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Comfort by Design: Selecting an Ergonomic Keyboard

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Ideas have come and some have gone since the first full-function ergonomic computer keyboards were commercialized 16 years ago in the US (1992). Today product choices and available features range from subtle to remarkable. Scientific studies have demonstrated that intensive, prolonged computer use is associated with upper body pain and injuries (repetitive strain injuries, or RSI), and that behavioral interventions such as rest breaks and postural training alone don't adequately solve these problems. Over time, other studies and real-world experience have shown that certain keyboard features and designs can reduce pain and increase productivity. However, buyers must choose wisely because not all products are equally effective and because individuals have differing needs.

With ergonomic keyboards, the melding of design objectives and features into actual products is what determines their true effectiveness and suitability. The design process requires not only the invention of ways to accomplish ergonomic objectives, but also the balancing of complexity, versatility, and cost. The prospective buyer must match this unique "mix" inherent in each product against his or her specific needs. This paper explains the various design features of ergonomic keyboards and should help in making purchase decisions.

WHY CONSIDER AN ERGONOMIC KEYBOARD?

A well-chosen ergonomic keyboard provides more comfort, increases productivity, and significantly reduces the risk factors for avoidable injuries. Although some might equate improved comfort with a potential loss of productivity, good ergonomic design should actually allow faster work, which will provide a competitive advantage over less ergonomically-equipped workers. Even so, the keyboard is often the last variable of a computer workstation to be changed when RSI is being addressed. Perhaps this is due to the difficulty in assessing and choosing from among the various alternative designs, or to the fear of possible lost productivity, or just to a general lack of awareness.

In the author's view, keyboard and mouse changes should be considered early in any RSI intervention and even as preventive measures before an injury has occurred. Pointing devices and keyboards require constant repetitive motion (e.g. typing 60 wpm equates to a highly repetitive 18,000 keystrokes per hour). Likewise, overuse of pointing devices is also associated with a high percentage of RSIs. Furthermore, mouse and keyboard design should be linked together, since mouse positioning is highly dependent on keyboard width. Both the keyboard or mouse can be responsible for awkward postures which reduces blood flow and restricts nerve and ligament movement, potentially leading to pain and injury. Therefore keyboard design should be a critical consideration in any workstation makeover when improved comfort and reduced injury risk are priorities.



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REPETITIVE STRAIN INJURIES (RSIs) IN OFFICE WORKERS

The US Department of Labor (DOL) compiles data for workplace injuries in private companies and has long reported RSIs for different occupations. However, until the late 1980s and early 1990's, few outside of academia were aware that certain aspects of office work (read "computer use") could lead to serious injury.

Making analysis of the problem more difficult, "computer users" per se are not reported as a group in DOL studies. DOL reports on lost-work injuries related to "repetitive typing or key entry" for different occupations, but their categories and format are inconsistent and variable. This makes it difficult to glean meaningful trends from DOL data for computer-related repetitive strain disorders.

Fortunately, the Center for Occupational and Environmental Health (associated with the UC Berkeley Ergonomics department) has published a very informative graph derived from DOL data (Figure 1). By looking at RSIs among "office workers" (who are virtually all computer users), a fascinating view emerges of RSIs in U.S. businesses over the final 20 years of the 20th century.

Remarkably, there was a sudden and dramatic rise in new RSIs in all industries, beginning in the mid-1980s. Office workers as a sub-group also showed a steep rise in new cases of RSIs. Curiously, the rise among office workers didn't appear until a few years after the "all-industry" increase began. Fortunately, both "epidemics" of RSIs peaked (1993 for office, 1994 for all industry). While the new cases in all industries continued to drop steadily through 2000, those of office workers dropped only slightly and even increased periodically through 2000.

It isn't clear whether the sudden rise in "all industry" RSIs was due to greater awareness of worker health inside businesses and/or the DOL, or was due to DOL reporting changes. Another possible cause was a sudden change in the pace and work habits of the American work force. While this seems somewhat unlikely for U.S. industry in general, it was certainly true for office workers. Dramatic changes were occurring in both work habits and methods in the same time period that their RSIs began to increase. The rapid growth of personal computer use in the mid 1980s was revolutionizing the nature of office work. Typewriters and adding machines were beginning to disappear and even telephones were being used in different ways as email increased in popularity. Many people believe that this explosion of computer use led to the explosion in office RSI.

