Reducing the Incidence and Cost of Work-related Musculoskeletal Disorders with Ergonomic Input Devices

Evidence for the efficacy of ergonomic keyboards and mice in reducing repetitive strain injuries and 10 steps to achieving a healthier workplace

Microsoft Corp.
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Abstract

The costs associated with repetitive strain injury (RSI) to businesses are estimated between $15 and $20 billion per year in the United States, according to the federal Occupational Safety & Health Administration (OSHA). Of the many risk factors associated with RSIs, one of the easiest to address is improper workstation configuration, including the use of an appropriate pointing device and keyboard. Properly designed ergonomic input devices have been shown to reduce computer-related pain and demonstrate a significant effect on the incidence of RSIs for primary prevention.

The cost savings resulting from an ergonomic workstation program can be substantial. Using numbers derived from modern studies on injury rates and a hypothetical company employing 500 computer users, a 10 percent reduction in repetitive strain injuries and symptoms would yield an **annual savings of $700,000**.

This paper examines the issue of repetitive strain injuries in the workplace and offers guidance on instituting an effective ergonomic program that reduces the incidence and cost of work-related RSIs.

Microsoft Corp. One Microsoft Way Redmond, WA 98052-6399 USA

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Musculoskeletal Disorders: the Scope of the Problem

The issue of musculoskeletal disorders (MSDs) not only affects employees, but also the companies that employ them. The Washington State Department of Labor and Industries, for example, reports the following:

"The magnitude, cost and burden of work-related musculoskeletal disorders (WMSDs) are enormous. From 1992–2000, there were 380,485 Washington state accepted workers' compensation state fund claims for nontraumatic soft tissue musculoskeletal disorders of the neck, back and upper extremity. These claims resulted in $2.9 billion in direct costs, and 26.9 percent of all state fund workers' compensation claims. Of WMSD claims during this time period, 32.4 percent were compensable with an average of 123 lost time days per compensable claim."[1]

The Significance of Repetitive Strain Injuries (RSIs)

MSD is a term that refers to a broad range of soft tissue disorders. One of the causes of MSDs is repetitive motion, and disorders involving repetitive activities are commonly referred to as repetitive strain injuries (RSIs). Perhaps the best-known example of an RSI is carpal tunnel syndrome, which occurs when the median nerve, which runs from the forearm into the hand, becomes pressed or squeezed at the wrist.

According to a Microsoft study, computer users strike the keyboard space bar an average of 669 times per hour.

RSIs result from the accumulation of many small injuries suffered during daily, routine activities. RSIs decrease blood flow or cause strain to the affected areas of the body, which can cause nerve compression, tendon damage, muscle strain and joint damage. Depending on the level of activity, the accumulation of injury can begin to outpace the ability of the body to heal itself, eventually leading to a potentially serious injury that can cause pain, loss of productivity, difficulty performing basic life skills, and even disability.

Since these injuries develop slowly, people tend to neglect the warning signs and work through the pain, unaware that they may be incurring significant injury. It is often much easier to address these problems early than it is to treat them after they have become full-blown disorders, as these injuries can be very costly and difficult to treat once they develop into a full MSD.

A survey found that PC users self-reported an average computer use rate of 5.8 hours per day, or 69 percent of their total working hours.

RSIs have been appearing in increasing numbers in office environments since the early 1990s, according to the federal Bureau of Labor Statistics (BLS).

Computer use requires a large number of repetitive actions. A Microsoft study that measured the computer usage patterns of 88 participants over nine months found that computer users strike the keyboard space bar an average of 669 times per hour of active computer use.

Another survey of 335 professionals found that desktop PC users self-reported an average desktop computer use rate of 5.8 hours per day, accounting for almost 70 percent of their total work day.[2] This combination of high-frequency activity with long periods of computer work means that damage to the body can accumulate very quickly.

