Humantech

Pilot Study: Performance, Risk, and Discomfort Effects of the RollerMouse Station

Prepared For:

contour
DESIGN

Completed: 08-30-02

Humantech, Inc.
Humantech Project #: 3258
Written By: M. Wynn, CPE
Reviewed By: J.Sanford, CPE

Pilot Study: Performance, Risk, and Discomfort Effects of the RollerMouse Station

Introduction & Background

This report summarizes the results of a pilot study to estimate if the RollerMouse impacts motion savings in keyboard and mouse-intensive tasks and to approximate theoretical potential time savings. In addition, study participants were asked to subjectively rate the usability of the device relative to a conventional mouse as well as the contribution to discomfort of the two input devices. Finally, reductions in ergonomic risk exposures were calculated using a risk factor survey.

There are certain inherent limitations to this pilot study. The sample size is extremely small in number and the task duration is quite short. Consequently, conclusions can be drawn as to the potential benefit of the RollerMouse but are scientifically proven.

The RollerMouse is an input device for standard business and personal computer systems (Windows and Macintosh operating systems). It positions typical mouse controls near the thumbs when keying, reducing the repetitive reaching that normally occurs when using a graphic user interface operating system. Figure 1 illustrates the RollerMouse Station and its intended position below a standard keyboard.

Figure 1 – RollerMouse Station

The concept of reduced motion requirements leading to time savings is not new; modern motion study techniques were introduced by Frank and Lillian Gilbreth in the early 1900's (Niebel, 1993). Motion study seeks to improve operations by eliminating unnecessary motions by improving work methods. One of the earliest demonstrations of methods improvements resulted in brick layers increasing output from 120 per hour to 350 per hour through motion study and the introduction of an adjustable scaffolding (Niebel, 1993).

Improved ergonomics in office workstation design has been shown to increase productivity in numerous studies. For example, Springer (1986) found in a laboratory study of furniture variations that the best case ergonomic furniture improved data entry by 15% and dialogue tasks by 10% compared to "traditional furniture". Francis and Dressel (1987) found in a field study of ergonomically designed workstations and chairs that productivity was improved by 20% compared to the traditional workstation setup. In both studies, productivity improvements were well correlated with subjective assessments of users such as comfort and satisfaction.

It is commonly accepted in industry that improved ergonomic design of office workstation can reduce user discomfort and therefore impact employee morale, quality, and productivity. This study does not attempt to quantify these measures, rather it focuses on motion economies and the direct short-term impact on productivity related to one specific workplace modification. The impact of reduced user discomfort is assumed to be negligible in the short-term trials conducted for this study.

The pilot study also calculates the impact of the RollerMouse on reducing ergonomic risk factors for the upper extremities for a specific workstation setup. Ergonomic risk factors are "conditions of a job, process, or operation that contribute to the risk of developing Cumulative Trauma Disorders" (Occupational Health and Safety Administration, OSHA 3123, 1990). A substantial body of credible epidemiological research provides strong evidence that three physical work-related risk factors contribute to the development of CTDs (NIOSH, 1997, NAS 2001): the *posture* assumed during the activity, the *force* applied by the person, and the *frequency* of the force application.

Methodology

Participants

Two Humantech employees were recruited for the study and participated on a voluntary basis. Both participants were familiar with the software program used and were given time to adjust to the workstation setup. The participants had plenty of experience using the conventional mouse (> 5 years each) and experience with the RollerMouse ranged between 2 days and 1 month. Neither participant reported any known upper-limb musculoskeletal disorders and verbal consent was obtained from each participant.

Equipment

A standard office workstation was used for the study in conjunction with two different input devices: (1) Logitech First Wheel Mouse (Model: M-BB48) and (2) Contour Design RollerMouse Station. To better accommodate the RollerMouse and to maintain consistency over both trials, a conventional "straight" keyboard was used by both participants. Microsoft Outlook was used as the software program for data entry of business cards. Participants had the option of using their own chair to ensure optimal comfort.

