

LAW ENFORCEMENT MANAGEMENT INSTITUTE

COMPUTER RELATED ILLNESS

THE IMPORTANCE OF THE PHYSICAL HUMAN-MACHINE INTERFACE

A RESEARCH PAPER

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR

LAW ENFORCEMENT MANAGEMENT INSTITUTE

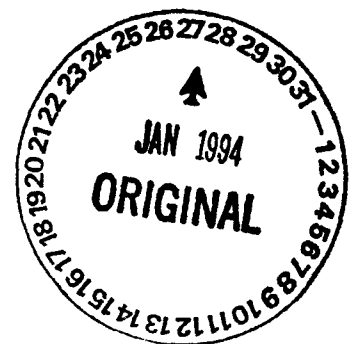
BY

DON L. PATTERSON

HOUSTON POLICE DEPARTMENT

HOUSTON, TEXAS

JANUARY 1994



#161

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	PROBLEMS - IDENTIFYING THE SYMPTOMS	5
	REPETITIVE STRESS INJURY	7
	HEADACHE	10
	TINNITUS	10
	HEAD, NECK AND LOWER BACK PROBLEMS	11
	STRESS-RELATED DISORDERS	11
	EYE DYSFUNCTION AND SITE DETERIORATION	12
	PREGNANCY COMPLICATIONS	15
	RADIATION RISKS	15
	CONCLUSION	17
III.	SOLUTIONS	18
	WORKSTATION DESIGN	19
	EQUIPMENT	21
	ENVIRONMENT	21
	JOB DESIGN	22
	SOFTWARE DESIGN	23
	TRAINING	23
	CONCLUSION	23

IV. GOVERNMENT REGULATION AND COMPUTER SAFETY ISSUES	24
AMERICANS WITH DISABILITIES ACT OF 1990 (ADA)	25
THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)	25
SAN FRANCISCO'S VDT WORKER SAFETY ORDINANCE	27
OTHER AGENCIES	28
CONCLUSION	29
 V. SUMMARY	 31
 VI. NOTES	 33
 VII. BIBLIOGRAPHY	 35

I. INTRODUCTION

For most of human history, designing and using tools was a highly individualized process. Tools were treated as extensions of the body — things that fit the natural shape of the hands and were easy to use. However, as humans progressed into the machine age, tools were designed to fit the manufacturing process or to fit a task, rather than to fit the persons who were to use them. Today's computers are largely products of mass-production methods, which emphasize ease of manufacturing, not the health and comfort of the human body which must interact with them.

Work-related injuries seem to be a natural hazard of manual labor, and most industries take precautions to protect their employees who are exposed to these risks. As computers have come to dominate the workplace, work-related injuries have become the scourge of white collar workers, as well. Although the hazards may be less apparent, computer users also face physical risks. Experts say hundreds of thousands of office workers are being disabled each year in an epidemic of motion related damage to the hands and arms.¹ In fact, more than 50% of the worker's compensation claims are cumulative trauma disorders due to the performance of repetitive tasks rather than the performance of heavy tasks, as in the past.² This illustrates how rapidly technology has changed the nature of the work place and emphasizes the need to update our understanding of a safe working environment.

Computers have simplified our jobs and made us more productive, and we expect more progress each year. The last thing we expect is for computers to change our lives for

the worse. Individuals involved in continuous computer-based work (i.e. dispatchers, data entry clerks, typist, secretaries, support staff, etc) are the ones most likely to suffer the consequences of poor ergonomic or workplace design. The especially conscientious and productive workers may be the most severely affected: those who work through lunch, volunteer for overtime, and take on extra projects—in short, the ones who do whatever it takes to get the job done. Contrary to common belief, the injured are often hard-working employees who want to keep their job. They say nothing, but if another employee files a claim for a similar injury, they often gain the courage to step forward.³

The occupational disease of the 90's, similar to the asbestos crisis of the 80's, will be suffered by those who spend much of their working lives — and perhaps their leisure hours as well — at a keyboard. This comes as bad news for the over 60 million computer users and their employers around the world.⁴ While injuries to the back remain the nation's most costly job-related hazard, damage to the wrist and hands is now the fastest growing category of worker's compensation claims — growing from 18% in 1982, to 28% in 1984, to 56% in 1992, as reported to the Occupational Safety and Health Administration.⁵

Why the dramatic rise in injuries? Health and safety professionals, doctors, ergonomists and physical therapists points to a variety of factors. Among the generally accepted causes are poorly designed workstations with keyboards placed too high, ill fitting chairs, stressful conditions, and extended hours of typing.⁶ Since "office work" or work at computers does not appear at first glance to be a hazardous

endeavor, many managers dismiss the possibility of injury or underestimate the injury potential. Many kinds of office equipment, not just the computers, but, for example, desks and chairs that badly match the body and its needs, may inevitably cause workers to suffer. Although the effects of a poor work environment may not be felt immediately, the cumulative effects of years spent working at the computer can be literally crippling.

As users are stricken with computer-related injuries, employers are also being exposed to enormously expensive medical costs, liability claims, and disruptions to their operations. In 1992, the typical, single illness or occurrence costs to a company for each afflicted employee were around \$48,000 in medical expenses and lost productivity. The estimated overall costs to U.S. businesses for workers' compensation and other related expenses (including lost time, replacement training, and medical costs) is \$20 billion per year.⁷ Not included in any of these figures is the immeasurable cost in pain and in diminished quality of life for thousands of people, and the numbers are increasing annually.

Some analyst believe that hidden hazards in the computerized workplace are killing us. Other assert that hidden hazards in the workplace are just making us sick. In any case, it seems that the computer, rather than always promoting productivity, is often stifling it. As computer technology has entered the workplace, it has been accepted so readily because people only saw it as a means to increasing productivity and efficiency. The inherent hazards of this technology were not initially apparent. Few anticipated the problems associated with the new-found speed and productivity.

Fortunately, there are simple, natural, and practical solutions to many of the physical and mental stress problems that arise from the way that we live and work with computers.

