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Designing an Ergonomic Circulation Desk: A Case Study

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Introduction

Library work increasingly involves extended use of computers, and library staff and administrators are becoming aware of the hazards to the hands and arms from overuse of keyboards and incorrect posture. Such injuries are collectively referred to as Repetitive Strain Injury (RSI) and include ailments such as carpal tunnel syndrome, tendonitis, epicondylitis, tenosynovitis, ganglionic cyst and Raynaud's syndrome [Marshall, 1996]. Each is potentially serious and, according to a recent *New York Times* article, it is becoming ever more common for people to leave computer-dependent careers as a result of RSI [Brody, 1992]. Although older workers seem particularly susceptible, RSI can occur even in young physically fit individuals. The library literature shows an awakening to the issue with significant articles recently being published in *Computers in Libraries*, *Library Resources and Technical Services*, and *College & Research Libraries News* [Thornton, 1995; Summer, 1996; Switzer, 1995].

The purpose of this article is to relate how the University of Colorado reacted to an outbreak of RSI in its circulation department. The focus will be on the design of an ergonomic circulation desk that was installed in early 1996 at a total cost of approximately \$30,000.

Environment

The Boulder campus is the flagship research institution of the University of Colorado system. The campus enrolls 27,000 undergraduates and 6,000 graduate students. In addition, the Boulder campus employs 1,200 faculty. The University Library is an Association of Research Libraries member with total holdings of 2,600,000 volumes housed in a main library and 5 external subject-focused branch libraries. Total circulation, excluding reserves

and renewals, is approximately 850,000 annually. Over 75% of all circulation happens at the main library circulation desk. The remaining circulation activity is distributed among the 5 branch libraries. Staffing at the main circulation desk consists of 4.5 full time equivalency staff and approximately \$42,500 annual student labor budget.

RSI & Circulation Staff

In 1994 the circulation department at the main library had 4 individuals diagnosed as being in various stages of Repetitive Strain Injury. Two eventually accepted early retirement based on medical disability. The other 2, who were younger, recovered somewhat. All 4 staff were suffering from Carpal Tunnel Syndrome. This is the classic Repetitive Strain Injury, involving strain to the nerve that runs through a channel—the carpal tunnel—of the wrist. Library workers who constantly bend and twist their wrists under pressure such as lifting books or prolonged keyboarding are particularly susceptible to this injury. Symptoms of Carpal Tunnel Syndrome include tingling, burning, pain, and numbness, and treatment ranges from wrist splints to surgery [Chadbourne, 1995].

The circulation department reacted to this outbreak in several ways. For the first time the department began an education program to learn about the causes and implications of Repetitive Strain. Everyone tried to change their work habits to minimize the stress placed on arms and backs. Second, the unit head redesigned jobs so that they had more variety. For example, instead of having the same person work at the book return for 2 hours at a time, it was limited to 30 minutes. A new person would then be rotated into the task. This minimized the number of repetitions muscle groups would endure. The department also minimized the number of times books were handled. It was determined, for example, that a book was handled 8 times from return bin to shelf. That was streamlined to 4.

The department also examined the equipment being used. Everything from chairs, booktrucks, barcode wands, keyboards, and desks was examined in consideration of how each was contributing to Repetitive Strain Injuries. What we concluded was that while work habits were the single greatest cause of Repetitive Motion Injury, poorly designed equipment was a major contributor to poor work habits.

Circulation Desk

Occasionally, miracles happen and one happened for University Libraries about that time. There were no sudden cures, but the graduating class of 1994 donated \$35,000 to the library and the Dean gave it to the Circulation department to replace the main library circulation desk.

The old circulation desk was an ergonomic calamity and had been identified a one source of RSI. It was 40 years old and built long before computers or desensitizers. Because of its unusual size—45 inches high and 34 inches wide—shorter staff could not reach across the desk to hand books to borrowers. Both keyboards and monitors were permanently fixed on the desk top at a height of 47 inches. In retrospect, it was no wonder we had RSI problems considering the 680,000 transactions happening each year at that desk.

