Visual Performance Research of Call Centre VDT Operators

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This paper considers different factors related to the visual functions of the VDT operators. The visual performance of the call centre VDT operators is analyzed. For that purpose, the checklists for the human - computer system are used. It is established that some elements characteristic for the computer vision syndrome are present at the VDT operators. The proposal of measures for the improvement of the human - computer interface in a call centre containing the advanced ergonomic design solution for the VDT worktable is given. The presented concept for the VDT worktable is based on the accommodation and convergence principles.

Key words: *VDT, computer vision syndrome, accommodation, convergence, worktable.*

1. INTRODUCTION

In everyday life and work, a growing number of people use a computer for different task realization. It is estimated that 90 millions of users worldwide use a computer daily (Sen and Richardson, 2002). The time that users spend with computers is also prolonged. However, the information society appearance has its own price, which cannot be expressed only through computer procurement costs. The additional cost that user often pays is his vision. Numerous problems concerning various visual functions exist also, particularly among people whose occupation is related to a longlasting computer work, as are video display terminal (VDT) operators.

Human eye functions basically remained unchanged during 40000 years of human evolution. Anyway, during the last 100 years, human visual tasks have been changed from the distant object observation to the predominant close work (Anshel, 1999). Nowadays, disproportionately more time is spent on close work, such as video display terminal work. Majority of authors agree with the evaluation that this work is related to visual fatigue and discomfort appearance (Psihogios et al., 2001). As a consequence of this state, it is estimated that between 50 and 90 % of American population of VDT users have experience with determined aspect of eyestrain (Dillon et al., 1999). Moreover, as a result of adaptation to arising changes in visual task performance, there is an increasing appearance of shortsightedness in developed information societies (Anshel, 1999).

Beside musculoskeletal discomfort, the vision problems are mostly reported by the VDT user population (Studeli and Menozzi, 2003). This statement is confirmed by numerous researches. Sugita et al. analyzed the subjective visual complaints of VDT operators. A significant difference in the number and kind of complaints related to the vision and visual acuity between a VDT group and a control group (that didn't work with video display terminals) is determined. Similarly, Yamada et al. also state in their research that significantly more subjective visual complaints exist within the VDT operators group, as compared with a group which didn't use video display terminals in their work (Nishiyama, 1990).

Operators that work in the call centre present particularly endangered population of VDT users, because their effective work is related to a continual video display terminal use. Thereby, it can be presumed that call centre VDT operators are exposed to a significant visual strain. For this reason, in the first instance it is necessary to present the relevant factors that are essential for the operator's work in vision sense, as concerns the visual functions. Thereafter, it is needed to determine whether and to what extent the call centre VDT operators are exposed to the visual strain. Finally, it is necessary to form the proposal of measures that can be useful for the call centre VDT operators, so as to improve the visual comfort and visual environment as well as to reduce visual function problems.

2. COMPUTER VISION SYNDROME AND ASTHENOPIA

According to the American Optometric Association (AOA) computer vision syndrome (CVS) is defined as a complex of visual sense and vision problems related to a close work, which manifests as a result of computer use (Sen and Richardson, 2002). CVS arises owing to a long-lasting video display terminal work. Majority of regulations punctuates that each person who spends minimum 3 h during a day in continual or intermittent video display terminal work becomes potentially imperiled with CVS occurrence. However, determined CVS symptoms can be manifested even after a shorter period of time, which is spent in VDT work. In

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accordance with that, Kabayama noted certain changes at subjects even after 2 h of VDT work (Nishiyama, 1990). AOA punctuate that about 70 % of workers in USA ails from CVS (Sen and Richardson, 2002). As call centre VDT operators spend over 7 h at terminal work, they can be classified as a high risked population susceptible to CVS occurrence.