One study found that 50 percent of study participants reported repetitive strain symptoms during the first year of their new job; 68 percent of reported RSI symptoms were deemed to be severe enough to be classified as a musculoskeletal disorder.

The extent of the RSI epidemic is being explored by researchers concerned with the depth of the problem. An epidemiological study published in the American Journal of Industrial Medicine followed 632 newly hired computer users for up to three years and found that more than 50 percent of them reported repetitive strain symptoms during the first year of their new job.[3] Worse, 68 percent of the reported RSI symptoms were deemed to be severe enough to be classified as musculoskeletal disorders (198 out of 291 instances).

The business cost of RSIs.

In addition to the humanitarian incentive, there is a strong business argument to be made for reducing RSIs. A typical reported upper-extremity repetitive strain injury leads to an average of 12 lost days of work[4] and costs on average **$38,500** for worker's compensation costs.[5] From a productivity standpoint, **worker productivity and effectiveness have also been shown to diminish when workers suffer from musculoskeletal symptoms**.[6]

RSIs represent 62 percent of all North American workers' compensation claims and result in nearly $15 to $20 billion in lost work time and medical claims each year.

Altogether, RSIs represent 62 percent of all North American workers' compensation claims and result in nearly $15 to $20 billion in lost work time and medical claims each year, as reported by OSHA.

How Ergonomics Can Help

As the severity of these problems grows, more emphasis is being placed on ergonomics, the study of designing equipment and devices that fit the human body, its movements, and its cognitive abilities.

Ergonomically designed office furniture and computer products are growing in popularity, both because of the improved comfort they offer and because of their ability to reduce injury. Ergonomic workstations help to maximize productivity by reducing worker fatigue and discomfort, reducing errors, and increasing input speed. As an example, researchers found that individual performance increased 25 percent when employees used an ergonomically designed workstation in the manufacturing industry.[10]

Below are a few examples of companies that have realized significant improvements in productivity and/or their bottom line after implementing the specified ergonomic initiatives.

> *Textile manufacturer Fieldcrest Cannon reduced work-related MSDs from 121 in 1993 to only 21 in 1996, a drop of more than 80 percent. The company implemented engineering controls such as springs for the material-handling boxes. Workers designed and management implemented an improved bagging system. The company also purchased adjustable chairs.*[7]
>
> *Bath vanity and furniture maker Woodpro Cabinetry Inc. made ergonomic changes that resulted in a decrease of almost 40 percent in workers' compensation costs, which declined from $103,824 to $61,000. The company adopted engineering controls such as dropping the conveyor belt so workers had easier access to the tops of cabinets, installing conveyors to minimize manual lifting, and purchasing angled tables to reduce bending and reaching. They also implemented job rotation.*[8]
>
> *Charleston Forge, a metal furniture manufacturing company, established an ergonomics program that cut lost workdays from work-related MSDs from 176 in 1991 to 0 in 1997. Ergonomic changes increased productivity 25 percent.*[9]

To drive these successes, ergonomics has identified many risk factors involved in the development of RSI. These risk factors include (among others) history of injury, rest and work patterns, workload, psychosocial factors (such as workplace stress), individual factors, work patterns, and workstation configuration. Addressing any of these risk factors can be helpful in reducing the incidence of RSI and increasing worker productivity.

Ergonomic Keyboards

The right keyboard can improve user posture and help minimize the risk of strain or injury. Splitting a keyboard so that each half better accommodates the natural posture of each arm is one way of accomplishing this (see Figure 1).

Figure 1. A split keyboard reduces ulnar deviation, twisting of the nerve on the little finger side of the forearm.

Split keyboards, which this paper refers to as ergonomic keyboards, come in two varieties: fixed and adjustable. Table 1 summarizes the advantages and disadvantages of each.

Fixed ergonomic keyboards come in a set configuration to accommodate most users. They are simple to set up and use without training, but they cannot be customized to accommodate individuals of unusual body shapes and sizes. Conversely, adjustable keyboards have movable parts and can be adjusted to accommodate almost any body type, but they can be difficult to set up, and the ergonomic advantage may be lost if they are not properly configured.

