Cumulative Trauma Disorders (CTD)

2.1 Overview

Cumulative Trauma Disorder (CTD) of the upper extremity(s) is the result of injuries to one or more tissues. These tissues may include muscle, tendons, nerves, the fascia, blood vessels, joints, cartilage, ligaments, and/or bone.

Mechanisms of injury in the development of (CTDs) remain controversial. There appears to be an injurious cycle of events that occurs where repetitive, excessive force, constant tension and pressure or trauma leads to the development of clinical disease. Evaluation of the cumulative trauma disorder requires an integrated approach that incorporates engineering analysis, ergonomics, clinical medicine, and behavioral medicine on a case-by-case basis.

It is emphasized that the term "cumulative trauma disorder" is not, in itself, a diagnosis, but refers to various individual diagnoses which are related to the specific mechanisms of injury listed above. The physician should provide specific diagnoses as possible in order to most appropriately develop and guide treatment. More than one diagnosis may often be appropriate in an individual case. (K.H.E. Kroemer, 2001)

Typical symptoms of (CTDs) include persistent pain, swelling, tingling, numbness, or heat around the affected area, both while working and resting.

The most familiar use of the term (CTDs) is for disorders of the hands, wrists, arms, or shoulders, and this is the definition used in this paper. However, Cumulative injuries occur often in connective soft tissues, particularly to tendons and their sheaths. They may irritate or damage nerves and impede the blood flow through arteries and veins. They are frequent in the hand-wrist forearm area, (for example, the 'carpal tunnel syndrome') and in shoulder and neck. Repetitive loadings may even damage bone, such as the vertebrae of the spinal column. A CTD can affect any part of the body, including the back.

2.2 Definition of CTDs

An operational definition is as follows (Mr Dreux, Mr. Engel or Mr. Yohay.)

Cumulative Trauma Disorders (CTD) is a collective term for syndromes characterized by discomfort, impairment, disability or persistent pain in joints, muscles, tendons and other soft tissues, with or without physical manifestations. It is caused or aggravated by repetitive motions including vibrations, sustained or constrained postures, mechanical compression, and forceful movements at work or leisure:

Many different terms have been used to describe the observed events. For example, the syndrome has also been called over-use injury, cervicobrachial disorder, cumulative trauma injury, repetition strain injury, repetitive motion injury (RSI), rheumatic disease, osteoarthrosis (Putz- Anderson, 1988).Of course, such general terms do not provide exact anatomical or pathological specifications, nor do they indicate the conditions that lead to CTDs. Clearly, repetitive strains may occur from many different occupational activities, such as in assembly, manufacturing, and meat processing, sewing, packing and other manipulations. CTDs are found among cashiers in supermarkets and

among keyboard operators. Also, these injuries are quite often associated with leisure and sports activities; the "tennis elbow" is one of the better known examples.

CTDs, are the summary results of many micro traumas. Though known since the early 1800s, they have become a matter of urgent ergonomics concern in the 1980s. They are usually caused by repeated and/or forceful exertions, often in the hand-arm-shoulder region. They predominantly occur to soft tissues, such as tendons and ligaments, and to nerves and blood vessels. They are commonly associated with certain occupational and leisure activities. Many CTDs can be avoided by a set of fairly simple and straightforward ergonomics procedures. (VDT Guidelines, N.J. Department of Health and Senior Services, 2003).

2.3 Other names for CTDs

We use the term CTDs because it is the term adopted by Occupational Safety and Health Administration (OSHA) and American National Standard Institute (ANSI) in the United States. There are many other names for these disorders, however. Here are some you might encounter:

●Repetitive strain injuries (RSI) (used by British Commonwealth countries)

●Occupational cervicobrachial disorders (OCD) (used in Scandinavian countries and Japan)

●Overuse syndromes (used in sports medicine)

● Regional musculoskeletal disorders (RMI) (used by rheumatologists)

● Work related disorders (WRD) (used by the World Health Organization)

Because CTDs are not yet entirely understood, health professionals often disagree on what to call this phenomenon. Some believe that even the term Cumulative Trauma Disorder is less than satisfactory because it tends to gather too many very different problems under one umbrella term.

2.4 How CTDs Differ From Injuries and Fatigue

CTDs are not the same as sprains, strains, and other injuries caused by a sudden trauma or a few days of overuse. They are also not the same as localized fatigue, like the sore shoulders one might get from a week of intense weight training. These injuries, while having symptoms that may resemble CTDs symptoms, develop quickly and require only a few days of rest for recovery. CTDs are distinct from these types of injuries in two ways. First, CTD involve a long latency period — months or years. Second, the symptoms persist even after days of rest. Full recovery in some extreme cases may take years.

2.5 Types of Common CTDs

The one CTD most people have heard of is carpal tunnel syndrome (CTS). This disorder affects the wrist and hand. While many of the common CTDs affect tendons, (CTS) is different: it is a nerve problem. Even though (CTS) is the best known CTDs, it is not the most common.

At sites where large numbers of CTDs have been properly diagnosed and documented, (CTS) cases typically make up less than 10 percent of the total number of CTDs cases.

▪ CTDs include:

Muscle Problems:

Myalgia (a general term for muscle pain)

Myofacial pain syndrome (irritation of the membrane around muscles) Tendon

Problems:

Tendinitis (irritation of a tendon)

Tenosynovitis (irritation of the sheath around a tendon)

DeQuervain's disease (tenosynovitis at the base of the thumb)

Epicondylitis (irritation of the tendon attachments at the elbow; includes

Tennis elbow and golfer's elbow)

Trigger finger (a type of extreme tenosynovitis, leading to locked fingers)

▪ Nerve Problems:

Carpal tunnel syndrome (damage to a nerve passing through the wrist)

Guyon's canal syndrome (damage to another of the three nerves passing through the wrist; similar to carpal tunnel syndrome but involving a different nerve)

Cubital tunnel syndrome (damage to a nerve passing through the elbow)

Thoracic outlet syndrome (compression of the nerves and vessels between the neck and shoulder)

Hypothenar hammer syndrome (nerve damage resulting from repeated impacts at the base of the palm)

2.6 Are CTDs New?

While they seem to have suddenly appeared on the scene, CTD have actually been around for centuries. An Italian physician wrote in 1717 about "the harvest of diseases reaped by certain workers," caused by "certain violent and irregular motions and unnatural postures of the body ... [that impair] the natural structure of the vital machine. In the early 20th century, maladies that we would now group together as CTD are seen as distinct problems and named after the blue collar occupations in which they commonly developed. For example, there was "stitcher's wrist," "bricklayer's shoulder," and "cotton-twister's hand." More recently, CTDs developed in white collar jobs. Telegraphers used to get "telegraphist's cramp," for instance, and clerical workers got "writer's cramp." The CTDs we're seeing today seem new because they arise within new occupations, such as data entry and check-out scanning. They are actually just the latest manifestation of an old category of disorders.

2.7 Are CTDs Growing Problem?

Franklin and others (1991) explained that whether or not the incidence of CTD in the office is really increasing is another difficult question to answer. The attention CTD are now receiving in the news certainly makes it appear so. In the midst of what could be called a "CTD scare,"

it is important to evaluate the evidence carefully. Recent press releases from the Bureau of Labor Statistics cite an alarming six-fold increase since 1981 in "disorders associated with repeated trauma.". Since 1991, the rate for office workers has lagged the rate for general industry by only three to four years. That is, the rate for 1994 for office workers was about the same as the 1990 rate for workers in general industry. Also according to the Bureau of Labor Statistics, "repeated motion disorders" now account for over 52 % of occupational illnesses. This frightening number is somewhat misleading, however.

