EFFECTS OF THE freeBOARD[*] ON COMPUTER WORK POSTURE

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May 17, 2007

CONTENTS

FIGURES

EXECUTIVE SUMMARY

- The freeBOARD is a unique keyboard that fixes the position of the mousing surface on the keyboard, closer to the body midline, to keep the right arm in a more neutral posture.

- The freeBOARD includes a mouse optimized for the dimensions of the built-in mousepad.

- An initial study was done to determine how the freeBOARD changed users' work posture in a corporate workplace.

- Thirty-one participants in a high profile financial institution volunteered for the study. Fifteen participants in an office used the freeBOARD for two weeks and were compared with 16 participants in another office who used the standard issue keyboard and mouse for the same period. Posture was measured twice for all participants: at the start of the study and again after two weeks. Complete data were gathered for 28 participants, 14 participants in each condition.

- Use of the freeBOARD significantly improved mousing in a neutral wrist posture.

- Use of the freeBOARD ignorantly improved seated work posture.

INTRODUCTION

Over ninety million adults in the United States use a computer.[1] The vast majority of computer users interact with their technology using a keyboard and a mouse and anecdotal reports of shoulder and arm discomfort related to computer mouse use are common.

A survey of 542 computer-aided design workers found significant associations between the position of the mouse, the degree of arm abduction and neck and shoulder pain.[2]

A study of each of three mouse positions found that when the computer mouse was positioned adjacent to a keyboard without a numeric pad when compared to performance of an identical task with the mouse adjacent to a standard keyboard, there was significantly less anterior (p=0.01) and middle (p=0.03) deltoid electromyographic activity.[3]

The location of the computer mouse at 1000 workstations at 37 companies across six states of the US has been evaluated.[4] Results show the following:

- over 92% of the workstations had the mouse on the right-hand side of the keyboard
- 54% had the mouse in the area immediately to the right of the keyboard
- 79% had the mouse at the same vertical level as the keyboard
- 13% had the mouse placed above the keyboard
- 8% had the mouse below the keyboard

A test of 6 positions of the computer mouse on the work table showed that users preferred the mouse in a close and relaxed, neutral posture of the arm.[5]

STUDY RATIONALE

The purpose of this research is to evaluate the ergonomic impact of the freeBOARD (Figure 1) on computer work posture when compared with other existing conventional keyboard and mouse combinations in use in a corporate setting.

The anticipated ergonomic benefits of the freeBOARD are:

1. Repositioning of the mousing surface closer to the body midline reduces shoulder abduction and improves comfort.

2. Repositioning of the mousing surface on the keyboard improves wrist posture.

The project was conducted in two offices of a high profile financial company located in Manhattan, New York City. The project involved comparing the effect of the freeBOARD on the work postures of a test group compared to a control group.

Users' seated postures were evaluated to determine whether the freeBOARD changed how people were working.

Users' wrist extension angles were measure and compared between groups to assess the effect of the freeBOARD on wrist posture.

Figure 1   The freeBOARD and mouse showing the retractable number pad

METHODS

TEST LOCATION

The study was conducted on-site at two facilities occupied by a financial institution. This company was chosen for its high-profile status, large size, and having a variety of computer-intensive work. Both their uptown and downtown Manhattan office locations were used. The control and experimental testing took place in separate office locations. The study was conducted between March and May 2007.

STUDY PARTICIPANTS

Thirty-one participants were recruited for the study, a test group of 15 participants and a control group of 16 participants. Participants varied in gender (18 males and 13 females) and in job function (administrators, information technology technicians and manager, bankers, and computer support). All participants were right-handed. Consent was given by all participants. Each participant received a freeBOARD for participating in the study. Complete data sets were obtained for 28 participants, 14 in both the test and control groups.

APPARATUS

Dimensions of the freeBOARD and the conventional keyboard are shown in Figure 2. Average key force for the freeBOARD is 0.6N compared with 0.5N for the conventional keyboard. Mousepad area is approximately 50% of a conventional mousepad.

