

# Muskuloskeletal Disorders

*A Framework for Understanding*



What are MSDs and why do they matter? . . .	3	Searching for causes . . . . .	8	How to work ergonomically . . . . .	15
A brief history . . . . .	4	Prevention and intervention . . . . .	10	A quick summary . . .	16
Quantifying the problem . . . . .	5	Ergonomic programs pay off . . . . .	11	For further reading . .	17
Who suffers? . . . . .	7				

## **A Day in My Life**

**Here I am — lost at 33.**

**Wondering where to go, wondering what to do.**

**Totally ostracized by my peers — feeling hopeless**

**as I tread the windmill of my life.**

**So many thoughts to express — where to start.**

**Start with the pain — all encompassing**

**so that I don't know how to alleviate it.**

**To sit, to stand, to do something to make it go away...**

*Excerpted from A Day in My Life*

W.R.I.S.T Newsletter, August–October, 1985, page 19

By Mersina, an RSI sufferer



# What are MSDs... and Why do They Matter?

*When daily activities involve repetitive movements of the hand and wrists, people may be at risk for musculoskeletal disorders.*

## **An overview**

Musculoskeletal disorders (MSDs) are relatively common conditions also known as cumulative trauma disorders (CTDs) and repetitive strain injuries (RSIs). All are collective terms for the MSDs involving tendons, tendon sheaths, lubrication of the tendon sheath, the related bones, muscles, and the nerves of the hands, wrists, elbows, shoulders, neck, and back. They include tendonitis, tennis and golfer's elbow, and carpal tunnel syndrome.

MSDs are frequently associated with sports activities. But these often painful and debilitating conditions are also occurring among office workers in significant numbers. As a result, businesses are experiencing loss of worker productivity and an increase in workers' compensation claims.

In recognition of the prevalence of MSDs, Steelcase has established collaborative relationships with leading ergonomics experts, developed products that address the problems, and participated in research to gain greater understanding of its causes and effects.

The good news is that preventative steps can help. Studies show that several companies that have instituted comprehensive ergonomics programs — including assessment, education, and intervention — have experienced success. When workers are involved in assessing their own needs and defining the solution, success rates are even higher. Over time, companies have reduced the incidence of MSDs, the cost of ergonomics programs per worker, and the amount of workers' compensation claims.

# A Brief History

*The physical problems resulting from repetitive tasks, particularly occupational duties, have existed for centuries.*

## MSDs are not new

At least 200 years ago, chronic musculoskeletal disorders were described as a "... harvest of diseases ... [related to]... certain violent and irregular motions of the body..."



While tendonitis (inflammation of the tendon) is estimated to be ten times more prevalent, carpal tunnel syndrome receives more attention in scientific literature and the media, probably because there are more objective diagnostic tests for nerve impairments than for tendon disorders.

A more scientific description of cumulative trauma disorders (CTDs) appeared in Gray's Anatomy of 1893: "The tendons of the extensor muscles of the thumb are liable to become strained and their sheaths inflamed after excessive exercise, producing a sausage-shaped swelling along the course of the tendon and giving a peculiar creaking sensation to the finger when the muscle acts. In consequence of its often being caused by such movements as wringing clothes, it is known as 'washerwoman's sprain.'" The action of wringing clothes had a counterpart in other trades, giving rise to an array of labels including: bricklayer's shoulder, carpenter's elbow, stitcher's wrists, game keeper's thumb, cotton-twister's hand, and glass arm (for telegraph operators).

One of the earliest accurately diagnosed cases of carpal tunnel syndrome was assessed in 1910 at Mayo Clinic. In 1927, a researcher reviewed the records of a Swiss insurance company and found 929 cases of crepitant (accompanied by a creaking noise) tenosynovitis, most of which were associated with repeated trauma. Between the 1940s and 1970s, various studies quantified such factors as percentage of the workforce afflicted, number of days of work lost, and average cost per case for treatment.

One study found that many more cases were uncovered when the source of the information was personal insurance records rather than plant medical and compensation records. It appeared that some workers, not realizing that their injury might be work related, sought medical help from their own physicians.

One of the most extreme outbreaks of RSI occurred in Australia in the early 1980s. The epidemic was so severe that in the hardest hit areas the RSI-related workers' compensation claims increased 100 percent between 1979 and 1980. Its victims were mostly female office workers who spent the majority of their time working at computer keyboards.