There is no unique viewpoint what symptoms can be classified as CVS. The presence of any of the following symptoms can be classified as CVS appearance: eyestrain, blurred vision, dizziness, nausea, eye redness, dry and burning eyes, near - sightedness, change in color perception, contact lens discomfort, slow refocusing, excessive fatigue, tearing, eye - coordination problems and occasional double vision (Sen and Richardson, 2002). Also, ocular tension, light and glare susceptibility, after - image appearance and presence of the eye pain and itching can be classified among CVS symptoms. According to the appearance frequency, CVS symptoms are ranked in the next order: eyestrain, headaches, blurred vision, dry or irritated eyes, light sensitivity, double vision and after - images (Dillon et al., 1999). The presence of a visual discomfort can be ascertained with appearance of any of the next seven CVS symptoms: itching, burning, aching, watering, blurring, dry or tired eyes (Psihogios et al., 2001). It is necessary that the mentioned symptoms are present during or after the end of VDT work, in order that can be labeled as computer vision syndrome (Sen and Richardson, 2002).

Asthenopia is an occupational term referred to the work related to visual complaints (Studeli and Menozzi, 2003). Asthenopia includes the similar or same symptoms that characterize CVS. It is estimated that about 30 % of VDT users frequently report asthenopic complaints (Studeli and Menozzi, 2002). It is considered that asthenopia arise due to exceptionally demanded visual work, which is performed at video display terminals. Laubli and Aaras emphasize that certain technical factors can cause appearance of asthenopia. Wolska and Schierz accentuate the importance of the lighting conditions, whereas Mocci and Smith consider that even stress at VDT workplace may cause asthenopia (Studeli and Menozzi, 2003).

3. VDT OPERATING DURATION AND VISION

Asthenopia manifests an increasing tendency during long - lasting work periods without proper pauses. In those cases, the subjective observation of eye strain or visual discomfort to a great extent corresponds to the perception of operator's work load (Studeli and Menozzi, 2003). Sugita et al. determined that there is a connection between number of hours that the operator spends at video display terminal work and elevation of subjective visual symptoms. Harima et al. also registered an increasing number of subjective symptoms with VDT working time duration. They indicate that after 3 h the increase reached a maximum. Yamano et al. point out that subjects which worked more than 4 h per day consecutively or intermittently showed a much more remarkable visual change, than those subjects worked intermittently less than 4 h per day. These results indicate that intermittent VDT work for less than 4 h per day can be recommended (Nishiyama, 1990). However, many CVS symptoms can occur only after 6-8 h of video display terminal work (Sen and Richardson, 2002).

Many researchers believe that it is difficult to prove long - lasting effects of VDT work on the visual system, but only temporary. Nevertheless, there are researches that point to the cumulative detrimental effects of VDT work on the human visual system. Shimai et al. carried out such a research by a questionnaire in a company manufacturing computer peripherals. The results indicated that the prevalence of subjective visual symptoms tended to increase, with the number of years worked with video display terminals. They concluded that the detrimental effects of VDT work on vision accumulate chronically, whereby they tend to be higher as the hours of video display terminal work per day increase (Nishiyama, 1990). Cumulative effects of VDT work over a long period of time can cause a diopter change, astigmatism worsening, eye - focusing disorders and eye coordination problems (Sen and Richardson, 2002).

4. ACCOMMODATION

On the occasion of close object observation, the human eyes perform three simultaneous actions: contraction of pupil, accommodation and convergence. The last two are important from the standpoint of VDT operator's vision and CVS (Sen and Richardson, 2002).

Accommodation is the process where the shape of the lens is changed, in order to bring an image into sharp focus on the retina (Schiffman, 1996). In this way, the eye adapts in order that a picture of adjacent objects should be clear. The muscle contraction within the eyeball (ciliaris) results in changing the lens shape (Sen and Richardson, 2002), thus influencing accommodation ability to focus various objects from different distance on the retina (Bullimore et. al). As a result of that it achieves a fine adjustment and focusing of the light rays, which originate from the objects located on different distances. The rays from a light source located more than 6 m away from the eye are nearly parallel to each other, so that they can be easily focused on the retina. In contrast, the light rays from a target that is relatively close to the eye are somewhat divergent from each other, so that they focus in the point located behind the retina (the lens cannot change the shape in the measure that is necessary for the clear image appearance). Thereby a blurred image of an object on the retina appears (Schiffman, 1996). Besides, ciliaris fatigue can also cause the sense of discomfort (Jaschinski - Kruza, 1988).