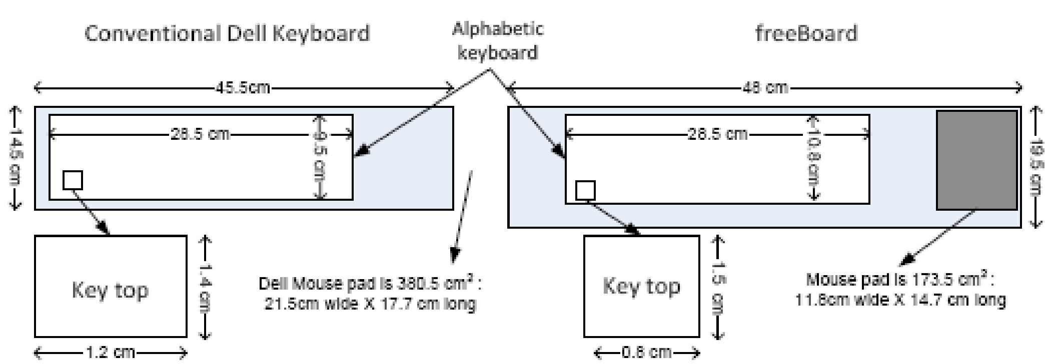

Figure 2 Dimensions of the keyboards

EXPERIMENTAL DESIGN

TEST GROUP PROCEDURE

The Rapid Upper Limb Assessment (RULA) tool was used to measure posture while each participant was typing and mousing to assess posture, an indication for future repetitive stress injury. A copy of this is shown in Appendix I. A goniometer was used to measure wrist extension while the participant held the mouse. Photographs were taken of the participant sitting in his or her current work station for subsequent checking of posture data.

One of the two locations was randomly chosen as the test location and all participants at that location were member of the test group. The freeBOARD was introduced and installed for all members. Features of the freeBOARD were briefly described. Once completely installed, RULA, wrist extension measurements, and photographs were taken again to measure any initial immediate changes in posture and desk space. These participants use the freeBOARD for two to three weeks to evaluate user responses to this intervention.

After two weeks of using the freeBOARD, a second RULA analysis was conducted, wrist extension measurements were taken and photographs were taken for documentation.

CONTROL GROUP PROCEDURE

Participants in the second location were assigned to the control group and they did not have any exposure to the freeBOARD or any other intervention during the time of the study. Control participants served only as a comparison to the test group, over the same two or three week period.

As with the test group, at the start of the study the control group participants were measured using the RULA tool and wrist extension measurements were taken while holding their mouse. Photographs were taken of the participant sitting in his or here work station.

Upon the return visit, two to three weeks later, RULA and wrist extension measurements again were taken, along with another photograph to document any visual changes.

RESULTS

Four participants in the test group and 3 participants in the control group used a keyboard tray. Statistical analysis showed no significant effects on keyboard tray use on the participant's seated posture, assessed with the RULA tool, and their wrist posture. The effects of a keyboard tray were not further considered in the analyses that follow. Figure 3 shows examples of the workstations.

Conventional keyboard and mouse on desktop

freeBoard and mouse on desktop

Conventional keyboard and mouse on tray

freeBoard and mouse on tray

Figure 3 Conventional keyboard and mouse and freeBOARD and mouse use

RULA SCORES

In both surveys the participant's seated working was assessed using the RULA method. Prior to use of the freeBOARD there was no statistically significant difference in seated posture between the groups. Two participants who were suffering from wrist pain were unable to continue using the freeBOARD for the full two weeks and their posture data were not gathered at the end of the study. In survey 2 a Mann Whitney U test was used to compare scores for the test and control groups. There was a statistically significant difference in RULA scores between the test and control groups (Z=-4.064, n=12, p=0.002) but there was no significant change for the control group. The mean RULA scores are shown in Figure 4.