Procedure

Verbal consent was obtained by the participants before starting the study. An instruction page was given to the participant outlining the details of the study (see Appendix). Participants were told they would enter 25 business cards into Microsoft Outlook and would only enter information into the 7 pre-designated fields (Name, Title, Company, Address, Business, Business Fax, and Email). Participants were instructed to only use the input device to switch between fields, rather than using the "Tab" key on the keyboard. Participants were told that they would complete two experimental trials (25 business cards per trial), one trial for each of the two input devices (see Figures 2 and 3 on following page). Participants were informed that they should complete each trial as quickly as possible without increasing errors, and to correct any errors as they were recognized.

Participants performed 5 practice trials prior to each experimental trial and were given an opportunity to ask questions. When it was clear to the administrator that the participants understood the task, the experimental trials began. During each experimental trial, the administrator used a digital camera to take still pictures of the participant and a camcorder was set-up to record a videotape for future analysis.

After each individual trial, a subjective survey was given to the participants to complete (see Appendix B). The survey consisted of two questions rated on a 1 to 10 scale: (1) Rate the overall ease of using the input device and (2) Rate your overall level of physical comfort while using the input device. Participants were given a 10-minute break to rest and walk around between trials.

After the completion of both experimental trials, participants were asked to make any further comments with respect to the input devices. Participants were debriefed and thanked for their participation.

Figure 2 – Conventional Mouse Setup

Figure 3 – RollerMouse Station Setup

Data Analysis

Testing sequence was arranged to ensure that each input device was used first in one trial. The 100 data trials consisted of 25 trials of each input device x 2 participants. The videotape recorded during the study was analyzed using the BRIEF™ and Methods-Time Measurement (MTM-1).

The BRIEF™ is an initial screening tool that uses a formalized rating system to identify ergonomic acceptability of job tasks. The BRIEF™ examines nine body parts for cumulative trauma disorder (CTD) risk factors. Risk factors are identified and tallied for posture, force, frequency, and duration. Each of these categories can receive a maximum score of 1. The total score for a body part is determined by adding its scores for posture, force, frequency, and duration. The maximum total score for the elbows is 3, and for all other body parts is 4.

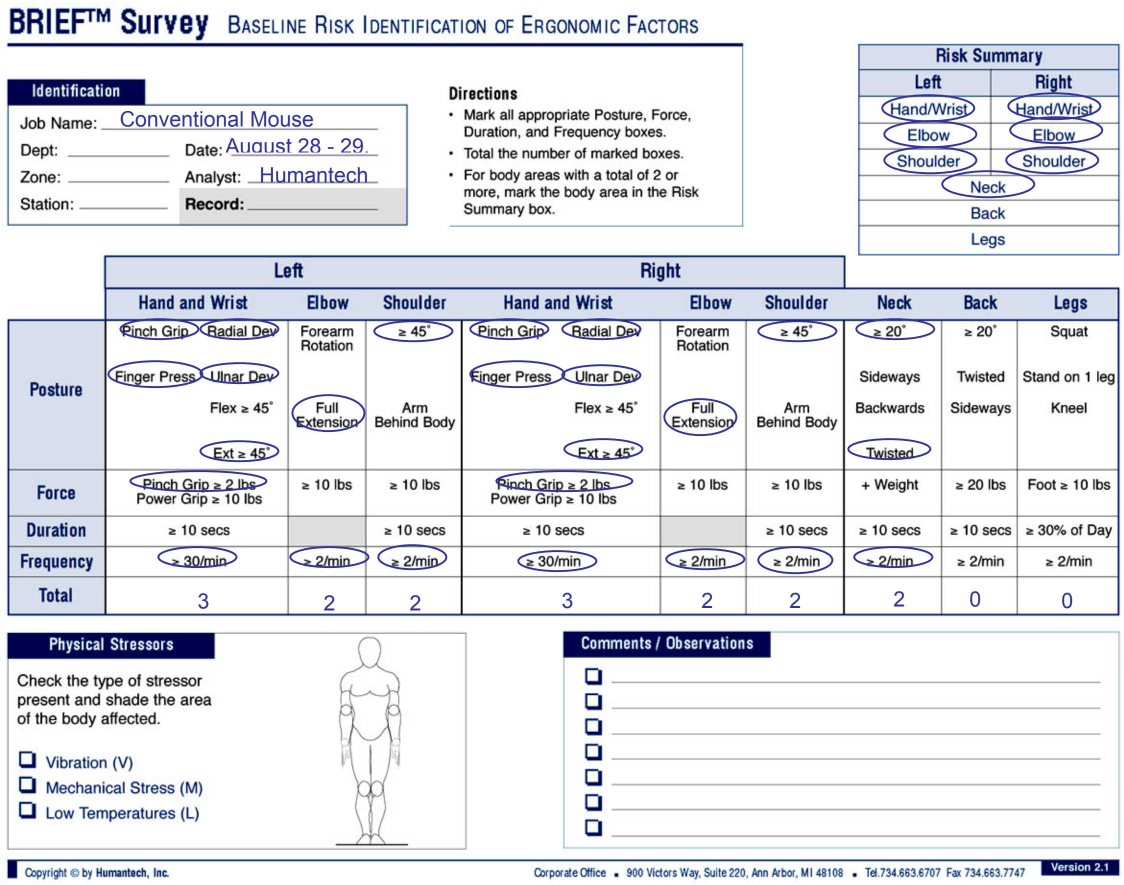
The Methods-Time Measurement (MTM-1) data used in this evaluation are standard time micro data. The standard time micro data provide an expected time allowance for sub-elements of motion, which when integrated together, provide an expected time value for a given task. Cycle time determined from the videotape was to define the current cycle time.