# Quantifying the Problem

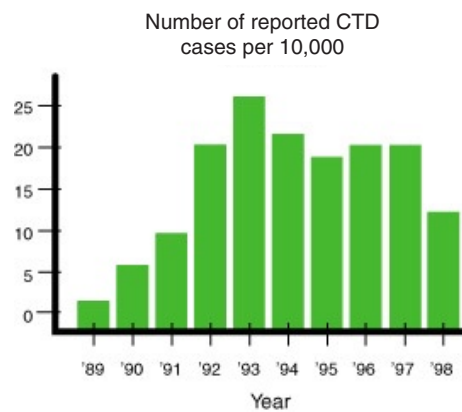
*While MSDs remain a problem, their rate of increase is diminishing.*

## Some data

The U.S. Bureau of Labor Statistics (BLS) annually issues statistics on the number of new occupational illnesses and injuries in private industry workplaces. The chart compares the year-to-year totals from 1989 to 1998 among finance, insurance, and real estate workers — a group predominantly made up of office workers.

An earlier study from the BLS confirms that the rate of increase is shrinking. The BLS compared their own data on reported cases of MSDs with numbers of insurance claims from a Liberty Mutual Study. The study included annual statistics from the mid-1980s to the mid-1990s. The results indicated that the trend in insurance claims paralleled the data from the BLS, that is, the overall rate of increase in MSDs began to slow by the mid-1990s.

Why the apparent increase in reported cases in 1991 and 1992? What factors explain the leveling off of increases of these disorders later in the decade? There is much speculation.



# Quantifying the Problem

*(continued)*

## *Awareness*

People who had been suffering from pain in the wrist and/or arm began to connect it with the work environment. Once OSHA required that these problems be reported, the incidence of reporting naturally grew significantly.

## *Reporting techniques and attitudes*

Once awareness of the problem grew, some workers who may not have been willing to report the problem to the company health service for fear of reprisals overcame their reluctance. This boosted the number of cases being reported. However, the system of coding and tracking MSDs is not an exact science and therefore it does not always yield accurate figures. Some people believe the incidence is much higher than numbers reported by the BLS.

## *Employer response*

Over a period of years employers began to make changes in work environments, particularly in manufacturing where the problems are more severe. They used education, training, and ergonomic interventions to address the problem. In the early phases of these efforts (assessment and education), more cases of MSDs came to the fore. As the programs evolved, rates of incidence dropped.

## *More health-related professionals*

Safety experts, ergonomists, occupational and physical therapists, human resources personnel, and facility managers became more aware of the problems and what to do to prevent them from becoming serious.

---

The goal of promoting well-being at work is not new; it has been the purpose of the occupational health movement since its modern inception in the late 1960s in both the United States and Sweden. These movements have been politically conscious attempts to roll back the residual destructive aspects of modern industrialization with scientific evidence or problems and scientifically formulated solutions."

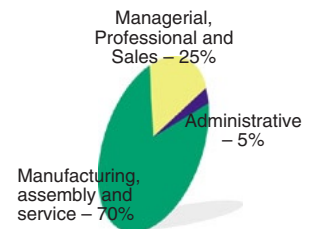
**Karasek and Theorell in *Healthy Work***

# Who Suffers?

*While less than one percent of the total United States population currently suffers from MSDs, the percentage has been as high as 15 percent in certain groups.*

## Influencing factors

Recent surveys by the BLS help clarify what types of workers suffer from repeated trauma. In 1993, of the 94,309 new cases that involved loss of time at work, 64 percent were females. Seventy percent of all cases included people in manufacturing, assembly, process, and service jobs. The balance represented managerial, professional, sales, and administrative types of jobs with only five percent in secretarial, typing, and data entry.



**Who suffers from MSDs?**

Although manual labor is the more fertile ground for occupational MSDs, significant numbers of today's office workers are also afflicted. The prevalence of computers and the shift to an economy dependent on information-technology has created a new set of performance standards in the workplace. People are expected to work with tremendous speed and accuracy and accomplish a wide range of tasks without ever leaving their seats and keyboards. As laptop computers have empowered people to work everywhere and anywhere, the environment and conditions in which people use a keyboard and mouse are often ergonomically ill suited to the task.

In addition, many workers who experience chronic pain become increasingly concerned about their physical state and ability to do their jobs. This adds to their stress level, which may, in turn, exacerbate their disorder.

