Ergonomic Research Summaries

Ergonomics is a design-based discipline concerned with fitting tasks and environments to workers. In the office, recent emphasis has centered on improving the computer interface. When a proper fit is achieved, workers tend to report reduced discomfort, improved task efficiency, and fewer work related musculoskeletal disorders. Successful office ergonomics interventions typically involve augmenting personal control of work components and training on equipment, healthy working postures, and technique.

The following summarizes salient research findings in the field of office ergonomics. Justification is provided for the implementation of ergonomic work tools, and an ergonomics training program. Journal citations are listed for all research findings.

Benefits of ergonomics interventions and employee level training

Rudakewych, M., L. Valent-Weitz, et al. (2001). Effects of an ergonomic intervention on musculoskeletal discomfort among office workers. Proceedings of the Human Factors and Ergonomics Society 45th annual meeting, San Diego.

This study reports the effects of an ergonomic intervention in an office environment. Three hundreds and fifty-six office workers received a negative-slope keyboard with upper mouse tray, an ergonomic chair, and ergonomics training. Before-and-after surveys were conducted to test the effectiveness of the intervention. Results show that the ergonomic intervention reduced the prevalence of musculoskeletal symptoms by an average of 40%.

Baxter, K., Harrison, D. (2000) A Simple Cost Benefit Analysis for an Ergonomics "Train-the-Trainer" Program. Proceedings of the XIVth Triennial Congress of the International Ergonomics Association and the 44th annual meeting of the Human Factors and Ergonomics Society.

TELUS, British Columbia, Canada established an ergonomics "Train the Trainer" program and found the following:

- 76% reduction in incidence of upper extremity MSD's
- Decreased lost workdays from 540 before training to 240 and 330 in the two years
- following the training
- Reduction of $97,266 in workers compensation claims
- Total cost savings were calculated as follows:
    - Savings in workers compensation claim costs + Savings in days lost – training cost = $163,131

McGlothlin, T. Office Ergonomics: Have you Hugged Your Mouse Today?. Applied Ergonomic Case Studies (2),126-133.

Eastman Chemical Company established an ergonomics program in 1992, which consisted of the following:

- A mandatory one-hour office ergonomics training course for all new hire office/support personnel
- An optional course on office ergonomics for any existing employees who work on computer workstations
- Workstation evaluations available for all employees
- An ergonomic intranet website that provided general ergonomic information as well as detailed guidelines for computer workstations, and a catalogue of frequently purchased ergonomic products
- A loaner program for ergonomic products so an employee could try out a product before ordering

Results:

- 82 percent reduction in cumulative trauma-related OSHA Recordables
- 84 percent reduction in cumulative trauma-related workers' compensation costs

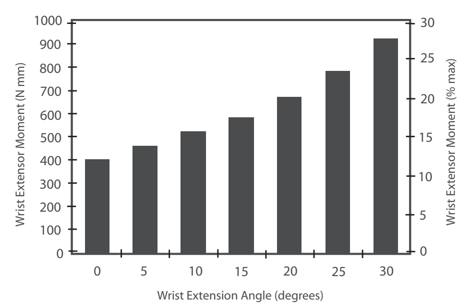
Musculoskeletal benefit of an articulating keyboard support

Hedge, A., D. McCrobie, et al. (1995). Beneficial effects of a preset tilt down keyboard system on posture and comfort in offices. Ithaca, NY, Department of Design and Environmental Analysis, Cornell University: 47.

- Positioned hands in a neutral posture 62% of the time compared with 42% for the traditional KB position
- Predicted carpal tunnel pressure remained below the critical threshold 82% of the time compared with 48% for traditional KB position
- Significant improvements in upper body comfort found for shoulders, upper arms, neck and back
- 91% of those using the tray said it helped their work performance and preferred it to their previous system.

Weir, P, Wells, R. The effect of typing posture on wrist extensor muscle loading, Human Factors, 44(3), 2002.

- Established a direct correlation between wrist extension angle, intracarpal tunnel pressure, and wrist extensor muscle activity risk factors
- 30 degrees of wrist extension correlates to a 27.5% increase in forearm muscle activity and greater than a two-fold increase in intracarpal tunnel pressure
- Findings validate the use of an articulating, negatively sloping keyboard support for reducing carpal tunnel syndrome



Bentzel, J and Gootzeit, R. (1999) Dynamometric Assessment of Upper Extremity Muscle Fatigue Sustained During Prolonged Computer Keyboard Activity in Standard and Tiltdown Keyboard Positioning

This study was conducted on 15 subjects aged 20-28 years. Twenty-three upper extremity muscle groups were assessed bilaterally using a dynamometer to determine changes in strength at baseline, 10 min., and 60 min. intervals of computer keyboarding in standard and tiltdown posture. A trend indicating a reduction in proportionate fatigue of the extrinsic finger flexors and extensors, wrist extensors and radial deviators, forearm pronators and supinators, elbow flexors and extensors, and shoulder abductor and deviators in tiltdown posture was observed. Subjective discomfort was reported by 53% of those tested to be greater in standard position. Only 17% of the sample reported minimal discomfort following computer keyboard activity in tiltdown position. The tiltdown keyboard position was preferred by 87% of the participants. One subject preferred the standard keyboard position and one subject had no preference.

