White Paper

VDT Work Monitors and Visual Fatigue

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EIZO NANAO CORPORATION

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1. Introduction

The emergence in recent years of PCs and IT technology has dramatically changed the style in which we work. While the office environment was primarily paper-based before PCs, each individual is now commonly assigned a PC. Document verification, checking, corrections, circulation, and so on were all tasks previously done on paper. This meant, among other things that issues related to paper and filing had to be faced. In contrast, the vast majority of tasks in modern offices are now done on the PC monitor. The development of IT technologies like the PC and Internet and paper reduction initiatives for environmental conservation, have made this commonplace.

The display terminals for the PCs used for work tasks are called VDTs (visual display terminals). The VDT is used for various tasks, including data input, retrieval and verification, text and image construction, editing and revision, programming, monitoring, and so on. These tasks generally fall under the umbrella term “VDT work.”

We undertook a survey of the relationship between fatigue, monitors, and the work environment for VDT work under the supervision and guidance of an ophthalmologist and a VDT occupational safety & health education instructor. The results showed that monitor functions and work instructions can be used to reduce visual fatigue.

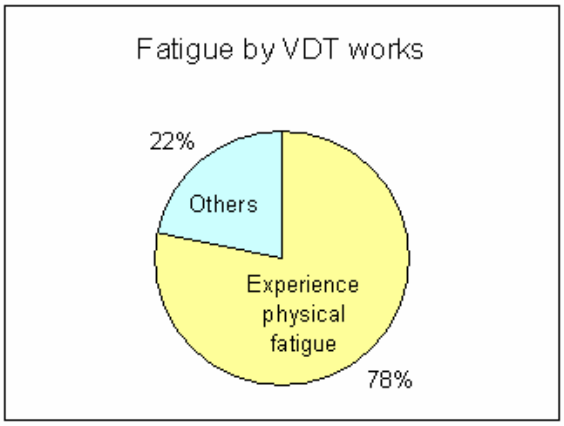
This white paper presents in detail the results of this survey and the monitor functions that reduce visual fatigue.

2. VDT Work Recognition

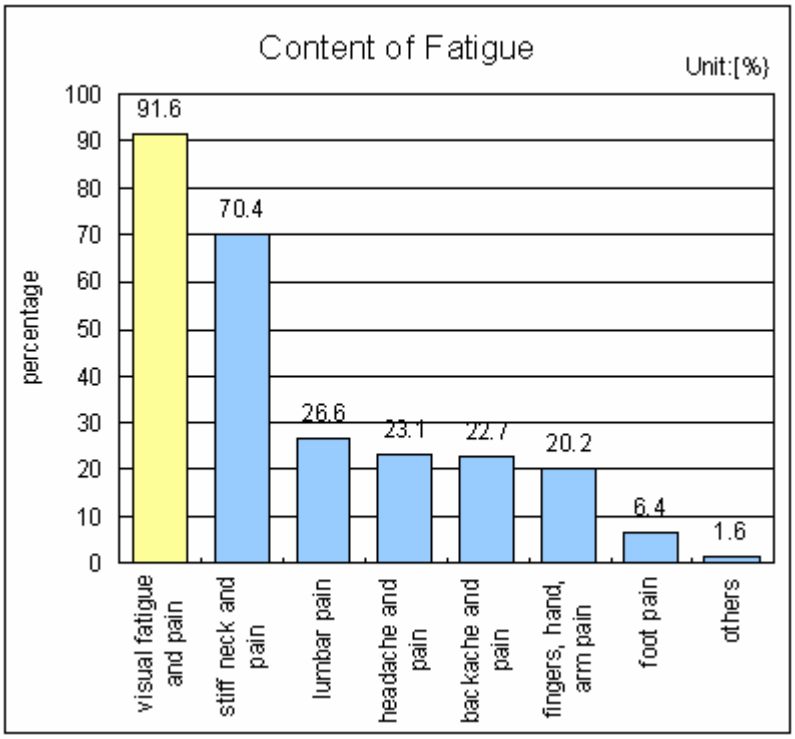
2-1. Japanese Ministry of Health, Labor and Welfare survey results

According to a 2004 survey by the Japanese Ministry of Health, Labor and Welfare, only 12.9% of companies performed physical examinations for VDT work over the past year, suggesting that recognition of VDT work issues remains low in the business world.