Table 1. Comparison of Fixed versus Adjustable Ergonomic Keyboards

	Fixed Ergonomic Keyboard	Adjustable Ergonomic Keyboard
	 The Sculpt Ergonomic Keyboard is an example of a fixed alternative keyboard design	 Goldtouch® Adjustable Keyboard
Advantages	• Easy to set up • Cannot be improperly configured • Designed for the general population	• Can be adjusted to accommodate individuals of unusual body shapes and sizes
Disadvantages	• One size fits all — no customization	• More difficult to set up to gain full benefit — special training may be required • Improper setup can lead to poor ergonomic alignment

Microsoft is the number 1 best-selling brand of ergonomic keyboards.[11] For example, the Natural Ergonomic Keyboard 4000 has been the number 1 best-selling wired keyboard in the United States.[12] Microsoft's success in the area of ergonomic input device design has been largely influenced by the fact that Microsoft is one of the few keyboard manufacturers to employ a full-time in-house ergonomist.

Evidence for a Fixed Ergonomic Keyboard Design

Because of the longevity of its popular design, Microsoft's Natural Keyboard has become one of the most researched ergonomic keyboards. "The Effect of Alternative Keyboards on Musculoskeletal Symptoms and Disorders" by Moore and Swanson, one of the largest and most meaningful studies of ergonomic computer peripherals, assessed whether keyboard design was directly linked to the risk of musculoskeletal disorders and symptoms.[13]

This study followed 289 people for two years as they used a specific keyboard: a standard keyboard, an adjustable split keyboard, or a fixed split keyboard (the Microsoft Natural Keyboard). The study concluded, "In terms of primary prevention, only the fixed alternative [Natural] keyboard demonstrated a significant effect on the incidence of musculoskeletal symptoms."

The Moore and Swanson study found that the Microsoft Natural keyboard design helped reduce the severity of symptoms for people who were already suffering, stating "the fixed alternative keyboard was associated with improvement of baseline wrist and carpal tunnel syndrome symptoms."

The Moore and Swanson study also determined that the Microsoft Natural Keyboard design helped reduce the severity of symptoms for people who were already suffering, stating "the fixed alternative keyboard was associated with improvement of baseline wrist and carpal tunnel syndrome symptoms."

Looking at the workers' subjective pain over time, a separate longitudinal study in 1999[14] compared a placebo standard keyboard with the Microsoft Natural Keyboard and two adjustable split keyboards. This study followed 80 computer users over six months and found that the Microsoft Natural Keyboard "demonstrated an improving trend in pain severity and hand function following six months of keyboard use" when compared with the standard keyboard. In addition, the Microsoft Natural Keyboard yielded the greatest user benefit of any of the tested keyboards. The 1999 study also established that **users were able to type just as quickly on a split keyboard as they could on a straight keyboard**.

In verifying the design intent of the Microsoft Natural Keyboard, a 2000 study[15] examined users' posture during use of this keyboard. The findings of this study yielded hints about the reasons for the reduction in pain and symptoms seen in the other studies. The study tested wrist posture of 16 participants using three keyboards: a standard keyboard, the Microsoft Natural Keyboard, and a keyboard with adjustable-angle design. This study concluded that **the Microsoft Natural Keyboard design "promoted a more natural hand position while typing, thereby reducing the potential for cumulative trauma disorders of the wrist."**

Advancements in Keyboard Comfort

Several ergonomic advances have been developed at Microsoft since the release of the first Natural Keyboard. These include both additional ergonomic features for users of split keyboards and the new Comfort Curve design, a slightly curved keyboard that provides some of the benefits of a split keyboard to users who prefer a straight keyboard. These latest innovations have culminated in the new Sculpt Ergonomic Keyboard, which has the Natural keyboard layout.