Cost benefits of ergonomic program implementation

GAO/HEHS-97-163 'Private Sector Ergonomics Programs Yield Positive Results'

American Express Financial Advisors

- Workers Compensation claims dropped 80% from $484,000 in year 1 to $98,000 in year 5
- $420,000 reduction in first year alone

Merrill Lynch

- 70% decrease in MSDs
- savings of $1.5 million

Marsh Report: Best practices in ergonomics

Summary of case study findings:

- Navistar, Chicago, IL – reduced workers' compensation costs for MSDs by 65% over a 6 year period
- SunTrust Banks, Atlanta Georgia – reduced workers' compensation costs for MSDs by $2.65 million over three years
- New York Times, New York, NY – reduced the number of cases by 84% over a four year period; reduced number of lost workdays related to MSDs by 91%

Hendrick, H. (1996) Human Factors and Ergonomics Society Presidential Address. Good Ergonomics is Good Economics

AT&T Global, San Diego

- Conducted extensive worksite analysis to identify ergonomic deficiencies and made workstation improvements
- Decline in lost workdays from 298 before implementation to 0 in both 1993 and 1994
- Claims dropped 75% from $400,000 to $94,000 in first year
- Savings of $1.48 million

Selected Bibliography

The following is a list of relevant research studies specific to key components of an ergonomic workstation.

1.0 Keyboard Research

Hedge, A., M. Goldstein, et al. (2002). Longitudinal study of the effects of an adjustable ergonomic keyboard on upper body musculoskeletal symptoms. Proceedings of the Human Factors and Ergonomics Society 46th annual meeting, Sept. 30-Oct. 4, Baltimore, MD.

Hedge, A., D. McCrobie, et al. (1995). Beneficial effects of a preset tilt down keyboard system on posture and comfort in offices. Ithaca, NY, Department of Design and Environmental Analysis, Cornell University: 47.

Hedge, A. and S. Morimoto (1999). "Effects of keyboard tray geometry on upper body posture and comfort." Ergonomics **42**(10): 1333-1349.

Hedge, A. and J. R. Powers (1995). "Wrist posture while keyboarding: effects of a negative slope keyboard support system and full motion forearm supports." Ergonomics **38**: 508-517.

Marklin, R., G. Simoneau, et al. (1999). "Wrist and forearm posture from typing on split and vertically inclined computer keyboards." Human Factors **41**(4): 559-569.

Simoneau, G. and R. Marklin (2001). "Effect of computer keyboard slope and height on wrist extension angle." Human Factors **43**(2): 287-298.

2.0 Case Studies

Karsh, B., F. Moro, et al. (2001). "The efficacy of workplace ergonomic interventions to control musculoskeletal disorders: a critical analysis of the peer-reviewed literature." Theoretical Issues in Ergonomic Science **2**(1): 23-96.

Pascarelli, E. and Y. Hsu (2001). "Understanding work-related upper extremity disorders: Clinical findings in 485 computer users, musician, and others." Journal of Occupational Rehabilitation **11**(1): 1-21.

Rudakewych, M., L. Valent-Weitz, et al. (2001). Effects of an ergonomic intervention on musculoskeletal discomfort among office workers. Proceedings of the Human Factors and Ergonomics Society 45th annual meeting, San Diego.

3.0 Low Back Pain Research

Snook, S. (2000). The role of ergonomics in reducing disability from low back pain. RENA annual research symposium.

4.0 Economics of Ergonomics

Baxter, K. and D. Harrison (2000). A simple cost benefit analysis for an ergonomics 'train-the-trainer' program. Proceedings of the IEA 2000/HFES 2000 Congress, San Diego.

Simpson, G. (1988). "The economic justification for ergonomics." International Journal of Industrial Ergonomics **2**: 157-163.

5.0 Mouse Research

Barr, A. (1996). Effect of VDT mouse design on task and musculoskeletal performance. Marconi Input Device Research Conference.

Dennerlein, J. and M. Yang (1999). Perceived musculoskeletal loading during use of a force-feedback computer mouse. Proceedings of the Human Factors and Ergonomics Society 43th annual meeting, Houston, Texas.

Hedge, A., T. Muss, et al. (1999). Comparative study of two computer mouse designs. Ithaca, NY, Cornell University.

Rempel, D., J. Bach, et al. (1996). Effect of pronation/supination on carpal tunnel pressure. Marconi Input Device Research Conference.

Shaw, G. and A. Hedge (1996). The effect of keyboard and mouse placement on shoulder muscle activity and wrist posture. Ithaca, Cornell University.