The same survey of office workers shows that 78% experience physical fatigue and symptoms from VDT work. Of these cases involving symptoms of physical fatigue, "visual fatigue and pain," at 91.6%, accounted for the highest proportion. This result suggests VDT work generates a certain type of fatigue.



Graph 1: Fatigue by VDT work (Japanese Ministry of Health, Labor and Welfare survey results, 2004)



Graph 2: Content of Fatigue (Japanese Ministry of Health, Labor and Welfare survey results, 2004

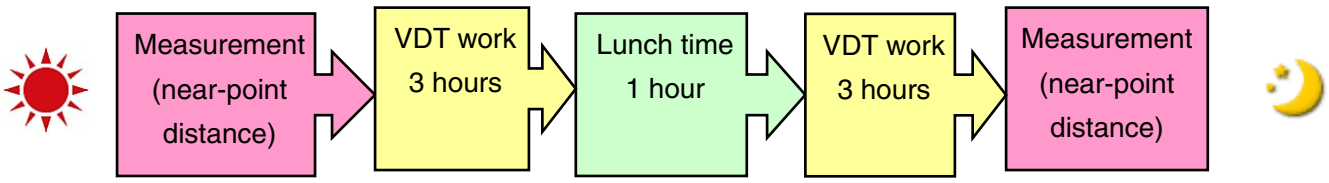
3. VDT Work Survey

We undertook a survey of the relationship between fatigue, monitors, and the work environment for VDT work under the supervision and guidance of an ophthalmologist and a VDT occupational safety & health education instructor.

It is generally believed that due to impaired accommodation response, visual fatigue increases the closest focal point (near-point distance). This survey assessed near-point distances before and after VDT work for different monitor settings and different monitor usage situations and investigated the effects on eyes and vision.

3-1. Survey method

The survey was carried out using the same VDT tasks with three changes in measurement conditions for the same test subjects. The near-point distance for the left eye, right eye, and both eyes of the test subjects were each measured 10 times just before work. Test subjects were subjected to three hours of VDT work consisting of intense input of text from magazine articles, following by a one-hour lunch break, followed by another three hours of VDT work. Immediately after the second work session, we measured the near-point distance for each subject's left eye, right eye, and both eyes.



This survey was performed for three days with measurement conditions varying each day.

The survey conditions are listed below.

<VDT work contents>

Inputting of text from magazine articles into a PC.

<Measuring instrument>

KOWA manufactured NP Accommodometer

Near-point ruler: A device measuring accommodation response and the closest distance at which objects can be brought into focus.

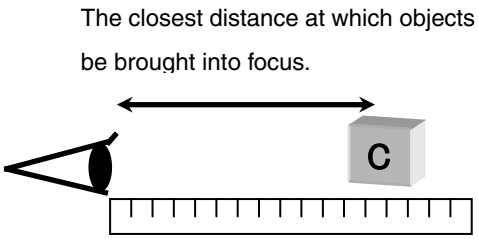


Figure: Near-point ruler

<Measurement procedure>

The near-point distance for the left eye, right eye, and both eyes were measured 10 times before and after VDT work.

<Measurement conditions>

Condition 1: FlexScan S2431W-E, standard setting (brightness 100%, approximately 450 cd/m^2)

Condition 2: FlexScan S2431W-E, appropriate brightness*
(Corresponding BrightRegulator function use)

Condition 3: FlexScan S2431W-E, appropriate brightness*
(Corresponding BrightRegulator function use) + VDT work instruction

**General office 500[lx] illumination intensity set to approximately100 cd/m^2*

<Test subjects>

11 subjects, male and female, from 20 to 30 years of age

<Condition 3 VDT work instructions>

The inspection was performed by the VDT occupational safety & health education instructor according to instructions based on the "Guidelines for VDT Work for Occupational Health" issued by the Japanese Ministry of Health, Labor and Welfare (published in 2002).

- Regular work breaks of 10 minutes for each hour.
- Correct working posture maintained.
- Correct monitor height, viewing angle adjustments, and document positioning.