The closest distance at which an object can be seen clearly is called the near point (Schiffman, 1996). Each object located at a lesser distance from the near point position will be blurred. Accommodation ability of the human eye decreases with aging (Bullimore et al., 1995). Until the 50 years of age, the amplitude of accommodation decreases in accordance with the linear function, whereby after that period this decreasing is more pronounced.

Accommodation changes arise as a consequence of video display terminal work also. Nakagawa et al. determined in their research that accommodation ability decreases as a result of VDT work. Yamada et al. established that the relaxation time for accommodation is significantly longer among VDT operators than among non-VDT workers. Ibi et al. also determined the significant decrease of the power of accommodation for the operators working more than 2 h with VDTs. Kurimoto et al. as well as Iwasaki et al. come to the conclusion that the low frequency component of accommodative fluctuation increased during VDT work. Tamura noticed that the average controlling time for accommodation was prolonged by video display terminal work. Takeda et al. determined significant increase of accommodative fluctuation in some cases even after 1 h of continuous VDT work (Nishiyama, 1990).

Ishikawa et al. found that the accommodative response decreases with aging regardless of the used type of video display terminal. Also, with VDT work the distance relating to the near point lengthens. Kabayama et al. reported that after 3 h of VDT work the near point distance lengthens. Kumashiro et al. present the similar conclusions. They determined that the distance related to the near point of accommodation lengthens after 60 and 90 min of VDT work, compared with the initially established distance before the terminal work (Nishiyama, 1990).

The human visual system possesses a predetermined accommodation distance named resting point of accommodation (RPA). RPA presents the distance whereon the eyes focus when there is nothing to focus on, in other words, when there is no particular target object (Ankrum, 1996). The distance referred to the resting point of accommodation depends on aging process also. RPA amounts about 79 cm for younger people, whereby it gets farther away with age (Ankrum, 1996). It is established that a continuous VDT work at the distance that is lesser than the distance in conjunction with the resting point of accommodation contribute to the eyestrain appearance (Jaschinski - Kruza, 1988).

5. CONVERGENCE

Convergence occurs when the eyes shift inward the nose, when one views close objects (Sen and Richardson, 2002). The objects located at a great distance from an observer do not require the convergence, because they can be fixated with parallel lines of sight of the both eyes. In a case of observing the objects located close to the observer, there is the need for coordinated action of both eyes. The level of convergence is controlled by using the muscles connected with eyeballs (Shiffman, 1996), which activity according to Collins and Fischer can contribute to eyestrain (Seen and Richardson, 2002). As the observed object is closer, the greater is the strain of the muscles involved in convergence (Ankrum, 1996).

The stress of convergence contributes more to the visual discomfort than the stress caused by the accommodation (Jaschinski - Kruza, 1988). Ibi et al. recognized the existence of important convergence disorders among the workers a year after the video display terminal implementation in a company, in relation to the period before the implementation (Nishiyama, 1990). If the convergence is not corresponding, the observer see a double image (Ankrum, 1996).

The human visual system also possesses a resting point of convergence (vergence) - RPV. RPV relates to the distance at which the eyes converge, when there is no targeted object at which the eyes should converge (Ankrum, 1996). The resting point of convergence does not correspond to the resting point of accommodation. The RPV averages about 114 cm (Ankrum, 1996).

6. DISTANCE FROM A DISPLAY

The distance from a display can have significant impact on the operator's visual performance. In the most ergonomic guidelines the distance between 45 and 60 cm as optimal is recommended, that is to say approximately, the distance between a display and the operator should be an arm length (Sen and Richardson, 2002).

However, more precise determination of the optimal distance from a monitor is in conjunction with the accommodation and convergence phenomena. Jaschinski - Kruza (1988) performed an experiment where the subjects were classified in two groups, with near and far resting point of accommodation. The group with the near resting point of accommodation had the RPA of about 50 cm, while the group with the far point of accommodation had the RPA of about 100 cm. Both groups performed a task on a computer with a monitor located at a distance of 50 cm and 100 cm. As expected, the group with near RPA had less eyestrain working with a monitor at the distance of 50 cm. However, both groups had less eyestrain with a monitor located at a distance of 100 cm, compared with a distance of 50 cm. Moreover, both groups of subjects judged the distance of 50 cm as too near and declared that the work was more comfortable at the distance of 100 cm. Also, the performance of subjects was better when the monitor at the distance of 100 cm was used. Both groups had the far resting point of convergence. An afterward research performed by Jaschinski et al. (1998) confirmed that the eyestrain is greater at the near distance from the monitor (Psihogios et al., 2001).