II. PROBLEMS - IDENTIFYING THE SYMPTOMS

Each work day, more than 40 million Americans hunch in front of desktop computers, and more and more of them are falling victim to painful, sometimes crippling, stress-linked injuries to their shoulders, hands, arms and backs.⁸ Stiff neck, headache, sore back, numb hands, trouble focusing the eyes, irritability and painful wrists are but a few of the litany of miseries computer users are likely to suffer after a lengthy session at the computer. The majority of the computer-related health problems are attributable to a poor office environment. Fortunately, these types of injuries can be prevented or relieved by the development of better management strategies for identifying and addressing computer-related injuries.

From 1981 to 1990, the same period when the number of computers grew from less than 6 million to nearly 50 million, the number of repetitive stress injuries (RSIs) grew from less than 25,000 to nearly 200,000.⁹ Computer-related illness is a phenomenon that has grown in direct proportion to the proliferation and use of computers, with repetitive stress injuries evolving from a problem found previously in factories, chicken processing and meat packing plants into an epidemic in homes and offices.

Unlike workers in yesterday's typewriter-equipped offices, today's users work at the keyboard for hours at a time, never varying their activity. Twenty years ago, office workers did many tasks; they went to the copy machine, got something out of the filing cabinet, or hit the carriage return. Now they do everything from their computer.

The human body was not designed to sit in the same position for long periods of time, and doing so places a great deal of stress on individuals. Add to that the trauma of making small, repetitive motions, and one has a real problem, or will in about five years, as cumulative traumas eventually lead to serious injury.

The common denominator is the computer, which by simplifying everyday tasks, has insinuated itself into all aspects of our work lives. But it is the misuse of the computer rather than the computer itself which can give rise to the problems, and it will be through an informed management strategy that this misuse can be corrected.

What are the problems? Computer-complaints primarily involve neck, shoulder, back, wrist, hand, or vision problems. The contributing factors for these injuries include not only repetition, but also force, sustained posture, and insufficient rest or recovery time. The fault for all of this lies particularly in the nature of the computer use itself, which promotes forced body positions and little task variations — and with poor workstation design, poor equipment placement, and/or poor user work habits, all of this makes the inherent problems even worse.

Computer-related health problems include of the following:

- Repetitive stress injury (including carpal tunnel syndrome and tendinitis).
- Headache
- Tinnitus (noise in the ears, such as ringing, buzzing, and roaring)
- Head, neck, and lower back problems
- Stress-related disorders

- Eye dysfunction and sight deterioration
- Pregnancy complications
- Radiation risks

To better understand these computer-related health problems, each is further defined and explained in the remainder of this section.

REPETITIVE STRESS INJURY (INCLUDING CARPAL TUNNEL SYNDROME AND TENDINITIS)

Constantly repeating a few hand movements while seated for hours — a toxic combination — has left many thousands of workers with a painful stiffening of shoulders, arms, wrists, hands and back. In severe cases, muscles and ligaments seize up altogether, disabling workers and leaving a wreckage of anxious employees, lawsuits and compensation claims.

The symptoms of repetitive stress injuries (RSIs) range from persistent aches in the forearms and wrists to pain that extends from the shoulder to the fingertips. Unlike a head injury or a heart attack, RSI is a cumulative trauma. What begins as a sore arm can, if left untreated, escalate into a full-blown disability. Days, weeks, months, years of typing gradually take their toll, until eventually you can't type anymore. Although the pain usually affects the dominant hand first, it is common for the problem to

ultimately effect both hands. There will be some trouble in the right wrist, so the left hand get used more, and you wind up with a mirror image set of problems.

Repetitive stress injuries encompasses damage to the muscle, tendons and nerves. Areas most commonly affected are the hands, wrists and arms (although the neck and shoulders can also be involved.) Among computer users, those injuries generally result from uninterrupted typing with awkwardly situated or inappropriate equipment, such as a keyboard placed too high or an ill-fitting chair.

RSIs were the first tangible symptoms of the injurious potential of the computer. Unlike a typewriter, a computer does not require that you move your hands to change pages, adjust ribbons, or perform any of a dozen similar tasks, so you tend to type for extended periods of time without resting. Created in the 1860s, the standard typewriter keyboard layout (QWERTY) was reputedly designed to impede typing speed so that fast typists would not jam the typewriter's keys. The QWERTY is inefficient and leads to a great deal of unnecessary motion. Future keyboard design will keep the fingers parallel to the forearm and reduce stress on the wrist.¹⁰

The combination of constant repetitive motion and inefficient finger movements that QWERTY requires is the ticket to the most well-known repetitive stress injury — Carpal Tunnel Syndrome (CTS) — a form of entrapment or compression neuropathy. A compression neuropathy is similar in effect to a bend in a garden hose. When the hose is bent, water can't get through. When a nerve is compressed, its impulses are blocked and cannot get through, often with disabling results.

CTS results from the compression of the median nerve, which transmits sensory and motor signals to and from the thumb and first three fingers. It is the architecture of the carpal tunnel — through which a number of ligaments, blood vessels, and the median nerve pass — that is responsible for the problem. During normal finger motion, the ligaments passing through the tunnel slide easily past each other. However, when the wrist is bent, finger motion generates friction by rubbing the ligaments against one another. Prolonged friction can cause those ligaments to swell and eventually press against the median nerve. In addition, the neuron itself can become irritated and swell, resulting in the loss of fine motor control and numbness. Swelling can also cause neural misfiring that lead to pain and tingling.

CTS afflicts some 230,000 workers annually, and the medical bill for treating carpal tunnel syndrome is \$805 million per year, according to National Institute for Occupational Health figures.¹¹ Researchers have identified four factors that cause carpal tunnel syndrome:

- *Repetitive and duration* - Prolonged, constant and repetitious movements such as typing irritate tendons and nerve casings, causing them to swell. (Someone typing at 40 words per minute makes 12,000 keystrokes in an hour.)
- *Force* - The harder a person strikes the keys, the more likely they are to suffer carpal tunnel syndrome.
- *Joint angle* - Flexing, raising or twisting hands to reach the keys constricts the carpal tunnel.
- *Prolonged constrained posture* - Holding any position without moving, such as raising arms to reach a keyboard, places excessive "static load" on muscles and tendons.