Smith, M., J. Sharit, et al. (1999). "Aging, motor control, and the performance of computer mouse tasks." Human Factors **41**(3): 389-396.

Woods, V., S. Hastings, et al. (2002). Ergonomics of using a mouse or other non-keyboard input device. Loughborough, University of Surrey & Loughborough University.

6.0 Carpal Tunnel Research

Hedge, A. (1995). "Minimizing carpal tunnel syndrome risks." Forefronts: Cornell Theory Center **10**(2): 6-9.

7.0 Seating Research

Dainoff, M. (1985). "Design of sitting machine crucial to office efficiency." Contract(June).

Drury, C. G. and B. G. Coury (1982). "A methodology for chair evaluation." Applied Ergonomics **13**(3): 195-202.

Hermans, V., M. Hautekiet, et al. (1999). "Lipoatrophia Semicircularis and the relation with office work." Applied Ergonomics **30**: 319-324.

McLeod, W., D. Mandel, et al. (1980). "The effects of seating on human tasks and perceptions."

Tougas, G. and M. C. Nordin (1987). "Seat feature recommendations for workstations." Applied Ergonomics **18**(3): 207-210.

Treaster, D. (1987). "Measurement of seat pressure distributions." Human Factors **29**(5): 563-575.

Zhang, L. (1996). "Identifying factors of comfort and discomfort in sitting." Human Factors **38**(3): 377-389.

8.0 Sit-Stand Research

Cham, R. and M. Redfern (2001). "Effect of flooring on standing comfort and fatigue." Human Factors **43**(3): 381-391.

Chester, M., M. Rys, et al. (2000). "Leg swelling, comfort and fatigue when sitting, standing, and sit/standing." International Journal of Industrial Ergonomics **29**: 289-296.

Grandjean, E. and W. Hunting (1977). "Ergonomics of posture - Review of various problems of standing and sitting posture." Applied Ergonomics **8**(3): 135-140.

Paul, R. and M. Helander (1995). Effect of sit-stand schedule on spinal shrinkage in VDT operators. Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting.

Pottier, M., A. Dubreuil, et al. (1969). "The effects of sitting posture on the volume of the foot." Ergonomics **12**(5): 753-758.

Winkel, J. and K. Jorgensen (1986). "Evaluation of foot swelling and lower-limb temperatures in relation to leg activity during long-term seated office work." Ergonomics **29**(2): 313-328.

9.0 Workstation Design

Bettendorf, R. (1996). Musculoskeletal disorders in the U.S. office workforce. Manchester, VT, Office Ergonomics Research Commitee: 1-9.

Burgess-Limerick, R., M. Mon-Williams, et al. (2000). "Visual display height." Human Factors **42**(1): 140-150.

Kroemer, K. (2000). Ergonomics of computer workstations. Proceedings of the Human Factors and Ergonomics Society 45th annual meeting. San Diego, Ergonomics Research Institute: 1-25.

Kroemer, K. and D. Price (1982). "Ergonomics in the office: Comfortable workstations allow maximum productivity."

Laeser, K., L. Maxwell, et al. (1998). "The effects of computer workstation design on student posture." Journal of Research on Computing in Education **31**(2): 173-188.

Sauter, S. and L. Schleifer (1991). "Work posture, workstation design, and musculoskeletal discomfort in a VDT data entry task." Human Factors **33**(2): 151-167.

Sommerich, C. (2001). "Effects of computer monitor viewing angle and related factors on strain, performance, and preference outcomes." Human Factors **43**(1): 39-55.

10.0 Postural Studies

Bendix, T. and F. Jessen (1986). "Wrist support during typing - a controlled, electomyographic study." Applied Ergonomics **17**(3): 162-168.

Dennerlein, J., M. DiMarino, et al. (2002). Wrist and shoulder muscle activity changes across computer tasks. Proceedings of the Human Factors and Ergonomics Society 46th annual meeting, Sept. 30-Oct. 4, Baltimore, MD.

Floyd, W. and J. Ward (1967). "Posture in industry." The International Journal of Production Research **5**(3): 213-223.

Hunting, W., T. Laubli, et al. "Constrained postures of VDU operators." 175-184.

Keir, P. (2002). "The effect of typing posture on wrist extensor muscle loading." Human Factors 44(3): 392-403.

Marshall, M., J. Mozrall, et al. (1999). "The effects of complex wrist and forearm posture on wrist range of motion." Human Factors **41**(2): 205-213.

Simoneau, G., R. Marklin, et al. (1999). "Wrist and forearm postures of users of conventional computer keyboards." Human Factors **41**(3): 413-424.

11.0 VDT/Glare Research

Hedge, A., D. McCrobie, et al. (1996). Effects of using an optical glass filter on computer worker's visual health and performance: Results of an ergonomic field study. Ithaca, Cornell Human Factors Labratory.

Lorusso, T. and A. Hedge (2001). Do anti-glare filters help computer users in offices?. Proceedings of the Human Factors and Ergonomics Society 45th annual meeting, San Diego.

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