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Transfer of knowledge and innovations in shaping working conditions of disabled and elderly people

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Abstract
The paper is an attempt to determine the assumptions for the development of working conditions including the needs of people with disabilities and the elderly. The basis for the development of assumptions were the experiences in the field of analysis of working conditions, mainly in health units and shaping of public space through innovative non-discriminatory solutions. Three main areas have been presented in the article, in which the transfer of knowledge may be acquired during the study: the area of ergonomics (ERG), the area of accessibility of work space with the relation of freedom in mobility and safety (SPA), and the area of information availability (INF). The considerations included in the article apply in the concept of Design for All (DFA), which is the one of the pillars of European Union directives, entitled European act on the availability, being a respond to the demographic challenge by increasing participation in the labour market and society for all.

Introduction

It is inevitable and socially necessary, and at the same time requested by the European Union and national policy, to soon overcome the barriers that prevent or hinder the integration of professional groups, such as people with disabilities and the elderly. On the basis of the European Council of June 21, 2012 the EPSCO (Employment, Social Policy, Health and Consumer Affairs Council) there is planned to adopt the draft conclusions of the EU Council with reference to the demographic challenge by increasing participation in the labour market and society for everyone. Moreover, in autumn 2012, the European Commission is going to present a proposal for a directive entitled: European Act on the availability, aiming to improve the market of goods and services for disabled and elderly people based on the concept of Design for All (DFA). Design for All embraces the idea of producing new technologies, which are for all possible users, including the elderly and disabled.

Knowing how to shape the working environment characterized by functionality, simplicity of using means of work, easy and intuitive access to information, safety, or participatory approach, will help employers to adapt to unavoidable changes in the structure of employment, as a consequence of demographic change. On the basis of the foregoing deliberations, an attempt to transfer knowledge and innovation has been done from the areas of shaping working conditions in health care organizations and the design of public spaces including the needs of people with disabilities, which are the subject of the author's previous research, into the shaping of working conditions for the elderly and disabled.

The conditions and needs of the disabled and elderly people with reference to their labour activities

Employment is the key element of social inclusion and economic independence of all citizens. The census of Population and Housing in 2002 [1] revealed that the population of people with disabilities at the time of the study was approximately 14.3% of the general population. The remarkable phenomenon is that every quarter of the year, the number of people with legally pronounced disabilities has been steadily decreasing in recent years, mainly due to the decrease in the number of people receiving pension for incapacity for work [2].

From the viewpoint of the professional activation, the number of legally disabled people at working age is essential (i.e. women aged 18–59 and men aged 18–64) – in 2010, this population was 8.6% of the population at this age [2]. The problem of professional activation is also evident in the group of the elderly. This group is growing dramatically, creating special needs in vocational training, new or non-standard forms of employment, especially employment flexibility that requires the use of ICT (Information and Communication Technologies) and ways of their implementation and adaptation for working conditions. Additionally, this problem is reinforced by the fact that the population of disabled people of working age is dominated by older (45–65 years) and less educated people [3].

The results of surveys carried out in the Labour Force Survey indicate that only about 20% of people with disabilities aged 18–64 years are employed, most of them being of relatively low degree of disability. Such a bad situation is directly related to the lack of education and adequate preparation for a job. In a group of Poles with disabilities there is the highest percentage of people with the lowest education. The largest number, about 68% of these people, have completed primary, secondary or vocational education. A little more than 25% of people with disabilities have a secondary education, and only about 6% of them higher education.

As far as European countries is concerned, the statistical data with regard to disabled people varies according different sources. The estimated number of disabled people is from 10% to 15% in Europe. 16% of the working age population in the European Union claim long-standing health problems or disability [4].

In the article, the concept of disability has been extended, together with the deliberations on the elderly. On one hand, such an assumption results from the relation of the elderly people to the aspect of disability, resulting, among others, from the surveys [5], which indicate that the frequency incidence of disability increases with age, and increases rapidly after the age of 40. Among the 40-year-olds one person for ten is disabled, and among the 50--year-olds almost one for five, whereas in the group of 70-year-olds almost every second. On the other hand, one should take into account the problem of the aging population and the successively growing age of retirement, eventually up to 67 in the year of 2020 for men and 2040 for women [6].

The problem of an aging society is not just limited to Poland or Europe, as it is a worldwide problem. According to the Polish Central Statistical Office, the number of Poles aged 65+ by 2035 will increase more than 1.5 times.

Such a rapid growth of the elderly concerns the whole world [7]. During the period 2000–2030, the projected increase in elderly population in the 52 study countries ranges from 14 per cent. The highest elderly population is Singapore (372%) and Bulgaria has the lowest population of the elderly in the world (14%) [8].