ERGONOMIC KEYBOARDS & THE RSI EPIDEMIC

The rapid growth in office RSI cases ended as abruptly as it began. Why? The sudden trend change in 1994 may have a logical explanation: the availability of alternative keyboards. The first Contoured™ model was introduced by Kinesis Corporation in late 1992, followed by the launch of a split-adjustable design from Comfort Keyboard Systems, then another split-adjustable model from Apple Computer in early 1993. Finally relief for keyboard-related RSI was available. In late 1994, after the "epidemic" had peaked, the fixed-split Microsoft Natural keyboard was released.

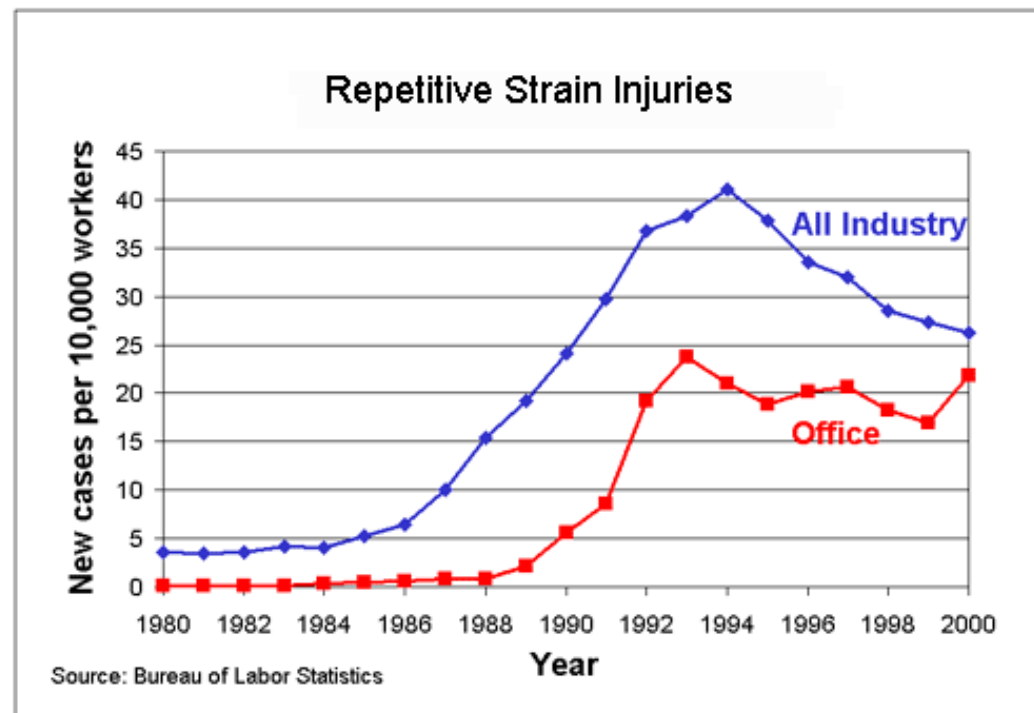
Although the explosive growth of new RSI cases stopped abruptly in 1994, the incidence of new cases has continued at a high level through 2000 (Figure 1). This suggests a continuing problem. While the results of several small research studies have been mixed, a large study in Atlanta published in 2002 documented that computer use among new employees was associated with pain and injuries (RSIs) at a surprisingly high rate (2). Other 2002 data shows that when RSIs result in work absences, they tend to require the longest absences of all leading occupational injuries or events (3).

Why haven't new RSIs continued to drop in frequency when the tools for effective intervention (e.g.

alternative keyboards) are available? The answer may be a combination of (a) reasonable caution combined with (b) human nature. In the mid-1990s, it was not known if new keyboard designs were safe or effective. Also, pending lawsuits by injured workers made companies leery of promoting alternative keyboards for fear of appearing to admit to a problem.

However today, research clearly confirms that certain alternative keyboards do reduce symptoms (4). Also, a recent systematic literature review assessing the quality and number of studies testing interventions among computer users found moderate evidence that rest breaks and postural training are ineffective and mixed to moderate evidence that alternative input devices can be effective (5). While this review highlights the need for more quality studies in this area, it seems to the author that reasonable caution is no longer a valid excuse for avoiding widespread deployment of appropriate ergonomic keyboards for all intensive computer users.

Figure 1. Trends in repetitive strain



Human nature may also help to explain the continuing problems with keyboard-related injuries. Even when confronted with the possibility of a future problem, most individuals don't implement a solution until the problem appears. For example, back in 1994, the vast majority of computer operators used the "ergo-worst" enhanced (traditional) keyboard, and this trend persists in 2008. Even if most computer users could be more comfortable and more productive with an appropriately-selected alternative keyboard, the standard keyboard is provided by computer manufacturers at no charge and therefore remains the default standard.