The circulation desks available commercially proved to be only a slight improvement from

what we already had installed. New desks had slots to hide computer cables and some even had terminal wells to recess monitors. However nothing was available that could be considered "ergonomic." There were no desks in which workstations could be adjusted to match the physique of the operator. Rather than perpetuate a poor design, it was decided that we would design and build a circulation desk based on ergonomic principles.

Determining Requirements

Our first step was to call in a consultant. The Boulder campus Office of Risk Management has an ergonomic specialist on staff. He guided us through the process of identifying our needs and selecting the products appropriate for our applications. He analyzed the work staff performed at the circulation desk. What he found did not surprise anyone in the department:

- The circulation desk experienced nearly constant patron interaction
- Most activity was for a single purpose; nearly 70% of all activity was check-out (check-ins being processed elsewhere)
- Each station was used by several operators during the day
- Because closed reserve materials circulate from the circulation desk, there was considerable movement between the reserve shelves and cabinets
- The equipment used was a computer monitor and keyboard, barcode wand, and desensitizer.

With such observations in mind, we started to design the new desk. Our goal was to create a desk with workstations that could be quickly and easily adjusted to fit anyone from about 5 foot 3 inches through about 6 foot 4 inches tall. Peripheral equipment such as barcode wands, desensitizers, and book stamps were to be within easy reach of the operator. The need to bend or twist was to be minimized—particularly when handling books but also when retrieving paper from printers. The old desk had computer equipment stacked on the counter top forming a barrier between the operator and borrower. The operator had to lean around equipment to converse with a borrower. Consequently, in the new desk, it was desirable to configure the equipment to provide better eye contact with borrowers. Finally, it was critical that adjustments be easily and quickly accomplished. If adjustments could not be completed by the operator very quickly, we knew they would never be used.

Desk Overview

This video shows the completed circulation desk as a borrower would view it [[QuickTime 1](#)]. It is fabricated from oak with a Formica top. The top is finished in a gray matte to minimize glare [Wilkinson, 1993]. There are 9 workstations for a total length of 32 feet. The desk top is 42 inches high and 30 inches deep. An ADA station is at the far end. Each workstation supports a keyboard, monitor, computer CPU, barcode wand, desensitizer, and various stamps and supplies [[Illustration 1](#)].

Seating

Seating has become a high-profile aspect of ergonomic workstations. In the end, we chose not to use chairs or stools at the circulation desk. With activity at the desk constant and

busy, it was determined that chairs would get in the way rather than help. Besides with people being assigned to the circulation desk with no more than 2-hour shifts, the staff felt they did not need seating. Instead, a closed-cell vinyl sponge mat was placed on the floor of the high traffic areas. Similar to a thick cushion, it reduces foot, leg, and back fatigue. Several variations of this product are available from ergonomic equipment suppliers and all are relatively inexpensive, costing about \$15 a square yard. This has proved to be successful in reducing fatigue. However, the matting has proved to be an obstacle for loaded booktrucks.

Monitor Position

After considering the seating, the computer configuration was examined. The primary consideration was adjustability. We first examined the monitor. The first prototype recessed the monitor into a deep well with a clear Plexiglas covering over the entire monitor. The monitor sat inside the desk tilted upwards with the screen visible through the Plexiglas. A major advantage of this configuration was that the counter was left clear of computer equipment. A full-scale mock-up of the workstation was constructed. Unfortunately, we were unable to make that configuration function. Regardless of where the monitor was positioned, there was so much glare the screen was unreadable. Moreover, with the monitor underneath the desk top, it proved too difficult to adjust. The operator had to bend under the desk and twist the monitor back and forth. Not only was this difficult and time-consuming, but an operator could be injured adjusting the monitor.

