DOI: https://doi.org/10.53052/9788366249981.03

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WYKORZYSTANIE OPROGRAMOWANIA CERAA DO OCENY ERGONOMII W MIEJSCU PRACY

Streszczenie: Dzięki ergonomii możliwe jest łagodzenie, ale także w pewnym stopniu zapobieganie chorobom związanym z pracą. Jednym ze sposobów oceny ergonomii w miejscu pracy jest wykorzystanie oprogramowania i aplikacji takich jak CERAA. W tym artykule omówiono to konkretne narzędzie programowe i jego funkcjonalności.

Słowa kluczowe: CERAA, oprogramowanie, ergonomia, edukacja

USING CERAA SOFTWARE TO ASSESS ERGONOMICS IN THE WORKPLACE

Summary: Thanks to ergonomics, work-related diseases can be mitigated and to some extent prevented. One way to assess ergonomics in the workplace is through the use of software and applications such as CERAA. This article will discuss this specific software tool and its functionalities

Keywords: CERAA, software, ergonomics, education

1. Introduction

The first part of the article focuses on the clarification of ergonomics, its origin, its use in the work process and also work-related diseases of workers, which arise when companies do not focus enough on proper ergonomics in the workplace. The term

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ergonomics comes from two Greek words: ergon – work and nomos – law. The term first appeared in 1950 and referred to ergonomics as a new interdisciplinary discipline that uses knowledge from multiple disciplines to optimise the relationship between a person's performance capabilities and his or her working conditions in the enterprise. Its aim is therefore to create working conditions for employees that do not overstress them. The subjects of ergonomics are:

- The determinants of performance in terms of the capacity of the visual, auditory and motor organs.
- Human adaptation and response to working conditions and the body's response to work environment factors [1].

2. Key activities of ergonomics

As mentioned above ergonomics is interdisciplinary, i.e. it uses knowledge from several sciences.
These can be divided into three groups:

- Technical, focusing on human anatomy, anthropometry, physiology, and biomechanics in relation to physical activity (posture, movements, lighting, OSH, etc.).
- Psychological, they focus on the mental side of employees, i.e. how they perceive the work environment, manage work stress, learn to work with equipment, motivate other colleagues to perform, and similar issues related to learning, perception, recognition, and the employee's interaction with products.
- And organizational, we can say that they are the opposite of psychological, as they focus on the enterprise itself, its organizational structures, processes and strategies. They include activities related to communication, planning, scheduling of work activities, and so on [2].

Bojnanský in the publication Occupational Safety and Health in Practice defines ergonomics as an interdisciplinary field studying the relationship between man and working conditions, applying the latest knowledge of biological, technical and social sciences. Its aim is to optimize the human position in working conditions in terms of achieving health, well-being, safety and optimal performance [3].

Excessive physical strain on workers in enterprises contributes to work-related diseases. These illnesses also represent a significant financial cost for businesses. Excessive workload also increases worker turnover, accidents and sick leave. By correctly identifying risk factors and implementing effective corrective measures, a business can reduce or completely eliminate the cost of wage compensation for impaired work performance [4].

From the above, it is clear that the work environment is one of the key factors that influence employee performance. It is therefore important that employees are provided with working conditions that enable them to remain at work for as long as possible. Health and safety is also protected by legislation, in particular Act No. 124/2006 Coll. (the Occupational Health and Safety Act). Occupational safety and health (OSH) is used as an accident prevention, but OSH is also quite a heavy

mechanism that is based on legislation that points to different areas. OSH affects the management and control organizations of manufacturing plants, but basically every working environment. Nowadays, OSH also includes the protection of its workers related to the performance of work, namely the provision of psychological and physical well-being, working relationships, working conditions, social protection and social amenities of workplaces [5].

3. Related software

The following section describes one of the available software solutions that can contribute to a more effective assessment of ergonomics in the workplace. Such a software solution is the Tecnomatix Jack tool from Siemens. It is a modelling and simulation tool whose functionality allows, for example, to assess whether workers are at risk of injury in their work. It also allows the dimensions of workers to be adjusted to match the real dimensions of specific workers in the company, resulting in much more accurate outputs. The created simulation can be tested for several parameters including risk of injury, reachability, energy expenditure, user comfort or other parameters important for simulation testing. The tool can also create animations based on a predefined scenario, such as a sequence of work movements in production. Once the sequence is defined, the human model or character can be further exchanged for differently sized characters, with postures and movements automatically recalculated to reflect actual reality. Thanks to similar simulations, it is possible to observe how different types of workers are affected by a given scenario with respect to their height, build or age [6].

