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## COMPUTER WORKPLACE ERGONOMICS

Changing technology has affected CWA members greatly- in some instances advantageously, but in others disadvantageously. Frequently, the employer that installs new technology does so under the guise of progress to increase worker productivity and efficiency. Quite often, employers purchase and implement equipment without informing the Union and with little concern for the safety and health of their employees.

In some instances, new technology has improved member working conditions, but, in others, new technology has produced several detrimental effects. One particular device-the computer- has, in part, resulted in increased worker productivity and efficiency, but often with a corresponding development of occupational safety and health problems.

The National Institute for Occupational Safety and Health (NIOSH) estimates that, at present, there are more than 100 million computer workers in the United States.

Since the latter 1970s, the number of CWA members utilizing computers has increased from a few thousand to more than 450,000. In the coming years, the number of Union members working with computers will continue to grow at an ever-increasing rate.

Research has indicated that there are specific health symptoms associated with the use of computers. These may be categorized as visual, musculoskeletal, and job stress-related.

### Visual Symptoms

Visual and ocular problems are most frequently reported by computer workers. Ocular complaints include eye discomfort, eyestrain, burning, itching, irritation, and aching. Other less frequently mentioned visual symptoms include blurred vision, double vision, color fringes, and reported deterioration of visual acuity. In addition, many workers indicate the occurrence of headaches.

The rate of visual complaints is dependent upon the type of computer work (data input, data output, and dialogue) and the particular visual demands associated with the work and the work environment. Many studies indicate that computer workers suffer from a high rate of visual disturbances. Data suggests that some types of computer work produce greater levels of visual complaints than traditional office or visually demanding inside work.

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Numerous studies have indicated that different types of visual discomfort may produce varied effects. For example, severe optical discomforts (eye irritation, soreness, and tiredness) may not go away within a short period of time following work and may be present at the start of the next workday. Health effects related to visual performance (e.g., blurred vision) may have a recovery period of 15-20 minutes or more.

Researchers note that the majority of computer operators around 40 years of age will require glasses. This usually occurs as a result of the natural deterioration of a person's eyesight. In this case, the lens of the eye loses its capability of focusing at close distances- farsightedness.

## **Musculoskeletal Symptoms**

Postural or musculoskeletal problems are common to many sedentary jobs. Operator complaints are most often related to the neck, shoulders, back, and wrists. Complaints mentioned less often involve the arms, hands, and legs. Researchers indicate musculoskeletal symptoms are more frequently reported by computer operators than workers in traditional jobs.

According to scientific and medical information, including data from studies conducted/sponsored by CWA's Occupational Safety and Health Department, serious musculoskeletal health symptoms are most often associated with computer jobs requiring constrained working positions for an entire work shift. In a seated position, the computer worker is subject to continuous stress on almost all postural muscles. The amount of the stress is dependent upon the position of various parts of the worker's body. Holding the head to the side or forward may lead to neck and shoulder fatigue and pain. Other neck and shoulder complaints result from the use or position of the operator's arms. For example, elevation of the arms will add to neck and shoulder strain. Prolonged, constrained postures required by the job will make this condition worse. Over the long-term, continued wear and tear may result in a gradual deterioration of joint tissues.

There are several common characteristics of computer jobs that have been related to increased musculoskeletal complaints. These include the design of the computer and workstation equipment, work pace, repetitiveness of the job, work and rest break schedules, and personal attributes of workers. All of these factors must be addressed to effectively reduce postural complaints.

## **Job Stress**

Job stress as reported by computer workers is often described in terms of psychological and physical strains such as frustration, anxiety, irritability, anger, depression, stomach or gastrointestinal disturbances, and muscle and psychological tension. During 1985, seven CWA North Carolina Locals, the North Carolina Women's Activity Network, the CWA Occupational Safety and Health Program, the North Carolina Occupational Safety and Health Project, and the School of Public Health-University of North Carolina conducted a computer workplace ergonomics study which identified an association between computer use and angina or chest pain. It is believed that job stress factors were, in part, responsible for this finding.

