PhD Qualifying Examination: **Human-Computer Interaction**

University of Wisconsin–Madison, Department of Computer Sciences

Fall 2012 — Monday, September 24, 2012

General Instructions

★ This exam has **7** numbered pages including this page.

★ Answer each question in a separate book.

★ Indicate on the cover of each book **the area** (HCI) of the exam, your **code number**, and the **question number** answered in that book. On one of your books, list the numbers of all the questions answered. Do not write your name on any answer book.

★ Return all answer books in the folder provided. Additional answer books are available if needed.

Specific Instructions

★ Answer all **6** questions.

Policy on Misprints and Ambiguities

The Exam Committee tries to proofread the exam as carefully as possible. Nevertheless, the exam sometimes contains misprints and ambiguities. If you are convinced that a problem has been stated incorrectly, mention this to the proctor. If necessary, the proctor can contact a representative of the area to resolve problems during the *first hour* of the exam. In any case, you should indicate your interpretation of the problem in your written answer. Your interpretation should be such that the problem is nontrivial.

Question 1. *Interaction Fundamentals*

You are employed by a software company that develops games for tablet computers (e.g., Apple's iPad). The senior developer has tasked you to help with the development of the tablet version of the classic Whac-A-Mole game. In the game, the screen will show a number of holes, and moles will pop up from the holes at random. Players will, using touch, hit the moles in the head to force them back into their holes *as fast as possible* to maximize their score. The development team needs your help particularly in designing the behaviors of the moles.

a) Briefly describe the *memories*, *processors*, and *operators* that will determine how much delay should be added between each mole popping up, based on the Model Human Processor and the Keystroke-Level Model.[1]

b) Based on Fitts's Law, make a back-of-the-envelope calculation to provide your team with a rough estimate of the *time* it will take the player to respond to each mole along with any assumptions you make.

c) The senior developer is also considering whether or not to add a wireless game controller to the game and to provide the players with the ability to use a joystick to control a mallet that will appear on the screen that they would use to hit the moles. Provide the senior developer with a comparison between joystick and touch-screen control in response time and error rates, making a final recommendation.

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[1] Card, S. & Moran, T. (1986). User technology—from pointing to pondering. In *Proceedings of the ACM Conference on the History of Personal Workstations*. J. R. White and K. Anderson, Eds. ACM, New York, NY, 183–198.

Question 2. *Research Design*

Consider the hypotheses below, taken from the HCI literature, and identify the *independent variables*, *dependent variables*, and *covariates*, as appropriate. For each hypothesis, propose an appropriate *research design* and a *statistical test* for an experiment that would test the hypothesis. Set up the statistical test based on the research design, describing how each variable will be considered and what *planned comparisons* would be appropriate to test the hypothesis.

(a) "**H1:** Users hearing a computer voice manifesting a personality similar to themselves will feel more social presence than those who hear a computer voice manifesting a dissimilar personality."[2]

(b) "**H1:** There will be significant differences between PSUs and FSUs[3] with respect to the time required to identify visual icons in a GUI."
"**H2:** Contrast sensitivity, visual field, visual acuity and color perception will have a significant influence on the time required to identify visual icons in a GUI."[4]

(c) "**H1:** There are some locations where each user is more likely to make photos public, compared to their overall behavior across all photos. Similarly, in some locations, a user is more likely to set photos as non-public."[5]

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[2] Lee, K.M. and Nass, C. (2003). Designing social presence of social actors in human computer interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*, pp. 289–296.

[3] PSUs and FSUs stand for partially sighted and fully sighted users, respectively.

[4] Jacko, J.A., Dixon, M.A., Rosa, Jr., R.H., Scott, I.U., and Pappas, C.J. (1999). Visual profiles: a critical component of universal access. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '99), pp. 330–337.

[5] Ahern, S., Eckles, D., Good, N.S., King, S., Naaman, M., and Nair, R. (2007). Over-exposed?: privacy patterns and considerations in online and mobile photo sharing. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07)*, pp. 357–366.

Question 3. *Qualitative Research*

An HCI researcher is interested in understanding how the introduction of robotic surgery technology affects the workflow of and interactions among surgery staff and patients, particularly staff's adoption of the technology and patients' perceptions of the staff and the surgical procedures, toward informing the design of future systems. The researcher plans to follow an ethnographic data collection and use Grounded Theory for data analysis.

(a) Describe <u>three</u> *data collection methods* that the researcher might use as a part of an ethnography, providing examples of how each method might facilitate the researcher's understanding of the studied phenomena.

(b) Briefly describe the <u>three</u> *coding steps* in Grounded Theory[6] with examples of how they might be applied to data from the study described above.

(c) *When* should the researcher expect to start the Grounded Theory process and *why*? *When* should coding end and *why*?

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[6] Corbin, J., & Strauss, A. (2008). *Basics of qualitative research*. 3rd Edition. Sage.

Question 4. *Usability Evaluation*

Usability evaluation is considered a close cousin of empirical research.

(a) Describe <u>three</u> *similarities* and <u>three</u> *differences* between usability evaluation and empirical research.

(b) Describe the differences between *expert-based* and *user-based*[7] usability testing, discussing their *advantages* and *disadvantages*. Provide <u>one</u> *example* for each approach.

(c) Discuss what is meant by "discount usability testing."[8] Describes <u>one</u> *practical implication* of this idea for usability evaluation.

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[7] Lazar, J., Feng, J. H., & Hochheiser, H. (2010). *Research Methods in Human-Computer Interaction.* Wiley.

[8] Nielsen, J. (1993) *Usability Engineering.* Morgan Kaufmann.

Question 5. *Research Design*

Reliability[9] is a key consideration in HCI research and empirical research in general.

(a) Provide a brief *definition* of reliability and discuss how it differs from *validity*.

(b) List <u>three</u> *threats* against reliability and describe <u>one</u> *precaution* the researcher might take toward mitigating each threat.

(c) Describe <u>one</u> *measure of reliability* used in *quantitative* research and <u>one</u> used in *qualitative* research and discuss how these measures ensure reliability in their respective contexts.

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[9] Lazar, J., Feng, J. H., & Hochheiser, H. (2010). *Research Methods in Human-Computer Interaction.* Wiley.

Question 6. *User Modeling*

Consider a design team interested in gaining a contextual understanding of how sales staff in a large home improvement store work and interact with customers toward designing mobile computing applications that improve staff efficiency and customer experience. Briefly describe the <u>five</u> *models* that the design team would create following a contextual inquiry[10] process, providing examples of what each model might capture. Discuss how each model might inform the other activities in the design process such as persona development[11] and task modeling,[12] providing one-to-one mappings between models and design activities.

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[10] Holtzblatt, K. & Beyer, H. (1993) Making customer-centered design work for teams. *Communications of the ACM,* 36 (10), 93–103.

[11] Cooper, A., Reimann, R., & Cronin, D. (2007) *About Face 3*. Wiley.

[12] Card, S. K., Moran, T. P., & Newell, A. (1980). The keystroke-level model for user performance time with interactive systems. *Communications of the ACM*, 23 (7), 396–410.