Results

Risk Factor Survey

Analysis of the video was conducted using the BRIEF™ survey. The completed BRIEF™ survey for using the conventional mouse is shown below in Figure 4.

Figure 4 – Results of BRIEF Survey for Conventional Mouse



BRIEF™ Survey BASELINE RISK IDENTIFICATION OF ERGONOMIC FACTORS

Identification

Job Name: Conventional Mouse
Dept:
Date: August 28 - 29
Zone:
Analyst: Humantech
Station:
Record:

Directions

- Mark all appropriate Posture, Force, Duration, and Frequency boxes.
- Total the number of marked boxes.
- For body areas with a total of 2 or more, mark the body area in the Risk Summary box.

Risk Summary

Left	Right
[✓ Hand/Wrist]	[✓ Hand/Wrist]
[✓ Elbow]	[✓ Elbow]
[✓ Shoulder]	[✓ Shoulder]
[✓ Neck]	
Back	
Legs	

	Left			Right					
	Hand and Wrist	Elbow	Shoulder	Hand and Wrist	Elbow	Shoulder	Neck	Back	Legs
Posture	[✓ Pinch Grip] [✓ Radial Dev] [✓ Finger Press] [✓ Ulnar Dev] Flex ≥ 45° [✓ Ext ≥ 45°]	Forearm Rotation [✓ Full Extension]	[✓ ≥ 45°] Arm Behind Body	[✓ Pinch Grip] [✓ Radial Dev] [✓ Finger Press] [✓ Ulnar Dev] Flex ≥ 45° [✓ Ext ≥ 45°]	Forearm Rotation [✓ Full Extension]	[✓ ≥ 45°] Arm Behind Body	[✓ ≥ 20°] Sideways Backwards [✓ Twisted]	≥ 20° Twisted Sideways	Squat Stand on 1 leg Kneel
Force	[✓ Pinch Grip ≥ 2 lbs] Power Grip ≥ 10 lbs	≥ 10 lbs	≥ 10 lbs	[✓ Pinch Grip ≥ 2 lbs] Power Grip ≥ 10 lbs	≥ 10 lbs	≥ 10 lbs	+ Weight	≥ 20 lbs	Foot ≥ 10 lbs
Duration	≥ 10 secs		≥ 10 secs	≥ 10 secs		≥ 10 secs	≥ 10 secs	≥ 10 secs	≥ 30% of Day
Frequency	[✓ ≥ 30/min]	[✓ ≥ 2/min]	[✓ ≥ 2/min]	[✓ ≥ 30/min]	[✓ ≥ 2/min]	[✓ ≥ 2/min]	[✓ ≥ 2/min]	≥ 2/min	≥ 2/min
Total	3	2	2	3	2	2	2	0	0

Physical Stressors

Check the type of stressor present and shade the area of the body affected.