Additional scientific studies conducted by/with CWA's Occupational Safety and Health Department have established a relationship with work organization/job stress factors and musculoskeletal repetitive motion health symptoms and disorders. For example, a scientific investigation conducted (and completed) in 1990 with the Department of Industrial Engineering, University of Wisconsin found that electronic performance monitoring was a major cause/promoter of worker psychological and physical health complaints. Monitored workers reported more boredom, high tension, extreme anxiety and depression, anger, and severe fatigue than non-monitored workers. Of particular significance, the study found that monitored workers reported more wrist, arm, shoulder, neck, and back musculoskeletal repetitive motion health problems and headaches than non-monitored workers.

Another scientific study conducted and completed in 1992 by the National Institute for Occupational Safety and Health (NIOSH) investigated the relationship between computer use, physical and work organization variables, and upper extremity musculoskeletal repetitive motion symptoms and illnesses. This important study found a relationship between work organization factors such as overtime, increased numbers of hours spent at the computer per day, fear of being replaced by computers, increasing work pressure, lack of a production standard, lack of job diversity with little decision making opportunity, high information processing demands, surges in workload, and electronic performance monitoring with the occurrence of computer worker repetitive motion health symptoms and illnesses.

In 1998, CWA announced the completion of the "CWA New Jersey State Worker Computer Workplace Study", the most comprehensive ergonomics study conducted in the public sector to date. The scientific investigation, initiated in 1996, was sponsored by the Union's Occupational Safety and Health Department, CWA's District One Headquarters and New Jersey public sector locals, the Department of Industrial Engineering-University of Wisconsin, the Psychology Department-Rowan University, and the State of New Jersey. The study focused upon worker computer use and the identification of potentially-related repetitive motion and occupational stress health symptoms and disorders. In turn, procedures for the resolution of member health problems were to be put forward.

Participants in the study included 514 CWA members employed within clerical, technical, and professional occupations for the New Jersey Treasury, Labor, Education, and State Departments. The investigation identified high rates of member musculoskeletal cumulative trauma or repetitive motion as well as occupational stress health problems. In addition, several work organization/occupational stress factors such as work pace, work load, job security, and control over the way the job was performed were identified as being related to these health problems.

During the Summer, 1998, CWA's Occupational Safety and Health Department and the School of Public Health-Johns Hopkins University completed a major computer workplace study involving Union leaders and members of Locals 2101 and 2150 located in Baltimore, Maryland. The nearly 250 participating members were employed as service representatives by Bell Atlantic and American Telephone and Telegraph (AT&T). The scientific investigation, initiated in 1996, addressed the relationship among occupational stress, stress at home, and health symptoms associated with musculoskeletal disorders or repetitive motion illnesses.

The findings from the study indicated that computer workplace repetitive motion health symptoms involving the hands, elbows, shoulders, neck, back, and legs occurred among a large number of participants. In addition, the scientific data found that job demand occupational stressors (e.g., constant and fast pace of the job, sales and adherence requirements, and scheduling) were directly related to the occurrence of computer workplace musculoskeletal disorder symptoms.

Of particular importance, the investigation did not find any relationship between non-occupational stressors (e.g., stress at home) and the causation of repetitive motion health symptoms. These scientific findings are of particular significance to CWA for a number of reasons. First, they support the Union's contention that member repetitive motion illnesses are work-related. In addition, the data demonstrates that occupational stress created from job demands, not non-occupational stress factors related to the home environment, are directly related to the occurrence of member symptoms of musculoskeletal disorders or repetitive motion illnesses. Also, the study's findings point out the negative aspects of employer policies and work practices associated with excessive job demands such as forced overtime and related productivity expectations.

These investigations have confirmed CWA's long-held belief that computer work organization job stress factors are related to the occurrence of member physical and psychological health symptoms and illnesses.

## **Computer Workstation Design**

The primary causal or promotion factors of computer-related worker health symptoms include the computer and workstation equipment, the work environment, and work organization. Proper design or redesign of these factors are directly related to whether and how often CWA members operating computers experience visual, musculoskeletal, and job stress health symptoms.

Ideally, computer design controls should be placed into the equipment during the manufacturing process. Manufacture and use of ergonomically designed computers will result in lower long-term costs, increased productivity, and decreased worker health symptoms.