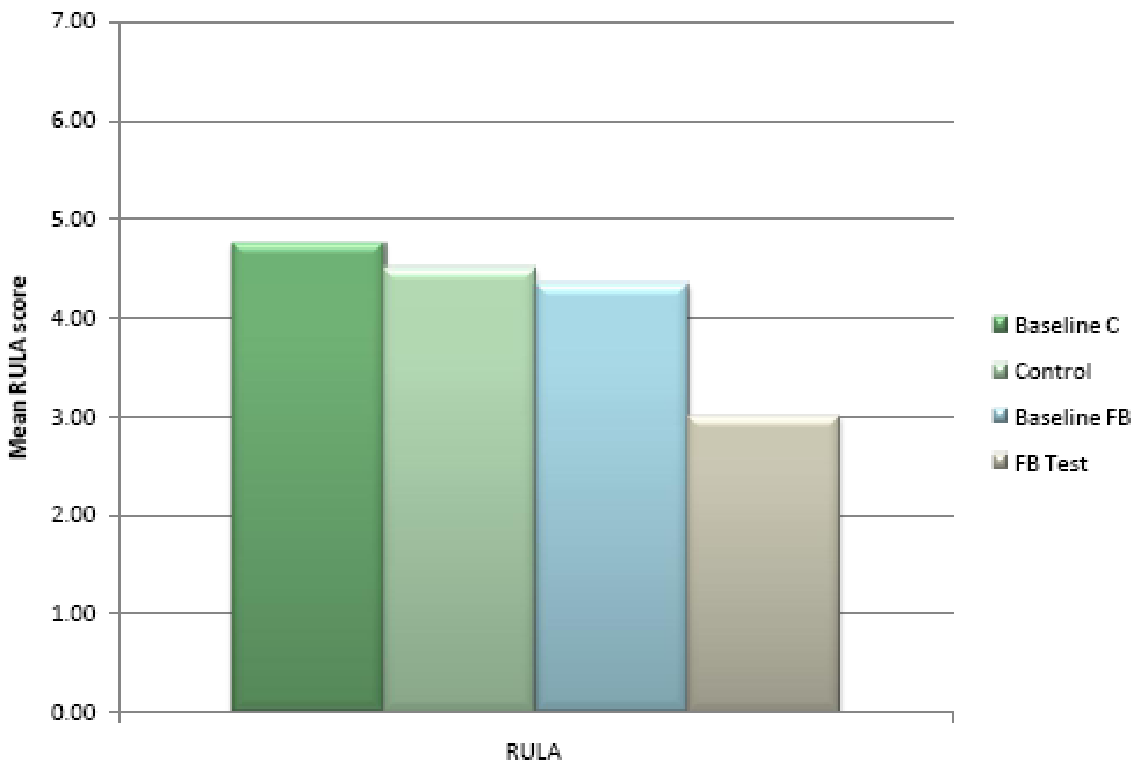

Figure 4 Mean RULA scores

(C=control; FB=freeBOARD)

COMPONENT RULA SCORES

The component RULA scores for specific body segments were statistically analyzed. The overall pattern of these scores is shown in Figure 5.

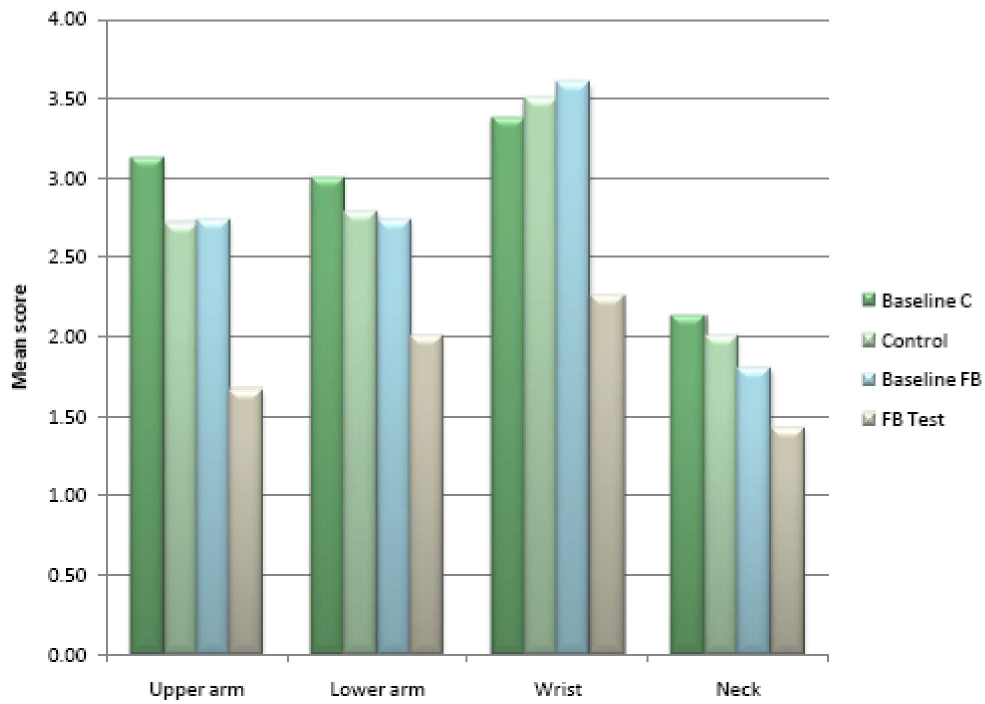

Figure 5   Mean component RULA scores

(C=control; FB=freeBOARD)

The results of the statistical analyses are described in the following sections.