Even in mild cases of CTS, recovery is a long and painful process. At the lowest level of damage, a wrist splint and rest from the irritating activity will usually result in near-complete recovery. One severe case of carpal tunnel can cost \$100,000 in medical and administrative expenses and lost productivity.¹² Among CTS sufferers, surgery is commonplace with an 80% success rate; but patients generally undergo lengthy post-operative rehabilitation with some never regaining full strength and use of their injured hand.

There are a host of other RSIs related to computer use. The most prevalent are tendinitis, the swelling or irritation of a tendon; thoracic outlet syndrome, a compression disorder of the nerves and blood vessels between the neck and shoulders; and ulnar neuritis, a nerve inflammation that is caused by pressure on the ulnar nerve in the elbow. Like CTS, the base cause of these injuries is computing at unsafe angles.

HEADACHE

The major causes of headaches among computer users are the monitor's brilliance and, tension and stress. Headaches may be caused by eyestrain, which is caused by glare, or simply reading too long without a break.

TINNITUS (NOISE IN THE EARS, SUCH AS RINGING, BUZZING, AND ROARING)

Noise can be very stressful when you are computing — even noise that you do not consciously hear, like a high and low frequency sounds that are beyond the audible range. Laser printers and computer cooling fans are major suspects. Direct noise from impact printers should also be reduced by placing covers over the printers or by isolating the printers from the rest of the work environment.

HEAD, NECK AND LOWER BACK PROBLEMS

Using one's head, neck and arms incorrectly can cause the vertebrae to slip out of proper alignment, pressing on nerves. Back and neck pains account for 93 million lost work days in the United States per year and is the number one cause of absenteeism.¹³ Back disorder medical treatment, afflicting 7 million people annually, costs 5 billion dollars per year.¹⁴

The major causes of neck and back aches are — poor posture; monitor positioning; not using a reference material stand, or using one improperly; long, uninterrupted work periods; improper chair; stress; and, improper style of eye glasses. Anyone who wears bifocals understands that repeatedly tipping your head back to see the monitor through your lower lenses can cause strain in your neck and shoulders.

STRESS-RELATED DISORDERS

Job stress and computer related illness go hand-in-hand according to a recent study by the National Institute for Occupational Safety and Health (NIOSH).¹⁵ The NIOSH study of 533 computer users at U.S. West Corp. found that workers were likely to suffer neck, arm or hand pain if they were worried about losing their jobs, were discouraged from socializing with co-workers, worked at boring, repetitive jobs, or were under other work-related stress. The NIOSH study questioned whether psychological stress contributed to worker's physical problems or vice versa.

In every job there is some amount of stress involved. Many things cause stress in our lives — jobs, finances, personal lives, and so on. No matter where the stress is coming from, it will affect job performance. Stress-induced illnesses and disorders are the problem not only of the sufferer, but of the employer, and society in general. It is a mushrooming national problem that is zapping billions of dollars from our economy because people are reporting that they are sick and they don't know why, and claiming worker's compensation.¹⁶

There are many ways in which stress can manifest itself and affect the workplace. Stress-induced illnesses not only cause missed workdays, but can lead to problems like alcoholism, drug addiction, depression and job performance problems. Stress problems as they relate to computer users is the repetitive nature of the work.

EYE DYSFUNCTION AND SITE DETERIORATION

It is estimated that 10 million Americans a year complain to their eye doctors about vision problems, headaches, and other problems related to computer use.¹⁷ These vision related problems may be caused or aggravated by regular use of computers. It is an expensive problem for businesses and an increasingly dramatic health problem for workers.

Your eyes are designed for long distance vision — for hunting and watching for the approaching enemy. They were not designed for reading, which occurs at arm's length, and they were especially not designed for working at a computer terminal for most of an eight-hour day with little, if any, relief. The transition from hunter to farmer to factory have occurred over tens of thousands of years — the later move from factory to office has occurred within a scant hundred years. Sitting too close to your monitor violates nature's basic design of the eye's focusing mechanism, and as with any improper use of your eyes, can and almost always will result in a host of problems — eyestrain, eye fatigue, eyeball ache, blurred vision, burning eyes, watery eyes and other discomforts.

Most computer users who spend four or more hours daily at a monitor report a variety of vision problems. The major elements of computer-user visual problems are:

- nearness of eyes to the monitor
- brightness of the monitor's image
- length of time spent at the monitor

- sensitivity of eyes to light
- poor resolution of the monitor's lettering.

Eyestrain can also result from low-refresh-rate monitors. Back in the time of text-only displays, most screens consisted of either an amber or a green foreground and a black background, a color scheme that is ideal for reducing eye fatigue. With the new color graphic mode monitors (GUI) many of us have attempted to match our displays to the coloration of the printed page. Unfortunately, a standard color graphics monitor has a refresh rate of only 56 to 60 Hz, which generates visible flicker in graphic modes.¹⁸ This flicker forces the neurons in the eye to continuously readjust and can lead to headaches and blurred vision.

Although there is a growing concern that computer use causes eye damage and eye deterioration, it still has not been determined whether computers are harmful to vision, and if so, to what extent. It probably will be years before definitive study is concluded because it must report results of years of cumulative effect on vision.

However, early results suggest that the people most likely to suffer from vision-related problems when working on computer are those who have uncorrected vision deficiencies.¹⁹ While you might be able to read your monitor screen even if you are slightly nearsighted or astigmatic and refuse to wear glasses or contacts, you're more likely to develop headaches and other symptoms of eye strain and fatigue from your work. In addition, some bifocals are not suited to computer work because their change in correction occurs too low.