It is necessary to emphasize that no studies have shown greater visual fatigue with monitor distance farther than the resting point of vergence (Ankrum, 1996). In the practical sense it means that a greater distance from a monitor is more comfortable for VDT work. The distance from a monitor should not be lesser than the RPV value, but in no circumstances lesser than 64 cm (Ankrum, 1996). In regard to the maximum viewing distance, this author punctuated that there is no limitation in this sense, and also from the visual fatigue aspect a longer distance is more comfortable for VDT work.

7. SPECIFICITY OF WORK IN CALL CENTRES

Call centre is defined as a place where the telephone users are served by an organization, along with the use of computer technology (ETSI, 2002). The operator in a call centre is a person whose job predominantly requires responding or making telephone calls whilst simultaneously using VDT equipment. Distinctively for call centes is the accomplishment of 24/7 operation, which means that service lasts 24 hours per day, seven days per week. The worker population of call centes is constituted of younger persons that are in average between 20 and 30 years of age, whereby the operators are mainly with secondary education. Supervisors permanently control their work. The "hot desking" system is applied, which means that the operator usually does not possess one VDT workplace, but work begins at the terminal that is not momentarily occupied. Most companies consider that the operator in call centre should spend about 80 % of working time answering the calls, while that percent for industrial operators is somewhat lesser and amounts to 60-70 %. Also it is considered that serving time per one user should not be longer than 2 minutes and 15 seconds, although in practice it is considerably shorter (ETSI, 2002).

8. AIM OF RESEARCH

It is not difficult to presuppose that the call centre operators work is visually demanded, because the most part of time they spend working on the video display terminal workplace. For example, in the Telecom Serbia about 90 % of operator's working time consist of VDT work. Although it is known that the call centre operator's work is especially stressed and strained, very little scientific research relates to the examination of their work. The reason for this maybe can be found in the fact that the call centre operator's work is monitored and controlled by the trade union organization activity, which agents sit in the rooms where this kind of activity is performed.

Having in mind all mentioned, the aim of this paper is to establish in what measure the call centre VDT operator's work can be considered as visually demanded, as well as to find the solutions which could make their work visually more comfortable and less fatigable.

9. METHOD

VDT checklists are used in this research as a basic tool. The checklists contain a list of situations for which it can be presumed that might occur in given circumstances (Sinclair, 1995). The application of the checklists belongs to the group of subjective research methods, which in the case of video display terminal work enables very realistic approach (Howarth, 1995).

VDT checklists present a tool that contains elements in the form of questions. Putting the questions we can determine and control whether and to what extent the observed system human - computer can be considered as suitable and ergonomically appropriate for the operator's work. Almost every VDT checklist contains determined number of areas, that is structural segments within which particular items are separated, that is the questions related to the area. Concerning content and structure, existing VDT checklists are often mutually different. Having in mind the variety of questions in different VDT checklists, the checklist that joined the different areas and items (within the scope of those areas) is formed, whereby the next VDT checklists are used for its designing: OEHS (2002), WSDLI (2002), LHC (1993), DOSH (1998), NYCOSH (2002), OSHA (1997), OSHA (2001), OML (1995), as well as the checklist of Somers et al. (1991). In this research, the area called vision that contains the next questions (formed in the previously described manner) is particularly considered:

*Q*1: Did you have a headache appearance during the video display terminal work?
*Q*2: Did you have experience with blurred and ambiguous letters, numerals and other symbols after long - lasting VDT work?
*Q*3: Do you feel a strain and eye irritation as a result of VDT work?
*Q*4: Do you have a problem with fixation of determined position, on the occasion of view redirection from a paper document to the monitor screen and vice versa?
*Q*5: Did you perceive screen flickering?
*Q*6: Are the presented symbols on the screen big enough for easy and fast reading?
*Q*7: Do you wear specially prescribed computer glasses?