There is presented the percentage of population aged 65 years and over and projected values in range of 2020–2060 for Poland and average in European Union in table 1.

Looking at the future of the structure of employment, consisting of the elderly, i.e. over the age of 55 and disabled people, it is necessary to take care of the working conditions which meet the accessibility criteria, taking into account the special needs of before-mentioned groups.

The needs are located in the areas of concern of this paper:

– the area of ergonomics (ERG);
– the area of accessibility of work space with the relation of freedom of mobility and safety (SPA);
– the area of information availability (INF).

Analyzing the needs of disabled people, the following types of disabilities have been included:

– physical disability (people with impaired movement, people with chronic internal diseases);
– sensory disabilities (blind and low vision, deaf and hard of hearing);
– mental disability (people with mental illness, people with intellectual disability).

The transfer of solutions from the industry and public services onto the ground of shaping working conditions of disabled and elderly people

The needs of disabled and elderly people in the area of ERG

Ergonomics means: easy to use, easy maintenance, interaction between users and products during usage, innovation of interaction between users and products, and safety to use [8].

Table 1. Percentage of population aged 65 years and over [9]

	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050	2060
PL	5.8	8.2	10.2	10.0	12.1	13.5	17.9	22.5	25.1	30.3	34.5
EU	9.6	11.0	12.5	12.9	14.5	16.0	19.1	22.6	25.6	27.8	29.3

Fulfilling the ergonomic criteria in shaping the processes and conditions tailored to the needs of people with disabilities and older people involves taking into account the relation of somatic relations in the antropotechnical system and, therefore, those which result from human corporeal qualities.

Table 2 provides a list of the key variables of somatic determinants for the elderly and people with disabilities.

Both, the coordination and fitness abilities belong to a group of motor abilities, which base on the functional ground [10]. Variables specified for the abilities mentioned above may be formed in a highly varied way depending on the age and type of disability, whereby they concern more people with physical and mental than sensory disabilities. The necessity of investigating the needs, which take into account variables listed above relates to physical jobs, especially in mass production such as the assembly line. Anthropometric features are also a crucial variables for people with physical disabilities and older people and play an important role in shaping the places of physical labour. An important element are the restrictions of mobility in the joints and the immobility or loss of specific body segments. The abilities of disabled and elderly employees to perform certain types of work are determined by the variables defining the load of musculoskeletal system and related to them postures at work. Anthropometric features of people with physical disabilities and their conditional characteristics determine in particular the shape, material and weight of work tools.

Supporting shaping of working conditions including somatic features is conducted using computer-aided methods based on modelling of anthropometric features and biomechanical analyses. Figure 1 shows the methodology of forming working conditions including computer methods having the foundations in industrial applications.

Acquisition of information on the anthropometric features of people with the musculoskeletal system dysfunctions is crucial in the proper adjustment of working conditions for the predispositions of disabled workers. The non-contact methods of obtaining quantitative data on anthropometric features are reverse engineering methods based on 3D scanning and photogrammetry, which have their main application also in industry.

Anthropometric data are the basis for the creation of computer representations of anthropometric characteristics with using human body modelling methods. Examples of computer software that meet the mentioned above assumptions are: Anthropos-ErgoMax [11] and Three Dimensional Static Strength Prediction Program 3DSSPP [12]. The programs have the wide possibilities to define somatic relations and external forces. It is possible then to simulate the actions of persons with the excluded physical activity of certain body segments. The simulation results show among others biomechanical assessment, stability analysis of the body, the analyses of maximum ranges of limbs of body models, allowing to design the ways of doing activities adjusted to the motor predispositions of the employee. Some computer programs, as mentioned Anthropos-ErgoMax, allow to analyse the anthropometric features in different age ranges. For example in Anthropos-ErgoMax software the maximum age range is 60–64.

Table 2. A list of the key variables of somatic determinants for the elderly and people with disabilities

A set variables	A list of variables
Coordination abilities	Combination of movements Keeping balance Rhythmisation of movements Rate of reaction Ability of co-operation Precision of movement
Fitness abilities	Stamina Speed Force flexibility
Antropometric features / range of movement	Dimensions of the upper limbs Dimensions of the lower limbs Growth Somatic features
Musculoskeletal system load	Body weight external load Direction of external force
Working posture	Stand position Seated position Arms position Legs position Head / neck position Wrist position Feet position
Construction features of the machinery park and working tools	Material Shape Weight

In particular, the recommended methods enable to the following tasks in the area of shaping working conditions including the needs of disabled and elderly people:

- adjustment of design features of work tools to motor abilities;
- analysis of the musculoskeletal system loads;
- designing manual tasks including motor dysfunctions;
- designing combined movements;
- determining the precision of movement.