PREGNANCY COMPLICATIONS

Aside from an increased risk for different kinds of cancer, scientists claim that low-frequency radiation can cause birth defects, miscarriages, and fetal deformity, and bring about changes in your body's genetic material (RNA and DNA).²⁰ However, no one has convincingly proven that a relationship exist between causal computer use and miscarriages, stillbirths and birth defects. Most research indicates that if there is any danger to fetuses or pregnant women, the cause is probably not anything the equipment does to the user but what the users do to themselves.²¹

RADIATION RISKS

Many experts now claim that computers, and more specifically, computer monitors, are causing significant health risks. Monitors and display terminals send forth radiation of various forms, which may, after long hours of close exposure, increases the incidence of radiation related illnesses.

We are all surrounded by radiation. Radiation, which is defined as "the emission of radiant energy," is given off by both the earth and the sun, and from nature in a variety of different forms. Just about every electrical device that you use gives off radiation, whether it be a television, a toaster, a hair dryer, or a computer. Radiation from electrical devices is produced by the electrical current flowing through the circuitry, which causes it to radiate various kinds of electrical and magnetic fields. These are

electrical radiation fields, called E-fields, and magnetic radiation fields, called H-fields, which make up what are known as electromagnetic fields (EMFs).

While the amount of radiation that monitors put out is not high, it is the fact that many people spend large amounts of time in close proximity to them and that is causing scientists to examine the problems more closely.²² What exactly are the potential hazards? The main component in most VDTs is the cathode ray tube (CRT), which is similar to the picture tube in your living room television set. The CRTs emit many different kinds of radiation, including gamma rays, x-rays, ultraviolet light, infrared light, heat, and microwaves; as well as radio frequency and low-frequency (including very-low-frequency [VLF] and extremely low-frequency [ELF] radiation).

Stress, depression, and learning disabilities are the other possible results from exposure to low-frequency radiation. Studies and reports suggest that there may very well be health risks from VDT use, but concrete evidence is lacking at this point. The World Health Organization in 1990 stated, "No positive results have appeared in attempts by researchers to correlate adverse health effects and exposures to VDT-like electromagnetic fields."²³

The Environmental Protection Agency in 1991 stated "Electromagnetic fields cause biological effects," but went on to agree with the World Health Organization that no direct relationship can be made linking VDT radiation and various health problems.²⁴ Most scientist agree that further studies are necessary and that a "better safe than sorry" policy would be prudent at this time.

CONCLUSION

Employees affected by these types of disorders frequently experience pain and functional impairment that may require a change in occupations. For the employer, these injuries result in loss of productivity and increased costs in the form of higher medical expenses and disability payments for injured workers.

Successful treatment of work-related injuries depends on early diagnosis and appropriate therapy. Prevention includes identifying sites and tasks that place employees at risk of injury and supporting efforts to develop safer work environments. Workers who report discomfort when it first occurs and seek immediate intervention may prevent progression to a more disabling and permanent condition.

III. SOLUTIONS

Improved computer-user working conditions isn't just a matter of physical health. It's also a matter of fiscal health. An average carpal tunnel case costs a company \$3,500 in worker's benefits and compensation.²⁵ Cases requiring surgery can cost as much as \$30,000. A study of California workers compensation claims showed it could cost up to \$50,000 to treat a case of tenosynovitis, a type of CTD. Once you total these costs, investing in new chairs, workstations, monitors, and other improvements seems like a bargain.

Although a computer certainly isn't engineered for injury, lack of attention to the human-machine interface is a disaster waiting to happen. The economics of the situation call for an immediate response. Not only will the individual benefit from a more comfortable and pleasant computing environment, but companies, too, will find cost savings, in terms of fewer sick days and more productivity. Moreover, given the cost of treating a computer-related injury like CTS, a company that implements an ergonomically correct computing environment will find additional savings in lower insurance and health-benefit costs.

The need for ergonomics grows as complex automation increases. Ergonomics — the study of people adapting to their environment — balances the needs of employees with the requirements of the new technology. To achieve this balance, six key elements are considered.

Those elements are:

- Workstation design, including chairs, work surfaces, and accessories such as document holders, wrist rests and footrest;
- Equipment, including VDTs (keyboards, mice, and screens);
- The environment, including space-planning, use of color, lighting, acoustics, air quality, and office temperature;
- Job design, including criteria and strategies for implementation change;
- Software design, meaning system and screen design for better usability;
- Training in ergonomics and technical skills to help people deal with the new technology.

WORKSTATION DESIGN

Workstations which offer the worker a choice of sitting or standing throughout the work day provide many benefits. Each individual needs to be able to adjust the workstation so that the back is in a neutral position, the wrists are straight, and the elbows are resting on padded surfaces. The key to most mechanical injuries is repetitive strain, and varying how you work — from moving the keyboard to your lap to standing up or lying down — goes a long way toward reducing continuous stress on any one part of your body. If you can't afford a new desk, consider adding a keyboard tray or support to your current desk. Keyboard drawers, originally designed for convenience, are being redesigned with ergonomics principals in mind as concerns about carpal tunnel syndrome (CTDs) continue to be recognized.

A properly designed, ergonomic, chair allows a person to sit comfortably while efficiently working. Individuals should be able to get close to the work while maintaining proper posture and to easily alter posture during the day without getting out of the chair to make adjustments. The chair should encourage movement and be flexible for persons of widely differing sizes. Chairs with the greatest adjustability offer the most potential comfort to a wide variety of users. Those which facilitate body movement while seated can help reduce stress and fatigue. Backrests, armrests and cushioned seat pans must be designed for maximum user comfort and proper application to the work tasks. The seat pan is the most important part of the chair. It should have an adjustable seat depth and freely tilt forward and back.

Footrest should be provided to any worker whose feet do not rest flat on the floor when the chair is adjusted to the lowest end of the adjustable range. This will occur among only about 5% of workers, if adequate adjustable chairs are provided.