☐ Vibration (V)
☐ Mechanical Stress (M)
☐ Low Temperatures (L)

Comments / Observations

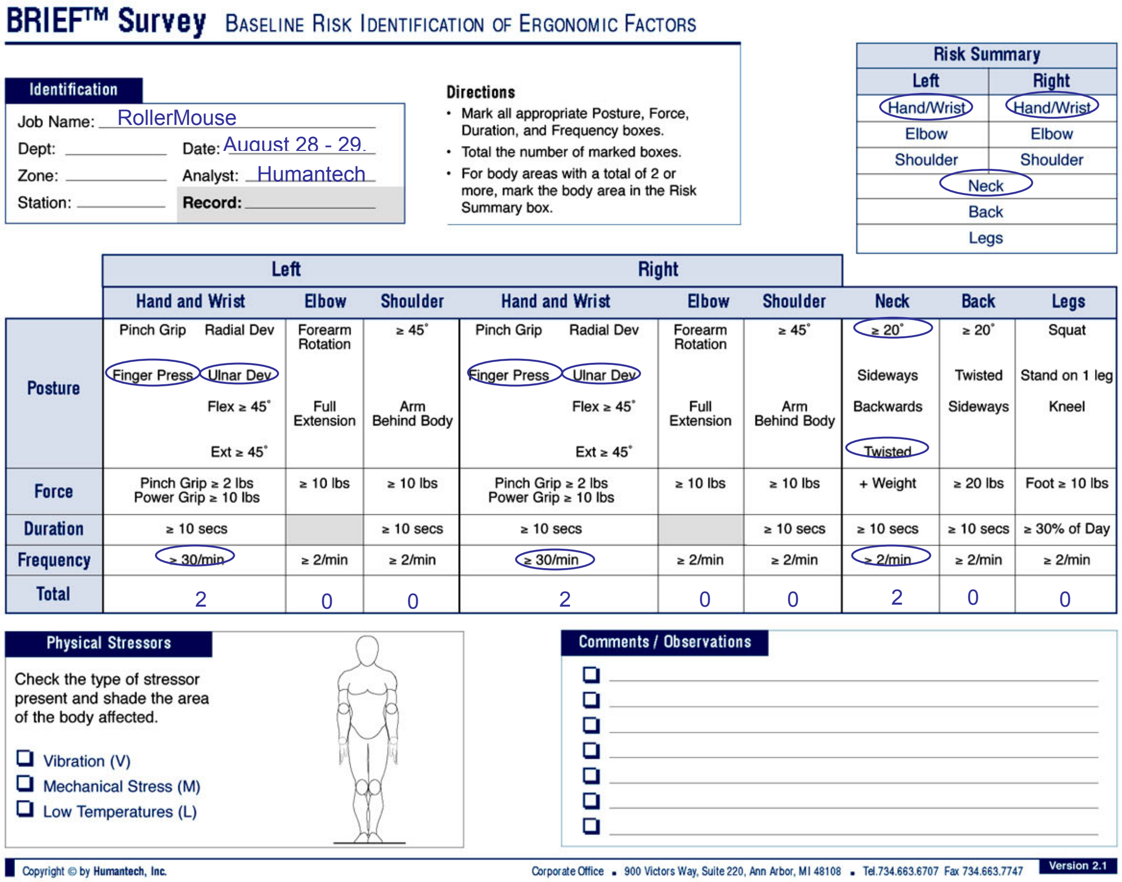
☐
☐
☐
☐
☐
☐
☐

Copyright © by Humantech, Inc. Corporate Office ▪ 900 Victors Way, Suite 220, Ann Arbor, MI 48108 ▪ Tel.734.663.6707 Fax 734.663.7747 Version 2.1

Based on the BRIEF™ survey for the conventional mouse, both hands/wrists were determined to be major ergonomic concerns. Both elbows, both shoulders, and the neck were determined to be moderate concerns and the back and legs were determined to be minor ergonomic concerns.

The completed BRIEF™ survey for using the RollerMouse is shown below in Figure 5.