UPPER ARM SCORES

The ratings of upper arm posture were compared for the control and test groups using Mann Whitney U tests. In survey 1 there was no statistically significant difference in upper arm posture ratings between the control (mean=3.13) and test group participants (mean=2.73), but in survey 2 the test group (mean=1.67) had significantly better upper arm scores (Z=-3.584, n=26, p=0.000) than the control group (mean=2.71). A Wilcoxon Signed Ranks test was used to compare survey 1 and survey 2 upper arm postures for each group. There was statistically significant improvement in upper arm posture for the control group (Z=-2.449, n=14, p=0.014). There was a statistically significant improvement in upper arm posture for the test group (Z=-2.652, n=12, p=0.008).

LOWER ARM SCORES

The ratings of lower arm posture were compared for the control and test groups using Mann Whitney U tests. In survey 1 there was no statistically significant difference in lower arm posture ratings between the control (mean=3.00) and test group participants (mean=2.73), but in survey 2 the test group (mean=2.00) had significantly better lower arm scores (Z=-3.528, n=26, p=0.000) than the control group (mean=2.79). A Wilcoxon Signed Ranks test was used to compare survey 1 and survey 2 lower arm postures for each group. There was no statistically significant improvement in lower arm posture for the control group. There was a statistically significant improvement in lower arm posture for the test group (Z=-2.887, n=12, p=0.004).

WRIST POSTURE

The ratings of wrist posture were compared for the control and test groups using Mann Whitney U tests. In survey 1 there was no statistically significant difference in wrist posture ratings between control (mean=3.38) and test group participants (mean=3.36), but in survey 2 the test group (mean=2.25) had significantly better wrist posture scores (Z=-4.002, n=26, p=0.000) than the control group (mean=3.50). A Wilcoxon Signed Ranks test was used to compare survey 1 and survey 2 wrist posture for the control group. There was a statistically significant improvement in wrist posture for the test group (Z=-3.035, n=12, p=0.002).

NECK POSTURE

The ratings of neck posture were compared for the control and test groups using Mann Whitney U tests. In survey 1 there was no statistically significant difference in neck posture ratings between the control (mean=2.13) and test group participants (mean=1.80), but in survey 2 the test group (mean=1.42) had significantly better neck posture scores (Z=-2.466, n=26, p=0.014) than the control group (mean=2.00). A Wilcoxon Signed Ranks test was used to compare survey 1 and survey 2 neck posture for the control group. There was no statistically significant improvement in neck posture for the control group. There was a statistically significant improvement in neck posture for the test group (Z=-2.236, n=12, p=0.025).

WRIST EXTENSION ANGLES

In both surveys the wrist extension angle was measured for all participants while they were holding their mouse on the mousepad or desk surface. Prior to use of the freeBOARD there was no statistically significant difference in wrist extension between the groups. In survey 2 an independent groups 't' test was used to compare the two groups. There was a statistically significant reduction in wrist extension for the test group using the freeBOARD compared to the control group($t=3.852$, $df=24$, $p=0.001$). Paired 't' tests were used to compare survey 1 and survey 2 angles for each group. There was a statistically significant reduction in wrist extension from survey 1 (pre freeBOARD use) to survey 2 (freeBOARD use), but there was no significant change for the control group. The mean wrist extension angles are shown in Figure 6.