Wrist rests or support have been shown to be beneficial for reduction of spinal disc pressure in the lumbar spine. Wrist supports also tend to alleviate muscle loading of the shoulder muscles. However, only 50 to 60 percent of operators prefer wrist rests. Wrist rests are thought to reduce the probability of wrist extension during typing, thereby decreasing any risk of cumulative trauma, although this is not confirmed at present.²⁶

EQUIPMENT

The ideal and ergonomically correct monitor would display text and graphics at the same resolutions as a printed page. This would mean a display capable of a least 300 dots per inch, an effective resolution that is not likely to be achieved soon. To improve the readability of displays in the near term, designers need to concentrate on display-adaptor technologies. In addition to improving screen resolution, adapters and cards must support refresh rates of 72 Hz or better. European standards already call for high refresh rates, and many European manufacturers are already producing high-refresh-rate cards and monitors. With the expected endorsement by the Video Electronic Standards Association of a 70 to 72 Hz refresh rate as standard, it is only a matter of time until the older 56 to 60 Hz refresh-rate monitors become obsolete. Along with higher refresh rates, noninterlaced displays will also become an industry standard for monitors and video cards alike.

The constant neck craning and head dipping brought on by trying to read reference papers which lie flat on your desktop can cause terrible neck ache. This can be eliminated completely by proper use of a reference-material stand.

ENVIRONMENT

Aesthetics, too, are important in reducing stress. The computer workstation and chairs should be arranged to complement the lighting, carpet, wallcovering, auxiliary

equipment, and accent pieces to product the mood you want. As simplistic as this may seem, researchers are beginning to identify environmental stress as a key factor in the development of work-related injuries. The human-machine interface of tomorrow will be composed of three parts: the machine, the receptacles for both the machine and the person, and the person. The major changes in personal computer design will be related to console devices (e.g., mice, keyboards, and monitors).

JOB DESIGN

Ergonomics and medical experts agree that taking regular breaks from typing can go a long way towards reducing the frequency of injury. Switch to another activity that uses the hands differently. Do not use more force than necessary to hit the keys. When taking notes or writing an original work, avoid holding your hands your hands in a tensed "ready" position when waiting to type.

Work hurried for any reason, causing workers to skip rest breaks, can greatly increase the likelihood of physical trauma. For example, an incentive system that restricts workers to forego usual momentary rest periods can be a major factor in the development of cumulative trauma disorders. Administrative controls which include mandatory rest periods, work sharing and rotation, and in some cases, adding more workers, may be necessary to reduce the likelihood of cumulative trauma.

SOFTWARE DESIGN

Efforts are being made to ensure that new software applications are "user friendly". The industry is moving toward designing products that improve user — rather than machine — productivity. Heightened awareness of the importance of physical human-machine interface brings with it a resurgence of interest in adaptive technologies and software-interface design.

TRAINING

Training is key because if an employee does not know how to take full advantage of ergonomic features in the workplace, he or she will not enjoy the benefits.

CONCLUSION

Most of the conditions which cause computer related disorders are in large part preventable. Reluctance to adopt preventative measures - including job redesign - will force these issues before the courts. Proactive programs initiated by concerned management and employees is the most prudent course. Police management can avoid computer related health problems by making sure the software, hardware, and the entire working environment - furniture, lighting and work patterns - meet the health needs of the employee.

IV. GOVERNMENT REGULATION AND COMPUTER SAFETY ISSUES

If financial or altruistic factors don't spur companies to act, there's a good chance the government may. Governmental intervention is forming not only at the federal level with the Americans with Disabilities Act and OSHA, but also at the city, county, and state government levels with ordinances from San Francisco, Suffolk County in New York state, and others.

Labor groups are lobbying for a national law to protect computer users. Even without the threat of new laws, corporate executives and middle managers are feeling the pinch — literally and financially — of carpal tunnel syndrome. The people who are most at risk are the professionals like designers, programmers and writers who are often the most creative, the most productive and the most valuable employees.

Formal interest in computer safety began when a group of journalists sued Eastman Kodak (Rochester, NY) over alleged physical and psychological damages incurred while using their Atex system. These suits fed public concern over computer safety, which reached a peak last December (1990) with the passage of VDT legislation in San Francisco.

For insight into the direction of some current and proposed regulations, several are discussed below.

AMERICANS WITH DISABILITIES ACT OF 1990 (ADA)

The Americans with Disabilities Act, passed July 26, 1992, requires that companies with more than 25 employees make "reasonable accommodations" for disabled employees. The "disabled" designation may apply to those who can prove repetitive stress injury requires accommodation, such as restructured, part-time or modified work schedules or assignment to a different position. Under the law, an employer may fire an employee if accommodations place an undue burden on a business.

Since the ADA's inception, almost 12,000 cases have been filed. Most ADA cases are settled out of court, with companies agreeing to make workstation changes based on recommendations from the employee's doctor. Ergonomic adjustments can cost as little as \$150 for swivel arm supports and as much as \$1000 for arm support plus an ergonomically correct keyboard and chair.²⁷

THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

The Occupational Safety and Health Administration (OSHA) has turned its attention to the fast-growing problem of repetitive strain injury.²⁸ Ensuing regulations could affect

computer users and their employers. Regulations could mandate how computer workstations are set up could cost employers up to \$1000 per employee for new equipment.

Ergonomically correct workstations might prevent career-ending repetitive strain injuries (RSIs) such as carpal tunnel syndrome. OSHA is analyzing data from a recently completed survey of 9,000 U.S. companies, and proposed regulations could be issued in 1994. The enacting regulations will be a long, complicated process, and it is unlikely they will become law before 1996.

OSHA is in the process of setting up an ergonomic standard that will help employers prevent illness and injury. Many organizations are taking a proactive approach by enhancing and protecting the health and comfort of their VDT users rather than waiting for an OSHA standard. Studies show that these organizations are making a wise decision because ergonomics delivers triple benefits: improved safety, productivity, and quality.

OSHA is also considering imposing rules requiring all employers to adopt ergonomic plans. However, its lengthy bureaucratic process is expected to take three to five years. Last year the federal government announced non-binding ergonomic guidelines for one of the most hazardous industries, meat packing.

SAN FRANCISCO'S VDT WORKER SAFETY ORDINANCE

The passage of the San Francisco ordinance set a nationwide precedent. This ordinance changed the future of office policies, designs and furnishings. Entitled "The VDT Worker Safety Ordinance," it was passed by the city's Board of Supervisors and signed by Mayor Art Agnos in an attempt to halt the spread of sometimes crippling conditions known as RSIs (Repetitive Stress Injuries) which may result from extended computer or VDT (Video Display Terminal) use.