Figure 5 – Results of BRIEF Survey for RollerMouse



BRIEF™ Survey BASELINE RISK IDENTIFICATION OF ERGONOMIC FACTORS

Identification

Job Name: RollerMouse
Dept: ______ Date: August 28 - 29.
Zone: ______ Analyst: Humantech
Station: ______ **Record:** ______

Directions

- Mark all appropriate Posture, Force, Duration, and Frequency boxes.
- Total the number of marked boxes.
- For body areas with a total of 2 or more, mark the body area in the Risk Summary box.

Risk Summary	
Left	Right
[✓ Hand/Wrist]	[✓ Hand/Wrist]
Elbow	Elbow
Shoulder	Shoulder
[✓ Neck]	
Back	
Legs	

	Left			Right					
	Hand and Wrist	Elbow	Shoulder	Hand and Wrist	Elbow	Shoulder	Neck	Back	Legs
Posture	Pinch Grip Radial Dev [✓ Finger Press] [✓ Ulnar Dev] Flex ≥ 45° Ext ≥ 45°	Forearm Rotation Full Extension	≥ 45° Arm Behind Body	Pinch Grip Radial Dev [✓ Finger Press] [✓ Ulnar Dev] Flex ≥ 45° Ext ≥ 45°	Forearm Rotation Full Extension	≥ 45° Arm Behind Body	[✓ ≥ 20°] Sideways Backwards [✓ Twisted]	≥ 20° Twisted Sideways	Squat Stand on 1 leg Kneel
Force	Pinch Grip ≥ 2 lbs Power Grip ≥ 10 lbs	≥ 10 lbs	≥ 10 lbs	Pinch Grip ≥ 2 lbs Power Grip ≥ 10 lbs	≥ 10 lbs	≥ 10 lbs	+ Weight	≥ 20 lbs	Foot ≥ 10 lbs
Duration	≥ 10 secs		≥ 10 secs	≥ 10 secs		≥ 10 secs	≥ 10 secs	≥ 10 secs	≥ 30% of Day
Frequency	[✓ ≥ 30/min]	≥ 2/min	≥ 2/min	[✓ ≥ 30/min]	≥ 2/min	≥ 2/min	[✓ ≥ 2/min]	≥ 2/min	≥ 2/min
Total	2	0	0	2	0	0	2	0	0

Physical Stressors

Check the type of stressor present and shade the area of the body affected.

☐ Vibration (V)
☐ Mechanical Stress (M)
☐ Low Temperatures (L)

Comments / Observations

☐ ______
☐ ______
☐ ______
☐ ______
☐ ______
☐ ______
☐ ______

Corporate Office ▪ 900 Victors Way, Suite 220, Ann Arbor, MI 48108 ▪ Tel.734.663.6707 Fax 734.663.7747

Version 2.1

Based on the BRIEF™ survey for the RollerMouse, both hands/wrists and the neck were determined to be moderate concerns. Both elbows, both shoulders, the back, and the legs were determined to be minor ergonomic concerns.

Micromotion Analysis

MTM-1 analysis was performed for both input devices and the predicted motion savings is summarized in the table below. Use of the conventional mouse required a reach of 12" while use of the RollerMouse required a reach of 1". Table 1 summarizes the predicted motion time for the task of reaching from the keyboard to the input device and back (it does not account for keying, curser repositioning, or any other tasks that remained the same with each device).

Table 1: MTM-1 Data

Input Device Motions Per Card Entry	Predicted Motion Time	
	TMU	Seconds
Conventional Mouse [REACH B (12") + REACH A (12")] * 7 FIELDS = [12.9 TMU + 9.6 TMU] * 7 FIELDS = 22.5 TMU * 7 FIELDS	157.5	5.7
RollerMouse [REACH A (1") + REACH A (1")] * 7 FIELDS = [2.5 TMU + 2.5 TMU] * 7 FIELDS = 5.0 TMU * 7 FIELDS	35.0	1.3
Difference between input devices	122.5	4.4

Based on the results of the MTM-1 analysis, the predicted motion savings per card is 4.4 seconds. Therefore, over the course of a 25-card trial, the overall predicted motion savings is 110.25 seconds (4.4 seconds/card x 25 cards). To calculate the percentage of predicted motion savings, the overall predicted motions savings was divided by the average time to complete the 25-card conventional mouse trial (1415.46 seconds, see Table 2 below). Therefore, the percentage of predicted motion savings, as a result of using the RollerMouse over the conventional mouse, is 7.8% (110.25-second time savings / 1415.46-second trial time).