3-2. Survey result 1: Levels of vision fatigue

Graph 3 on the following page compares the average near-point distance (30 times per person × 11 people ÷ 11) to measurement conditions and illustrates the changes before and after VDT work as a percentage change in distance. This graph shows significant differences in this value, with near-point distance lengthening following VDT work, which we believe represents increased vision fatigue.

The following are conclusions drawn from this survey.

3-2-1. Vision fatigue observed after extended periods of VDT work

Monitors were initially set to high brightness settings. The average near-point distance before and after VDT work increased 14.61%. This result suggests vision fatigue can be detected after a single day of VDT work*. (Measurement condition 1)

** Results and subjective perceptions vary from individual to individual*

3-2-2. Decline in fatigue when monitor brightness is reduced to more appropriate levels

The *Guidelines for* VDT *Work for Occupational Health* issued by the Japanese Ministry of Health, Labor and Welfare includes an entry recommending minimizing differences in brightness between the monitor and hard-copy documents and/or keyboard.

In this case, the test environment was characterized by the same illumination as a typical office (500[lx]). The illumination is converted to a monitor brightness of 100[cd/m^2]. In this case the monitor was adjusted to this brightness and VDT work allowed to proceed.

The results indicate a lesser increase in average near-point distance for monitors set to appropriate brightness levels (setting condition 2). This suggests reducing brightness settings (within reason) will reduce vision fatigue*.

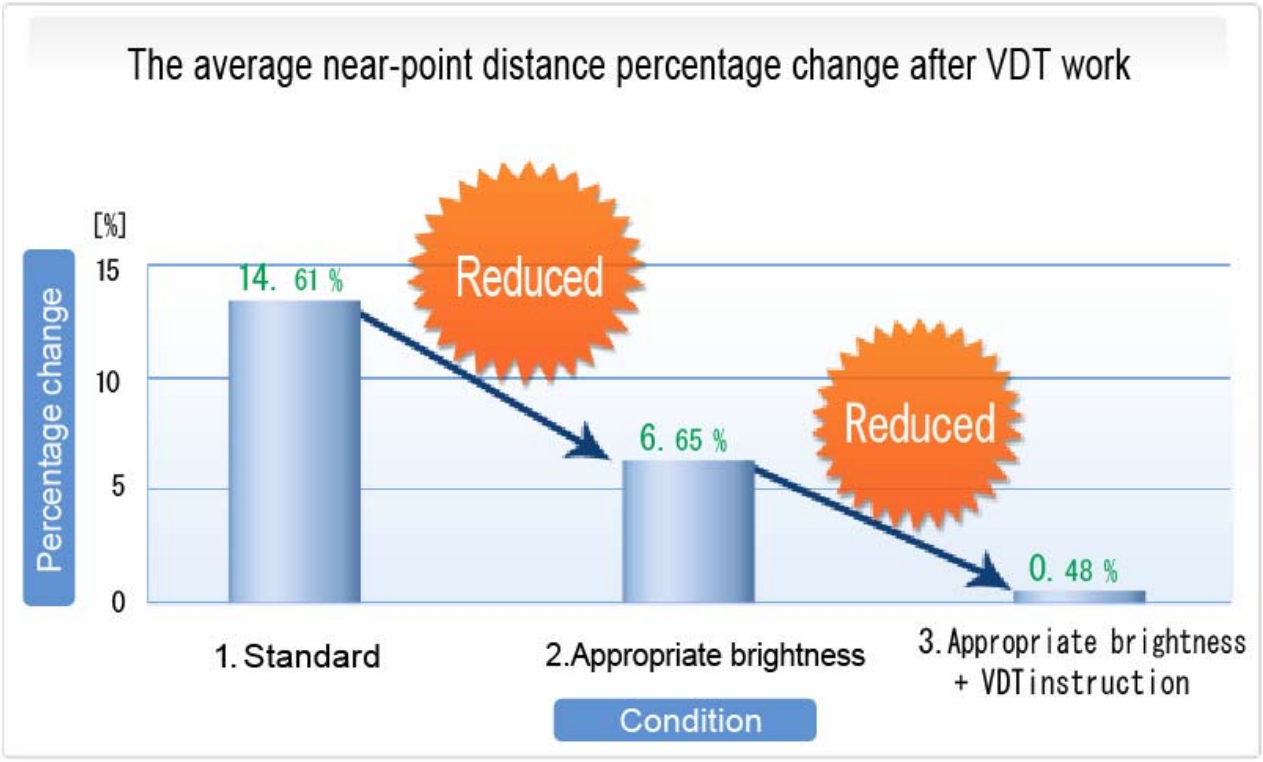
** Results and subjective perceptions vary from individual to individual.*

