



An Ergonomic Evaluation of a Hybrid Keyboard and Game Controller

Albert Ting and Alan Hedge

Cornell University

Dept. Design & Environmental Analysis

Ithaca, NY 14850



Acknowledgment

- This study was made possible and funded by:
 - Cornell University Human Factors and Ergonomics Laboratory
 - New York State College of Human Ecology at Cornell University summer grant
 - Microsoft Corporation for their donation of a Sidewinder Gamepad
 - Winel Inc.



Alphagrip

- Alphagrip is a conventional input device and a videogame controller that works as a handheld product that does not require a worksurface.





Alphagrip

- Alphagrip is also a hybrid keyboard and game controller with a chording keyboard.





Keyboarding Away From The Desk

- Keyboards are awkward to use when no worksurface is available or while seated in a sofa.
- The AlphaGrip is an input device capable of full keyboard and gaming functionality that is also portable and does not require a worksurface.
- The purpose of this study was to examine the effects of a hybrid keyboard and game controller on performance, comfort, and posture, based on the trend that computing is moving away from the desk.





Methods

Laboratory experiment

- AlphaGrip tutorial
- Typing task using AlphaGrip
- Gaming task using AlphaGrip
- Gaming task using Microsoft Sidewinder gamepad
- Typing task using a generic keyboard on a worksurface
- Typing task using a generic keyboard on the subject's lap
- Comfort / discomfort survey after each task
- User impressions survey



Subject Selection

- Ten women and 10 men were chosen for the laboratory experiment from the survey respondents based upon the following characteristics:
 - Age (18-21 years old)
 - Typing skill and frequency (>40 words/minute and at least 1 hour/day typing)
 - Gaming experience and frequency (>4 years and at least once a week)
 - Handedness (Right Handed)
 - Fluent in English
 - No prior history of repetitive strain injuries



Laboratory Experiment

- The entire study was performed at the Cornell University Human Factors and Ergonomics Laboratory, Ithaca, NY beginning in March 2000 and ending in June 2000.
- Subject posture in each condition of the laboratory experiment was video taped from 3 views (right, left, and overhead).
- The experiment required approximately 2 hours of the subject's time.
- The subjects were compensated with \$50.00 for their participation.



Experimental Conditions

- Subjects were asked to perform the following 15 minute tasks during the laboratory experiment in random order:
 - Type using a “traditional” 88-key keyboard that was placed on a work surface.
 - Type using a “traditional” 88-key keyboard placed on their lap
 - Type using the AlphaGrip
 - Play a video game using the Microsoft Sidewinder gamepad
 - Play a video game using the AlphaGrip





Learning to Use the AlphaGrip

- Prior to beginning the laboratory tasks the subjects were allowed to “discover” and play with the AlphaGrip for 10 minutes.
- Subjects were then asked how to use the AlphaGrip.
- Then the subjects were given a 5 minute verbal tutorial on how to use the AlphaGrip.