Innovations Make Natural Keyboards Even More Ergonomic

Advances in the split keyboard include an increased gable angle, a padded palm rest, a palm lift, a curved key bed and a natural arc design.

The **gable angle** has been increased. This helps users untwist (depronate) their arms and use a more natural handshake position while typing.*

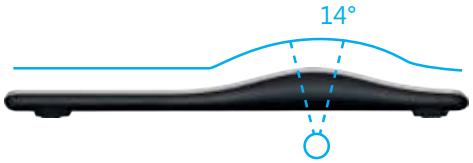

Figure 2. Gable angle

- A new **padded palm rest** and **palm lift** help reduce wrist extension. The palm rest helps prevent the wrist from dropping excessively while typing and reduces contact pressure while the hand rests on it (note that the hand should not rest on the palm rest during typing). The removable palm lift provides a reverse tilt to the keyboard, which helps reduce wrist extension even more — an ergonomic benefit that has been documented by two independent studies.[16, 17]

Figure 3. Palm lift

- The **curved key bed** was developed based on research indicating that keys at the extents of the keyboard are often struck off-axis, resulting in less efficient key strikes. The curved key bed helps address this by pointing the keys more toward the center of the user's hand. This helps the user strike the keys more directly while typing, reducing the amount of force required.

Figure 4. Curved key bed

- The **natural arc** addresses the fact that fingers all have different lengths by adding a gentle curve to the key layout. This not only helps the keyboard better match the hand, it also reduces the reach required for the most distant keys (such as the Backspace key) by arching the keys closer to the center of the hand.

*Natural Ergonomic Keyboard 4000 shown.

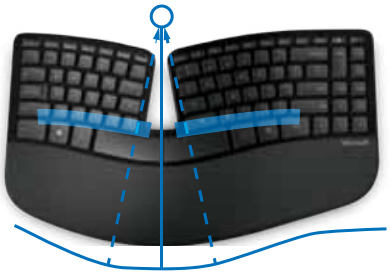

Figure 5. Natural arc reduces pinky reach

This advanced Natural design is available in the Sculpt Ergonomic Keyboard (pictured above in figures 2–5).

Comfort Curve: Ergonomic Benefits for Those Who Prefer a Straight Keyboard

The Comfort Curve concept provides a six-degree curved design, in contrast to the 12-degree split angle used on Microsoft Natural keyboards. This reduced angle allows the keys to remain in a contiguous arc, rather than being split into two distinct keyboard halves. This is for people who prefer to use a straight keyboard, but are looking for better posture and improved comfort. Studies have found that the Comfort Curve design improves wrist posture, although not as dramatically as a fully split keyboard.[18] In a Microsoft satisfaction survey, 94% of Comfort Curve users said that they would recommend it to their friends and family. Further, 88% stated that their next keyboard will also be a Comfort Curve. Comfort Curve is available in a variety of models at multiple price points.

Figure 6. Six-degree curve

The newest Comfort Curve model, the Comfort Curve Keyboard 3000, maintains the six-degree arc of the original, and offers two primary benefits over the previous version.

1. **More familiar:** The new Comfort Curve design has keys that are more like those of a straight keyboard – they are all the same size. This makes the keyboard more familiar to straight keyboard users.

Figure 7. The Comfort Curve Keyboard 3000 - six-degree curve, similar to Figure 6, but without enlarged 'b' and 'n' keys

2. **More comfortable:** The new design has been modified to add curvature in the third dimension while maintaining the six-degree arc of the original Comfort Curve.

Figure 8. The Microsoft Comfort Curve Keyboard 3000 - seven-degree dome curvature of Comfort Curve contour. Note the similarity to Figure 2 – Natural keyboard gable angle

Compact Keyboards

Some people find it more comfortable to use a compact keyboard because a large keyboard can push the mouse out too far to the right, requiring an awkward external shoulder rotation to reach it. Research has shown reduced shoulder muscle activity associated with the use of a narrow keyboard – such as one with no number pad. [24]

Figure 9. The Arc Keyboard – with no number pad

Figure 10. Sculpt Mobile Keyboard – with no number pad

Ultimately, no single keyboard is ideal for everyone; each individual needs to choose the keyboard that works best for him or her. That is why Microsoft offers a variety of ergonomic keyboard designs to suit various preferences in terms of size, shape and configuration.