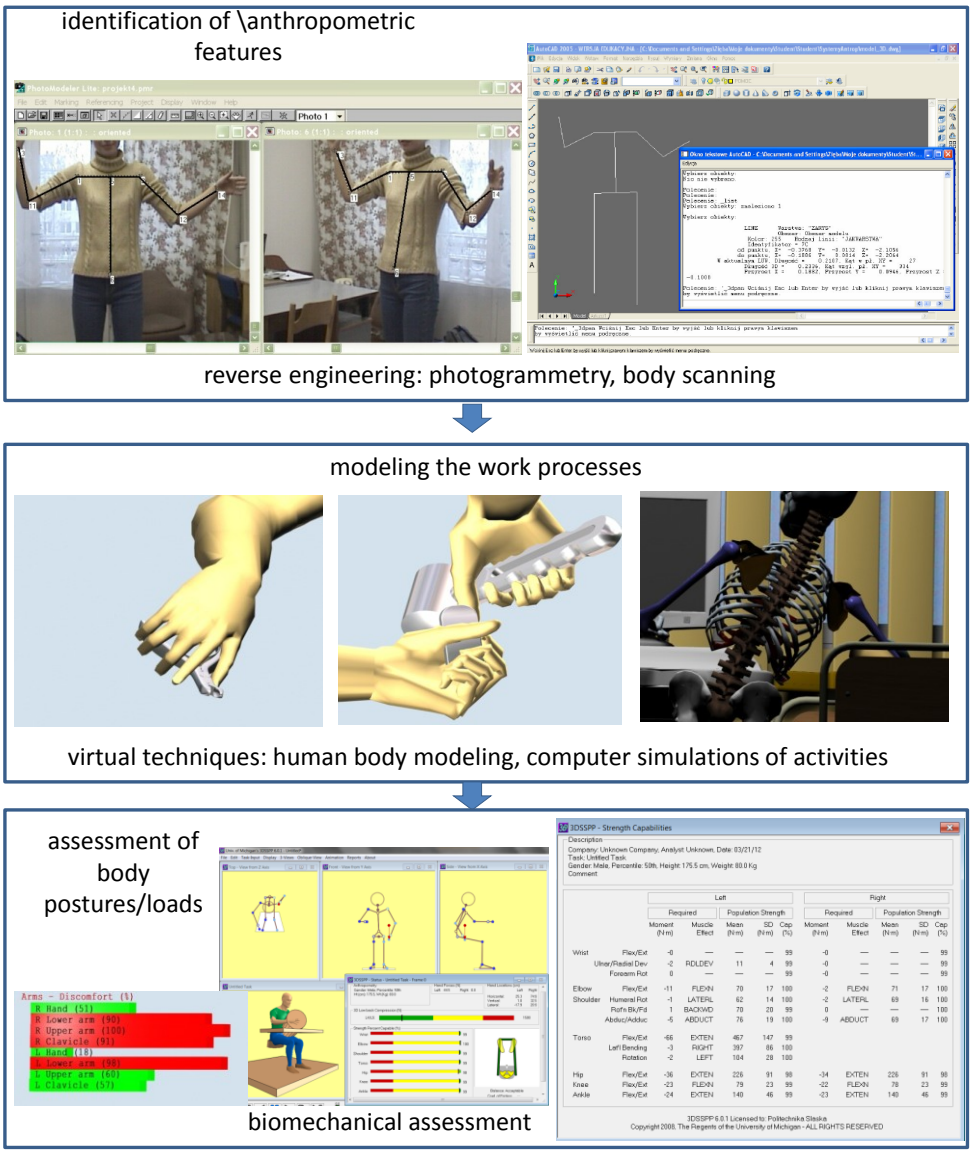

Fig. 1. Using the virtual technics for shaping working conditions for disabled and elderly people

The needs of disabled and elderly people in the area of SPA

The main criteria in the shaping of spaces in the employing establishment are the following:

– orientation;
– freedom and independence in moving;
– safety.

While the employing establishment should be understood as the work premises defined as a space with buildings, and places of work, or places to which the employee has free access, work areas, workstations and hygienic and sanitary rooms [13].

Having regard to the mentioned above criteria, the architectural aspects including small architecture and colour are the main deliberation subject and in particularly:

– the orientation of the passageways;
– safety of staircases;
– adjustment of lifts;
– adjustment of doors;
– non-slip floor;
– the consistent layout of equipment in passageways (such as various types of barriers consistently at a specific location);
– even lightning;
– adjustment of toilets;
– selection of appropriate dimensions of infrastructure.