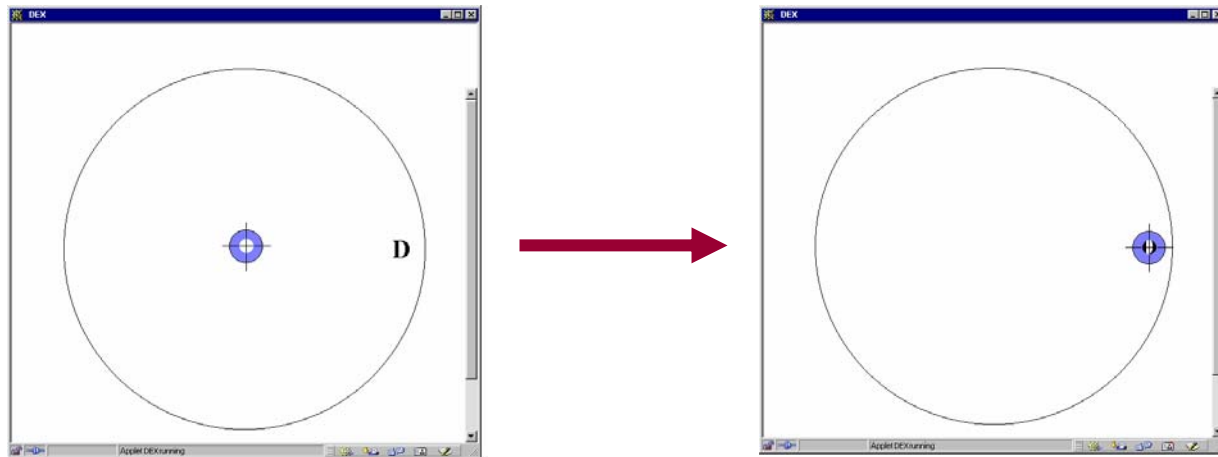


Study Measures

- Typing performance was measured by using Mavis Beacon 9 Typing Tutor Package.
- Gaming performance was measured the subject's score playing "Nerf Arena Blast" and a dexterity game developed by the investigators.
- Comfort / discomfort was measured through surveys after each task.
- Wrist posture measured using electrogoniometer –instrumented gloves (Greenleaf Medical).
- Video motion analysis (Peak Performance) was used to assess overall body posture.
- A user reactions survey was conducted at the end of the study.



Dexterity Game



- Letters representing the gaming buttons on the controllers appeared around the edge of the circle.
- Subjects were asked to move the “target” using the “directional-pad” to cover the letter and then press the corresponding gaming button on the controller.
- Accuracy and time to target were recorded during this 3-minute sub-task.



Microsphere Workstation

- All tasks were performed while the subject was seated in the Microsphere workstation because this allowed for more upright computer task postures and more reclined gaming postures.



microsphere with accessories available soon

Ting, A. and A. Hedge (2001) An ergonomic evaluation of a hybrid keyboard and game controller. Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting, Vol. 1, 677-681.



Why Microsphere?

- The Microsphere workstation had several advantages over other workstation / desk chair arrangements:
 - Pivoting keyboard work surface allowed quick removal of the keyboard when it was not in use during the study.
 - Fixed distance between subject and monitor during all tasks.
 - Subjects could lean backwards or lean forwards during the tasks, imitating possible sofa seating postures.



Typing Performance

	Words Per Minute (Average)	Words Per Minute (Std. Dev.)	Percent Accurate (Average)	Percent Accurate (Std. Dev.)
AlphaGrip	9.35	2.46	92.10%	6.63
Keyboard on Desk	45	2.24	96.25%	14.53
Keyboard on Lap	43.35	2.87	95.85%	15.83

- Average typing speed was 9.35 wpm after initial 15 minutes of AlphaGrip use, but typing was proportionally more variable than with the keyboard (higher S.D.).
- Percent accurate was 92.1% after initial 15 minutes of AlphaGrip use and proportionally less variable than the keyboard tasks.



Gaming Performance

	Nerf Arena Blast Score (Average)	Nerf Arena Blast Score (Std. Dev.)
AlphaGrip	6,792	326
Microsoft Sidewinder Gamepad	7,130	387

- Subjects scored similarly using either AlphaGrip or Sidewinder.

	Time to Target (sec^{**})		Accuracy	
	(Average)	(Std. Dev.)	(Average)	(Std. Dev.)
AlphaGrip	2.07	0.52	90.20	5.87
Microsoft Sidewinder Gamepad	1.99	0.41	92.80	6.56

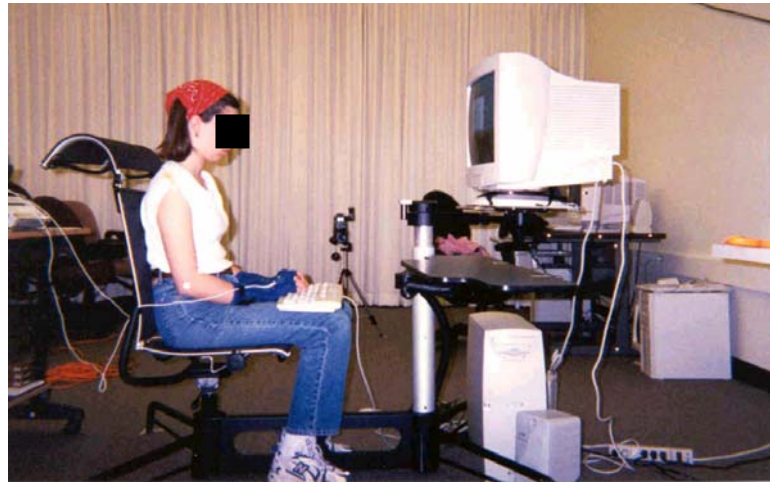
- Performance with the dexterity sub-task was similar between controllers as well.