3-2-3. Decreased fatigue observed following compliance with VDT work instructions

The *Guidelines for VDT Work for Occupational Health* published in 2002 by the Japanese Ministry of Health, Labor and Welfare addresses not just monitor brightness, but the position of the worker in relation to the monitor, work posture, and breaks, among other issues. In this case, subjects were asked to perform VDT work in similar fashion under the supervision of the VDT occupational safety & health education instructor.

The results (setting condition 3) show reduced changes in average near-point distance, suggesting dramatic reductions in fatigue*.

**Results and subjective perceptions vary from individual to individual.*



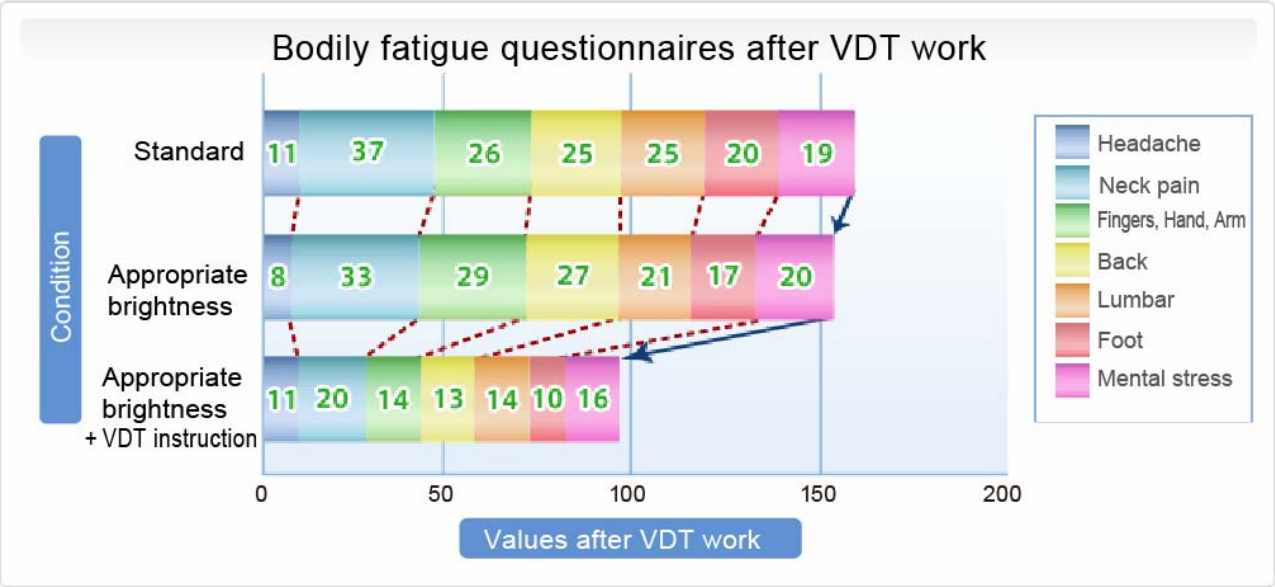
Graph 3: The average near-point distance percentage change after VDT work