Occupational illnesses are not nearly as prevalent as occupational injuries. When occupational illnesses and injuries are combined, CTD make up only about two percent of all reported occupational health disorders. Back pain, for the sake of comparison, accounts for 20 percent of all disorders. Many people believe that the number of CTD cases has not dramatically increased, only the number of reported cases. They point to OSHA's stepped-up enforcement of reporting requirements and estimate that the apparent increase in CTD cases in recent years partly reflects more diligent reporting. Whether the increase is in actual cases or reported cases makes little difference; either way, the problem is real and requires a response. In 1994, there were 332,000 new reported cases of CTDs.

Figure (1) illustrates the increase of CTDs cases in all industrial sector compared to other illnesses.

Figure (1): Repeated Truma Disorders (source: Buren of labor statistics, 1995).

2.8 Causes of CTD

Research is still far from complete on exactly what causes CTD. Organizations with CTD problems are finding that they may occur in one department but not in another, even when both departments have the same furniture, job activities, and electronic equipment. So far, it seems that CTD are caused by a complex set of conditions having to do with job activities, individual physiology, the work environment, technology, management, and sociology, as well as non-work activities and environments. As they are currently understood, risk factors for CTD can be split into three general groups:

2.8.1 Ergonomic Stresses

These factors involve the interaction between the body and the physical environment.

The Center for Ergonomics at the University of Michigan and others use a multi-factor ergonomic model to analyze CTD risk in a work environment. Briefly, the ergonomic stresses include:

- **Repetitive activity.**
- **Holding a position without movement.**
- **Use of force or strength.**
- **Localized pressure.**
- **Awkward positions.**
- **Low temperature.**
- **Vibration.**

The last two usually do not apply to offices but are included here to show the complete model. Although repetition is only one factor on this list, the risk caused by the other factors becomes greater if repetition is involved.

2.8.1.1 Repetition without rest breaks

A number of studies have given strong evidence that repetitious work is associated with increased CTDs. The question then is, how much repetition is too much? One researcher suggests that human tendons cannot tolerate more than 1,500 to2,000 exertions per hour. This is about the number of keystrokes performed in an hour by each finger when a person types at 60 words per minute. But infrequent periods of intense repetition may not be a very serious CTD risk. Researchers are convinced that, in order to be high-risk, the repetitive activity must

make up a large component of the worker's typical day. Recent studies, for example, have found a relationship between CTDs and very short "work cycles," when those work cycles are performed for more than 50 percent of the worker's on-the-job time Very short work cycles are activities that take less than 30 seconds to perform once. Some examples are keying, opening letters, stapling, flipping through files, or sorting letters. In offices, repetition seems to have become more commonplace since the advent of computers. Keyboards in and of themselves are apparently not the issue, since CTDs do not appear to have been as prevalent among typists in the age of typewriters. Typewriters necessitated that the user take brief breaks in order to change paper, make corrections, and hit the carriage return lever. These built-in breaks may have kept typewriter users from developing as many CTDs as computer users now do. Such momentary breaks in a repetitive routine are often called "micro-breaks,"

And they may be more valuable than the standard twice-daily 15-minute breaks.

2.8.1.2 Holding a position without movement

Holding a position for a long time, generally speaking, reduces blood flow, depletes nutrients, and leads to a buildup of harmful metabolic wastes. This causes fatigue and, if done over a long period, can cause permanent damage. In fact, holding a position for a long time requires a longer recovery time than an equivalent period of repeated movements of the same type. Recent reports about telephone directory assistance operators getting CTDs point to the danger of constantly sustained hand positions. These workers typically type only about 20 strokes per minute (professional typist’s type about 300). Repetition is not the

problem for them. However, many operators hold their fingers in readiness above the keyboard as they wait for a caller to make a request. Maintaining this position puts stress on muscles, joints, ligaments, tendons, nerves, and blood vessels, and may be a major cause of CTDs for these workers. This particular static hand effort can be found among VDT workers of nearly any type. Programmers and journalists reading a document on screen, for example, often hold the fingers of their left hand over the keyboard while the right hand works the cursor keys or a mouse. Other kinds of sustained hand positions can also cause problems in the office. People using computer mice sometimes keep their mouse-hand in a grasping position for long periods. Holding the telephone to the ear for a long time is another possibly dangerous habit, causing potential problems in the nerves passing through the elbow. All in all, workers can hold static postures for four primary reasons: habits, the environment, stress, and the nature of the job.

Habits many sustained static positions observed in office work are unnecessary; they are simply the result of habit. For example, some people use a great deal of effort to hold their elbows out and hunch their shoulders while typing, while others with the same furniture use chair armrests and relax. Some people cock their heads stiffly while typing, while others constantly and subtly change head position. Some people hold one or more fingers straight out while using a mouse (rather like some people hold teacups). The environment sometimes, workers do not change posture because their environment makes it difficult. For example, an administrative assistant may keep his arm outstretched during pauses in message taking because the message pad is at the far end of his work surface. Glare on the computer screen may force an operator to slouch low in his chair and never switch to

other postures. A typist may hold his hands stiffly over the keyboard when pausing because he has no comfortable and convenient place to rest his hands. Stress another possible reason workers maintain static positions is tension or stress. Relaxed workers, for instance, typically rest their fingers and hands between keystroke bursts or mouse movements. Tense workers, on the other hand, often extend fingers unconsciously or assume stiff postures. Unfortunately, the twinges of pain experienced in the early stages of CTDs can make a person even tenser. Job requirements The last reason for sustained, static positions is that some jobs just demand it. Prolonged typing leads to prolonged sitting, for example. Mouse work can require long periods of gripping (although it is possible to grip more loosely). Some jobs require long periods on the phone.

2.8.1.3 Excessive use of force or strength

Not surprisingly, repetitious activities requiring moderate force are harder on the body than similar activities requiring light force. This principle certainly applies to typing. A typist may make up to 10,000 separate impacts per finger per day. Obviously, a few extra grams of force per impact can really add up. New research suggests that keyboard design affects the amount of impact fingers experience. People unconsciously type more lightly on some keyboards than on others, partly because the keys depress more easily on these keyboards, and perhaps also because the keys give clearer or quicker feedback through a tactile or audible click. On the other hand, it's possible that some people simply use more force regardless of the equipment. One study showed that people with (CTS) used 18 percent more force to do a given activity than people without (CTS) , even

though both groups used the same equipment. Keying, though, is only one of several kinds of activities in the office that can lead to force-related CTDs. It is possible to use too much force when:

Stapling, stamping, or • performing other impact activities Stapling is an underestimated problem. The fleshy part of the hand that usually does the stapling covers an important nerve which can be affected by the impact.

Grasping large file folders or • books Large, heavy, smooth, dry objects such as manila folders require a surprising amount of force to keep the item from slipping out of the fingers. This requires a strong "pinch grip" that can be quite taxing.

Lifting a file or book • habitually lifting items incorrectly can be equivalent to using too much force. For instance, picking up even a one-inch-thick file folder can demand considerable force from the tendons and muscles of the hand and forearm, especially if the folder is high on a shelf or far from the body across a table.

Pushing or pulling a heavy • files drawer or scooting around an office on a chair

When people "scoot" their chairs around their offices, they usually perform awkward, difficult exertions of the legs, lower back back injuries, and sometimes arms. This is an often overlooked potential area for excessive use of force.

