging steel coils and sheets and for driving overhead cranes were introduced. These measures were combined with rotation at different work stations to avoid overstraining individual workers' muscles, joints and ligaments. Initiatives aimed at improving the general health of employees included individual health check-ups and rehabilitation.

Age dependent ability for shift work: Attention was paid to understanding the different attitudes towards shift work between older and younger employees. Older workers often prefer few night shifts in succession, while younger workers generally have no difficulty with working night shifts. Thus, it is important to create an understanding between the age groups by making the younger workers understand the biological differences between young and old, and by informing them about the medical problems that they could face in the future.

Union initiatives: The unions and the workers introduced several working teams aimed at constructing a good shift schedule taking into consideration older workers. The schedule was ultimately decided through a democratic process, including a trial run of each proposed schedule, an employee questionnaire, and an employee vote.

7. CONCLUSION

Not only European Union member states, but also many countries in the world are currently affected by the phenomenon of an ageing population. Improvements in the health care quality and reduction of the birth rate have now resulted in an increase of older population (people over 65 years). Estimates point to the fact that around 2050 there will be one elderly person (65+) for only two people of working age (15–64), instead of the current four. These demographic changes will undoubtedly have an impact on the pension system, health, education, social care and other areas including the area of industrial production. In the upcoming years more frequent employment of older workers is expected. However production systems must be adapted to this. Older people (workers) are usually affected by various degenerative changes associated with age, such as. weight gain, reduced flexibility and mobility, reduction of physical strength, deteriorating eyesight and hearing, etc. If these factors are not taken into account and the companies do not adequately respond, they may face increase of accidents and occupational diseases, and of course the loss of productivity.

Initial predictions of population ageing from the end of 20th century are now real and only their refinement occurs. It is already clear that if industrial practices do not adapt to this trend it will face serious problems in the future. In the last 20 years there have been several surveys, especially in the health area, which goal were to accurately reveal the form and degree of ageing. Researches are focused mainly on the limited range of motions (joints), loss of muscle mass in conjunction to loss of power, visual impairment and hearing loss or decreased productivity, and contrary increases the time needed to rest. Some of these studies (e.g. limited range of motions) appear to be obsolete. Also a disparity between the results of individual studies was observed. In certain areas it is therefore necessary to obtain actual data.

Regarding the readiness of industrial enterprises for described demographic changes, we can talk within the Czech Republic absolute ignorance or neglecting of these predictions. The world's great industrial companies are already starting with strategies on how to be prepared for an ageing population. This is especially automotive,

consumer industry and services. If there will be no constantly raising awareness in the Czech Republic of the needs of the ergonomic rules application in industrial production, we can't even count with more radical taking into account the needs of ageing workers. This will need to be changed in the future.

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REFERENCES

- [Doriot 2006] Doriot, N., Wang, X. Effects of age and gender on maximum voluntary range of motion of the upper body joints. *Ergonomics*, 2006, Vol. 49, No. 3, pp 269-281. ISSN 0014-0139. DOI: 10.1080/00140130500489873
- [European Commission 2012] European Commission. The 2012 Ageing report: Economic and budgetary projections for the 27 EU Member States (2010–2060). Luxembourg: Office for Official Publications of the European Communities, 2012. ISBN 978-92-79-22850-6. DOI: 10.2765/19991
- [European Commission 2005] European Commission. Green Paper, Confronting demographic change: a new solidarity between the generations. Brussels: Communication from the commission, 2005.
- [European Monitoring Centre on Change 2015] European Monitoring Centre on Change. Inclusion of ageing workers: Four company case examples. Eurofound, 2015 [online]. [15. 1. 2015]. Available from <http://eurofound.europa.eu/observatories/emcc/articles/other-working-conditions/inclusion-of-ageing-workers-four-company-case-examples>.
- [Golini 2001] Golini, A. Demographic trends and population policies. *Futures*, 2001, Vol. 33, No.1, pp 27-41. ISSN 0016-3287. DOI: 10.1016/S0016-3287(00)00051-3
- [Heron 2013] Heron, R. J. L. Investing in the health of working age people-good for individuals, business and the economy. *Occupational Medicine*, 2013, Vol. 63, No.5, pp 314-317. ISSN 0962-7480. DOI:10.1093/occmed/kqt064
- [Hult 2010] Hult, C., Stattin, M., Janlert, U., Järholm, B. Timing of retirement and mortality – A cohort study of Swedish construction workers. *Social Science and Medicine*, 2010, Vol. 70, No. 10, pp 1480-1486. ISSN 0277-9536. DOI: 10.1016/j.socscimed.2009.10.043
- [Chung 2009] Chung, M. J., Wang, M. J. J. The effect of age and gender on joint range of motion of worker population in Taiwan. *International Journal of Industrial Ergonomics*, 2009, Vol. 39, No. 4, pp 596-600. ISSN 0169-8141. DOI: 10.1016/j.ergon.2007.11.004
- [Ilmarinen 2005] Ilmarinen, J. Towards a longer worklife – Ageing and the quality of worklife in the European. Helsinki: Finnish Institute of Occupational Health, 2005. ISBN 951-802-686-6
- [Kiss 2005] Kiss, P., De Meester, M. Need for recovery in ageing workers. *International Congress Series*, 2005, Vol. 1280, pp 202-207. ISSN 0531-5131. DOI: 10.1016/j.ics.2005.02.056