The landmark ordinance — a first for any American city — went into effect on January 26, 1991. The law applies to businesses in the city and county of San Francisco with 15 or more workers. Businesses must provide VDT workers with adjustable computer equipment and furnishings, proper lighting and training in VDT use. To help relieve workers stress or discomfort, computer work must be interrupted with alternate activity or 15 minute rest breaks every two hours. The law also mandates the development of low radiation guidelines for VDTs.

The ordinance provides for a four year implementation plan. After one year, all new equipment must meet the standards. After two and one-half years, old equipment must comply, but employers need not spend more than \$250 per workstation. After four years, ALL equipment must meet the standards regardless of cost. Fines up to \$500 per day can be imposed for non-compliance.

Health officials, labor leaders and many legislators are convinced the harmful effects apparently associated with VDT use in the workplace are worthy of serious attention. The San Francisco Ordinance was not the first attempt at legislation, although it may be among the most successful to date. Supporters claimed steps were needed to protect workers because neither federal nor state legislators had adopted standards for VDTs. Critics were fearful the measure would prove so costly it might force some companies to either leave town or go out of business. VDT legislation was introduced in California as early as 1984 and many bills have been introduced since. All were defeated by industry pressure or vetoed by the Governor.

OTHER AGENCIES

As of April 1990, only the states of Maine and Rhode Island had laws governing ergonomics standards for VDT use. Since then, a bill was defeated in Massachusetts and legislation in Suffolk County, New York was overturned by a state judge claiming the county had no authority to create such a statute. Currently, a New Jersey State Assembly committee is studying VDT safety measures. Many other states, county and city agencies already have or are expected to look into possible legislation covering the health of VDT workers.

These regulations would be the first aimed at preventing RSIs in the workplace. An existing law, the Americans With Disabilities Act, covers people already afflicted with

RSIs. This law (ADA) requires companies to make "reasonable accommodations" for such employees or face prosecution and payment of compensatory damages.

The U.S. Labor Department had planned to issue guidelines in Fall 1990 outlining how industries should handle repetitive strain illnesses. This has been delayed while the Department gathers public commentary.

CONCLUSION

Despite the growing rise of injury among office workers, no specific safety laws from either the federal or the state level has been enacted to mandate employee protection.²⁹ However, the following activities are being considered:

- The Occupational Safety and Health Administration (OSHA) is responsible for overseeing worker safety and health. As of February, 1993, 23 states had OSHA approved plans.
- In 1994, the American National Standard Institute (ANSI) and the Human Factor and Ergonomics Society (HFES) will jointly publish updated guidelines for the design of VDT work stations
- Another organization, the National Safety Council (NSC) is currently developing a standard for the control of CTDs.

In early 1991, a City of San Francisco ordinance promised to set new standards for office and VDT ergonomics, but it was subsequently overturned. In 1989, then-mayor Ed Koch vetoed VDT legislation in New York City. In 1988, Suffolk County, NY passed the country's first VDT law, but that was overturned in a higher court. While such protective legislation appears to be stalled in court, the mayor of San Francisco

implemented the provisions of the overturned ordinance for the city employees. Provisions of the vetoed New York City bill were included in a union agreement.

While the ergonomic needs of the office workplace are being addressed, it appears that many of our courts have set up most of the barriers through their slow and uninformed litigative processes. Proposed legislation has encountered delays and setbacks. Arguments against proposed ergonomics and health standards are that they are too costly, they are discriminatory, and they would conflict with existing regulations. Opponents are spending millions in the courts while clients are paying out millions in health claims. Despite the blocked legislation, individual claims are being settled.

Most of the conditions that cause these disorders are in large part preventable. Reluctance to adopt preventive measures — including job redesign — is one of the big reasons these issues come before the courts. Today, proactive programs initiated by concerned management and employees seem to be the most prudent course. There are many organizations and individuals who support proactive measures. If 50 million computer workers represents a constituency whose occupational health concerns need to be recognized and address, stalling positive measures in the courts only postpones addressing the problems. Business and other opponents lose not only money they spend in court, but also the millions lost through absenteeism and claims.

V. SUMMARY

In the past few years, ergonomics has become acknowledged as the solution to many of the health concerns affecting 45% of the American work force which functions in an office environment . Since 1980, the number of work-related injury and illness claims has tripled, to more than 350,000 in 1991.³⁰ It is estimated that 6 of every 100 workers will develop some form of computer related illness or sustain an injury associated with the use of a computer. Anyone who works in an automated office is familiar with the common problems associated with computer usage. We spend a large part of our lives working. Paradoxically, while we often go to great lengths to turn our homes into safe, pleasant environments, we rarely do the same for our office or workspaces.

As managers, preserving human natural resources will become even more important in this decade. Prevention, not correction is the most logical long term health strategy. It is not only less costly but also more effective. One preventative measure is to provide safe work environments for office employees through ergonomics. Demands for increased productivity and quality continue; therefore, as overhead costs soar, it is in everyone's best interest to minimize cost by preventing health problems before they occur.

OSHA is in the process of establishing an ergonomic standard that will help employers prevent illness and injury. Many organizations are taking a proactive approach by

enhancing and protecting the health and comfort of their computer users rather than waiting for an OSHA standard.

The real key to safer, healthier computing is common sense. But caution should be exercised. A suggested management strategy would incorporate the recognition of a problem or potential problem of computer related injuries and illnesses, seek professional input from qualified Environmental Safety Professionals before remodeling or changing a workstation, and avoid the lure of inexpensive gimmicks which could further exacerbate the problem and leave management the subject of a worker compensation claim or lawsuit for neglect.