2.8.1.4 Localized pressure

Too much external pressure on muscles, blood vessels, nerves, and tendons can lead to inflammation and reduced blood flow. Over time, constant pressure can cause CTDs. (CTS) is an example of a CTD caused partly by localized, though usually internal, pressure. Experts believe (CTS) is to a great extent a result of excess pressure on the median nerve inside the wrist. Swollen tendons in the carpal tunnel or external pressures on the base of the palm can squeeze the median nerve, damaging its ability to conduct signals to and from the hand. In offices, workers put excess pressure on the forearms and hands when they habitually rest them on angular surfaces such as sharp keyboard edges, work surface corners, or hard, angular chair armrests.

Hard, flat surfaces can also cause localized pressure, especially when angular parts of the body such as elbows rest on them. A major nerve that runs around the outside of the elbow can easily be pressed between the bone and a hard surface. You are familiar with the vulnerability of this nerve if you have ever hit your "funny bone."

2.8.1.5 Awkward positions

Habitually placing parts of the body in awkward, overextended, or unbalanced positions can also lead to CTDs, mostly because awkward positions press on nerves, stretch tendons, or otherwise push and pull tissues beyond their normal capacity. Talking on the phone for long periods, for example, is a potentially awkward posture. Some people use their shoulder to prop the telephone against the ear, putting strain on the tissues in the shoulder. Even those who hold the phone with their hand while talking can cause problems in elbows and hands.

Phones are not the only culprit, of course. Just about any activity done in an awkward way frequently or for long periods has CTD potential. In every case, repetition or use of excess force aggravates the harmful

effects of awkward positions. Observers often see poor neck postures in offices. People may turn their head to the side to read copy while keying, or bend the head back to see the screen through bifocals. People doing several simultaneous tasks, such as keying, changing dictation tapes, and assembling files, often lean far over their work surface to reach staplers, tape machines, etc. Awkward positions of the wrist when talking about CTDs, the awkward position considered to have the greatest CTD potential has to do with the wrist. Quite a bit of research has associated CTDs with awkward wrist positions. Statistical studies have shown that constantly working with the wrist excessively bent up, down, or to the side is related to CTDs. Other studies have supplemented this statistical relationship with more physiological observations. Using catheters inside the wrist, these studies have confirmed that certain awkward wrist postures produce pressures within the carpal tunnel that are high enough to cut off blood flow and potentially cause other damage. Based on these studies and on the physiology of the wrist, ergonomists believe the most healthy wrist position is straight, or bent slightly upward. Many factors in the office can contribute to awkward wrist positions. Some examples are inappropriate keyboard height or angle, lack of support for resting hands, splayed elbows, or toothick wrist rests. In addition, VDT users may bend their wrists incorrectly to the side when they reach for side function keys.

Computer mice are also associated with awkward wrist posture. Many mouse users rest their forearms on their work surface and move the mouse around primarily through wrist movements. The resulting side-to-side bending of the wrist is believed to potentially cause CTDs. Some research has suggested that conventional flat keyboards inevitably cause an incorrect position of the wrist because they force the forearms

to rotate inward and often force the wrists to bend sideways. This assumption has led to the design of several "alternative" keyboards such as the Grandjean, Morita, Tony!, Herzog, Maltron, and Ullman keyboards. Some of these keyboards split the keys into left-hand and right-hand groups, aiming them inward to reduce bent wrists. Other keyboards abandon all pretense at flatness and crack the keyboard in half, raising the center point to create a tent shape. This eliminates the forearm rotation required for standard flat keyboards. On the whole, these models are currently prototypes, unavailable for general use.

2.8.2 Psychosocial stresses

Psychosocial stresses refer to the effects of the organizational or social environment on the worker.

In the last decade, researchers have been giving more attention to non-physical factors that seem to contribute to the incidence of CTDs. Employers dealing with CTDs have learned a new term: "psychosocial." This word refers to the psychological and sociological factors that complement the physiological ones. Psychosocial factors may help explain why companies have outbreaks at some of their sites but no cases at other sites, despite identical equipment, jobs, and furniture. Two upcoming NIOSH studies of outbreak sites, scheduled for publication later this year, will examine psychosocial issues as well as the usual ergonomic issues.

CTDs are physical phenomena. However, psychosocial factors such as stress affect whether or not certain physical behaviors end up causing a CTD. Fear of CTDs and ignorance about CTDs qualify as psychosocial factors, too. Psychosocial factors also help determine whether workers with CTDs seek early treatment, or whether they file for occupational

health benefits. These issues are part of a complex field of study called "health behavior."

2.8.2.1 Job-related stress

Several studies have indicated a link between job-related stress and CTDs. Possible stressors include:

- **Lack of control over work activities**
- **Lack of control over larger management issues**
- **Lack of job autonomy and control**
- **Boredom**
- **Unclear roles**
- **Job dissatisfaction**
- **Job insecurity**
- **Lack of social support**
- **Management-labor conflicts**
- **Major workplace changes**

Some people have objected to the findings of these studies because the studies rely not on objective, observable evidence, but on workers' own reports concerning stress and symptoms. The question here is whether stress causes CTDs, or whether having CTDs causes increased perception of stress, or both.

2.8.2.2 Apprehension about and ignorance of CTDs

People involved in the Australian CTD epidemic of the mid-1980s recall lurid media stories in that country implying that a twinge of tendinitis is always the first step in an inevitable downward spiral toward permanent crippling. The resulting panic, some observers believe, contributed as much to the four-year-long epidemic as any ergonomic factors. In light of such observations, some North American employers hesitate to inform their workers about CTDs because they are afraid of starting a panic. Some companies have in fact found a consistent jump in reported cases after every educational presentation on CTDs. However, these same companies have concluded, and studies have proven, that CTDs caught and treated early involve a quicker and less expensive recovery than CTDs left untreated until the crisis stage. As one observer has put it, "Remember that these musculoskeletal ailments also occur naturally as a normal part of aging and everyday wear and tear. The question is when do they become serious enough to worry about. Take normal aches and pains, perhaps increased by work, give them a sinister name and associate them with surgery, and you have a possible overreaction. One of the challenges we are facing today is treating all cases equally while recognizing the potential for other causes.The way in which a company's management responds to CTD cases seems to contribute to the pattern of an outbreak. If management denies the problem altogether or punishes sufferers somehow, any or all of these three patterns may occur:

1. Increased job stress and anger, leading to more CTD cases as well as other organizational problems

2. Suppression of reporting of symptoms, leading to more advanced cases when symptoms can no longer be ignored, or

3. Desertion by employees with symptoms, who decide to change to less risky careers or find more understanding employers

2.8.3 Physiological Stresses

Some CTD risk factors arise from the individual worker's physiology.

As mentioned before, the causes of CTDs are extremely complex and not completely predictable. Many people with ergonomic risk factors do not develop CTDs; others get CTDs for no obvious external reason. There is some evidence that workers new to a job are more prone to developing CTDs. One possible reason for this is that new workers are not physically conditioned for the particular activities the job requires. Based on this assumption, some companies have instituted exercise programs aimed at strengthening muscles and improving flexibility. Some research has also found apparent correlations between certain physical conditions and CTDs.Some of these conditions are:

• Vitamin B-6 deficiency

• Diabetes

• Obesity

• Rheumatoid arthritis

• Pregnancy

• Taking oral contraceptives

• Gynecological surgery

• Small or square wrists

The effect of gender on CTD risk is a controversial issue. Some studies have suggested that women tend to get CTDs more often than men, but this may have less to do with feminine physiology than with other factors. For example, women more than men tend to have jobs involving fine hand work such as typing or small assembly. Women may also be more willing to seek treatment when they experience symptoms. Studies that have attempted to isolate gender from all other relevant factors have found at most only minor relationships between gender and CTDs.