Gender also plays a role. A study of 652 workers confirmed the idea that women are at greater risk for developing this condition. However, the study cautions, "A large portion of women in a clinical series may reflect more the social and reporting differences between males and females than an underlying difference in risk." And later... "the small risk associated with gender in the workplace could be more a matter of the design of the workplace than one of physiology. Since the stature of the average female is less than that of the average male, women often have to work in a different posture than that of their male counterparts and may be exposed to greater stress than males."

# Searching for Causes

*After more than 100 reports and studies on various probable causes including gender, workspace design, stress related to the introduction of computer technology, and social trends, the exact causes of MSDs are still unknown.*

## The quest continues

The Office Ergonomics Research Committee (OERC) is at the center of contemporary research and thinking on MSDs in office settings. Steelcase was one of 16 U.S. companies who formed the group in April 1991.

### Occupational Factors

Repetition  
Force  
Static muscle load  
Movement velocity  
Awkward postures  
Cold temperatures  
Activity/rest cycles  
Vibrations

Concerned by reports of increasing numbers of MSDs among office workers, the OERC established several objectives:

- To understand office-related MSDs.
- To assess how office work may or may not cause or exacerbate MSDs.
- To determine interventions that can prevent or resolve MSDs.
- To determine whether appropriate medical treatment is available.

The first order of business was to develop a better understanding of causes of MSDs and how to deal with them. This required more comprehensive data on the type and frequency of the disorders in the office environment, and the effect of input devices, workspace ergonomics, job design, exercise, and psychosocial factors.

### Non-occupational Factors

Congenital defects  
Acute injuries  
Chronic diseases  
Aging  
Gender  
Recreational activities  
Transient conditions that affect hormones

As part of the OERC's effort to expand their knowledge base, the committee funded research studies, symposia, and literature analysis. Studies indicated that a range of hand and wrist disorders were common among workers who performed intensive work with their hands. However, researchers agree it is difficult to define an exact set of causes.

One of the primary controversies centers on the degree to which occupational and non-occupational factors contribute to MSDs. In addition, medical literature has cited obesity and vitamin deficiency as probable causes of carpal tunnel syndrome. It is almost always possible to find cases to support one factor or set of factors over another.

# Searching for Causes

*(continued)*

## **Office-specific studies**

The OERC has diligently pursued answers to what causes MSDs in office workers. To further study input devices they conducted studies and reviewed research on keyboards, keyswitch design characteristics, key force, and alternative keyboards.

One study concluded that users hit the keyboard much harder than they need to. Another found that split keyboards and adjusting the angle of keyboards can have a positive impact on wrist angle.

And, while the OERC concurs that proper use of workspaces, ergonomic accessories, and personal computer equipment can affect how comfortably a person works, the exact relationship between discomfort, MSDs, and long-term effects is still unknown.

The consistent theme that arises from studies, symposia, and actual experience with workers in office settings is that multiple factors contribute to the cause of MSDs. Isolating one environmental or equipment-related factor as the primary cause, or cure, does not appear to be a valid approach. At the same time, more evidence is mounting in support of a holistic approach to prevention and intervention.



# Prevention and Intervention

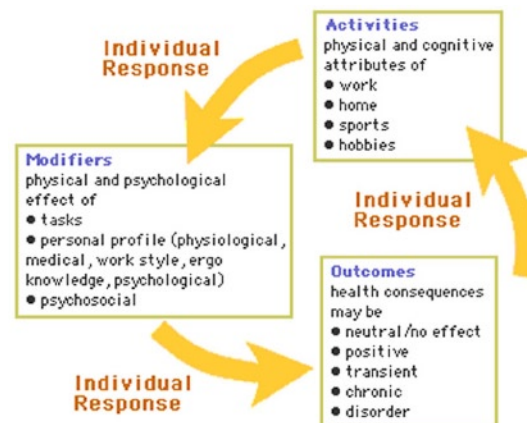
*Steelcase and the OERC take a systems approach to understanding the multiple factors that contribute to MSDs.*

## A framework

The OERC has created a framework that represents a reoccurring cycle in a person's life and the impact of life's activities, including hobbies, work, sports, and home, on health outcomes. It demonstrates that life's activities are modified by task, personal (psychological, medical, work style, knowledge of ergonomics, psychological), and psychosocial factors. These modifiers affect whether a health outcome is neutral, positive, disorder, transient, or chronic.