SELECTING THE BEST ERGONOMIC KEYBOARD

The design principles and useful features of effective alternative keyboards are generally well accepted. They work together to:

1. Minimize awkward postures,
2. Minimize unnecessary force, and
3. Reduce unnecessary repetition.

However, the design process to achieve these objectives is not simple or straightforward with keyboards, because so many interacting features must be considered. The final product must also be judged not only by how well its features minimize risk factors of typing (and mousing!), but by its learning curve, cost, and reliability.

Different individuals will choose a different solution to meet their needs once they have balanced all these factors. The following is intended to provide a systematic approach to evaluating alternative keyboards.

Assessing your level of need

If your goals are comfort, productivity, and hopefully avoiding a potential future injury, there are many options to choose from. However, if you are already experiencing an RSI, it is important to first see a health care professional to provide guidance regarding the most effective keyboard based on the injury. Extreme injuries often require extreme solutions. So expect to spend more time adapting to unique features, but hopefully not regretting it.

An important part of assessing your level of need is to consider the cause of any common computer-related aches and pains. Is it typing? Or is it perhaps moving, or clicking, a mouse? If mousing is the major problem, you may want to try a new mouse before investing in a new keyboard. However, be aware that the numeric keypad section on traditional keyboards and on fixed-split keyboards such as the Microsoft Natural can cause mousing pain by forcing you to hold and move the mouse too far away from your body. Changing to a compact keyboard (without the dedicated

Figure 2. Benefits of splay, separation

Traditional keyboard requires bent wrists



Adjustable splay allows straight wrists for different body sizes, requires some adaptation time.



Total separation provides straight wrists plus comfortable neck and shoulders, without adaptation

numeric keypad on the right side) would probably enhance any benefits you could expect from a new pointing device.

Prioritize design features

Some products have a fixed set of features, while others are reconfigurable or have optional accessories to provide different features. If you need more features, be aware that the cost and/or complexity of the product is likely to increase. Since most peoples needs change over time, it is generally wise to get a keyboard with the flexibility to adapt to different needs, as long as cost/complexity attributes don't exceed your comfort level.

Splay or separation (Figure 2). Splay is the most familiar configuration because of the widespread familiarity of keyboards based on the Microsoft Natural. However, total separation actually seems to require less adaptation time for most people and should provide more comfort than splay for most users. Try "play typing" with your forearms extended straight in front of your shoulders, then compare that to making a "V" with your hands together while your wrists are straight. If you opt for total separation, determine how far apart your pointer fingers are when positioned for typing. Keyboards which totally separate (Kinesis Freestyle, Comfort keyboard) limits the separation distance of your pointer fingers to approximately 11 inches, though options for extended separation are be available. Greater separation may be achieved with the Comfort keyboard by removing the numeric keypad or purchasing a Freestyle keyboard with a longer linking cable.

Tenting (Figure 3). Tenting is the elevation of the middle section of a split keyboard. Raising the thumbs relaxes the forearm muscles and increases blood flow and comfort. How much tenting is needed? For most people, tenting in the range of 10-20 degrees is optimal (7). In special cases, greater tenting may be more comfortable, but typing tends to be more difficult at higher angles. Many people who aren't experiencing RSIs find they don't even need 10 degrees, but want just a little tenting. Ideally a product has adjustable tenting so that you can experiment with different angles, or change the tenting if your needs change over time (or someone else needs to use your keyboard!). Also consider your priorities for sturdiness, reproducibility, ease of adjustment, and total range of tenting. Some products (e.g. Goldtouch, Comfort keyboard system) are continuously adjustable and have greater tenting range than several Freestyle models, but may be difficult to configure reproducibly and/or are less sturdy once adjusted.

Palm Supports (Figure 4). Wrist rests have generally been discredited for increasing the pressure inside the carpal tunnel of the wrist. Palm rests are more widely accepted for reducing the upward bending of the wrist (extension), and most users seem to find them comfortable and relaxing for the neck and shoulders.



Figure 3. Benefits of tenting (thumbs elevated)

Un-tented use keeps forearm muscles tense



Tenting relaxes forearm muscles

However, ergonomists tend to be divided on the value of palm rests, so check with your ergonomic professional.