Figure 11. Separate number pad

The separate number pad provides greater work space flexibility, allowing you to move it out of the way when not in use. This helps to prevent shoulder rotation, which is a risk factor for RSIs of the upper extremities. The number pad, which is viewed as very important by most users, is not used as frequently as one might expect. But when users need to enter numbers, they want it to be readily available.

Pointing Devices

While there are a lot of different pointing devices in the world today, this paper focuses on mice.

Microsoft has run a variety of studies aimed at determining what makes a mouse feel comfortable, and one of the key factors that influences mouse comfort is pressure on the hand. Too much pressure is uncomfortable because it causes the mouse to press sharply into the palm. The proper amount of pressure can be maintained if the mouse contacts a large area of the hand in an even, distributed manner.

To design the optimal mouse contact area, Microsoft uses a variety of technologies and techniques. These include a pressure-sensitive glove, which determines what parts of the hand contact the mouse and the location of contact, as well as infrared thermography to evaluate the contact area.

One of the key criteria for selecting a mouse is whether it is designed for the right hand only or for use by either hand (ambidextrous). Both approaches have their advantages and disadvantages (see Table 2 for a summary). Right-hand-only mice have been optimized for comfort in the right hand, which allows for additional tailoring of contact area, and for the wrist to be positioned with less pronation (twist in the forearm). Ambidextrous mice can be used in either hand (making them useful for corporate standards). They can be used to balance the loads between the arms. However, the mouse shape must remain more generic to accommodate use by either hand.

Table 2. Comparison of Right-Handed versus Ambidextrous Mice

	Right-Hand-Only Mouse	**Ambidextrous Mouse**
	 Sculpt Comfort Mouse	 Wireless Mouse 5000
Advantages	• Optimized for best right-hand comfort • Windows touch tab for easy access to apps and the start screen • Provides reduced wrist twisting (pronation)	• Can be used in either hand • Can be switched from hand to hand to balance work load
Disadvantages	• Cannot be used in the left hand	• Not optimized for single-handed comfort

Because hand sizes and comfort preferences differ, Microsoft offers a wide variety of desktop mouse shapes and sizes.

Advancements in Mouse Comfort

Microsoft has combined some new breakthrough ideas in mouse comfort with some of the concepts that have made the Natural line of keyboards so successful. One of the results is the Microsoft Sculpt Ergonomic Mouse.

Figure 12. Microsoft Natural Wireless Laser Mouse 7000 promotes a neutral, relaxed posture

As evident in figure 11, the Sculpt Ergonomic Mouse design looks unique. This is due to the fact that it has been designed from the ground up to fit the relaxed posture of the hand. Poor posture has been identified as one of the key risk factors for RSI.[23] The neutral, relaxed posture that this mouse encourages is very important and was the core driver for the design. In addition, it has evolved to accommodate a broader spectrum of hand sizes.

The elevated thumb scoop and the slant of the top of the mouse encourage a vertical wrist posture that has been shown to result in lower carpal tunnel pressures.[20] Similarly, the curved finger posture is provided by the curving form of the mouse. This rounded form was designed to reduce the static muscle load that is required with traditional mice to hold your fingers straight over the buttons. This bent finger posture has also been associated with reduced carpal tunnel pressure.[20]

Figure 13. Microsoft Sculpt Ergonomic Mouse - features that promote a relaxed hand and wrist posture