2.9 Reducing the Risk Factors for CTDs

Of course, the best way to deal with CTDs is to prevent them. OSHA has recently developed a suggested program for dealing with CTDs. In an unpublished guideline for general industry, they propose, as a start, four elements that they consider crucial to the effectiveness of any program:

1. Commitment of top management to the program

2. Employee involvement

3. Existence of a written program

4. Regular review of the written program

The written program itself, in turn, has three components:

1. Identifying current and potential problems at the site

2. Interventions: Ergonomic and Psychosocial

3. Medical management

This following section will give a brief description of the issues involved with the program. While much is not known about what causes CTDs, the information on the following pages is meant to help reduce risks.

2.9.1 Identifying present and potential problems

The most effective approach in any situation is to address the most severe problem areas first. Therefore, the first step in a CTD management program is to review available records for evidence of CTDs and identify problem departments or jobs. Surveys of workers as well as general knowledge about high risk jobs can also help target affected groups. Workers should be assured that they can report symptoms honestly without fear of retribution of any kind from management. Once the problem areas are identified, the jobs and work areas involved should be analyzed for CTD risks, preferably by an expert. The ergonomic risk factors described previously, along with the interventions described on the following pages, can help guide this analysis.

2.9.2 Ergonomic Intervention

2.9.2.1 Avoid repetition without breaks

Building in breaks one way to avoid long periods of repetitive motion is to try to get employees to break up their work sessions with breaks. Some people believe that typewriter users avoided CTDs because the typewriter forced them to pause in their typing to change paper, etc. At least one company has considered simulating this by building pauses and lags into the software their employees use. Not surprisingly, this is hardly the most popular solution. Another possibility is to give workers official permission to take short breaks frequently to stretch or use

different muscle groups. Officially sanctioned rest breaks don't always help, however, since some people don't bother to take them. People who have something to gain from fast and furious work — such as journalists and managers — often ignore or even resent required breaks. Some companies with CTD outbreaks have declared mandatory lunch hours in an attempt to reduce the length of non-stop keyboard sessions. Existing research suggests that mid morning and mid-afternoon breaks don't positively affect comfort or fatigue as much as shorter, more frequent breaks. This research suggests that workers should take a short break of five to 12 minutes every hour. Even if such breaks reduce the overall number of minutes spent working, the evidence is fairly strong that frequent breaks prevent "performance decrements" and may actually increase productivity. Mild exercises or activity during breaks sem to help even more than "resting" breaks. Should break length and frequency be left entirely up to the workers? Maybe not. Studies suggest that when this is done, workers tend to wait until they have begun to feel fatigued before taking breaks, or resume work before "recovery" is complete. The best approach might be clearly defined expectations about break times and lengths. Reducing keyboard work to cut down on keyboard use, one organization stopped using electronic mail, causing people to return to using the telephone or foot transportation around the office. Another company eliminated keyboard work for employees recuperating from CTDs by investing a great deal of money in voicerecognition computers capable of taking dictation. Besides being expensive, however, these computers are very, very slow. Even so, the company believes the system is worth the price because it allows talented people to continue working while they recover from CTDs.

Redesigning jobs it's often possible to enlarge job descriptions so that each worker performs a more varied group of tasks throughout the day. For example, clerical work can be redistributed so that workers perform more general departmental support rather than single activities. Word processors can take on file management, telephone, calendar maintenance, or mail processing work, while mail processors or receptionists can do more word processing. This can be an informal process, or planned out more formally as job rotation. Many workers have sufficient task variety but perform their tasks in excessively repetitious ways. Such workers can rearrange their tasks to avoid repetition. For example, mail processing clerks tend to open all the mail at once, then spend hours processing it on a computer. They could be encouraged instead to alternate between opening and recording small batches. Limiting work hours People doing repetitious or forceful work should avoid doing so for long periods. Eliminating overtime is one way of preventing extreme overuse, and some companies with many clerical workers have done so.

2.9.2.2 Avoid maintaining positions for long periods

The four reasons for holding static positions — habit, the environment,

Stress, and job requirements — each require slightly different interventions.

Changing habits Unconscious work habits can be as tough to break as unconscious personal or speech habits. Some companies are trying to help their employees do so, and have instituted programs that involve raising awareness of the value of good work habits, doing individual evaluations, and providing diligent follow-up. They often find that

making the employee aware of his own habits is one of the most difficult steps. Playing videotapes back to the employee has proven helpful for this. Another useful tool is a small feedback instrument, worn while working, that beeps when the arms aren't relaxed. One company involved in this process has learned that permanent habit change takes a minimum of two weeks of nearly daily reminders and checkups. After an initial evaluation and "Prescription," they assign trainers to observe and counsel individual workers for as long as it takes. Reducing stress General stress reduction programs are more common than habit-changing programs, since stress is thought to contribute to many work-related problems besides CTDs. Corporate stress reduction programs are typically comprehensive programs with a long timeframe. They might include education about stress recognition, coping behaviors, relaxation methods, health behavior, and personality typing. Of course, these programs are most effective when they not only train people to cope with stress, but also work to eliminate underlying stressful conditions, particularly when those conditions have to do with the company's policies or culture. Adjusting the environment

One good way to avoid static postures is to avoid static furniture. Some examples:

Adjustable-height tables are ■ valuable for overall posture change. Some desks and tables adjust all the way from sitting to standing height, a great feature for refreshing circulation.

Since there seems to be no ■ ideal posture, it's essential that a work chair permit posture changes. In fact, some experts believe that freedom to move around is the single most important consideration in chairs designed for use in VDT workstations.

Tilting, swiveling monitors ■ and glare screens enable users to move anywhere without glare constraints.

Articulating arms let users ■ bring lights, phones, and other equipment with them as they move around in the workstation.

Headsets free up the arms and ■ shoulders for frequent phone users.

Mobile document holders allow ■ workers to change the angle and position of a document so that they can move their head and neck occasionally and still see their work. Some companies see adjustable furniture as a key factor in reducing CTD risks. Some even stock "libraries" of specialized support accessories. Employees can borrow items to see if they're helpful, and then order one for them if they wish. A few companies even stock a variety of the larger adjustable items for employees to try, like ergonomic chairs and adjustable tables. Other companies use outside resources. A store in California, for example, specializes in ergonomic chairs, and will help visiting employees choose the most appropriate chair for their special preferences, work style, and task requirements.

Redesigning jobs

Job enlargement, task rearrangement, and self-pacing can help reduce the demands for long-term sustained positions such as sitting or using a mouse. The issue of job redesign is difficult to tackle, and it benefits from employee as well as management involvement. Some companies that have undertaken job redesign programs have enjoyed increased productivity and motivation as side benefits. These successful programs have typically used a great deal of employee input and careful, ongoing feedback.