Table 2: Time Trial Data

Input Device	Average Time to Complete Trial (Seconds)
Conventional Mouse	1415.46
RollerMouse	1349.10
Difference between input devices	66.36

Time Study

Based on the actual time study, the difference between trial times (conventional mouse versus RollerMouse) was found to be 66.36 seconds. To calculate the percentage of actual motion savings, the time difference between input devices was divided by the average time to complete the 25-card conventional mouse trial. Therefore, the percentage of actual motion savings, as a result of using the RollerMouse over the conventional mouse, is 4.7% (66.36 second time difference / 1415.16 second trial time).

Subjective Survey

The results of the 2-question subjective survey is shown in Table 3. Questions were rated on a 10-point scale (1 being best, 10 being worst).

Table 3: Subjective Survey Data

Question	Rating (1 to 10)	
	Conventional Mouse	RollerMouse Station
Rate the overall ease of using the input device	3	3.5
Rate your overall level of physical comfort while using the input device	6.5	3.5

The results indicate similar ease of using the conventional mouse (3) and RollerMouse (3.5). When rating the overall level of physical discomfort, the conventional mouse scored higher (6.5) than that of the RollerMouse (3.5).

Discussion

The results of this pilot study indicate a potential advantage of the RollerMouse input device over a conventional mouse in a workstation setup that requires long reaches when using the conventional mouse. The RollerMouse resulted in faster data entry and less discomfort to the user, as well as a reduction in ergonomic risk exposure to the hands/wrists, elbows, and shoulders.

The observed time savings (4.7%) was approximately 60% less than the predicted motion savings (7.8%). This was possibly due to a slight increase in time to reposition the cursor, related to a learning curve effect. One subject, who had one day's exposure to the RollerMouse, commented that they would benefit from more time to become familiar with the RollerMouse.

Both participants rated the RollerMouse more comfortable to use than the conventional mouse. Comments pointed towards the reduced reach distance for the RollerMouse as well as the need to grip the conventional mouse tightly while repositioning the cursor.

One participant had significantly more experience with the RollerMouse and found the device to be easier to use than the conventional mouse. This participant commented that the RollerMouse is easy to control because both fingers and thumbs can be used to access the cursor control.

The conventional mouse setup resulted in high ergonomics risk exposure to the right hand/wrist as well as moderate ergonomic risk exposure to the right elbow and shoulder. RollerMouse reduced the risk exposure to each of these areas of the body.

One potential limitation of the RollerMouse is that certain keyboard designs include a built-in wrist rest. These keyboards may reduce the effectiveness of RollerMouse and users may find them incompatible. The maker of RollerMouse has identified an adjustable angle keyboard that works well with the RollerMouse, this can be found at www.contourdesign.com.

Conclusion

The use of a conventional mouse in workstation setups where there is not enough room to locate the mouse next to the keyboard has been noted as problematic by many Ergonomists. This pilot study indicates that the RollerMouse may prove to be an effective solution for long reaches to the mouse and demonstrates the potential for improvements in productivity, user comfort, and ergonomic risk exposures.

References

Dressel, D. L. and Francis, J. (1987). *Workplace Influence on Worker Performance and Satisfaction An Experimental Field Study*. Promoting Health & Productivity in the Computerized Office. London: Taylor & Francis Ltd..

National Academy of Sciences. (2001). *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities.* National Academy Press.

National Institute for Occupational Safety and Health. (1997). *Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back.* NIOSH Publication 97-141.

Niebel, B. (1993). Motion and Time Study, 9th Ed. Boston, MA: Irwin.

Occupational Safety and Health Administration. (1988). Ergonomics Program Management Guidelines for Meatpacking Plants. OSHA Publication 3123.