Another important benefit of the vertical wrist posture is that it helps to get the sensitive area of the hand out of contact with the desktop. This area of the hand is just over the carpal tunnel, and research has shown that external force applied to this area can have a powerful effect on carpal tunnel pressure.[19] For instance, a 1 kg force applied here was found to drive carpal tunnel pressure to a mean pressure of 136 mm Hg, four times higher than the recommended pressure. Other research has shown that once carpal tunnel pressure begins to exceed 30-40 mm Hg, it begins to interfere with nerve function and circulation.[21,22] Unfortunately, many people rest this area directly on the desktop while using a traditional mouse. The Sculpt Ergonomic Mouse was designed to roll the hand onto its side so that these sensitive areas are not in contact with the desktop (such as with a traditionally shaped mouse).

Figure 14. Examples of hand contact area with desk with the Natural mouse on left and a traditional mouse on the right. The darker colors indicate the greater amount of pressure a traditional mouse puts on the area of the carpal tunnel. The Natural Wireless Laser Mouse 7000 is an earlier generation of the ergonomic mouse. The design has evolved over time to produce multiple ergonomic mice, most recently the Sculpt Ergonomic Mouse.

In addition to ergonomic design, the Natural mouse also offers productivity and performance features such as a laser sensor, a wireless connection and a tilt wheel. In testing, the Natural mouse demonstrated pointing performance equivalent to that of a traditionally shaped high-end mouse. New users were also able to immediately use the Natural mouse effectively. Many other ergonomic mouse designs have a learning curve and provide inferior pointing performance.

Notebook Mice

A study[2] performed by the Human Factors and Ergonomics Society followed the differences in usage patterns between desktop and notebook computer users.

One of their most profound findings was that notebook users who used an external pointing device reported a lower incidence of pain when compared with notebook users who used only the notebook's internal pointing device. Based on this finding, an external pointing device is recommended for use with notebook computers. Microsoft offers a variety of comfortable, portable and convenient notebook computer mice.

A lower incidence of pain was reported for notebook users who used an external pointing device.

Figure 15. Example of external pointing device (Microsoft Sculpt Mobile Mouse) to provide improved comfort for notebook computer users

Notebook-sized mice can also be beneficial for those with smaller hands. For example, research published in 2007 found benefits for right posture, forearm muscle activity and performance for children using a child-proportional mouse (a commercial notebook mouse).[25]

The Cost Benefits of Ergonomic Programs

As mentioned in the introduction, the costs related to repetitive strain injuries are very high — estimated by OSHA as costing U.S. businesses $15 billion to $20 billion per year. The incidence rate of musculoskeletal symptoms (a precursor to RSI) is also very high. A 2002 study[6] surveyed 1,283 computer users from different occupations; 87 percent of females and 76 percent of males reported that they were experiencing at least one musculoskeletal symptom. Addressing these symptoms early is key to preventing full-blown injuries.

Table 3. Quantifiable Costs Associated With RSI

Cost	Description	Source
$159.20 per day	Average white-collar labor rate	BLS, 2000[4]
$38,500	Average workers' compensation upper-extremity RSI claim	CA CHSWC, 2000[5]
12 days	Average number of work days lost per upper-extremity RSI injury	BLS, 2000[4]

The values in Table 3 have been compiled to calculate the cost of a single instance of RSI. These values represent several quantifiable costs associated with injury: worker's compensation costs for medical treatment and the costs associated with lost work days. The total cost of an instance of RSI is calculated by adding the worker's compensation cost to the cost to replace the lost labor. By this calculation, **the direct medical and labor replacement costs of a single instance of RSI based on these studies are $40,410**.

RSI cost = worker's compensation cost + days lost per injury x (daily labor rate)

Of course, individual companies can and should make these same calculations using their own internal values to determine how costly an instance of RSI is to their organization.