** The seconds time unit may not represent an actual second. The CPU speed of the testing computer may have accelerated the timer in the Java applet. However, the unit represents a consistent unit of time.

Ting, A. and A. Hedge (2001) An ergonomic evaluation of a hybrid keyboard and game controller. Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting, Vol. 1, 677-681.



Wrist Posture Validation



- The meanwrist postures (radial/ulnar deviation and flexion/extension) from the work surface and lap typing task video motion analysis were not significantly different from the mean wrist angles recorded from the wrist posture gloves.
- The mean wrist angles for the tasks involving the AlphaGrip or Microsoft gamepad could not be confirmed via video analysis, as those controllers were held at a “skewed” angle.



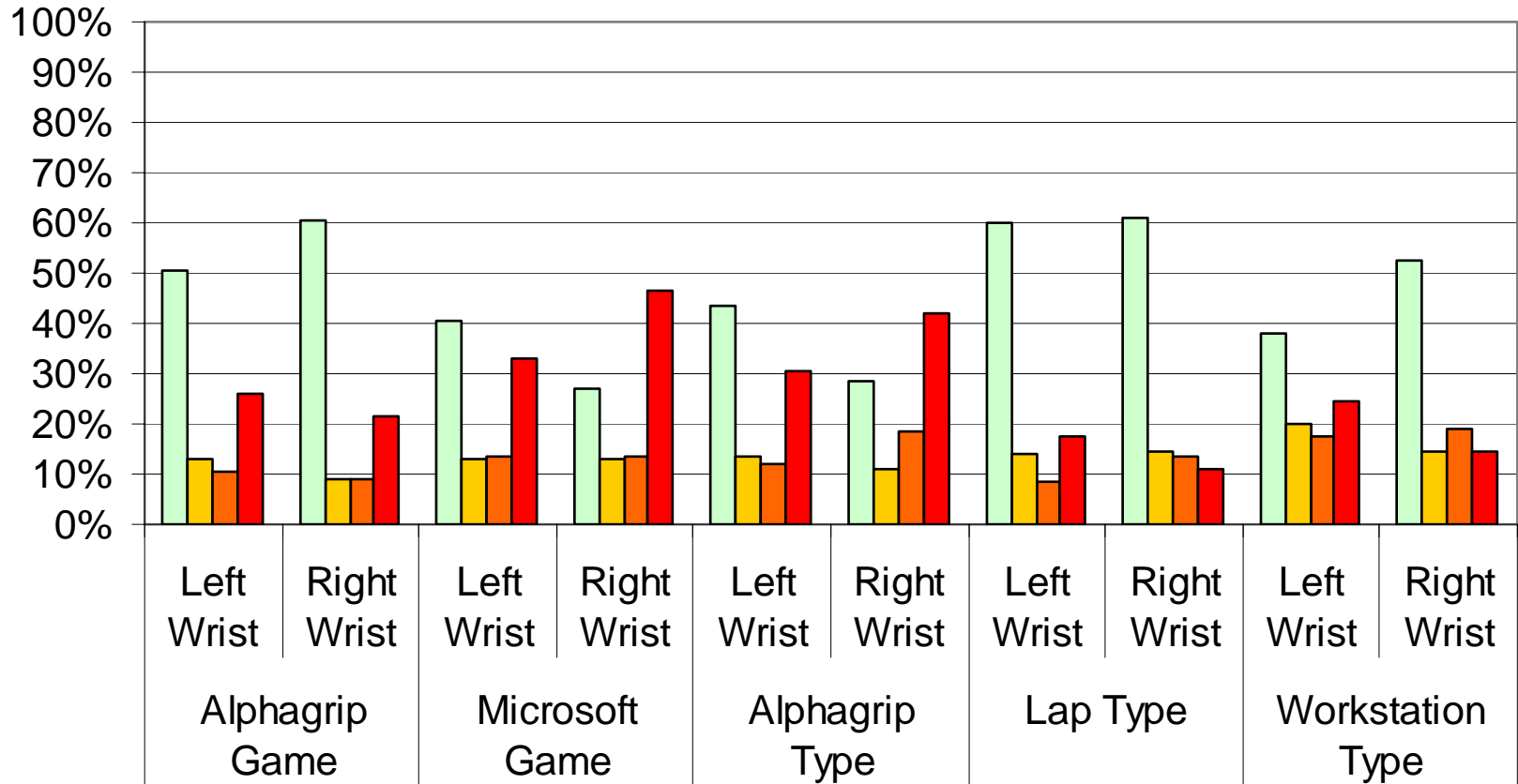
Wrist Posture

- Four zones of risk were identified for all possible wrist postures in either the flexion/extension or radial/ulnar planes. The ranges of wrist angles contained by each plane are as follows:
 - Zone 1 Lowest risk: -10.5° to 10.5°
 - Zone 2 -15.5° to -10.6° & 10.6° to 15.5°
 - Zone 3 -15.6° to -20.5° & 15.6° to 20.5°
 - Zone 4 Highest risk: < -20.6° & $>20.6^{\circ}$