The next concept worked considerably better. We found a monitor stand built by a company called Monitor Mate and sold by Saunders Ergo (800/375-1119). Although expensive—about \$275—the stand adjusts vertically by nearly 8 inches. Moreover, it is counterbalanced. Consequently, with the stand adjusted for the weight of the monitor, an operator may quickly raise or lower the monitor without effort [[QuickTime 2](#)]. Sitting on a 40 inch counter, the monitor can be lowered so the center is at about 55 inches or raised so the center is at about 62 inches. In addition, the monitor's tilt adjustment may be used to position the screen to avoid glare. This configuration will adjust to fit anyone from about 5 foot 3 inches to about 6 foot 2 inches.

So that the operator could have better visual contact with the borrower, the monitor was mounted at a 20° angle. It is still easy to read the screen, but the monitor is not directly between borrower and operator. To provide a neat appearance, the base of the monitor stand was mounted beneath the desk top [[Illustration 2](#)].

Keyboard Tray

The next major component considered was the keyboard tray. It proved surprisingly difficult to identify a workable solution. A flat or backward-sloping keyboard places considerable stress on your wrists by, among other things, constricting blood flow [Hedge, 1995]. Ideal typing posture is for hands to rest on a keyboard with a negative tilt. To achieve a negative tilt, the keyboard tray must tilt forward. This places the front row of keys higher than the back row. Additionally, the keyboard tray must be adjustable vertically so that the keyboard may be positioned just below the operator's elbows [Tessler, 1994].

It was obvious that an adjustable keyboard tray was needed. Although we could identify dozens of adjustable keyboard trays, most were designed around a single user workstation. They were built to be adjusted once or twice a day and left alone. Instead, we needed a tray that was easy and durable enough to be adjusted every 15 minutes. Moreover, it had to be vertically adjustable within about an 8 inch range and it needed a negative tilt feature.

We finally identified a keyboard tray sold by Ergo Kare (800/927-5273) that adjusts 7 inches vertically and with an adjustable negative tilt of 25 degrees [[Illustration 3](#)]. Fortunately, of the trays we found, this tray also proved to be one of the easiest to adjust. While many trays have 2 or 3 levers for adjustments (thus guaranteeing no one will ever adjust them), this tray has one lever that adjusts the keyboard up or down. It is locked in place by releasing the lever. The entire keyboard tray also slides backwards and forwards. Consequently, when no one is working at that particular station, it can be tucked away [[QuickTime 3](#)]. Each of these was about a \$125 which was very reasonable considering that it was one of the better designed trays we identified.

Barcode Readers

In terms of barcode scanners, what is ergonomically in vogue are large gun-shaped readers that are permanently mounted on a stand. The idea is that the operator passes the item beneath reader for scanning. Potentially, this can result in less handling presumably fewer Repetitive Strain Injuries.

On the advice of our ergonomics specialist, we experimented with one for several days. It was universally hated. What we found was that instead of handling a 4 ounce pen, we were handling a 5 pound book. Consequently, in our situation, the mounted readers did not function as well as the lightweight pen readers.

Desensitizers

One rule of thumb is that frequently used equipment should be within 40 centimeters of the hands that use it [Dyer, 1992]. So when installing the desensitizers, they went very close to the operator on their left side. To achieve an uncluttered look, the 3M in-counter desensitizer was used. This particular desensitizer is designed to be a flat metal plate on top of the counter. Although it functions well and reduces clutter on the desktop, it is permanently in place and not adjustable.

Permanently mounting equipment, particularly frequently used equipment, is ergonomically risky. It is not possible to permanently position equipment so that one placement fits everyone's physique and work style. This has held true with the placement of these desensitizers. Perhaps a better choice would have been the 3M model 930 "brick" desensitizer. Its portability allows the desensitizer to be placed on either side or any position from the operator.

Printer and Computer CPU

Locating the printer required a compromise. Each workstation is equipped with a printer that is used to print receipts for returned books and statements of accounts. It is placed on a

retractable shelf mounted at 30 inches on the operator's left [[QuickTime 4](#)]. This is a height for which most people do not have to bend too far to reach.

The cabinet maker that built the circulation desk originally specified a retractable shelf that also lifted the printer vertically once extended. However, the mechanism was expensive, slow to function, and awkward to lock into place. Because we print relatively few times each day, it was determined that the fixed-height retractable shelf would be suitable for printer placement.