However, many computers in use are not properly designed to meet the needs and characteristics of workers. Improper computer design may cause or promote health symptoms. Areas of concern include character legibility, reflectance quality of the screen, adjustability of screen angle, contrast and brightness controls, and appearance of the equipment.

Character legibility is crucial to the operator's ability to read screen characters. Adequate screen and character size are necessary to avoid visual discomfort. Computer screen sizes that are at least 9 inches by 11 inches are recommended. Characters should be distinct and large enough to be easily read. Computer screens should be manufactured/equipped with anti-reflection coatings. Such coatings, sprayed on the inside surface of the screen during the manufacturing process, cause a change in the way light is reflected from the screen, thereby reducing the luminance of reflected images without degrading the character image.

In the case of existing poorly designed computers, there are several methods of reducing screen reflections or glare. A variety of screen filters or surface treatments are available to minimize screen reflections. Since these retrofit methods have specific advantages and disadvantages, they should be used only after other steps have been taken to eliminate glare. Careful analysis of workstation and workplace features is necessary to determine the best means of retrofitting computer equipment. For this reason, expert personnel should be consulted before glare reduction treatments are purchased and implemented.

Computers should be equipped with adjustable angle (tiltable), contrast, and brightness controls. Availability of these adjustments will allow operators to position the computer to fit their particular physical characteristics. Ideally, operators should view the screen at an angle of 10-30 degrees below horizontal. For machines not so equipped, adjustable stands should be provided.

Computers should also be equipped with brightness and contrast controls. Such controls will allow the operator to adjust the computer to her/his liking, thereby reducing one cause of visual discomfort. Controls should be placed in a location that is convenient to the worker, preferably on the front of the machine. Also, computer equipment should have a non-reflective matte finish.

To allow for flexibility in positioning computer equipment, computers should have separate screen and keyboard units and electrical cords that are long enough to allow freedom of arrangement. Operators can then position both the screen and keyboard for optimal convenience and comfort.

Keyboards should be thin and the angle should be adjustable. Key surfaces should be concave for finger comfort and have a matte finish to reduce reflections (e.g., gray, beige, or a similar color).

Where used, mouse equipment (as well as other devices such as track balls and joysticks) should be detachable and moveable. The mouse should be designed to fit comfortably into the hand and positioned with the click buttons level with the keyboard. The mouse should be at the same height and angle as the keyboard and situated next to the keyboard. Also, the work surface upon which the mouse is used should be large enough to allow for the proper and intended operation.

Of importance, employers should establish an annual schedule for computer maintenance. Scientific data clearly demonstrates that poorly maintained computers may produce distorted screen characters and promote worker health symptoms. Adoption of an annual maintenance schedule will compensate for aging and maintain optimum computer contrast, focus, and distortion-free images.

Due to the causal relationship between computers and visual/eye discomfort and, possible permanent visual deterioration of visual acuity, concerned CWA members should be provided eye examinations upon commencement of employment or assignment of work upon computers and annually thereafter. Such examinations should be conducted by an ophthalmologist or optometrist and should include, in addition to routine optical testing, refractions, acuity, and accommodation testing, tests for color vision function, and examination of the cornea and the lens for opacity and the retina for detachment.

Factors important to workstation design include the computer table, chair, document holder, lighting, foot rest, and wrist and arm rests.

Computer tables or desks should be vertically adjustable to allow for operator adjustment of the screen and keyboard. Tables or desks should be of sufficient size to allow the computer and other tasks to be performed without excessive twisting, turning, or stretching of the trunk, shoulders, neck, or arms. Proper design should allow for different arrangements of computers as the task requires. The surface of the table should be large enough to allow for all necessary equipment and work materials. Computer tables should have a non-reflective matte surface and table tops should be as thin as possible to allow room for the worker's thighs and knees. There should also be adequate space under the table to allow workers to vary the position of their legs. Tables should also have rounded corners to prevent injury. Care should be taken in the selection of adjustable equipment to assure that there are no pinch points, protruding handles, or parts that may cause operator injury. Secondary work surfaces such as a separate keyboarding /mouse surface or document holder may be required to store, layout, read, and /or write on documents or materials.