Figure 1. Tecnomatix Jack software demonstration, according to [6]

Below are some of the features that make this tool a valuable contribution to ergonomics, such as:

- Anthropocentric databases from around the world.
- Force – influenced posture prediction function.
- Posture prediction function based on upper limb exertion.
- Ergonomic analysis tools including NIOSH, OWAS, RULA.
- Manual modelling that can be used for example in hand anthropometry.
- Realistic skin of human models thanks to deformable mesh technology [6].

In the study entitled Usability of Siemens Tecnomatix Jack 7.1 software in manual work process innovation, a challenging manual operation was investigated in order to

find a more optimal way to perform this operation in practice using Tecnomatix Jack software. With the help of the Simulation Builder function, which can create reusable, modifiable simulations, the study changed the environment or modified virtual operators. With the software, the study was able to evaluate the forces acting on the virtual human model but also the exact position when the position at work exceeded the recommended NIOSH limits. Specifically, when a given worker is at increased risk of injury [7].

Software support is a valuable asset to businesses in implementing the correct corrective actions or ergonomic changes, especially in creating simulations, evaluating tasks in both the current setup and the proposed solution. [7].

4. CERAA overview

CERAA or also CEIT Ergonomics Analysis Application is a screening application for the assessment of spatial conditions and working positions from Asseco CEIT. The application is based on an augmented reality platform and complies with current legislation and technical standards. The assessment takes place thanks to augmented reality in a real workplace with a human 3D adjustable model. Each model in the app can be further zoomed, rotated or augmented with augmented reality using markers, which are one of the app's add-ons. Another advantage is that the application is user-friendly. It also offers instant information on ergonomic risks. Another indisputable advantage of the app is that it can be programmed on the basis of legislation in other European Union countries. The recommended hardware is a device (tablet) with Android 5.1 [8]. CERAA contains a total of 4 Modules. Each of these modules focuses on a different area within the workplace screening assessment.

4.1. First module

The first module focuses on various functionalities such as the screening assessment system which includes ergonomic workstation, reach zone, work plane height and working postures. All the mentioned functionalities are an important part in screening assessment of the conditions and working postures of the employees [8].

Figure 2. CERAA, Working positions, according to [8]

4.2. Second module

The second module focuses on the audit of administration. It contains 77 principles of ergonomics based on legislation and technical standards, which can be assessed by self-assessment or assessed directly by the agronomist. The audit of administrative workplaces focuses on individual workplace components such as the desk, work and rest modes, monitor, keyboard and mouse, functional and dimensional requirements of the workplace, work chair and footstool, microclimate and noise, and last but not least lighting and visual comfort. Module number two also includes a series of questions to assess the workplace within each of the above areas. Subsequently, within this module, the assessor is also provided with an overall assessment of the workplace based on the data entered with respect to legislation and technical standards [9].

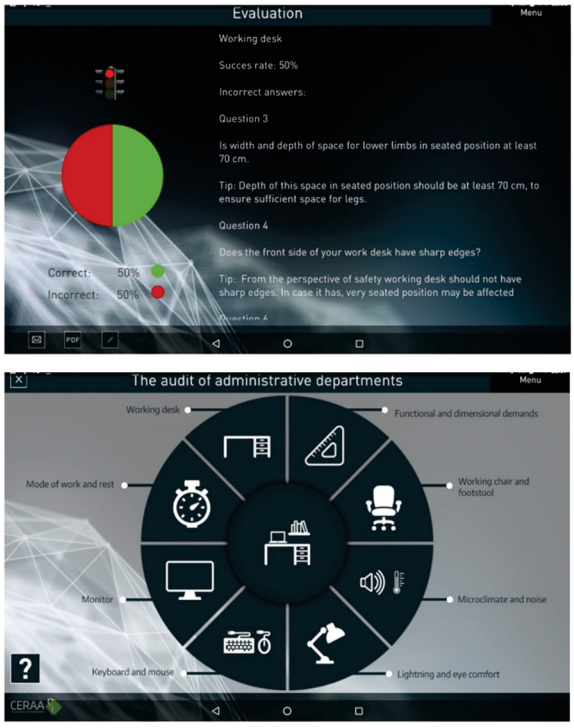

Figure 3. CERAA, Principes of ergonomics, according to [9]

4.3. Third module

The third module focuses on manual handling of loads. This module also provides a wide range of assessment elements such as the description of the load, the extent of load handling, the type and description of the load grip and also its weight limit. The module again relies on data from legislation and standards that specify load handling based on gender, age or the environment in which the load handling is performed [9].