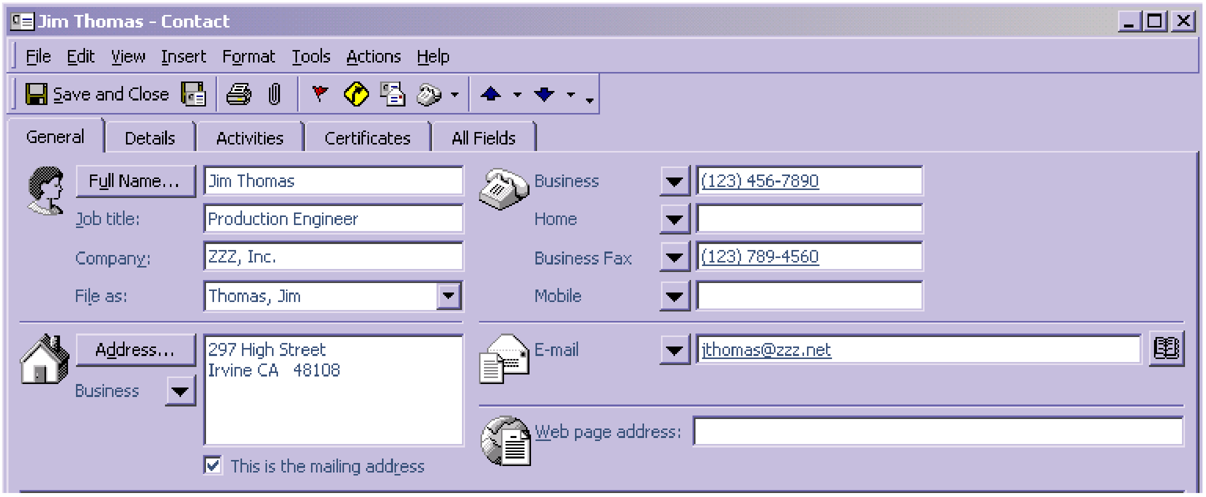
Springer, T. J. (1986). *Improving Productivity in the Workplace: Reports from the Field*. St. Charles, IL: Springer Associates, Inc..

Appendix A: Participant Instructions

Prior to beginning the trial, familiarize yourself with the task of entering new contact information from business cards into Outlook Contacts.

1. To enter a new contact into the database, click on the "new contact" icon located in the upper left corner

2. Enter the contact information from business cards into the appropriate cells, entering information into the following cells (see below for a sample entry). Disregard any extra information that is provided on the business cards (e.g. company website).
   - Full Name
   - Job Title
   - Company
   - Address
   - Business
   - Business Fax
   - E-mail



Full Name...: Jim Thomas
Job title: Production Engineer
Company: ZZZ, Inc.
File as: Thomas, Jim
Business: (123) 456-7890
Home:
Business Fax: (123) 789-4560
Mobile:
Address... Business: 297 High Street
Irvine CA 48108
☑ This is the mailing address
E-mail: jthomas@zzz.net
Web page address:

Trial

The trial consists of entering contact information from 25 business cards into an Outlook database. Use the input devices as positioned and do not use the TAB or ENTER keys to navigate within Outlook (use the input device for all cursor repositioning).

You will complete the trial twice, using a different input device each time (you will be instructed when to use each device). Complete the trial as quickly as possible without increasing errors, correcting any errors as you recognize their occurrence.

Appendix B: Subjective Survey

INPUT DEVICE: ***Conventional Mouse***

1. Rate the overall ease of using the input device:

1	2	3	4	5	6	7	8	9	10
EASY									DIFFICULT

2. Rate your overall level of physical comfort while using the input device:

1	2	3	4	5	6	7	8	9	10
VERY COMFORTABLE									NOT AT ALL COMFORTABLE

INPUT DEVICE: ***RollerMouse***

1. Rate the overall ease of using the input device:

1	2	3	4	5	6	7	8	9	10
EASY									DIFFICULT

2. Rate your overall level of physical comfort while using the input device:

1	2	3	4	5	6	7	8	9	10
VERY COMFORTABLE									NOT AT ALL COMFORTABLE