VI. NOTES

1. Brody, Jane E. "Epidemic at the Computer: Hand and Arm Injuries." Science Times, March 1, 1991. Sec 1.
2. "VDT Injury Prevention Must Start With The Employer!" The HAG Digest, Spring, 1992, 1 - 4.
3. Fernberg, Patricia M. "Guide Your Firm to a Healthy Workplace." Managing Office Technology. June, 1992. Pages 28 - 30.
4. Harwin, Dr. Ronald, and Colin Haynes. Healthy Computing. New York: American Management Association. 1991.
5. Furger, Roberta. "Danger at Your Fingertips." PC World Lotus Edition, May 1993, 118, 124.
6. Ibid.
7. Rizzo, Terrie Heinrich. "Preventing VDT Victimization." Krames Communications Spring Catalog, 1993, 4.
8. Lohr, Steve. "Designing healthy work chair a matter of ergonomics." Houston Chronicle, 12 July 1992, Morning Edition, Sec D, 3.
9. Huttig Jr, J. W. "Painless Computing." PC Today, April 1992, 18 - 22.
10. Harvey, David A. "Health and Safety First." Byte, October 1991, 119 - 128.
11. Canter, Sheryl. "Green Machine - Friendly Furniture." PC Magazine, May 25, 1993, 124 - 145.
12. Furger, Roberta. "Danger at Your Fingertips." PC World Lotus Edition, May 1993, 118, 124.
13. "Ergonomic Solutions." Computer Comforts Ergonomic News, October, 1991, Volume 1.
14. Ibid.
15. Huttig, Jr., J. W. "Stress, Illness Related." PC Today. September, 1992. Page 9.
16. Malik, Mary S. "All Stressed Up and No Place to Go." Modern Office Technology. February, 1993. 27 - 28.
17. Huttig Jr, J. W. "Painless Computing." PC Today, April 1992, 18 - 22.
18. Harvey, David A. "Health and Safety First." Byte, October 1991, 119 - 128.

19. Rosch, Winn L. "Does Your PC — Or How You Use It — Cause Health Problems?" PC Magazine. November, 1992. Pages 491 - 495.
20. Hsu, Jeffrey. "Deadly Monitors? VDTs, Radiation, and You." PC Today, April 1992, 24 - 26.
21. Rosch, Winn L. "Does Your PC — Or How You Use It — Cause Health Problems?" PC Magazine. November, 1992. Pages 491 - 495.
22. Hsu, Jeffrey. "Deadly Monitors? VDTs, Radiation, and You." PC Today, April 1992, 24 - 26.
23. Ibid.
24. Ibid.
25. Huttig Jr, J. W. "Painless Computing." PC Today, April 1992, 18 - 22.
26. "Loss Control Bulletin - Video Display Terminals." Continental Insurance. June, 1991. Section 91-1. Pages 1 - 9.
27. "Ergonomic Regulations" PC World - Lotus Edition. January 1994. Page 72.
28. Ibid.
29. "News Briefs" The Haig Digest. October 1993. Page 2.
30. Dykeman, John B. "Is Ignoring Ergonomic Warning Courting Disaster?" Modern Office Technology. August, 1992. Page 10.

VII. BIBLIOGRAPHY

1993 Ergonomics Catalog. Direct Safety Company, Phoenix, Arizona.

Alters, Diane. "A Growing Pain in the Workplace." Star Tribune. March 8, 1992. Sec D, 1 -4.

"Are Wrist Braces Safe?" Managing Office Technology. December 1993. Pages 30 - 31.

Baker, Bob. "State Considers Ergonomic Rules for Workplace." New York Times Newspaper.

Bartholomew, Doug. "RSI." Information Week. November 9, 1992. Pages 33 - 44.

Beachy, Debra. "No Pain, Big Gain - Firms starting to stress safer work areas." Houston Chronicle, 25 January 1993, Morning Edition, Sec. B, 1-2.

Beer, Bennett J. "Mice increase risk of repetitive injury." Networld Today. October 6, 1993. Pages 10 and 14.

Berlyn, William. "Critical Factors in the Evaluation of Ergonomically Designed Computer Keyboards." Comfort Keyboard Systems. April, 1993.

Betts, Mitch. "Muscle-stressed to IS: Get involved." Computerworld. September 21, 1992. Pages 87 - 90.

Brody, Jane E. "Choosing the Right Angles To Prevent Keyboard Injury." Personal Health, March 4, 1992.

Brody, Jane E. "Epidemic at the Computer: Hand and Arm Injuries." Science Times, March 1, 1991. Sec 1.

Brody, Jane E. "Proper office technique prevents injury." Houston Chronicle, 8 March 1992, Morning Edition Sec. G, 2.

Canter, Sheryl. "Green Machine - Friendly Furniture." PC Magazine. May 25, 1993, 124 - 145.

"Carpal Tunnel Syndrome - Relieving the Pressure in Your Wrist." Krames Communications. 1987. Pages 2 - 7.

Cody, Angela. "Office Seating: Finding the Perfect Fit." Office Technology Management. January, 1992. Page 42 - 45.

"Computer Users' Ills Attract More Attention." Wall Street Journal. May 1, 1991. Sec B 6.

Condon, Ron. "Europe adopts tough rules for user health." ComputerWorld. January 2, 1992. Page 7.

Congleton, Jerome, J. "American National Standard for Human Factors Engineering of Visual Display Terminal Workstation Granjean, Ergonomics in Computerized Offices." Neutral Posture Ergonomic, Inc. 1991.

Dykeman, John B. "Is Ignoring Ergonomic Warning Courting Disaster?" Modern Office Technology. August, 1992. Page 10.

"Ergonomic Solutions." Computer Comforts Ergonomic News, October, 1991, Volume 1.

"Ergonomic Regulations" PC World - Lotus Edition. January 1994. Page 72.

Fernberg, Patricia M. "Guide Your Firm to a Healthy Workplace." Managing Office Technology. June, 1992. Pages 28 - 30.

Fernberg, Patricia M. "Laying Down the Law on Ergonomics." Modern Office. October, 1992. Pages 74 - 78.

Fritz, Mark. "A Hazard to Your Health?" Information Center Quarterly. Fall, 1991. Page 16 - 22.

Furger, Roberta. "Danger at Your Fingertips." PC World Lotus Edition, May 1993, 118, 124.