The framework also provides a vehicle for discussing current research and theories, identifying limitations in the findings, and developing future research and theories that will have the most impact on the multiple factors of MSDs. It is intended as a communications tool to support interaction among researchers, research grantors, ergonomists and safety professionals, supervisors, purchasing agents, end users, the general public, students, designers, and manufacturers of equipment, office furniture, and accessories.

The OERC funded a symposium of 17 international experts from many related disciplines to explore the role of psychosocial influences in MSDs. The information presented underscored both the importance and complexity of psychosocial factors on both reporting and experiencing cumulative trauma disorders.



Individual responses include physical and mental processes.  
Source: OERC

# Ergonomic Programs Pay Off

*While workplace programs and intervention can affect only a segment of all the possible factors associated with MSDs, a number of companies who have instituted comprehensive office ergonomics programs have achieved excellent results from an approach that combines training, changes in equipment, and the involvement of an interdisciplinary team.*

## **Steelcase/Details**

Steelcase, Details (a company that develops and markets work tools), the University of Wisconsin, and a Midwestern catalog clothing company collaborated to study how workspace ergonomic improvements affect employee productivity and comfort.

Four groups of customer service employees were selected for the study, with one group serving as the control. The participants' work involved intensive use of telephone and visual display terminals. Using a holistic approach, the ergonomics team started with benchmark surveys to define the status of worker health and comfort prior to any interventions. Following the benchmark studies, a participatory ergonomics program was initiated. Workers were first asked to help assess their own needs.

"Participatory ergonomics starts with involving workers early, in exploration and planning stages," said Paul Allie, Steelcase researcher. "When the workers participate in determining the best work environment for them, we see a much higher rate of acceptance and success."

Following assessment, workers were asked to select the computer support and work tools that would best meet their needs. Participants in the non-control groups were given ergonomic interventions shortly after the peak holiday season began, and were trained in the proper use and adjustment of the various interventions.

The sample for the study was 95 percent female with a mean age of 45, a mean height of 5'4" and a mean weight of 158 pounds. The interventions included three types of changes:

# Ergonomic Programs Pay Off

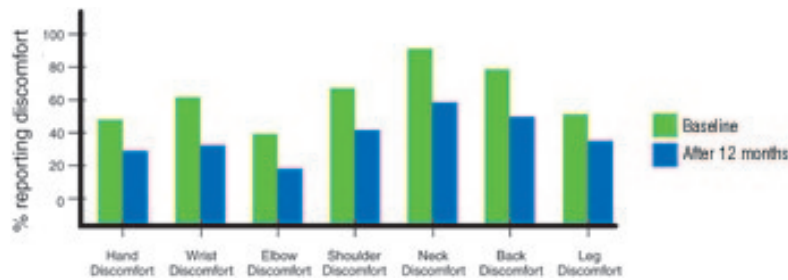
(continued)

**Workspace layout** — adjusted worksurface height, increased leg room, repositioned monitors and/or telephone.

**Computer support and worktools** — added Details products, including document holders, keyboard shelves, monitor holders, footrests, wrist rests, and auxiliary task lighting.

**Steelcase seating** — increased adjustability features that addressed specific needs.

Surveys completed six and 12 months after the interventions showed reduced discomfort in the neck, shoulders, elbows, wrists, hands, back, and legs. Most importantly, effects of ergonomic intervention contributed to worker productivity. All experimental groups improved productivity an average of 5.2%. The control group reported a 0.42% increase. It appears that when workers can optimize the placement of their computer equipment and documents, they are more productive and work with less discomfort.



## Hewlett Packard

As another example, one Hewlett Packard site with approximately 2,000 workers created an ergonomics team representing facility design, technical maintenance, environmental health and safety, health services, and site purchasing. The team was empowered to define a mission and set goals. Its focus was on four main objectives:

- to implement a program for training and educating employees.
- to conduct an audit of facilities including seating, accessories, and work-surfaces and make recommendations for improving workspaces.
- to provide appropriate furniture and equipment.
- to involve workers in the improvement process.

Among the prevention tactics were teaching workers the proper (neutral) position; taking stretch breaks; rotating tasks, and teaching keyboard techniques. The company reported dramatic results. Medical costs, which were \$2,079 per case in FY 1990, dropped to \$620 per case in 1991. Facility and training costs fell from \$450 per employee in 1990 to \$250 in 1991.