[Kuenen 2011] Kuenen, J. W., Osselaer J., Berz, K., Kaye, Ch., Sander, A., Schouten, W. J., Tsusaka, M. Taking Action on Aging – What Some Companies Are Doing. The Boston Consulting Group, December 2011 [online]. [20. 1. 2015]. Available from https://www.bcgperspectives.com/content/articles/consumer_products_financial_institutions_taking_action_aging_what_some_companies_doing.

[Loch 2010] Loch, Ch. H., Sting, F. J., Bauer, N., Mauermann, H. How BMW Is Defusing the Demographic Time Bomb. *Harvard Business Review*, March 2010 [online]. [20. 1. 2015]. Available from <https://hbr.org/2010/03/the-globe-how-bmw-is-defusing-the-demographic-time-bomb>.

[Mohren 2010] Mohren, D. C. L., Jansen, N. W. H., Kant, I. J. Need for recovery from work in relation to age: A prospective cohort study. *International Archives of Occupational and Environmental Health*, 2010, Vol. 83, No. 5, pp 553-561. ISSN 0340-0131. DOI: 10.1007/s00420-009-0491-9

[Morschhäuser 2006] Morschhäuser, M., Sochert, R. Healthy Work in an Ageing Europe. Essen: Federal Association of Company Health Insurance Funds, 2006.

[OECD 2010] Organisation for Economic Co-operation and Development. Labour force statistics for OECD member countries. Paris: Organisation for Economic Co-operation and Development, 2010.

[Preston 1989] Preston, S. H., Himes, C., Eggers, M. Demographic conditions responsible for population aging. *Demography*, 1989, Vol. 26, No. 4, pp 691-704. ISSN 0070-3370. DOI: 10.2307/2061266

[Rechel 2013] Rechel, B. et al. Ageing in the European Union. *The Lancet*, 2013, Vol.381, No.9874, pp 1312-1322. ISSN 0140-6736. DOI: 10.1016/S0140-6736(12)62087-X

[Sinaki 2001] Sinaki, M., Nwaogwugwu, N. C., Phillips, B. E., Mokri, M. Effect of gender, age, and anthropometry on axial and appendicular muscle strength. *American Journal of Physical Medicine and Rehabilitation*, 2001, Vol. 80, No. 5, pp 330-338. ISSN 0894-9115. DOI: 10.1097/00002060-200105000-00002

[Suhrcke 2006] Suhrcke, M. et al. Health economics: Investment in health could be good for Europe's economies. *British Medical Journal*, 2006, Vol. 333, No. 7576, pp 1017-1019. ISSN 0959-8146. DOI: 10.1136/bmj.38951.614144.68

[Tsai 2005] Tsai, S. P., Wendt, J. K., Donnelly, R. P., De Jong, G., Ahmed, F. S. Age at retirement and long term survival of an industrial population: prospective cohort study. *British Medical Journal*, 2005, Vol. 331, No. 7523, pp 995-997. ISSN 0959-8146. DOI: 10.1136/bmj.38586.448704.E0

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