Wrist Posture

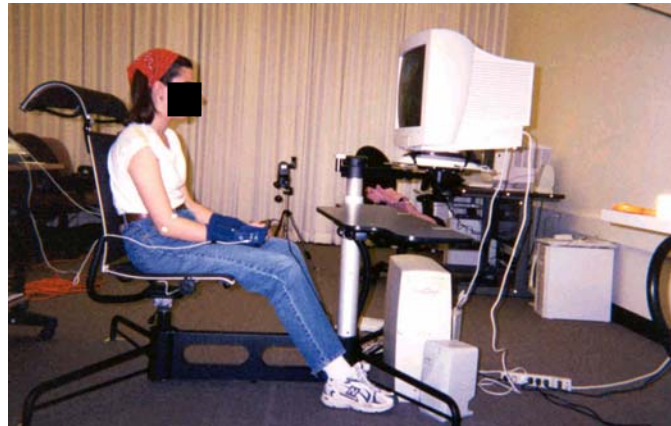
■ Lowest Risk Zone 1
 ■ Zone 2
 ■ Zone 3
 ■ Highest Risk Zone 4



Ting, A. and A. Hedge (2001) An ergonomic evaluation of a hybrid keyboard and game controller. Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting, Vol. 1, 677-681.



Body Posture



- Video motion analysis shows subjects spent similar amounts of time “leaning forward” or “leaning back” while gaming with the Microsoft gamepad and the AlphaGrip.
- When typing with the AlphaGrip, subjects had the tendency to “lean forward”.
- Mean elbow flexion angle was significantly higher during the work surface typing task.



Comfort / Discomfort

- Subjects rated 23 areas of the body before and after each condition, including the Neck, upper back, lower back, right shoulder, left shoulder, right upper arm, left upper arm, etc.
- Subjects reported significantly greater right thumb and right and left pinky finger discomfort after the AlphaGrip typing task, when compared to the other 4 tasks.
- The AlphaGrip gaming task did not result in significant right thumb discomfort. (The pinky fingers were not used in the gaming task.)
- Subjects reported significantly greater lower back and right and left shoulder discomfort after the lap typing task, probably because of the seated posture.



Overall Comfort / Discomfort

- Taking the average of all the reported discomfort for each task results the order of least discomfort during a task to most discomfort during a task (means for gaming tasks were significantly different than the means for the typing tasks) was as follows:

Least
discomfort
↑
↓
Most
discomfort

- Microsoft Sidewinder Gamepad gaming task
- Generic keyboard on work surface typing task
- AlphaGrip typing task
- AlphaGrip gaming task
- Generic keyboard lap typing task



Survey Results

- **Several questions asked on both reactions to Alphagrip based on pictures of this device, and then asked again at the end of the laboratory study (after using the AlphaGrip).**
- **“Would you use this device to type a report?”**
 - **Before Use Yes - 0, No - 20**
 - **After Use Yes - 8, No - 12**
- **“Would you use this device to play a game?”**
 - **Before Use Yes - 14, No - 6**
 - **After Use Yes - 7, No - 13**
- **“I would buy this device.”**
 - **Before Use Yes - 1, No - 19**
 - **After Use Yes - 7, No - 13**



Implications for Performance

- The AlphaGrip's mean of 9.35 wpm and 92% accuracy after an initial 15-minutes of use is impressive.
- Unfortunately, establishing the learning curve, or the maximum typing speed on the AlphaGrip was out of the scope of this study.
- The similarity in Nerf Arena game scores and Dexterity game scores to the Microsoft Sidewinder gamepad, indicates that the AlphaGrip is a viable alternative as a game controller.



Conclusion

- Lap typing resulted in the highest level of discomfort among the five tasks in this study.
- Currently, lap typing is the only readily available solution for TV centric computing.
- Conventional keyboards are not optimal for videogames.
- With design refinement, the AlphaGrip may be an alternative product.