Although constantly in use, the computer's CPU is never touched by the operator. Consequently, it was placed at the very bottom of the workstation [[Illustration 4](#)]. The objective was to keep it away from the operator's work space. This placement was met with opposition from the Libraries' automation department. Several valid problems with this placement were outlined. Sitting so close to the floor, the CPU would be at risk of being damaged by being kicked. Moreover, the CPU fans could draw in excessive dirt and dust causing premature failure. Because of the distance between the CPU, wand, keyboard, and monitor, several extension cables would have to be created for each workstation. Extension cables, it was explained, have proved notoriously unreliable. Finally, because the CPU would be sitting so close to the floor, it would be very difficult to repair. However, the proposed alternative location directly beneath the monitor did not conform to the design of the rest of the desk. We concluded that the health of the staff took precedence over the equipment and placed the CPU near the floor.

Reserve Collection

The main library reserve collection is housed in the circulation department and items are loaned from the circulation desk. At over 125,000 transactions annually, reserve activity adds a huge workload to the circulation desk. At semester peaks, nearly 8,000 items are on reserve. Most are photocopies stored in file folders. Traditionally, file folders are stored in file cabinets and, for many years, the circulation department kept 20 file cabinets filled with folders. Consequently, 400 or 500 times a day staff would yank open a 30 pound drawer, stoop or reach to get a folder, and then 400 or 500 times a day yank the drawer open again to refile them. Obviously this was not a healthy thing to be doing.

A staff member proposed filing folders in open bins similar to those in which LP records were filed [[Illustration 5](#)]. Although space-consuming, each measures 60 inches by 40 inches, these bins do not require bending or excessive reaching to retrieve folders. With file cabinets, only one drawer could be open at a time. However, the bins allow open access to all folders simultaneously. Consequently, retrieval is much faster.

Lighting

Lighting proved to be a particularly difficult challenge. The ceiling height in the main library circulation desk area is unusually low. It is only slightly higher than 8 feet. Moreover, because the circulation area is located in the basement, no natural light reaches the department. Typical fluorescent fixtures proved too bright and caused considerable glare on the computer screens. A significant source of glare is the lens panel on fluorescent lights [Anshel, 1994, p. 21]. The electricians were able to fit the fixtures with louvers that

reduce the scattering of light from the fixtures and softens screen glare.

Full spectrum lamps were considered for the circulation desk area. It has been claimed by manufacturers and some researchers that these sunlight simulating lamps are less fatiguing than white fluorescent lights [Hughes, 1980]. Recent evidence, however, indicates that such assertions are probably exaggerated [Veitch, 1991; Boray, 1989]. These studies have indicated that full spectrum lamps have no impact on performance or mood of workers compared to traditional fluorescent lamps. Moreover, full spectrum lamps are considerably more expensive than traditional fluorescent tubes. We found that the University's Facilities Management department does not purchase full spectrum lamps. If installed, expired full spectrum tubes would be replaced by cool white fluorescent tubes unless the library made special provisions to purchase and replace the tubes. Given the doubt surrounding their effectiveness, the considerable expense, and the difficulty of replacement, it was determined to use traditional cool white fluorescent lamps throughout the circulation department and public areas.

Conclusions

The total cost of the project was approximately \$36,000. The figure includes expenses that would have been incurred with any change of circulation desk. Lighting work cost \$2,400; carpeting cost \$3,700; and electrical was \$1,100. The cost of the ergonomic hardware such as monitor lifts and keyboard trays was \$4,100. Each reserve bin cost \$3,000. The cost of constructing the desk was \$18,500. The total cost compares favorably to the purchase price of a prefabricated circulation desk.

The outbreak of RSI described earlier has not reoccurred in the University of Colorado's circulation department. It is probable that the ergonomic features of the circulation desk contributed to this decrease. However, equipment alone will not prevent RSI. Changing poor work habits is crucial—but the most difficult aspect—to minimizing injuries. While proper equipment is an important component of a safe workplace, it must be supplemented with regular training to be effective.

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