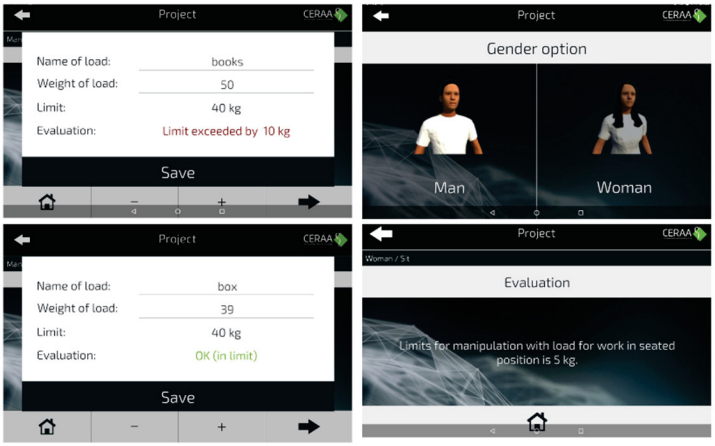

Figure 4. CERAA, Settings, according to [9]

4.4. Fourth module

The fourth module focuses on the examination of action forces as a function of grip. Custom hardware, software and evaluation methodology were developed for the module. Thanks to a special device (glove) it is possible to display the force measurement in real time, to capture the working action, to synchronize this action with the video recording and, last but not least, to verify the limits of the measured forces [9].

Figure 5. CERAA, Glove, according to [4]

5. Selected functionalities

Chapter four describes in more detail some of the functionalities that belong to the first module, which, as mentioned above, focuses on functionalities in the area of screening assessment.

Reach zone – The reach zone functionality displays the optimum and also the maximum handling space of the worker in sitting or standing position. Both reach zones are modelled in the application based on calculations of the width, height and depth of the space for optimal handling. Data from anthropometry and formulas from design standards were also used in the modelling. For each gender but also position and height a different reach zone is determined [8].

Blue plane – Within the range zone, the application has an extension of the blue plane, which is shown in the figure number six on the right and indicates the position of the heart. In the context of ergonomics, this plane informs us about the boundary above which workplace elements should not be placed. Should elements be placed here there will be unphysiological working postures of the upper limbs [8]

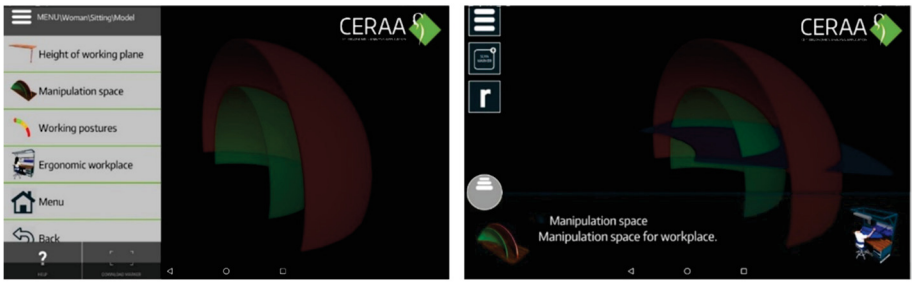

Figure 6. Reach zones in CERAA, according to [8]

Augmented Reality for Reach Zones – Reach Zones can also be displayed or transferred to Augmented Reality. Since the virtual model of the range zones is modelled in real dimensions, it is always necessary to step back when transferring the range zones to augmented reality and within a distance of 1.5 to 2 meters [8].

Information points – The r icon in the Reach Zones tab displays the points that are tied to the model in addition to the zones mentioned. These points carry information that will be displayed when clicked. In the figure below we can see a point with information about the Working Position Height. The maximum work plane height for a given worker is 705 mm. The optimal work plane height for a given worker is 540 mm [8].

Figure 7. Information points in CERAA, according to [8]

6. Use of the CERRA application in teaching

The CERAA application is also used in the course Ergonomics and Work Measurement, where students work directly with the application. The application allows students to better understand the links between legislation and practice in the field of ergonomics. Using augmented reality, the students first determine the position in which the worker or figure will perform the work tasks. They then take a picture of the manikin in a position that is deficient, analysing what corrective measures would be appropriate to ensure that the manikin is not at risk from an ergonomic point of view.
On the photos below we can see two working positions. The right sitting working position is ergonomically inappropriate, as the worker in this position passes the right hand to a position above the blue plane. The latter, as mentioned above, is the limit of the heart above which there should be no elements in the workplace with which the worker must come into regular contact during the work shift. In the photo on the right we see the worker standing. This position is inappropriate on initial analysis due to the excessive tilt of the worker's head, also we can observe a slight rotation and bending of the back.