The space, which takes into account the needs of people with disabilities, it is a space in which the employee moves in an intuitive way and in which there are no architectural barriers.

However, in addition to architectural aspects, that indicates the degree of adjustment of the building to the needs of disabled and elderly people, the essential problem is to easy for everybody mark the

important places in the area of the building. Thus, during designing a work space it is necessary to pay special attention to the following issues:

- localization and adaptation of the reception / concierge;
- access to all rooms in which an employee can stay;
- designate the thematic areas of the building.

Shaping the work space it should meet the requirements written in numerous legal acts, inter alia [14, 15, 16] and can also base on the author's experience in the assessment of accessibility and designing of non-discriminatory solutions. One of the manifestations of such activity is the author' method for carrying out the diagnosis of the availability of Agnieszka Kowalska-Styczeń and Joanna Bartnicka [17, 18, 19].The method is intended to assess the availability of closed spaces and the close surrounding around the building.

The basis for developing the methods were the pilot studies [19], consisting of inter alia: research with experts in the field of accessibility and field investigation in selected public buildings, including visual inspection, registration and analysis of factographical materials, analysis of internal documentation, which supplemented the knowledge of the area of availability and allowed to preparing assumptions for the method. These are the following assumptions:

1. Taking into account such types of disabilities as: sensory, physical, psychological, cultural, where under the concept of cultural disability the authors understand those people who do not speak a particular language (such as foreigners, illiterate).
2. Taking into account the basic needs of users in the passageways of the building and close surrounding of the buildings.

Having regard to above assumptions there were developed the diagnostic tables with special checklists, which have become the basis for assessing the availability of public buildings.

In particular, the diagnostic tables are a tool for the analysis of adjustment of the building to meet the needs of people with different types of disabilities, and therefore may also be used to evaluate and design of the work space. They take into account the design solutions across all floors of the building to which the person may have access. The compliance with the requirements included in the checklist is a confirmation, that the establishment is prepared to accept the disabled and elderly people, and while contributes to creation of safety and ergonomics of all working people.

One of the proposed in the study method of shaping space distinguishing easy orientation is wayfinding [20, 21]. There was proposed a division of the building into the zones marked with a specified colours. The colour zone in turn is integrated with elements of equipment, the small architecture, facilities, etc. In addition, the recommended colour contrasts indicate the paths in the intuitive way. There were also taken into account the needs of colour blind people, in particular 3 following types of colour deficiencies:

- deuteranopia: colour deficiency affecting red--green hue discrimination;
- protanopia: mild colour vision defect in which an altered spectral sensitivity of red retinal receptors (closer to green receptor response) results in poor red-green hue discrimination;
- tritanopia: hereditary colour vision deficiency affecting blue-yellow hue discrimination.

The needs of disabled and elderly people in the area of INF

The crucial receptor relations in shaping the antropotechnical systems taking into account the needs of disabled and elderly people is the perception of information which is especially important for persons with mental and sensory impairment. In this case, the traditional forms of presentation of information in the shape of written text should be replaced with alternative ones such as the audio / video transmission, picture or pictogram. The ability to receive information depends on the colours and contrasts, character size, readability, etc.

The latest research studies on the perception of graphic icons on cell phone screen with the participation of elderly people with visual problems and impaired mental conditions [8] indicated that they are able to read the text characters of the size of 5 mm. More complicated symbols should be as large as 30 mm and consist of realistic pictorial types of symbols rather than the 2D type of simplified symbols. Graphical symbol together with textual explanation make it easier to comprehend than those with plain graphic alone. As far as the colour is concerned, the study indicated that simplified graphic should be rendered in warm colour, while graphic with text should be difference in colours, and should avoid using warm colour tone. Finally, graphical symbols with extensive detail should be rendered with cool colour tone to help enhance the visibility of the elderly.

Other studies on the design of symbols in public spaces suggest user involvement in process of symbols design at the conceptual design stage. The aim of such research is to identify user needs, desires

and preferences [22] and most of all to increase the chance of the symbols being interpreted correctly, according to users' mental models [23, 24].

The prerequisite for effective, efficient and comfortable for the employee performing the work processes is the availability of relevant information resources. The information should help not only in doing work activities indicating the patterns of conduct, but also meet the criteria in the SPA area. These elements both in open and enclosed spaces may greatly increase the safety and availability of utility information supporting the mobility. The use of colour contrasts between certain groups of elements of the environment is one of the simplest and yet effective modifications that can be applied without incurring excessive expenses.