In addition to the direct costs mentioned above, there are costs associated with reduced productivity of those suffering from musculoskeletal symptoms. The Hagberg survey[6] mentioned above was one of the first to quantify this effect. Of those workers suffering from at least one musculoskeletal symptom (87 percent of females and 76 percent of males), 9.9 percent on average reported reduced productivity due to their musculoskeletal symptoms. Furthermore, the researchers found that **the "mean loss of productivity per month was 16.8 hours" for the workers who reported reduced productivity**. Averaged out over the entire work force studied in this survey, the average employee lost roughly 1.66 hours of productivity per month due to musculoskeletal symptoms. At the average white collar labor rate cited above, that is $33 per employee per month lost to musculoskeletal symptoms.

For an example of the potential savings available from reducing the risk of RSI, let's look at a hypothetical company with 500 newly hired computer users. This scenario is based on the assumption that these workers are similar to those studied by Gerr, et al. in 2002[3] and that the workers make average white-collar labor rates. In the Gerr study, more than 50 percent of computer users reported RSI symptoms within the first year. And, as previously mentioned, 68 percent of them reported these musculoskeletal symptoms were severe enough to be classified as musculoskeletal disorders upon medical examination (198 of 291 instances).

Based on these numbers, it can be expected that 34 percent of workers from the hypothetical company in this scenario will experience a musculoskeletal disorder within one year of beginning their jobs. For this analysis, it is assumed that injuries require average medical costs for upper-extremity RSIs, or $38,500 per claim.[5] This is the largest assumption in the analysis because it assumes both that the disorders documented in the Gerr study were similar to the average reported injury and that the cost to treat neck and shoulder disorders is similar to treatment costs for upper-extremity injuries.

Using these values, it can be expected that 170 of the 500 employees (or 34 percent) will experience a repetitive strain injury in their first year on the job. At a cost of $40,410 for each injury in workers' compensation and replacement labor costs, the yearly total cost associated with repetitive strain injury is $6.87 million dollars. Adding to the cost $33 per month per employee for reduced productivity,[6] totaling $198,000 ($33 x 12 months x 500 employees), **our hypothetical company incurs a quantifiable cost of more than $7 million dollars a year due to repetitive strain injuries**.

These numbers make clear the strong financial incentive for reducing risk factors for repetitive strain injuries. Ergonomic changes that yield even a modest reduction in repetitive strain injuries and symptoms can have a very strong impact on costs. For instance, **a 10 percent reduction in injuries and symptoms for the hypothetical company discussed above would yield a reduction in costs of over $700,000 per year**. Ultimately, implementing a solid ergonomics program is not only good for employees, but good for the bottom line as well.

Ten Steps to a Healthier, More Productive Workplace

A solid ergonomics program that includes thoughtful keyboard and mouse selection can help you take advantage of the potential cost benefits discussed in the previous section. The following 10 steps will help get you started.

1. **Conduct ergonomic assessments.** Consider contracting an ergonomic specialist who can assess employees' workstation needs on an individual basis and help you implement ergonomic solutions. These specialists can be great resources when considering which products to purchase.

2. **Make seating comfortable and adjustable.** Good posture is important to comfort and well-being. You don't have to spend thousands of dollars on a chair; look for something comfortable that allows a user to adjust the height, backrest and armrests to suit his or her body type. An office chair should support the lower back. Feet should reach the floor. (If not, a foot rest will help.)

3. **Select a good monitor.** Purchase a high-quality computer screen. Make sure the text characters on the screen look sharp, are high in contrast (e.g., black on white), and are a comfortable viewing size. Monitors should be placed at a comfortable height that doesn't make users tilt their heads excessively up or down. When seated comfortably, a user's eyes should be in line with the top of the display (about 2–3 inches below the top of the monitor casing).

4. **Use ergonomic keyboards and mice.** Employees spend a good part of the day with their hands on a mouse and keyboard. Ergonomic input devices are designed for comfortable posture, reducing unnatural strain and minimizing forces. Consider purchasing mice and keyboards that have been designed by ergonomists, such as those developed by Microsoft (microsoft.com/hardware).