In this research 33 operators participated in the Telecom Serbia call centre. The subjects were 25.5 years of age in average. All video display terminal workplaces had nearly the same equipment, which involved CRT monitors without the screen filters. The subject's task consisted of encircling an answer yes or no beside the corresponding question. Additional information and explanations as regards the vision and operator's work are obtained by interviewing.

10. RESULTS, ANALYSIS AND DISCUSSION

The positive given answers of the subjects (yes answers) in dependence of designated control question (from *Q*1 up to *Q*7) are shown in the figure 1. The horizontal axis is assigned with *Q* and refers to the corresponding question, while the vertical axis is assigned with *N* and presents the number of positive given answers.

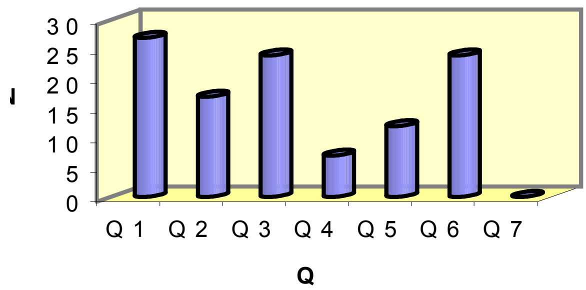

Figure 1. Number of operators with the positive answers in dependence of the type of control question.

Proportionately shown, results indicate the following:

81.81 % of VDT operators in call centre had the experience with headache appearance during the work

51.51 % of VDT operators had the problems with accommodation and convergence
72.72 % of VDT operators felt strain and eye irritation
21.21 % of VDT operators had problems with fixation
36.36 % of VDT users perceived screen flickering
27.27 % of VDT operators considered that the presented alphanumeric symbols are not of necessary size
0 % of VDT operators wore specially prescribed glasses for VDT work.

The hypothesis that relates to the control question *Q*2, regarding to the accommodation and convergence problems of the call centre VDT operators will be tested. The null hypothesis is that the 50 % of VDT operators in the call centre have accommodation and convergence problems ($H_0 : P=P_0$), whereas the alternative hypothesis is that the less then 50% of operators have this kind of problem ($H_1: P<P_0$). With respect to the testing of hypothesis that is based on checking of the answers with two possible alternatives, exact binomial test will be applied. According to the null and alternative hypothesis, as well as accomplished requirement that is $n\,p\,(1\text{-}p)<9$ (n - number of subjects), the formula for determination of value P yields (Kostic, 1990):

$$\mathrm{P}\,(\mathrm{X} \mid \mathrm{x} \leq \mathrm{r}\,) = \sum_{x=0}^{r} B_x(n,P_0) = \sum_{x=0}^{r} \frac{n!}{x!(n-x)!} P_0^x \, q^{n-x} \quad , \qquad (1)$$

where q=1-P_0. In this case P_0=0.5, n=33, r =17 (number of subjects with a positive answer) and α=0.05 (accepted level of the test significance). Substituted values in the formula (1) yield P=0.635. As $P>\alpha$, according to the decision making criterion (Kostic, 1990) the null hypothesis is accepted. Thus, the percent of VDT operators with accommodation and convergence problems is on the level of 50 % (in other words, it cannot be accepted that less than 50 % of VDT operators have accommodation and convergence problems).

The hypothesis that relates to the control question *Q*3 will be tested, regarding the strain and irritation of the visual system. The null hypothesis is that 70 % of VDT operators in the call centre have problem with the appearance of strain and irritation of the visual system, whereas the alternative hypothesis is that less than 70 % of operators have this problem. As in the previous instance, the exact binomial test will be applied. In this instance P_0=0.5, r=24 and α=0.05. Substituted values in the formula (1) yield P=0.695. As $P>\alpha$, the null hypothesis is accepted. It means that the percent of VDT operators with the problems that relate to the strain and irritation of the visual system is on the level of 70 %.

The hypothesis that relates to the control question *Q*4, concerning the fixation problem of operators in the video display terminal work will be checked. The null hypothesis is that 20 % of VDT operators in call centre have the problem with fixation, whereas the alternative hypothesis is that less than 20 % of operators have this problem. In this instance P_0=0.2, r=7 and α=0.05. Substituted values in the formula (1) yield P=0.665. As $P>\alpha$, the null hypothesis that the percent of VDT operators with fixation problem in the terminal work is on the level of 20 % is accepted.