During the process of adjustment working conditions to the needs of disabled and elderly people, one should take into consideration the following elements:

- selection and presentation of announcements and information;
- selection of dimensions and location of tables and cabinets;
- selection of pictograms and legible forms of visual information about the elements of the work space;
- selection of appropriate forms of communication for people with visual impairments, for example through the use of tactile signs;
- selection of appropriate technical devices supporting information reception for people with impaired hearing;
- intuitive designations of pathways;
- intuitive, easy access to information;
- selection of colours, taking into account the needs of people with low vision and colour blindness.

The guidelines for shaping the availability of information are included in the above mentioned in section 3.2 method of diagnosis. They contain a number of requirements for the selection of colours, contrast, graphic elements, etc. The authors also suggest innovative solutions in range of tactile signs in the form of maps, plans, plates integrated with the tactile tiles on the floors [25], that can be used both in open space, as well as inside the buildings, and, therefore, also in the workplace (the system has gained a silver medal at the exhibition of inventions: IV International Warsaw Invention Show IWIS 2010, for team: Christophe Bevilacqua, Agnieszka Kowalska-Styczeń, Joanna Bartnicka). The most important feature of the solutions is they are non-discriminatory, i.e. they are intended for: healthy people through the legible way of presentation of the information based on colours, colour blind people through the selection of specific shades, blind and visually impaired people through a special system of tactile signs. There was taken into account also the needs of people with physical and intellectual disabilities. The proposed tables and maps are located at a height suited to people of short stature, and in wheelchairs. The solutions can also be used to better mark the escape routes. Figure 2 shows examples of solutions in terms of tactile signs.

Fig. 2. The examples of tactile signs

The availability of contextual information, regardless of location and time, is the another factor influencing the efficient and safe execution of work processes by disabled and elderly people. It is proposed to use the radio frequency identification technology RFID. RFID technology enables to non-contact automatic identification and data capture by using radio waves of different frequencies. The technology is the succession of barcode technology. The main components of the RFID system are tags having a unique code and readers, which are compatible with the mobile device, such as PC PDA, audio player etc. Currently, RFID technology is used primarily in industrial, logistics, trade. However, it is becoming increasingly popular also in health care. Previous studies on the use of this type of technology in shaping the working conditions in health care units [26] give rise to a recommendation of this type of technology in applications for disabled and elderly people, despite their high degree of manufacturability. The study indicates [8] that the elderly people still possess the ability to learn an unfamiliar technology, comprehend the symbolic representation, and reach the most complicated level of menus access. Most of them have no memorizing problem; all they needed is some instruction on the gadget's utilization. Figure 3

presents in simple way the scheme of operation of RFID technology in sharing information resources.

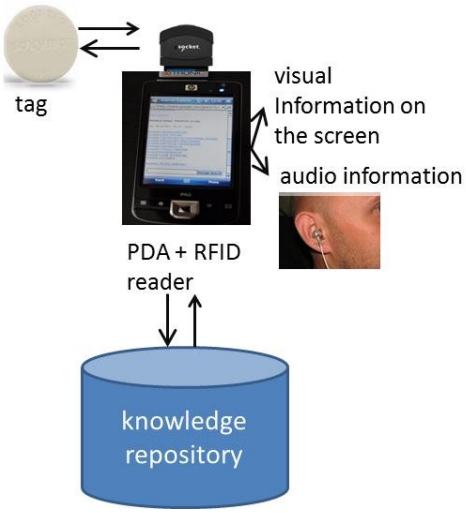

Fig. 3. The way of sharing information using RFID technologies

The recommended applications of RFID technology are as follows:

– RFID as a substitute for the pictograms in the workplace, which are recognized by the voice. The pictograms may include: warning signs for the threat, for example, for an oncoming vehicle, also order signs, prohibition signs, information signs, etc.
– The access to handheld repositories of knowledge containing instructions of performing operations, technical and user documentation, descriptions of the operation of machinery and equipment, etc. which are available via the audio / video channels.

Conclusions

The rule is that awareness of societies especially of the decision-makers in the area of the needs of people with disabilities is unsatisfactory and requires far-reaching actions aimed at not only financial support in this area but, especially in the first stage, the professional and awareness support. People with disabilities, despite their great ambitions, abilities and needs of professional activities, are ignored in the labour market. Such a phenomenon is inconsistent with the principle of equality and social justice. The chances of finding and keeping a job that will allow to independence in private life and public space or satisfy the health, cultural, educational needs will increase when the idea of Design for All will be more promoted especially among the employers. The need of ergonomic research in the area of the groups of people with impaired efficiency is also based on profound demographic changes and increasing number of elderly people in the labour market.

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