Supporters prefer them unless a user is not able to achieve proper positioning of the keyboard. This is often the case with an obese user or someone with especially short arms. Others feel that palm rests should be avoided. While some keyboard designs are available only one way (with or without a palm support), others have integrated or optional palm supports. If tenting is needed, make sure to consider whether the available palm supports will adjust with the keyboard as you adjust the tenting. Otherwise they won't be effective over a range of keyboard tenting settings.

Key layout and special actions. Some keyboard designs require substantial adaptation time because keys are located in unfamiliar locations (e.g. the Kinesis Contoured and to a much smaller degree, the Goldtouch). Additionally, some keyboards provide extra keys with special actions, which can be a boon to productivity. However, most keyboards with special keys require a driver to be installed. If you work in an organization which frowns on installing un-approved software, be wary of keyboards that require a special driver.

Straight rows and columns. The Contoured keyboard has an orthogonal layout (straight rows and columns). This is simpler than the diagonal layout of the other keyboards, and is inherently easier to learn than the traditional keyboard, although it takes several days of adaptation for touch typists.

Concave key arrays. The Contoured keyboard, like the British Maltron keyboard that pre-dated it, uses concave arrangements of alpha keys to dramatically reduce reaching, promote relaxation of the fingers and allow easy access to an additional row of keys. When combined with a built-in palm rest, this arrangement prevents the undesirable awkward posture called wrist extension.

Money back guarantee and Warranty. Ergonomic keyboards cost more than traditional keyboards. Even with your best effort to analyze needs and select the appropriate product, you may find the design you have chosen doesn't work for you. Be sure to buy from a dealer or manufacturer that provides a money back guarantee period of at least 30 days, and offers a warranty of at least two years. Also, some keyboards can be repaired cost effectively after the warranty period. If you can use your ergonomic keyboard for many years, the higher initial cost will look like a bargain compared to a less expensive keyboard that is worn out and must be discarded after one or two years.

REFERENCES

- (1) Graph adapted (re-titled) from UC Berkeley Ergonomics

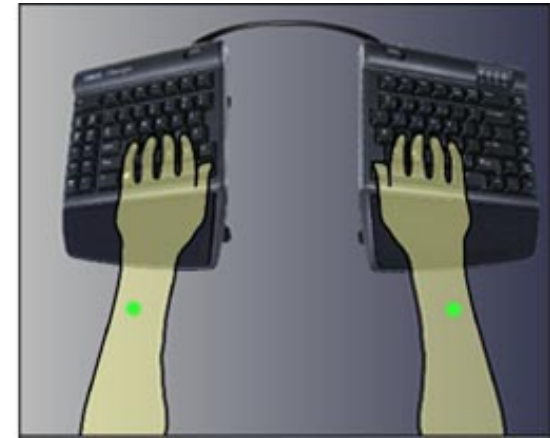
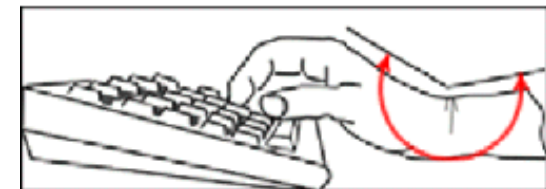


Figure 4. Wrist extension can be avoided by using a palm support (under the fleshy portion of the palms). Do not use a wrist rest, which can increase the pressure inside the carpal tunnel.

Wrist extension happens when a palm support is absent.



Without palm support, many users rest on the edge of their desk

Department web site, <http://www.me.berkeley.edu/ergo/research/injuryrate.html>

(2) Gerr, Fredric MD (Emory University), et. al, A Prospective Study of computer Users: 1. Study design and incidence of musculoskeletal symptoms and disorders, *Am. J. Ind. Med.*, 41: 221-234 (2002).

(3) Editor's comment, *Monthly Labor Review*, May 1, 2002 ([Http://www.bls.gov/opub/ted/2002/apr/wk5/art03.htm](http://www.bls.gov/opub/ted/2002/apr/wk5/art03.htm))

(4) Tittiranonda, Pat et al, Effect of four computer keyboards with computer users with upper extremity musculoskeletal disorders, *Am J Ind Med.*, 35:647-661 (1999).

(5) Brewer, Shelley eta al, Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users: a systematic review, *J. Occup. Rehab.*, 16 (3): 1053-0487 (2006).

(6). McLoone and Jacobsen, Innovation and design process for a fixed-split ergonomic keyboard *Human Factors and Ergonomics Society Annual Meeting Proceedings*, 50(5):2133-2137 (2006).

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Adding palm supports minimizes extension and resting on edge of desk



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