2.9.2.3 Avoid excessive use of force or strength

The use of force can often be reduced with technological solutions. Using less force on keyboards many people type with more force than is necessary. It may be possible to learn to type more softly, but it's difficult and requires discipline and follow-up. Companies that have tried to reduce their employees' keying force believe that it takes weeks of constant monitoring and feedback to get a permanent change. Instruments are available that give continuous feedback to workers about the amount of force they use when typing. It's also possible that certain kinds of keyboards can encourage people to type more lightly. Some keyboards are advertised as "light-touch," and claim to require less force to operate. Preliminary research suggests that these claims may be at least partly true. On the other hand, it's possible for keyboards to be too sensitive, and users may have to suspend their fingers over the keytops during pauses rather than resting them lightly on the keys. One company stocks a variety of keyboards for employees to try, and collects data on reactions to each kind. Using less force on other kinds of equipment Staplers, punches, and stamps can also be risks. These items can be evaluated for ease of operation, and electric models that require no force can be substituted. Lifting carefully Workers can learn to lift objects from a low position close to the body, especially if shelving can be strategically rearranged. Mechanical devices such as carts or wheeled tables might be used to reduce the number of times a given object has to be lifted. In some cases, it may be possible to divide up heavy files, thereby reducing the weight of individual pieces. Scooting safely a quick, partial solution is to provide a hard chair mat that makes scooting easier. Better workstation design might be even more effective: placing work surfaces in a U shape

around the occupant allow him or her to visit several work positions by swiveling rather than traveling.

2.9.2.4 Reduce localized pressure

One approach to reducing this risk factor is to provide work surfaces with rounded or soft corners in the places where people frequently rest their hands or arms. Waterfall and bullnose work surface edges are designed exactly for this. Wrist rests can also help people avoid resting wrists on work surface edges.

Soft, rounded chair armrests are important as well. Armrests on many current office chairs are either soft plastic or upholstered foam. For manufacturing reasons, upholstered armrests are always softer than the bare plastic versions.

Flat surfaces can contribute to a problem when workers rest angular body parts, such as elbows, on them. People do this frequently when they talk on the telephone, holding the handset to the ear and propping their arms on their work surface or chair armrest. Headsets or even shoulder rests are good solutions.

2.9.2.5 Avoid awkward positions

Many awkward postures can be reduced simply by rearranging the work area.

Correcting wrist posture: the up-down problem People who do a lot of typing have a tendency to bend their wrist downward or upward too much. To achieve a straight wrist position is usually a matter of bringing the keyboard, work surface, chair, and floor into alignment with

each other. It's a good idea to adjust furniture "from the ground up." The chair's height should be adjusted first, to allow the feet to rest comfortably on the floor or if necessary on a footrest. The keys should then be set at approximately elbow height, and the work surface or monitor support should have the top of the monitor screen at or below eye level. In general, the posture should be comfortable and the wrists as straight as possible.

Even with the keyboard and chair properly adjusted, some people still have a tendency to drop their wrists while typing. In these cases, placing a wrist rest under the wrists will help keep them in alignment. Correcting wrist posture: the side-to-side problem Some computer designs can encourage users to bend their wrists in a side-to-side motion. This behavior can be corrected by relearning good habits, or sometimes by purchasing alternative equipment. Older PC keyboards and many current industry-specific keyboards have function keys to the left of the letter keys. Many people bend their wrists sideways in order to reach these keys. Those who do so should learn to move their entire hand over to reach the side keys, keeping the wrists straight throughout the motion. Wrist rests, unfortunately, are sometimes suspected of helping one wrist problem while contributing to another. When users become too dependent on them, they don't bother to lift their hands and arms when reaching for side keys. Users should always be aware of this possibility. Mouse users also have a tendency to bend their wrists sideways. Rather than moving the entire forearm with the mouse, they rest their forearm on the work surface edge and move the mouse around with wrist motions. People can learn to move the mouse correctly, or they could change to a newer mouse design. One kind of mouse, for example, is sensitive to speed; the cursor moves farther across the screen when the mouse is moved quickly. The result is that

these mice theoretically need only about a two-by-two-inch square to operate, thus reducing the hand movement necessary to operate them. Trackballs, operated by a stationary hand, are another option, but because they involve intense use of the thumb, they may have their own set of risks. At present, there is virtually no published research on the ergonomics of pointer devices such as these. Craned necks and twisted torsos using a copy stand and moving the copy to a position very close to the screen — or perhaps below the screen and above the keyboard — is an easy solution. Mid-focal length "computer glasses" help bifocal users, as does lowering the monitor. Leaning Analyzing the person's activities and rearranging the work area can eliminate long reaches and improve efficiency. Raised shoulders This can happen when work surfaces or keyboards are too high or when chairs are too low. Constantly raised shoulders have been linked with upper back injuries back stress. This behavior can be improved simply by bringing the different components into better alignment.

2.9.3 Psychosocial Interventions

2.9.3.1 Stress management programs

The subject of an employee stress management program is beyond the scope of this paper. Such programs, however, can be powerfully effective when used in conjunction with a CTD medical management

program. The resulting "holistic" approach to CTDs has produced excellent results at companies that have tried it.

Several key elements seem to appear consistently in successful stress-reduction programs:

Control. Successful programs ■ often have large steering committees that ensure input from workers as well as managers.

Self-reliance. The various ■ components of the program often stress the workers' active involvement rather than passive education by outsiders. Input from workers is especially important if jobs need to be modified.

Dealing with underlying ■ issues. Successful programs should address larger corporate policy and culture issues that contribute to stress, as well as treating the surface symptoms of stress.

Whole employee goals. Factors ■ outside work often play a big role in producing job stress; these factors can be influenced by a company-sponsored program.

2.9.3.2 Training and education

We may be entering an era of greatly increased ergonomic awareness. The transition toward it may prove either rough or smooth. It seems clear that educating all employees about CTDs and about the proper use of equipment is essential to smoothing the transition. Educating management also seems to be crucial, since uninformed management can block effective prevention or treatment measures. Today's typical ergonomic training programs usually cover the nature, causes,

treatment, and possible ways to avoid CTDs. Some companies issue ergonomic handbooks to all employees as a permanent record of the material covered in training. Another has an "ergonomics hotline" which employees can call, anonymously if they wish, to talk about symptoms, work practices, and environments. They can either ask questions or make suggestions. Training programs can be supplemented by ergonomic advisors. Many companies have occupational health professionals assigned to counseling workers with and without CTD problems. One company retrains employees with CTDs who are unable to return to keyboard jobs. They are educated in office ergonomics and now spend their work days visiting employees, one at a time, observing, interviewing, and advising. Medical management Conventional medical management programs for CTDs often resemble private medical practice, but with more paperwork. Workers seeking help are diagnosed, treated until they are well, and then sent back to work. A more progressive program, outlined by OSHA in an unpublished document, includes the following elements:

Having experts periodically ■ tour the workplace to spot problems

Surveying workers regularly ■ about the presence of CTD symptoms with written surveys