3-3. Survey result 2: Levels of vision fatigue questionnaire

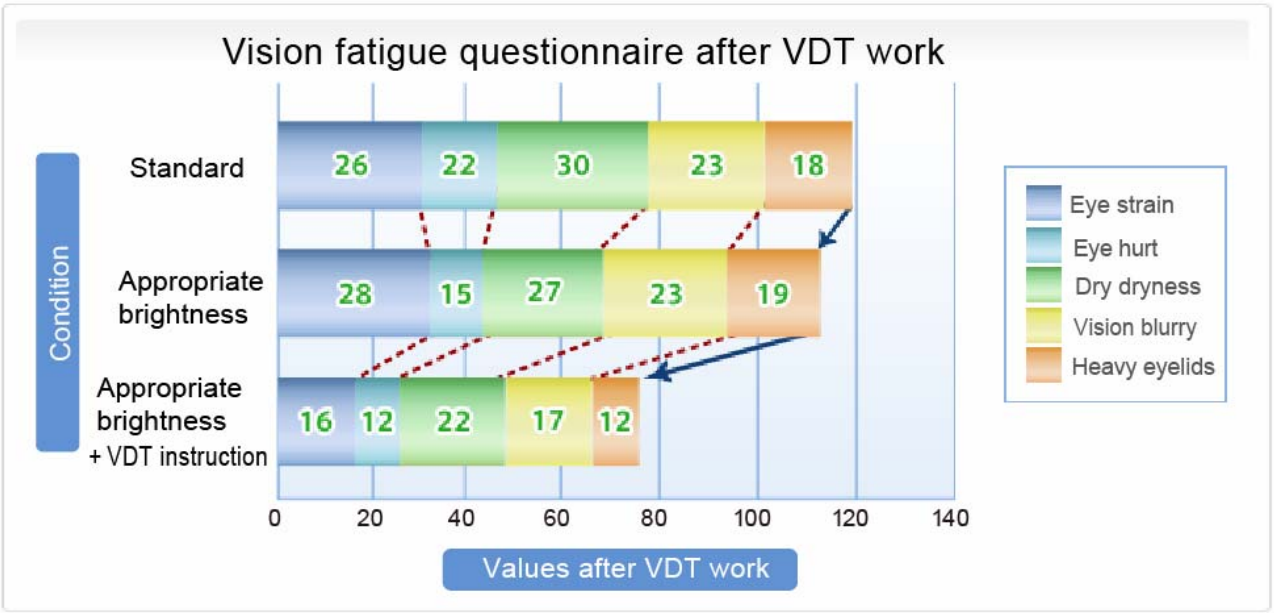
In addition to the survey described above, we had all participants fill out questionnaires after all VDT work. The graphs below are evaluated in 5 steps for all questionnaire items (a higher value indicates higher perceived fatigue) with a total for each measurement condition. The first is a bodily fatigue questionnaire (Graph 4). The second is an eye strain questionnaire (Graph 5)

With both cases, we found lower values for Appropriate brightness settings and Appropriate brightness settings + VDT work instruction conditions than for Standard settings. Based on this result, we believe appropriate monitor brightness settings, correct posture, and regular breaks reduce levels of fatigue*.

(* Results and subjective perceptions vary from individual to individual.)



Graph 4: Questionnaires after VDT work



Graph 5: Vision fatigue questionnaire after VDT work

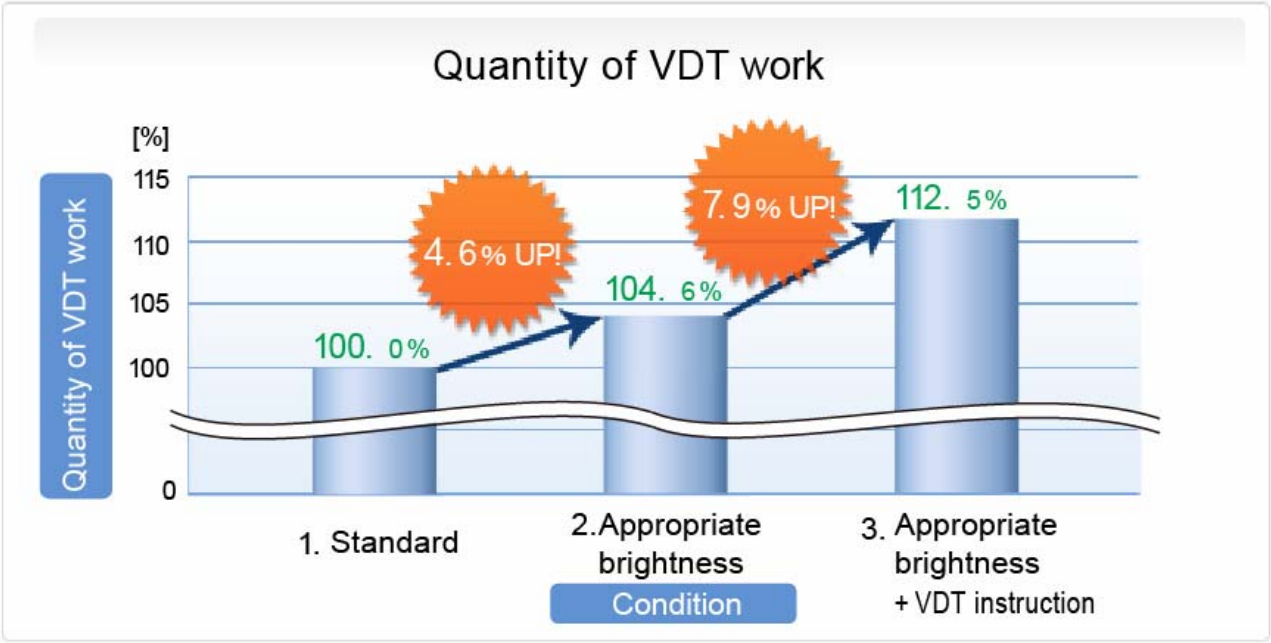
3-4. Survey result 3: Effect on work efficiency