5. **Utilize software and hardware tools.** Work efficiency can be improved by effectively using the software and hardware features that ship with ergonomic keyboards and mice. Many keyboards and mice come with hot keys, wheels, programmable options and other shortcuts for improving productivity.

6. **Properly position keyboards and mice.** Place keyboard and mouse at the same height, about elbow level. Center keyboards in front of users with mice as close as possible. Upper arms should fall relaxed at sides.

7. **Improve lighting.** In the computerized office, workstation lighting should be lower than in traditional industrial workplaces. Desk lamps can supplement lighting for more visually intensive tasks such as reading paper documents.

8. **Offer training.** To get the greatest advantage from these new tools, employees need to learn how to properly set up and use them. Also, encourage employees to take breaks throughout the day to exercise mind and body.

9. **Manage employee health.** Provide medical management to handle workers' compensation claims, provide necessary medical treatment, and get injured employees healthy and back to work as soon as possible.

10. **Evangelize ergonomics.** Embrace the importance and success of your ergonomics program. Recognize good ergonomic activity by employees to demonstrate your commitment to their overall health and well-being.

Additional information can be found on the Web, including in the Microsoft Healthy Computing guide, available at Healthy-Computing.com, and the Typing Injury FAQ, available at tifaq.org.

Summary

The incidence rate for symptoms of repetitive strain injury among computer users is very high. According to findings mentioned above from a 2002 study[6] surveying 1,283 computer users from different occupations, 87 percent of females and 76 percent of males reported that they were experiencing at least one musculoskeletal symptom. Addressing these symptoms before they become full-blown injuries is very important because it is generally much easier to prevent RSIs than it is to treat them.

Microsoft has developed numerous devices designed to reduce the stress and strain of repetitive keyboard tasks, including ergonomically designed keyboards and mice. The Microsoft Natural line of keyboards, launched in 1994, has become the No. 1 best-selling ergonomic keyboard design of all time.[11] In fact, this fixed alternative keyboard design has been shown to reduce wrist and carpal tunnel syndrome symptoms.[13] Following on the success of the Natural keyboard design, Microsoft now offers two new ergonomic keyboard designs. First, the advanced Natural Ergonomic Keyboard 4000 builds on the design principles used in the original Natural keyboard. Second, the Comfort Curve design offers some of the benefits of the Natural keyboard to those who prefer a flat keyboard design.

Microsoft also has developed a line of mice that reduce strain by providing proper contact area with the hand. These designs have culminated with the release of the breakthrough Natural Wireless Laser Mouse 6000, designed from the start to fit the relaxed shape of the hand. The result is a mouse that improves posture while maintaining excellent pointing performance.

Using these devices as part of a solid ergonomics program can lead to a reduction in the instance of repetitive strain injury. A recent study[13] demonstrated the injury-prevention benefits of using the fixed alternative design of the Microsoft Natural Keyboard over time, concluding that, "In terms of primary prevention, only the fixed alternative keyboard demonstrated a significant effect on the incidence of musculoskeletal symptoms." In turn, this reduction in RSI risk can lead to dramatic cost savings — over $700,000 per year based on the hypothetical example of 10 percent injury reduction in a 500-person company.

Implementing a strong ergonomics program based on ergonomically designed mice and keyboards — such as those offered by Microsoft — can improve employee health and bolster the bottom line.

Related Links

See the following resources for further information:

- Microsoft's Healthy Computing resources:
  Healthy-Computing.com
- Washington State Department of Labor and Industries MSD information:
  lni.wa.gov/safety/research/occhealth/muscdis/default.asp
- Ergoweb Inc.'s ergonomic success stories:
  ergoweb.com/news/detail.cfm?id=567
- Future Industrial Technologies press release, "Carpal Tunnel Syndrome Reaching Epidemic Proportions," Jan. 18, 2005:
  prnewswire.com/cgi-bin/stories.pl?acct=109&story=/www/story/01-18-2005/0002858900&edate
- The Typing Injury FAQ: tifaq.org

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