Encouraging early reporting of ■ symptoms

Following appropriate medical ■ procedures for diagnosing and treating CTDs

Producing health assessments ■ of all workers in high-risk jobs

Maintaining a list of low-risk ■ jobs that workers can rotate through

Keeping accurate records one ■ variation on this is called the "Job Continuance Strategy," currently used by parts of the U.S. government. In this approach, CTD sufferers are given prompt treatment, and go back to work as quickly as possible under a modified job description. The emphasis of this program is on a speedy return to some kind of work. A back injuries back pain treatment model used by one state government may translate well into a CTD program. The back program includes objective measures of individual work capacity, a welldefined supervision and follow-up program, education, early and aggressive treatment, participative rather than passive therapy, and early return to gainful, perhaps modified activity. After two years, the program has reduced the average number of days of lost time for back pain to 6 days per worker, compared to the national average of 14 days. The outlook for prevention The publicity about CTDs will continue to bring about a jump in the number of reported cases, according to some experts. Old misdiagnoses will be corrected, unreported cases will come to light, and new cases will be reported in the early stages. Since all this is now beginning to happen simultaneously, it looks much like an epidemic. New outbreaks of CTDs will almost surely subside. Remember how common neckbraces were back in the 1970s? Since then, improved designs of seatbelts and headrests in cars have vastly reduced whiplash injuries. In the same way, occupational health specialists will become more skilled and experienced at catching CTD cases early, managers and workers will redesign jobs to avoid CTD danger, prevention programs will settle into place, and research will help improve prevention and treatment. Experts estimate that these measures will show noticeable effects in three to eight years. Even if new cases of CTDs decline from current levels, all evidence points to continuing emphasis on ergonomics, both of the physical and psychosocial kind. Since the first ergonomic office chair was

introduced in 1976, interest in ergonomics has increased steadily on the part of employers, facility managers, and workers. Now, because of increasing educational efforts, the 1990s may be the decade when awareness of good ergonomics becomes completely integrated into office life.

Bammer G, and Martin B, "Repetition strain injury in Australia: medical knowledge and social movement," The Australian National University: Working Paper 19, August 1990.

2.5 Types of CTD

(James E. McGreevey)These painful and sometimes crippling disorders develop gradually over periods of Weeks, months, or years. They include the following disorders which may be seen in office Workers:

1-Carpal Tunnel Syndrome

A compression of the median nerve in the wrist that may be caused by swelling and irritation of tendons and tendon sheaths.

2-Tendinitis

An inflammation (swelling) or irritation of a tendon. It develops when the tendon is repeatedly tensed from overuse or unaccustomed use of the hand, wrist, arm or shoulder.

3-Tenosynovitis

An inflammation (swelling) or irritation of a tendon sheath associated with extreme flexion and extension of the wrist.

4-Low Back Disorders

These include pulled or strained muscles, ligaments, tendons, or ruptured disks. They may be caused by cumulative effects of faulty body mechanics, poor posture, and/or improper lifting techniques.

5-Synovitis

An inflammation (swelling) or irritation of a synovial lining (joint lining).

6-Bursitis

An inflammation (swelling) or irritation of the connective tissue surrounding a joint, usually of the shoulder.

7-Epicondylitis

Elbow pain associated with extreme rotation of the forearm and bending of the wrist. The condition is also called tennis elbow or golfer's elbow.

8-Thoracic Outlet Syndrome

A compression of nerves and blood vessels between the first rib, clavicle (collar bone), and accompanying muscles as they leave the thorax (chest) and enter the shoulder.

9-Cervical Radiculopathy

A compression of the nerve roots in the neck.

10-Ulnar Nerve Entrapment A compression of the ulnar nerve in the wrist.

2.10 The Symptomes Of (CTDs)

(James E. McGreevey)

- **Numbness**
- **Decreased Joint Motion**
- **Swelling**
- **Burning**
- **Pain**
- **Weakness**
- **Redness**
- **Clumsiness**
- **Tingling**
- **Cracking or popping of joints**
- **Aching**

The above symptoms may involve the upper and lower back, shoulders, elbows, wrists, or fingers. If symptoms last for at least one week, or if they occur on many occasions, a doctor should be consulted

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K.H.E. Kroemer

2.11 Stages of CTDs

The clinical features of CTDs are various, variable, and often confusing. Common symptoms are pain, tenderness, weakness, swelling and numbness. The onset of these symptoms can be gradual or sudden. Three stages have been defined:

Stage 1: Shows aches and 'tiredness' during the working hours, but which usually settle overnight and over days off work. There is usually no reduction in work performance. This condition may persist for weeks or months, and is reversible.

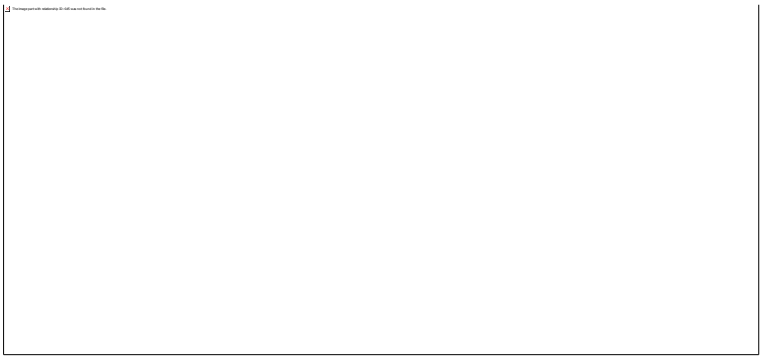
Stage 2 :Has symptoms that start early in the workshift, and which do not settle overnight. Sleep may be disturbed and the capacity to perform the repetitive work reduced. This condition usually persists over months.

Stage 3: Is characterised by symptoms that persist at rest, pain that occurs with non-repetitive movements, and disturbed sleep. The person is unable to perform even light duties, and experiences difficulties in other tasks. This condition may last for months or years, (Chatterjee, 1987). Treatment in the first stage is, of course, preferred. Often, the condition causing the symptom can be alleviated by ergonomics means. In the more advanced stage, medical attention is necessary.

2.12 agonals of CTDs

Unfortunately, diagnosis and treatment of CTDs are still a difficult business, mostly because so much information is not yet known. One problem is the variety of conditions that fall into the CTD category. They have many things in common, but the various kinds of CTDs have different symptoms and methods of diagnosis. Physicians usually depend on a patient's reports of symptoms, which might include

persistent pain, tingling, numbness, or a feeling of heat in the affected area both while working and resting. Also, physicians will obtain a detailed history of the symptoms and of the patient's work and non-work activities. If the problem seems to be a CTD, the physician might do tests to determine which kind of CTD is involved. Tests might involve moving the wrist in particular ways or using instruments to determine whether nerve function has been affected.



2.13 Treatment of CTDs

(James E. McGreevey)

Treatments, of course, depend on the nature and severity of the condition. Mild cases caught early can often be successfully treated with anti-inflammatory drugs, rest or restricted activity, and possibly physical therapy. There is increasing evidence that early treatment is far more effective, per dollar spent, than late treatment. Depending on the type of CTD, severe or longstanding cases can be treated with prolonged rest, anti-inflammatory drugs, immobilizing splints, heat or ice treatments, or physical therapy. For CTS cifically, some cases have

been treated successfully with surgery, but this is considered a last resort. The operation involves severing the band of ligaments that forms one wall of the carpal tunnel. When this operation is done properly, many patients experience immediate relief and can return to work after a recovery period. Another somewhat controversial treatment is exercise. So far, there has been little research on its effects on CTDs. Although some studies have suggested that exercise can be beneficial, another found no effect on CTD symptoms.4 many experts agree exercise can even cause possible harm. One commonly recommended exercise for office workers' wrists, for example, places the hands in exactly the position that has been shown to increase pressure inside the carpal tunnel.

Usually the best treatment for CTDs is rest from the activities that caused the problem, or a change in work practices. It is important that a doctor be seen as soon as the early symptoms of a CTD are recognized. This is because treatment is more successful if the disorder is diagnosed early. The doctor may send you to another doctor who specializes in the nervous system (neurologist) or muscular treatments (physical medicine and rehabilitation) for further tests and treatment. Medical treatment will vary for each type of CTD. The doctor may prescribe one or more of the following treatments:

• Wrist splint to keep wrist from bending

• Cold and hot baths

Greenspan, Joseph, M.D., "Carpal Tunnel Syndrome: A Common But Treatable

Cause of Wrist Pain," Postgraduate Medicine, 84: 7 (McGraw-Hill Health Care

Group, New York, November 15, 1988), p. 34.