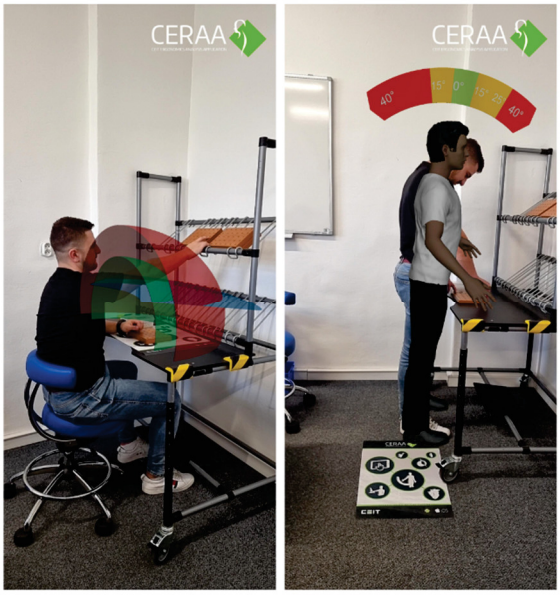

Figure 8. Using CERAA with student, bad positions

After the analysis is done, students will generate several options for remediation in class. They implement and review these corrective actions. In addition to the methods, legislation and standards, the augmented reality application CERAA also serves as a checking tool. The application makes it possible to see immediately whether the worker's reach zones established by legislation and standards are complied with, whether the worker's back or any other part of the body is too straight,

or whether any parts of the worker's body are in an unnatural position at work, which could cause work-related illnesses.

In the figure below left we can see the output from the CERAA application after corrective actions have been implemented. In the figure worker has adjusted the range zone in which he or she moves while performing the work activity. The worker's tools have been relocated to a more accessible point that is below the blue plane, a location where it is safe for the worker to operate the tools. In the figure on the right we see the corrective action to the standing position. After looking at all the criteria, it was found that the standing position was not suitable for the task and needed to be performed in a seated position.

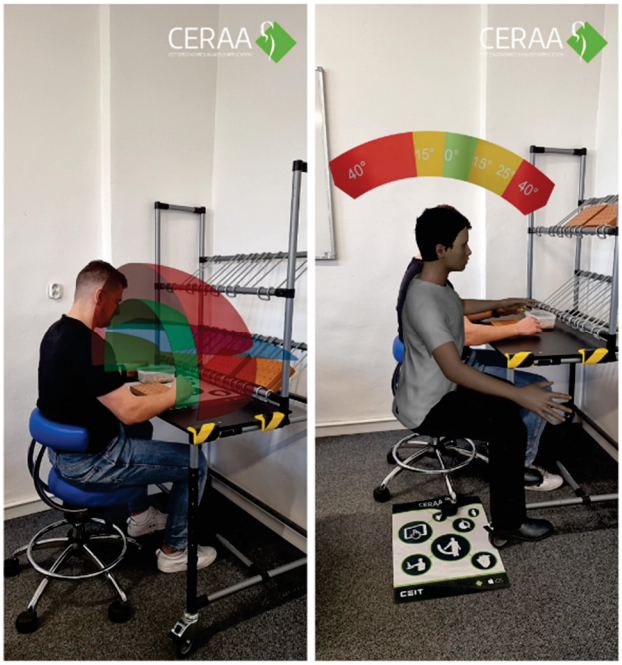

Figure 9. Using CERAA with student, good positions

7. Conclusion

The CEIT Ergonomics Analysis Application or CERAA for short is a user-friendly, comprehensive application for the assessment of spatial conditions and working postures. In addition to augmented reality, it has data from legislation and technical standards, making it a valuable asset not only in the field of ergonomics. The application is also clearly applicable in the teaching process. CERAA provides students with an insight into the application of legislation and standards in practice using augmented reality, so that they can gain a better understanding of the importance of ergonomic compliance in the workplace. It would be beyond the scope of this

article to describe all the functionalities, however, based on the functionalities tested, it can be deduced that CERAA is in many ways a suitable application not only for practitioners and ergonomists but also for teaching students.

ACKNOWLEADGMENT

This article was created with support of KEGA project 032ŽU-4/2021

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