To assess the effect on work efficiency corresponding to these differences in the work environment, we totaled the number of characters entered for each measurement condition and compared the efficiency for 60 minutes of work.

As shown in Graph 6, reducing monitor brightness to appropriate brightness settings improved work efficiency by 4.6%. Efficiency was also better – by another 7.9% – when work was done according to VDT work instruction and with assigned breaks.

While the task in question was simple character entry, the combination of appropriate brightness, correct posture, breaks, and so on appear likely to increase work efficiency*.

**Results and subjective perceptions vary from individual to individual.*



Graph 6: Efficiency of VDT work

4. Monitor Functions That Support Comfortable VDT Work

Here is a description of the functions incorporated into the monitors and applications designed by EIZO which promote safe, efficient VDT work styles.

4-1. BrightRegulator function†

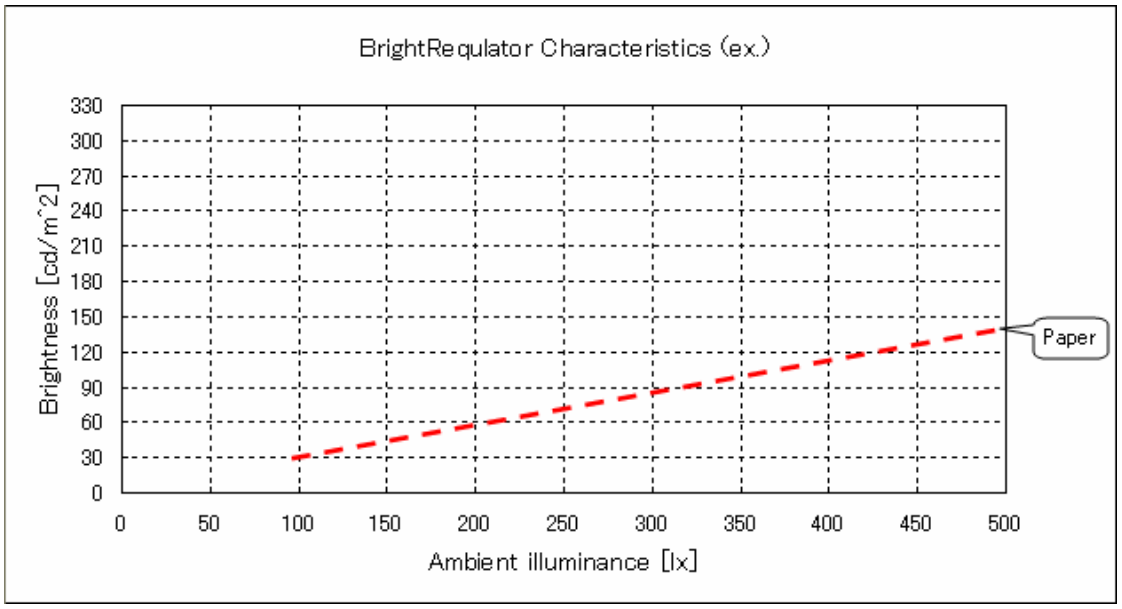
The Guidelines *for VDT Work for Occupational Health* issued by the Japanese Ministry of Health, Labor and Welfare (published in 2002) recommend minimizing differences in brightness between monitors and hard-copy documents and/or keyboard.