The rigid carpal bones are held together by ligaments. Together they form a tunnel-like space within the wrist. Passing through this tunnel is the median nerve, along with the tendons for all four digits. Sensations in the thumb and first two fingers of the hand are transmitted by fibers of the median nerve within the carpal tunnel. Manifestations of carpal tunnel syndrome, and sometimes irreversible nerve damage (most likely caused by excessive motion within the unyielding tunnel), can result from compression or irritation of the median nerve as it passes through the carpal tunnel in the wrist.

Once carpal tunnel syndrome is diagnosed, recommended treatments range from taking more breaks and performing hand and finger exercises to surgery. In between these extremes are such recommended methods of treatment as adding Vitamin B6 to the diet (many sufferers have been found to be deficient in pyridoxine, the largest component of Vitamin B6; but currently no definitive studies exist to show any causal relationship), wearing wrist splints at night

and on the job, icing hands and wrists, and taking anti-inflammatory drugs (such as aspirin and ibuprofen) to ease pressure on the median nerve. Surgery is not always necessary, but it is recommended where other methods have failed or where nerve damage has already occurred. The operation itself is relatively simple, and when successful, relief is usually immediate and long lasting. But even this drastic cure is effective only 80 percent of the time; and if subsequent surgeries are needed, effectiveness is reduced.

Stevens, Sun, Beard, O'Fallon, and Kurland, "Carpal Tunnel Syndrome in

Rochester, Minnesota, 1961 to 1980," Neurology, 38 (Edgell Communications,

Cleveland, January 1988), p. 136.

The work environment. Cumulative trauma disorders and carpal tunnel syndrome used to be associated with assembly-line workers in factories or factorylike work environments, such as the meatpacking industry. The increasing incidence of carpal tunnel syndrome currently being reported in today's offices, however, raises difficult questions about the physical nature of office work, which some say can resemble work in a factory. In the office, VDT users appear to be most vulnerable. In fact, carpal tunnel syndrome has been nicknamed "VDT disease." And because these workers are primarily female, carpal tunnel syndrome appears to affect women more than men. One study of carpal tunnel syndrome done in Rochester, Minnesota, and broken down according to sex and age, shows that cases among women were almost three times those among men.

"Women at Higher Risk for RSIs Than Men," Occupational Hazards (June 1995), Another study of repetitive strain injuries (RSIs) in Ontario, Canada, found that females had a higher risk of injury than their male counterparts and received compensation benefits longer than men. The difference in injury rates between men and women was attributed to the fact that the risk of RSIs is increasing in jobs primarily filled by women.

"Revised VDT Workstation Rule Due in the Fall," CTDNews (July 1995).

A revised VDT workstation technical standard, now in the final stages of editing and review, will provide recommendations and detailed

guidelines on computer workstation equipment. The ANSI/HFES 100 American National Standard for

Human Factors Engineering of Computer Workstations is a voluntary technical standard that regulatory bodies may use as a guideline to write laws. The pending standard shows how all equipment interacts in a workstation, such as chair height and angle, work surface size, and keyboard key force, and is based on accepted scientific data and practices in the field of human factors and ergonomics. The standard may help facility managers select the right equipment and configure workstations to prevent CTDs from occurring in the first place.

"IRS Accounts for Ergonomics," Occupational Hazards (April 1995),

The Internal Revenue Service is currently using the revised standard

for guiding workstation equipment purchases for the department's 110,000 employees.

"Repetitive Stress Injuries," CQ Researcher (June 23, 1995), pp. 537–560.

"CTS Surgery Costs $2 Billion Annually," CTDNews (November 1995).

The fact that keyboards have been around a long time suggests that the keyboard itself is an unlikely culprit. Otherwise, why weren't there such large-scale outbreaks of carpal tunnel syndrome in the days of the bullpen secretarial pools? One possible explanation may be that using a typewriter provides more natural breaks in the typing routine: changing paper, erasing, returning the carriage. Researchers suspect that even short breaks like those may delay or prevent the onset of some of these conditions. Another reason could relate to changing cultural norms. There is speculation that women office workers today tend to work

longer at these jobs than office workers of yesterday, thus increasing the cumulative years of repetitive work. There is evidence that older workers are more likely to be diagnosed with carpal tunnel syndrome, which probably reflects the cumulative nature of the disorder. Right now, any worker performing repetitive wrist movements for eight hours a day, five days a week is in a high-risk category. And, given that there are millions of VDT users in offices around the country, hitting as many as 10,000 keystrokes an hour, office workers will continue to be extremely vulnerable. Implications for the office. Based on the numbers for the past few years, it appears likely that the incidence of CTDs and carpal tunnel syndrome seen among office workers will continue to rise. With this type of disorder, prevention is ultimately less costly than cure, so the mandate is clear: Companies employing large numbers of office workers will need to become informed and take appropriate action in order to begin preventing carpal tunnel syndrome. The question of course is, What is the appropriate action? Many employers are confused. And while unknowns remain and companies wait to learn more about CTDs and CTS in particular, the problem may lead to strained relations between employees and employers. For management, the need to prevent CTDs in the workplace must be balanced against production quotas and other business concerns. For employees, there may still be reluctance to report symptoms, based on fears about automation and possible job loss. In the office, there are most likely five variables (sometimes overlapping) that may play a part in the high incidence of this problem:

Job design.

That is, the movements and repetition required by the job itself;

Equipment design.

The design and layout of the computer, keyboard, and any other equipment used in the performance of work;

Furniture design.

The work surface, the chair, their relative height, and the placement of the keyboard in relation to them;

Worker habits.

Customary ways in which an individual worker performs his or her job; and

Worker health.

The state of a worker's individual health, as well as outside activities related to overall lifestyle.

2.9.1 Job design.

The push toward high production and the trend toward specialization in jobs have left many office workers with job descriptions that are narrow, allowing little flexibility, coupled with a high demand for output. A partial solution would be to reverse this trend, redesigning jobs to make certain they are not limited to a few highly repetitive motions for eight hours a day. Allowing periodic breaks and structuring jobs to include a variety of physical activity would certainly help, although acceptable limits of repetitive movement are still not known. In the future, more attention may be paid to designing jobs around the workers, rather than forcing workers to adapt to existing designs of jobs.

2.9.2 Equipment design.

Poorly designed keyboards can significantly increase the risk of carpal tunnel syndrome. The thickness and adjustability of the keyboard and the angle of the key tops themselves affect the movements a user must make. Possible solutions currently being investigated by manufacturers include the recommendation of adjustable keyboard supports; strategic layout of frequently used keys such as the "shift," "control," and "function" keys to reduce the need to twist the wrists awkwardly; and reduction of the force required to strike the keys. (An important factor in reducing force appears to be giving the keyboard user adequate feedback—the user needs to hear the "click" that indicates a key has been hit and see the resulting character appear on the screen in order to relax his or her push when striking keys.) In addition, engineers and designers are developing alternative keyboards, all designed to provoke minimal twisting of the wrist.