Furthermore the hypothesis that relates to the control question *Q*6, regarding the size of alphanumeric symbols presented on the terminal screen will be tested. The null hypothesis is that the 27 % of operators in the call centre estimate that the size of presented alphanumeric symbols on the terminal screen is inadequate, whereas the alternative hypothesis is that less than 27 % of operators have this observation. In this instance P_0 =0.27, r =9 and α =0.05. Substituted values in the formula (1) yield P=0.602. As $P>\alpha$, the null hypothesis that the percent of VDT operators which estimate the size of alphanumeric symbols as inadequate is on the level of 27 % is accepted.

By the analogous procedure it is established that the percent of VDT operators who had the problem with headache appearance is on the level of 80 % (P=0.671 > 0.05). Mathematically considered, not less than 35 % of VDT operators perceived screen flickering. The reason for this maybe can be found in the occasional malfunctions of monitors due to their twenty - four hour use that have been lasting for several years, although the monitors are of later generation with the appropriate refresh rate. The result that there are no operators who use in their work specially prescribed computer glasses does not indicate that this need does not exist, but that the vision problem of operators is not especially treated in this way.

11. PROPOSAL OF MEASURES FOR VDT OPERATORS VISUAL COMFORT IMPROVEMENT

Having in mind all mentioned, in this section the proposals for the visual comfort improvements of call centre VDT operators will be presented. In spite of that, the techniques and procedures for improvement of visual surroundings at VDT workplace, which are a result of the insight in the state of Telecom Serbia call centre and that are not out of the paper framework will be presented. Some of those solutions are relatively simple for the realization and they do not demand special financial investments. Besides, the presented solutions have global character and they can be applied in other call centres too.

11.1. Visual cueing device application

Visual cueing device is a result of long - lasting work of Dillon (Dillon et al. 1999). Relaxation of the sense of sight for VDT users and increasing contraction to a visual task is the basic purpose of this device. The device consists of the colored light stimuli that emit the light of different frequency. After every working hour or more often, the operator should direct his attention to the device, which is seated on the VDT worktable. The sensation produced in this way is relaxing and very pleasant. However, this device has its second function as well. It is known that the terminal monitor with its electrical activity can cause an altered state of consciousness, which often characterizes sleepiness. Setting the light pulsation rate in the beta domain of brain waves, the state characteristic for the necessary focus attention is achieved. For his invention, Dillon received speciall gratitude from the lighting industry's society of engineers IESNA, for his contribution to the advancement in the area of Ergonomics (Dillon et al. 1999).

11.2. Screen filter application

The screen filter utilization has the multiple advantage. Beside the reduction of radiation from VDT monitors, the glare from a terminal screen can be reduced to a large extent. It is necessary to mention that with screen filter application the eyestrain can also be diminished and the headache appearance eliminated, during and after long - lasting video display terminal work.

11.3. Adjustment of the monitor distance

From the theoretical standpoint, as is mentioned before, it is often the case that in the recommendations a distance from a monitor that is shorter then the optimal for VDT operator's work is cited. From the practical standpoint, it is often the case that the operators work at the close distance from the monitor, due to different physical obstacles and other limitations. Having in mind that the VDT work at the close distance from the monitor leads to the visual strain and discomfort, the interface design in the way that enables an increasing of the distance between the monitor and operator can be recommended.