Figure 1: BrightRegulator sensor

EIZO monitors feature the BrightRegulator function*, which automatically adjusts monitor and document brightness. The surrounding light is measured by an optical sensor located at the front of the monitor that automatically adjusts the brightness of the monitor to minimize differences in the brightness of hard-copy documents and the monitor display. This function helps set brightness to levels appropriate for the demands of the VDT work environment.

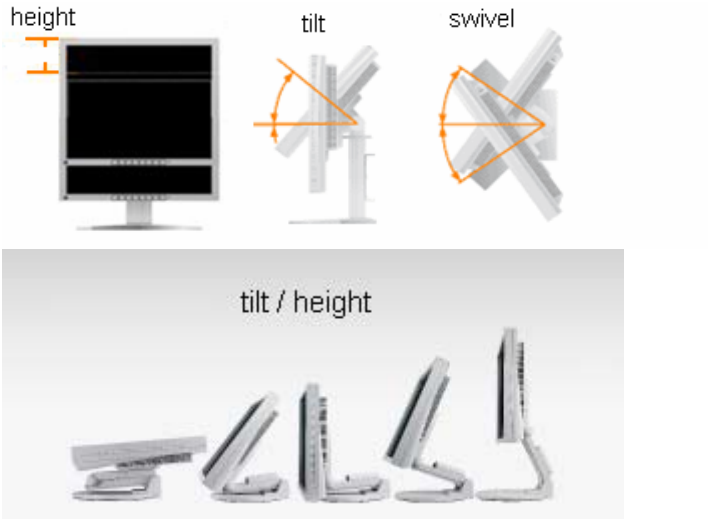
** The specific features of this function depend on the actual model. (Note that the factory default setting for this function is OFF.)*

†*BrightRegulator is known as Auto EcoView with models released after September 2008.*



Graph 7: BrightRegulator Characteristics

4-2. Stand and position adjustment functions



The *Guidelines for VDT Work for Occupational Health* (published in 2002) also provides recommendations on the position of the worker relative to the monitor and work posture.

To increase the flexibility in setting up the monitor, we equip our monitors with multiple position functions including tilt, swivel, and height adjustments*. This makes it easy to adjust the monitor's position to suit the environment of each worker.

** The specific features of this function depend on the actual model.*

4-3. Break reminder function (EyeCare Reminder)

The Guidelines *for VDT Work for Occupational Health* (published in 2002) also addresses work breaks. In condition 3, we recommend a 10-minute break for every hour of VDT work under the supervision of the VDT occupational safety & health education instructor.

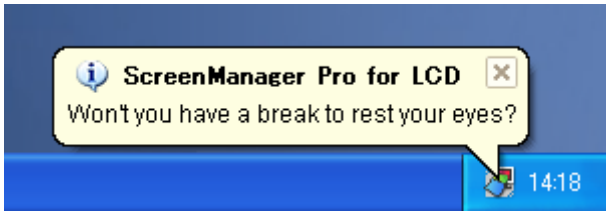


Figure 3: EyeCare Reminder function

Our EyeCare Reminder function promotes similar awareness. The EyeCare Reminder function displays message prompting workers to take breaks by making the appropriate settings in ScreenManager Pro for LCD, our monitor utility.

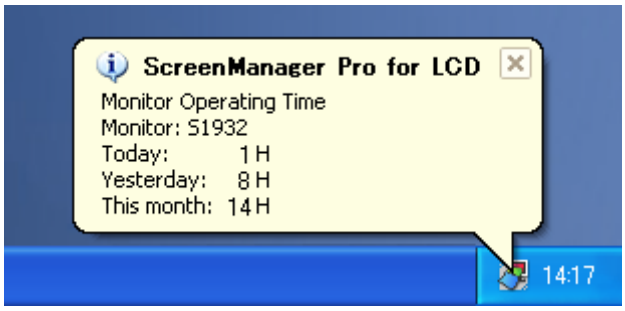


Figure 4: EyeCare Reminder function

An EyeCare Reminder function is also incorporated into the utility's monitor usage time management function. This function totals the number of hours of monitor usage for each day and month and displays them on the screen, allowing workers to manage and improve their VDT work habits.