Depending upon the design of the computer, it may be necessary to provide some means of adjusting the height of the screen, keyboard, and mouse. While adjustable tables that provide this option are available, in some cases the need may be satisfied by providing display stands. Also, articulating, adjustable keyboard/mouse work surfaces might be provided. Adjustable computer heights become more important when different workers must share the same workplace.

Poor chair design can be one of the most significant causes of musculoskeletal stresses and strains. Proper chair height and support to the lumbar region of the back are critical factors contributing to worker musculoskeletal complaints. Many computer operators are exposed to unreasonable musculoskeletal loads due to poorly designed computer chairs. Continued and prolonged exposure to a static loading of muscles may lead to an irritation of joints, tendons, and muscles causing a substantial amount of pain. In many cases, researchers report that these stresses and strains carry over beyond the work hours.

Proper chair design involves consideration of the back-rest and the seat pan. Adjustability of computer chairs to fit the physical characteristics of workers is essential in helping minimize or delay the onset of muscle fatigue. Researchers indicate that computer operators who use poorly designed chairs develop poor work postures and report increased levels of musculoskeletal health symptoms.

The backrest of the chair should provide for support of the lower, middle, and upper portions of the back. The backrest should provide proper support for the back and allow for adequate relaxing of muscle tension while the operator temporarily leans back in the chair. Backrests should be independent from the main portion of the seat and allow for tension and tilt (forwards and backwards) angle adjustments. To increase stability, chairs with five casters are recommended. The seat should be moderately contoured with the front edge well-rounded to avoid pressure on the underside of the thighs. The ability to adjust the slant of the seat surface forwards or backwards either by a shifting of the body or by means of a specific control can be an added comfort feature. Controls should be easy to use or they may not be used at all. Seats should be covered with materials that promote air circulation.

Document holders should be provided at computer workstations involving data input or where hard copy is used. A document holder allows the operator to position and view material without straining her/his eyes or neck, shoulder, and back muscles. Ideally, the document holder should be adjustable both in angle and height to allow for repositioning of work or use by a different operator.

Due to the nature of the computer itself, computer work environments require less illumination than traditional office settings. When workplace illumination is decreased and operators must work with hard copy, supplementary or task lighting should be provided. Such lighting should be adjustable and fitted with glare control equipment. The need for task lighting is extremely important for operators working with hard copy.

Adjustable foot rests should be provided if workers cannot adjust their chairs low enough so that their feet rest firmly on the floor. To avoid strain and pressure on the wrist, hand, and arm muscles, tendons, and nerves, wrist and arm rests should be provided to requesting employees. In addition, palm rests may be necessary when using certain terminals.

Due to the static loading of postural muscles associated with prolonged constrained sitting postures, standing workstations can be made available for (periodic) employee use.

## **Workplace Design**

All too often, computer equipment is installed in traditional offices with little or no redesign of the workplace. In many cases, CWA members have witnessed the implementation of computers in their work environment without proper consideration of ergonomic factors. Variables important to proper computer workplace or work environment design include illumination, temperature, humidity, and noise.

The proper amount of workplace illumination is essential for computer work to be performed without the development of worker visual discomfort and fatigue. Too much light can cause glare or veiling reflections which, in turn, make screen characters difficult to read; whereas, too little light overtaxes the eyes as the operator strains to read other materials.

Computer workplace illumination levels should be much lower than traditional offices. Most experts recommend illumination levels between 300-700 lux as compared to traditional office levels of 1000 lux. Task lighting should be utilized for hard copy work.

High levels of illumination contribute to direct and reflected glare. Direct glare comes from workplace lighting or light from windows. Reflected glare occurs as a result of light bouncing off smooth, glossy surfaces such as walls, floors, and furniture forming veiling reflections on the computer. Glare reduces screen contrast and increases the amount of visual effort utilized to make out screen characters. Glare can be best controlled by eliminating or modifying the source.

Light levels may be too high because of the brightness of existing light fixtures and/or light from windows. In the case of existing workplace lighting, fluorescent dimmers or luminaire covers may be installed. In some cases, indirect lighting may provide a more desirable method of illumination and eliminate the harsh brilliance and glare of ordinary fluorescent lighting.

Although not preferred, workplace illumination may also be reduced by turning off certain lights. However, such a step may result in insufficient illumination for hard copy and may increase the glare originating from normally-lit portions of the work environment. Another approach would be to reduce by one-half the number of fluorescent lights in a given fixture. Also, white warm-tone bulbs should be used in fluorescent fixtures.