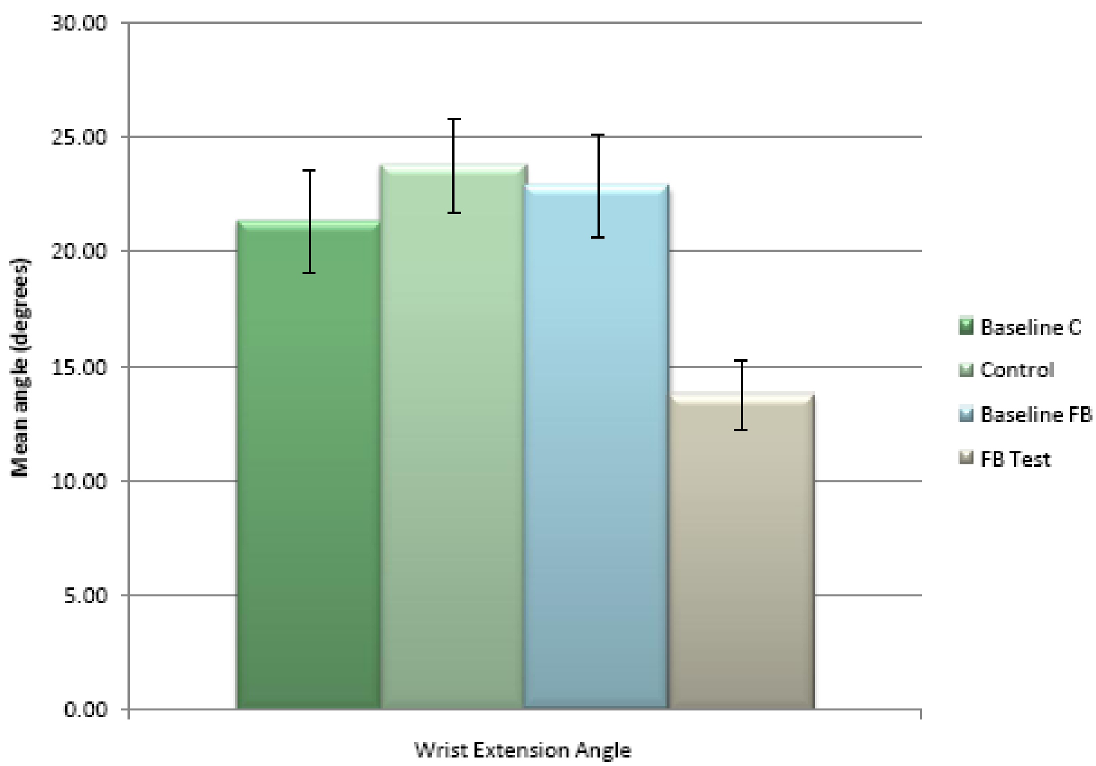

Figure 6 Wrist extension angle for mouse use (mean ± standard error)

(C=control; FB=freeBOARD)

DISCUSSION

There is a growing body of evidence from studies of computer workers that relates mouse location relative to the body to the risk of developing a musculoskeletal injury. Ergonomists generally agree that maintaining a wrist neutral posture is desirable and it is widely accepted that keeping the wrist extension angle less than 15 degrees can be protective against injury because this reduces pressure inside of the carpal tunnel. [7] The mean wrist extension angle for mouse use with the freeBOARD was less than the 15 degrees criterion normally applied to determine a neutral hand posture, which shows that vertically the hand is placed in a more neutral position with the mouse on the freeBOARD.

Work posture as assessed by the RULA method is indicative of the risk of a musculoskeletal injury, and lower scores are preferable. Results from the study show that use of the freeBOARD on a regular work surface significantly improved participants' seated posture and that this occurred for the upper arm, lower arm, wrist, neck and torso.

Participants in this study were full-time computer users. The use of the freeBOARD significantly improved many aspects of the participants' posture, even though the test group was not trained on the use of the product and this design was unfamiliar to participants. Thirteen of the test group participants continue using the freeBOARD.

The freeBOARD is a promising new design and further research into the benefits of this is warranted.

REFERENCES

1. US Census Bureau. (1999). Computer use in the United States. Current Population Reports. 20-522.

2. Karlquist, L.K., Hagberg, M., Koster, M., Wenemark, M., & Anell, R. (1996) Musculoskeletal symptoms among computer-assisted design (CAD) operators and evaluation of a self-assessment questionnaire. International Journal of Occupational & Environmental Health, **2**, 185-194.

3. Cook, C.J. & Kothiyal, K. (1998). Influence of Mouse Position on Muscular Activity in the Neck, Shoulder and Arm in Computer Users. Applied Ergonomics, **29** (6), 0003-6870.

4. Dennerlein, J. & Johnson, P. (2003). Positions of the Computer Mouse within a Thousand Workstations. Summit for People and Technology. Proceedings of the 47th Annual Meeting of the Human Factors and Ergonomics Society, Denver, Colorado, October 13-17, 2003. Human Factors and Ergonomics Society, Santa Monica, California. Available in CD-ROM Format, pages 1279-1282.

5. Karlquist, L.K., Bernmark, E., Ekenvall, L., Hagberg, M., Isaksson, A. & Rosto, T. (1998). Computer Mouse Position as a Determinant of Posture, Muscular Load and Perceived Exertion. Scandinavian Journal of Work, Environmental & Health, **24** (1), 62-73.

6. McAtamney, L. & Corlett, E.N. (2004) Rapid Upper Limb Assessment (RULA) In Stanton, N. et al (eds.) Handbook of Human Factors and Ergonomic Methods, Chapter 7, Boca Raton, FL, pp. 7:1 – 7:11.

7. Hedge, A., McCrobie, D., Morimoto, S., Rodriguez, S. and Land, B. (1996) Painfree computing: use of a preset tiltdown keyboard system and new tools for visualizing wrist postures lead the fight against carpal tunnel syndrome. Ergonomics in Design, **4** (1), 4-10.

* freeBOARD is a registered trademark of Jasper Designworks

APPENDIX – RULA SCORE SHEET