5. Summary

Our survey found that VDT work monitor brightness settings, appropriate monitor position settings, work posture, and taking breaks are all important. The automatic brightness adjustment capability of the BrightRegulator function, convenient tilt and swivel for monitor position adjustments, height adjustment functions, and break time reminder functions provided by EIZO products help improve the safety and efficiency of VDT work. We believe these monitor functions help workers work better, with less fatigue.

Below are some comments from the ophthalmologist and the VDT occupational safety & health education instructor responsible for guidance and instructions for this survey.

Comments from Dr. Isao Otaka, Director at the Yokohama Sotetsu Building Eye Center

What precisely is human eye fatigue? We eye doctors still do not have a clear understanding of this issue. For humans, several elements appear to contribute to "tired eyes." There is no doubt that "tired eyes" result when the muscles (ciliaris muscles) used for focusing become fatigued from adjusting the lens thickness. When the ciliaris muscles become tired, the power to adjust (accommodation response) the thickness of the lens decreases. When accommodation response declines, the near-point — the closest point at which objects can be brought into focus — gradually grows more distant. This survey sought to assess eye fatigue quantitatively using near-point measurements before and after PC monitor use.

The EIZO monitor comes with default factory settings. Ideally, when it is first set up, the brightness settings should be reduced to appropriate levels to preserve the accommodation response and reduce eye fatigue. Fatigue is also less likely to occur if instructions for proper monitor viewing posture, breaks, and so on are issued as part of VDT work instructions.

Profile

Dr. Isao Otaka is the director at Yokohama Sotetsu Building Eye Center and the president at Aikeikai Medical Corporation. Prior to managing the clinic, Dr. Otaka served as a director in the department Ophthalmology at Shizuoka Red Cross Hospital from 1999. Prior to that, he was a research scholar at Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami USA from 1996 to 1998. Previously, he served at Kameda Medical Center and Keio University Hospital. As a renowned doctor of pterygium surgery in Japan, he has performed successful surgeries on hundreds of domestic and overseas patients. Dr. Otaka is a board certified Ophthalmologist of Japanese Society of Ophthalmology. Dr. Otaka earned his M.D. degree from the School of Medicine, Keio University in 1993.

Comments from Katsue Takabayashi, (VDT Occupational Safety & Health Education Instructor)

In the present era—the information age—the number of hours spent before a VDT in the office is rising, along with the numbers of workers who experience symptoms of physical or mental fatigue. In 2002, the Japanese Ministry of Health, Labor and Welfare published VDT work guidelines with the goal of alleviating such stresses. In 2004, based on a nationwide study of the physical/mental effects of VDT work, they issued the *General Survey Results on Technical Innovation and Labor.*

Long hours of VDT work generally result in tired eyes, shoulder tension, and other symptoms of VDT syndrome, though little scientific data is available on which usage environment, work conditions, and PC monitor characteristics have the greatest influence in causing the above symptoms. Those who use PCs on a daily bases contributed tremendously to the amount of information provided for this research.

The research data and questionnaires from this study document the differences in fatigue sustained over an entire workday due to environmental differences and work differences of VDT work—not just in vision and the eyes, but in the overall physical and mental state. This data will also enable us to recognize the importance of creating an environment that allows healthy and comfortable VDT work and encourage the attention to function and efficiency considerations, and monitor settings (brightness, height, and angle adjustments). It should also help in the promotion, throughout the business world, of safer and more comfortable VDT work habits.

Profile

Ms. Katsue Takabayashi is a founder and the president of Digital Health Center Co., Ltd. The firm primarily provides information and consulting services to create a healthy computing environment in the workplace as well as supervision services to promotional campaigns for institutional clients. Previously, Ms. Takabayashi was employed as a research analyst and contributed to a localization project with Thomson Corporation and Thomson Reuters in Japan. For five years she has been a VDT Occupational Safe & Health Education Instructor (JISHA) and a Guide of Eye Health at AllAbout which is the Japanese content site of About.com.

Ms. Takabayashi obtained a B.A. in English and American Literature from Tsurumi University. She has been admitted to the Graduate School of System Design Management at Keio University for fall 2008.