# Ergonomic Programs Pay Off

*(continued)*

## **Avmed Health Plan**

One of the corporate missions of Avmed Health Plan, a non-profit HMO, is to improve the health of members and employees while keeping health care rates low. Faced with internal growth and overcrowding in existing facilities, Avmed built a new building on its Gainesville, Florida campus. That effort included development of a corporate ergonomics program to help reduce day-to-day costs while providing a healthy and attractive work environment for employees.

The result? Avmed saved over \$1.7 million in workers' compensation claims.



AvMed Health Plan experienced savings after implementing an ergonomics program.

## **GAO Study**

A report of the United States General Accounting Office summarizes the experiences of several major employers who implemented long-term ergonomics programs. The companies, who followed a common approach, yielded common results. They experienced a reduction in:

- total cost of workers' compensation claims attributed to MSDs (one company realized a 91% improvement in costs)
- the average cost of MSD claims
- the rate of incidence
- the number of lost or restricted workdays (one factory experienced 28 months without a lost-time injury)

The companies also saw improvements in quality, productivity, and employee morale.

The GAO concluded that gains can be achieved through low cost analysis and controls that are part of an ergonomics program tailored to specific conditions.

# Ergonomic Programs Pay Off

*(continued)*

No single approach to office health and safety can work for every business. Each program should be tailored to the organization's unique needs, work processes, and culture. Typically, organizations follow a framework like the one outlined here to develop a custom program for their specific situation.

- 1. Identify Issues** — document the need; research potential solutions, resources, ideas, and plans; demonstrate possible consequences; form a task force involving workers who will be affected.
- 2. Define Direction** — write a mission statement; define ergonomic goals; develop strategies that will accomplish goals; establish program objectives and timetable.
- 3. Conduct Research** — interview or survey employees; videotape employees as they work to document and analyze tasks; complete situation analysis report; consult with ergonomics experts for resources and information.
- 4. Develop Recommendations** — evaluate data from situation analysis; compare data to available solutions; develop product applications to address and/or prevent identified problems; develop educational tools and programs for employees and managers.
- 5. Implement Program** — test recommended solutions; implement solutions in normal environment and solicit employee comments and evaluation; install solutions; conduct post-occupancy evaluation and fine-tune solutions; educate employees; evaluate and incorporate feedback from actual use of product and work tools; continue to educate employees on use of product and on ways to relieve stress through exercises and breaks.

# How to Work Ergonomically

*Here are some suggestions for improving the health and comfort of employees in the workplace.*

## Some tips

### Did You Know?

Up to 10 pounds of force is needed to hold a mouse. This force stresses the muscles and connective tissues in the forearm. The further away from the body the mouse is held, the more stress on the elbow, neck, and shoulders.

### Job Design and Management

- Encourage workers to vary tasks during the day, particularly those involving repetitive motions.
- Remind workers to take small, 10–30 second breaks from the computer every two hours.
- Allow workers discretion in how they work — their posture, schedule, pace, and work processes.
- Educate workers on the value of ergonomics.
- Help workers discover the features and functions of their workspace that enable them to adjust their environment for safety and comfort.
- Encourage people to take periodic, deep breathing breaks to help relax muscles.

### General

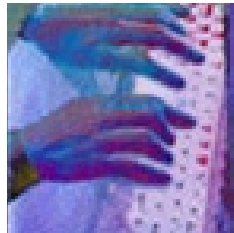
- Improve clarity of vision by looking down at materials.
- Avoid staring at your monitor; look away to give your eyes a rest.
- Position computer display directly in front of keyboard to keep focus straight ahead.
- Provide well-padded arm rests on chairs.
- Encourage balanced seating postures.
- Provide sit/stand workspaces for customer service applications that normally require workers to remain at their desks.
- Reduce mouse-related muscle strain by keeping mouse close to body.
- Keep elbows close to the torso while using keyboard or mouse.
- Offer keyboards with detachable numeric pads to frequent mouse-users.
- Offer split keyboards to computer users with wide shoulders.
- Move the whole hand to reach distant keys; do not stretch just the finger.

# A Quick Summary

Research indicates that workers with jobs involving repetitive movements of the hand and wrists have suffered from musculoskeletal disorders (MSDs) for decades. Since the 1980s, loss of time at work and increased workers' compensation claims have focused attention on the causes and possible cures for these disorders.