Furger, Roberta. "Weird Keyboards: RX for Hands." PC World Lotus Edition, May 1993, 64.

Harvey, David A. "Health and Safety First." Byte. October 1991, 119 - 128.

Harwin, Dr. Ronald, and Colin Haynes. Healthy Computing. New York: American Management Association. 1991.

Heller, Martin. "Positioned for Success" Windows Magazine. November 1993. Pages 171 - 184.

"Help for repetitive stress injuries." Houston Chronicle, 24 May 1993, Sec. D, 4.

Huang, Kent. "For many, benefits of low-emission monitors are worth the extra price." Image World, May, 1993, Page 25.

Huttig Jr, J. W. "Painless Computing." PC Today, April 1992, 18 - 22.

- Huttig, Jr., J. W. "Stress, Illness Related." PC Today. September, 1992. Page 9.
- Hsu, Jeffrey. "Deadly Monitors? VDTs, Radiation, and You." PC Today, April 1992, 24 - 26.
- Jones, Jeffery R. "Preventing Repetitive Strain at the Keyboard." Krames Communications. 1991.
- Joyce, Marilyn, "VDT Safety is a Companywide Effort - Ergonomics 9 to 5." Kames Communications, Fall, 1992. 4 - 5 .
- Lacey, Julia S. 15 Easy Steps to Workstation Comfort. Texas: A CRT Services, Inc. Publication. 1993.
- Lacey, Julia S. "Avoiding and Treating Carpal Tunnel Syndrome." How to Survive Your Computer Workstation.
- Lacey, Julia S. How to Survive Your Computer Workstation. Texas: A CRT Services, Inc. Publication. 1990.
- "Legislative Efforts Mandate Changes in the Office." The HAG Digest, Summer, 1991, 1 - 4
- Lemmons, Phil. "Call for Action: Saving the Nation's Hands From RSI." PC World Lotus Edition, May 1993, 15.
- Lohr, Steve. "Designing healthy work chair a matter of ergonomics." Houston Chronicle, 12 July 1992, Morning Edition, Sec D, 3.
- "Loss Control Bulletin - Carpal Tunnel Syndrome." Continental Insurance. September, 1991. Issue 91-6.
- "Loss Control Bulletin - Video Display Terminals." Continental Insurance. June, 1991. Section 91-1. Pages 1 - 9.
- Lunde, Shirley A. "The Kinesis Ergonomic Keyboard." Kinesis Corporation, 27 April 1993.
- Malik, Mary S. "All Stressed Up and No Place to Go." Modern Office Technology. February, 1993. 27 - 28.
- Minnick, Donald J. "Is Your Office Free Of Health Hazard?" The Office. October, 1991. Pages 67 -68.
- Nadel, Brian. "A Look Behind the Screen." PC Magazine. May 25, 1993, 137.
- "News Briefs" The Haig Digest. October 1993. Page 2.

- Nolan, Rodney J., CSP. "Safety Report for HPD Central Communications Division." SAFETEX Safety Experts, Inc. 26 July 1991. (Photocopy).
- Poor, Alfred. "CRT Radiation: A Glowing Concern?" PC Magazine. June 30, 1992. 117 -118.
- Redfern, Andy. "U.K. Study: VDUs Safe for Pregnant Women." BYTE, October 1992, 38.
- Rist, Oliver. "Four Steps to the Healthy Office." PC Magazine. May 25, 1993, 122.
- Rizzo, Terrie Heinrich. "Preventing VDT Victimization." Krames Communications Spring Catalog, 1993, 4.
- Roffmann, Amy. "Is Your Office A Big Pain?" Better Homes and Garden. September 1993. Pages 34 - 38.
- Rosch, Winn L. "Does Your PC — Or How You Use It — Cause Health Problems?" PC Magazine. November, 1992. Pages 491 - 495.
- "RSIs: All in Your Head" Managing Office Technology. December 1993. Pages 29 - 30.
- "San Francisco Firms Confront Computer Law." Wall Street Journal. July 16, 1991. Sec B 2.
- "Save Your Employees From Computer Vision Syndrome." Computer News and Views, Volume 1, Number 1. Page 4.
- Schantz, James E. "Ergonomic Furniture: A Wise Company Investment." The Office. February , 1993. 52 - 53.
- Schwartz, Heidi. "VDT Law Gets The Red Flag." Facility Manager, May, 1992.
- Schwartz, Karen. "Repeat Offenders - Repetitive-Motion Injuries Major Concern of '90s Workplace." Associated Press.
- Schmidt, Robert. "Comfortable Keyboards" PC Novice, October, 1993. Page 44 - 46.
- Seidel, Kevin. "As RSIs skyrocket, companies are finally taking ergonomics seriously." PC Week. June 28, 1993. Page 126.
- Silverman, Dwight. "Equipment may help reduce repetitive stress injuries." Houston Chronicle, 28 March 1993, Morning Edition, Sec E, 2.

Stump, Paul. "ERGONOMIC GUIDE FOR VDT (Visual Display Terminal) COMPUTER WORKSTATION - A Employee HandBook." Human Factor Associates, Inc. 1992. Pages 1 - 6.

"The Backbone of Your Business Deserves Better Support." Relax The Back Store. 1 - 4.

"VDT Injury Prevention Must Start With The Employer!" The HAG Digest, Spring, 1992, 1 - 4

Whyte, Christine. "Can Wrist Supports Prevent Carpal Tunnel Syndrome?" PC World, November, 1991. 53 -55.

Whyte, Christine. "Can Wrist Supports Prevent Carpal Tunnel Syndrome?" PC World. November, 1991. 53 - 60. Possible duplicate ref#50

Will-Harris, Toni. "WARNING: Your Office May Be Hazardous to Your Health." WordPerfect The Magazine. August, 1991. Pages 58 - 61.

Witt, Philip L. "Engineering The Office into the Next Decade." NOVA Office Furniture, 1991,.

"Working with VDTs - The Human Interface." Krames Communications. September, 1991. Pages 1 - 8.