2.9.3 Furniture design.

The exact role that furniture plays is unknown at this time. However, most ergonomists believe that the design of furniture can play a role in helping to minimize CTD occurrence in the future. Furniture should provide optimal postural conditions: The user should be comfortable and well supported, able to shift position easily and to sit or stand in a variety of positions. The keyboard should be placed in an appropriate position relative to seating. This is generally thought to be at a height and angle where the wrist does not have to bend up or down excessively to reach any keys. The wrist should always be straight or bent up very slightly when fingers are on the keyboard. This may be accomplished by the use of an adjustable keyboard support, an adjustable work surface (or a fixed work surface installed to suit the individual user), or an adjustable chair. Most ergonomists say that, of the furniture elements, the keyboard and the chair and their relationship

to each other are the most important. Ideally, the elbows should be bent at approximately a right angle (from about 70 to 90 degrees), leaving the hand slightly higher than the elbow. In addition, chairs designed with armrests can take some of the load off shoulder and upper arm muscles. The use of adjustable keyboard trays and palm rests may also be helpful. Any palm rest should provide a broad, soft area of support for the wrists and be of approximately the same thickness as the front of the keyboard. The wrist should be nearly straight or bent up slightly to reach the keyboard, and the palm rest should not interfere with this position. It should be noted, however, that a palm rest will not necessarily prevent a cumulative trauma disorder and, in fact, when used incorrectly, may actually do harm by forcing the wrist up at an awkward angle. Palm rests have a second inherent danger: Users can become too dependent upon them, leaving the hand resting on the palm rest and bending the wrist instead of moving the hand to reach side keys. The main benefit of a palm rest continues to be that of supporting the weight of the arm to prevent arm and hand fatigue and sometimes shoulder and neck pain.

2.9.4 Worker habits.

Of all the factors involved, certainly the one the worker has most control over is habit. In fact, because of the worker's intimate knowledge of his or her own comfort level, this factor may be the most flexible, and therefore the most important, of all. Most ergonomists recommend educating employees about the risks of CTS and other cumulative trauma disorders. Employees can be taught about their individual equipment and furniture in order to use them optimally. Changing posture during the course of the day (including alternating sitting and standing positions if possible), taking breaks, and performing tasks intermittently rather than singly for hours at a time—all of these can

make a difference. Because worker habits come about partially in response to job demands, management can also play a role in changing them. Management must lead the way, not only by providing information regarding proper use of furniture and equipment, but also by building more flexibility into job descriptions.

2.9.5 Worker health.

Both the general health and the outside activities of the individual worker can affect his or her predisposition to develop a cumulative trauma disorder. Workers whose outside interests mimic certain occupations, such as weekend carpenters, musicians, and frequent drivers, are likely to be at increased risk. Even such seemingly harmless weekend activities as knitting, drawing, or playing squash or racquetball can influence a person's susceptibility to development of a CTD.

General health factors and the presence of certain health conditions also affect a worker's predisposition to develop a CTD. Illnesses such as diabetes and rheumatoid arthritis have been suggested as complicating factors. With the exception of the increased susceptibility associated with certain sports such as racquetball and squash, regular exercise is generally believed to be a positive deterrent to susceptibility.

Legal questions.

The legal issues surrounding CTDs and carpal tunnel syndrome are extremely complicated and threaten to become more so before they are resolved. Although OSHA released federal guidelines for the meatpacking industry, there are as yet no concrete legal standards governing cumulative trauma disorders. A proposed OSHA standard that would protect workers from repetitive-strain disorders, originally

scheduled for release in September 1994, has been repeatedly shelved and may not be issued at all given the anti-regulatory climate in Congress and medical uncertainty about RSIs. Initial estimates put the cost of complying with the agency's regulations at $21 billion for U.S. businesses. Some believe that regulations should be made by the states, but in November 1994 the California Standards Board unanimously rejected an ergonomics standard in that state—the only state to formally propose a standard. The province of British Columbia in Canada is also pursuing an ergonomics standard, in part because more than $400 million was paid out in workers' compensation claims between 1988 and 1992 for ergonomics-related injuries. Without specific guidelines, OSHA must rely on the general-duty clause of the U.S. Occupational Safety and Health Act in order to determine whether to cite and fine employers for failing to address a CTD hazard. The general-duty clause requires employers to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious harm to his employees. But even this clause is open to interpretation as it relates to CTDs. The terms "recognized hazards" and "serious harm" are still subjective enough to require interpretation. And the underlying requirements to support a citation from OSHA include that the "hazard" be recognized as such by the employer and that there be a "feasible method by which the cited employer could have abated the recognized hazard. Although OSHA has the authority to determine whether or not a citation should be issued and a fine levied, the current reigning confusion leaves the organization itself vulnerable to legal challenge. Most employee claims fall under no-fault workers' compensation laws, which protect employers from direct lawsuits. But rather than preventing lawsuits in general, this situation sometimes tends to merely divert them to third parties. Thus, a newspaper publisher may be

immune from an employee's carpal tunnel syndrome lawsuit, but the paper's equipment or furniture supplier may not.

Currently, more than 3,000 repetitive-stress-injury lawsuits are pending against keyboard manufacturers. But while manufacturers do not believe that their products are putting users at unreasonable risk of injury, computer giants like Compaq Canada, Inc., attach warning labels to their keyboards and include a booklet on workplace ergonomics to ensure that customers are using their products correctly. Since there are no existing specific guidelines on how to prevent CTDs and since it is believed that personal factors can complicate and aggravate work-related disorders of this type, about all that can be said for certain is that questions of legal responsibility regarding CTDs are extremely difficult to answer. Several related questions remain to be answered as well: What governing body will take control of this issue and at what level— federal, state, or even local? Will lawsuits end up providing guidelines for future legislation? For employees with claims, will their state of residence affect the outcome? And for employers, what will be required to make their workplaces safer?

The future.

Cumulative trauma disorders will certainly be a leading occupational issue in the future. Even so, research has yet to reveal the exact causes of CTDs and carpal tunnel syndrome, and there remains disagreement within the medical profession about the genesis of CTDs as well. The focus will undoubtedly be on prevention. Despite the lack of agreement as to cause, prevention will come about most likely by careful attention and adjustments to all the different factors believed to affect carpal tunnel syndrome and other CTDs. The rising awareness of CTDs has already begun to create change within some offices. The Los Angeles

Times, whose incidence of CTDs was particularly high, hired outside safety consultants to work with the paper's safety department to try to halt the spread of CTDs within the company. Some changes taking place in other companies include instituting specific training programs aimed at raising awareness and managing presumed risk factors, redesigning high-risk jobs, and providing stress counseling programs for employees. Perhaps the biggest change will come from individual workers themselves and, more importantly, from supervisors who manage them. Employers may need to redesign highly specialized jobs to allow for greater flexibility and rotation of tasks, perhaps following the teamwork approach now being practiced by some automobile manufacturers. After IBP, Inc., the nation's largest meatpacker, initiated a comprehensive ergonomics program, the incidence of RSIs among employees at the company's plants was reduced by 50 percent in the first full year of the program. For decades, voices in favor of a more humanistic workplace have disapproved of highly repetitive, specialized jobs on the basis that they were mind-numbing and resulted in worker dissatisfaction. But in the past, America's devotion to the assembly-line method of production has precluded doing much to change this. Now, with medical expenses from CTD surgery alone estimated at $2 billion a year, costs incurred in workers' compensation cases estimated at $7.4 billion a year, and the potential for increased insurance premiums and lawsuits, change may be brought about by a wholly pragmatic concern—it may simply be too expensive to go on the way we have.