While research, literature reviews, and symposia are adding to the overall understanding of MSDs, experts have not isolated one predominant cause. The data seems to support the theory that multiple factors are to blame, both occupational and non-occupational.

Those concerned about MSDs can be encouraged by corporate results that show comprehensive ergonomics programs can improve and maintain the well-being of workers. Continued research into the complex causes and possible cures for these disorders offers hope that incidence rates will continue to decline.



## For further reading

- Allie, P. "Establishing an Ergonomically Correct Call Center." Telemarketing and Call Center Solutions Magazine, November 1996.
- Allie, P. and Faiks, F. Supporting Natural Human Motion While Seated. Grand Rapids, MI: Steelcase Inc.
- Amadio, P.C. Historical review: The Mayo Clinic and Carpal Tunnel Syndrome. Mayo Clinic Proceedings, 67, 1992: 42-48.
- American National Standards Institute. ANSI Standards and the Healthy Office: Toward a More Complete Understanding (Issue Brief No. 2-1877). Grand Rapids, MI: Steelcase Inc., 1991.
- Armstrong, T.J., Fine, L.J., Goldstein, S.A., Lifshitz, Y.R., and Silverstein, B.A. "Ergonomics Considerations in Hand and Wrist Tendonitis." The Journal of Hand Surgery, 12A (5.2) (1987).
- Arthritis Foundation. Carpal Tunnel Syndrome. Atlanta, GA: Arthritis Foundation, 1987.
- Bear-Lehman, J. Occupational Therapy Management of Upper Extremity Cumulative Trauma Disorders. Paper presented at the Upper Extremity Cumulative Trauma Symposium, Nov. 1985, University of Michigan.
- Briggs, C.A., and Green, R.A. "Effect of Overuse Injury and the Importance of Training on the Use of Adjustable Workspaces by Keyboard Operators." Journal of Occupational Medicine, 31(6) (1989).
- Brogmus, G.E. Reporting of Cumulative Trauma Disorders of the Upper Extremities May Be Leveling Off in the U.S. Paper presented at the Human Factors and Ergonomics Society 39th Annual Meeting, 1995.
- Faiks, F. and Reinecke, S. Investigation of Spinal Curvature While Changing One's Posture During Sitting. Grand Rapids, MI: Steelcase Inc.
- Faiks, F. and Reinecke, S. Supporting the Lumbar and Thoracic Regions of the Back During Sitting. Paper presented at the North American Congress on Biomechanics, 1998.
- GAO, AEFA, and Raytheon TI. "Policy Implications of Employer Experiences Implementing Ergonomics Programs." Presentation at the HFES Annual Conference, 1997.
- Hendrick, H.W. International Practice Trends in Ergonomics. Paper presented at the National Ergonomics Exposition & Conference, Oct. 1995, San Jose, CA.
- Hewlett Packard. Applying Ergonomics to Office Workplaces. Paper presented at the conference: Addressing the Employee Health Crisis in Today's Computerized Office, 1992, Cornell University.
- Hoffman, M.S., Purvis, C., Adams, E., and Bettendorf, R. A Framework for Understanding Upper Extremity Musculoskeletal Disorders. Paper presented at the conference: Work With Display Units, 1997.
- Karasek, R. and Theorell, T. Healthy Work: Stress, Productivity and the Reconstruction of Working Life. New York: Basic Books, Inc., 1990.
- Kiesler S., and Finholt, T. The Mystery of RSI. American Psychologist 43(12) (1988): 1004-1015.
- Office of Ergonomics Research Committee. Musculoskeletal Disorders in the U.S. Office Workforce. Manchester Center, VT, 1996.
- Osterman, N.H. A Self-help Guide to Solving Ergonomic Problems. Paper presented at the National Ergonomics Exposition and Conference, April 1996, Chicago, IL.
- Steelcase Inc. Ergonomics in the Healthy Office (S1803). Grand Rapids, MI: Steelcase Inc., 1991.
- Steelcase Inc. Evaluation of the Effectiveness of Office Ergonomic Improvements. Grand Rapids, MI: Steelcase Inc., 1996.
- Steelcase Inc. Future-proofing the Workplace for Faster, Less Costly Change: AvMed Healthcare Case Study (S10936). Grand Rapids, MI: Steelcase, Inc., 1999.
- Steelcase Inc. Toward Healthy and Effective Offices (S1875). Grand Rapids, MI: Steelcase Inc., 1994.