11.4. Ergonomic designing of VDT worktable

Here the design concept of VDT worktable based on the ergonomic principles will be exposed. Respecting that the operator's work in the call centre characterizes long - lasting continuous performing of the tasks that are followed by accommodation and convergence problems, it is necessary to design a worktable in the way that will enable alleviating or eliminating of this detrimental effects on visual functions. Existing solutions of VDT worktables do not provide a possibility to the operator to regulate independently the optimal distance from the monitor. In the main, the three basic types of worktables can be seen. The first type of VDT worktable has only one working surface where complete equipment is located, such as monitor, keyboard, mouse and so on. The working surface is limited, so that the operator does not have a possibility to influence essentially the monitor position change, nor to enlarge the distance from the monitor. The second type of VDT worktable offers somewhat better solution, because it contains two working surfaces. On the upper surface a monitor is installed, while the lower surface (that is lesser) is used for placing of a keyboard. By using the lower surface for a keyboard placement, the distance from the monitor can be enlarged to a certain extent. The shortcoming of this variant is that an increasing of distance from the monitor can be accomplished in relatively narrow limits. Furthermore, by setting the working chair height according to the lower surface, the situation may occur where the upper edge of a monitor is above the operator's eye level (the situation that should be avoided according to the most of authors). The shortcomings of the second solution are partially avoided in the third solution. This solution of VDT worktable also provides two surfaces, the upper and lower. In this case the upper surface is used for the input devices placement, whereas on the lower surface a monitor can be placed. In this way it is assured that the upper edge of the monitor is on the level, or below the eye level of an operator. Such a solution is applied in the Telecom Serbia call centre. However, this solution has certain shortcomings too. Before all, the upper as well as the lower surface is fixed in the horizontal as well as in the vertical direction. Thereby, an operator does not have a possibility to regulate the distance from the monitor. The lower part of the worktable has a small surface that is just enough for a monitor placement, but not for its positioning.

In order to avoid the mentioned shortcomings of VDT worktables, it is necessary to apply the concept that contains the next characteristics. First of all, it is necessary that the VDT worktable possess two surfaces, the upper and the lower. The upper surface is used for input devices placement. It should be adjustable in the vertical direction. The lower surface serves for a monitor placement. It should be movable in horizontal as well as in the vertical direction. This solution provides that the upper edge of the monitor is on the eye level or below the level of operator's eyes, but at the same time it enables that the operator can independently adjust the distance from the monitor. In this way the distance from the operator to the monitor that is two or more times longer than a distance that is obtained with the first solution of worktable is achieved. In figure 2, the advanced concept of VDT worktable in the XY plane is presented. The arrows present the possible directions of surface translation.

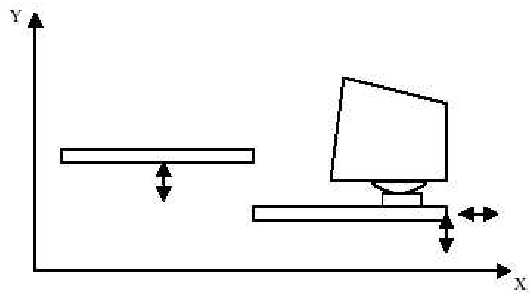

Figure 2. The ergonomic concept of VDT worktable, based on the principles of accommodation and convergence.

11.5. Size adjustment of the alphanumeric symbols

The application of the alphanumeric symbols that are of small size is one of the reasons for operator's approaching to a video display terminal screen. Instead of such approach that may cause rapid visual fatiguing, it is necessary to apply the approach that is based on the parallel increasing of the mentioned distance, but as well as the size of used font. Thus, increasing of the distance between the operator and the terminal screen should follow corresponding increasing of the font size as well. For call centre work, the used font should not be lesser than 12 pt (ETSI, 2002).

11. CONCLUSION

The conducted analysis reveals that among VDT operators in Telecom Serbia call centre there are some elements indicating the computer vision syndrome existence, that is to say the asthenopia. The proposed solutions for visual comfort improvement of VDT operators have the purpose to alleviate or eliminate the existing vision problems. Realization of these solutions can have the effect on the prolongation of the exceptionally short working life of call centre VDT operators and their work make more efficient.

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ИСПИТИВАЊЕ ВИДНИХ ПЕРФОРМАНСИ ВДТ ОПЕРАТОРА У КОЛ ЦЕНТРУ

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У овом раду су разматрани различити фактори повезани са видним функцијама ВДТ оператора. Анализиране су видне перформансе ВДТ оператора у кол центру. У ту сврху су коришћене контролне листе за систем човек - компјутер. Установљено је да су код ВДТ оператора присутни елементи карактеристични за синдром компјутерског виђења. Дат је предлог мера за побољшање интерфејса човек - компјутер у кол центру, који садржи унапређено ергономско дизајнерско решење ВДТ радног стола. Презентовани концепт ВДТ радног стола заснован је на принципима акомодације и конвергенције.