High illumination levels may also be caused by natural light coming through windows. Light from windows may be reduced by the installation and use of curtains, blinds, or shields.

The proper placement of computer screens is also an important means of eliminating glare and reflections. Screens should be positioned perpendicular to windows. In turn, the operator's line of sight should be parallel to windows and light fixtures. In cases where computer equipment cannot be properly positioned to reduce/eliminate glare, room dividers, partitions, or screens may be placed behind the computer screen to reduce glare.

If, after attempting to eliminate glare by the aforementioned methods, reflections are still present, then the computer should be modified. For computers that are not manufactured with sufficient anti-glare treatment, the use of filters is recommended.

The filter is meant to absorb incoming light and reduce the amount of reflection from the screen. Since all filters reduce character luminance, care must be taken to choose filters that do not reduce contrast and degrade the legibility of screen characters to the point of causing the operator increased visual effort.

Veiling reflections may also be reduced by installing a hood over the computer screen. This device is used to block angular reflections and glare sources. However, screen hoods may make it difficult to look between the screen and source documents. Hoods also tend to accentuate contrast variations between the screen and the lighter colors within the workplace.

Where there are glossy, smooth, or bright walls and equipment in the work environment, they should be painted non-reflective matte or pastel colors. Floors should be carpeted to eliminate reflections and reduce noise.

Computer workplaces should be engineered and maintained to provide comfortable temperature and humidity levels. Temperatures should range from 68 degrees to 75 degrees.

Scientists have suggested that computer workers working in locations with improper humidity levels may develop eye irritation and upper respiratory illnesses. Humidity levels should be maintained between 30% and 60%. Proper humidity levels will help prevent eye irritation and upper respiratory illnesses.

Noise must also be considered as a source of problems in the office. Bothersome and distracting noise may come from the computers, printers, and conversations between other workers. Suggested methods of resolving noise problems are not overcrowding workstations and equipment, and, where appropriate, using muffling partitions and barriers. Panels can be used to separate workers. Particularly noisy equipment should be placed in a separate area or room. In addition, computers should be equipped with a fan to dissipate heat. Care must be taken, however, to avoid such equipment that adds to a noise problem.



## **Work Organization**

Work organization is as crucial a factor in causing worker health complaints as proper design of the computer, workstation, and workplace. Work organization includes both job and organizational design. Job design includes the type and nature of a given task, time spent performing the job, work pace, and the amount of control over the way the job is performed.

Organizational design factors include worker participation in computer implementation, computer training, supervisory style, and employee monitoring.

Employers should also employ administrative methods like flexible working hours (flex-time) and selection of break time to allow employees more control over their work. Flex-time may be of particular value as a stress reduction technique for shift workers. Computer workers should be provided frequent, short rest breaks to reduce fatigue and physical stress. Computer down-time should not be viewed as a period of rest. On the contrary, when a computer system goes down, operators view these periods as irritating and stressful. This stress reaction occurs because the operator has no control over the length of time the down-time will continue. NIOSH recommends that for jobs that require more than 60% viewing time, constant rapid muscular action, fixed postures for extended periods of time, or that are highly repetitive and boring, breaks of fifteen minutes every hour should be provided. Computer jobs with less stringent requirements should contain breaks of fifteen minutes every two hours.

## **What Can You Do?**

All CWA members should make sure that their employer is maintaining a safe and healthful workplace. The key to making the workplace safe for all members is strong, active local safety and health committees. The committee can identify dangerous conditions at the workplace and discuss them with management. If the employer refuses to resolve the safety and/or health hazard(s), the committee can request an OSHA inspection. The committee should always coordinate its activities through the local officers, the CWA Representatives, and the negotiated safety and health committees.

In addition, CWA members may obtain information and assistance by contacting the:

CWA Occupational Safety and Health Department

501 Third Street, N.W.

Washington, D.C. 20001-2797

Webpage: [www.cwasafetyandhealth.org](http://www.cwasafetyandhealth.org) (<http://www.cwasafetyandhealth.org/>)

Phone: (202) 434-1160.

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