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

University of Wisconsin–Madison, Department of Computer Sciences

Spring 2011 — Monday, February 6, 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. *User Research*

Your company is interested in developing a new line of technologies that will help *nuclear families* — parents and children living together — better coordinate their joint activities. Because this application area is new to the company, your boss has asked you to devise a plan to study the target users of these technologies.

(a) Describe how the *day reconstruction method*,[1] *experience sampling method*,[1] and *cultural probes*[2] might be used to study these users in no more than three short paragraphs that would be included in an executive summary.

(b) Provide an assessment of the advantages and disadvantages of each method so that your boss understands why these methods may or may not fit well to the problem at hand.

(c) Offer a final recommendation in your report for one of these methods and the justification for your recommendation in a brief paragraph, focusing on the key benefits of the recommended method for the company and the development process.

[1] Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004). A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method. *Science*, 306 (5702), 1776–1780.

[2] Gaver, B., Dunne, T., and Pacenti, E. (1999). Design: Cultural probes. *Interactions* 6 (1), 21–29.

Question 2. *Study Design & Data Analysis*

A middle-school teacher you know wants to start using Smart Boards in the classroom. He would like to make sure that this new technology actually improves student engagement and learning before he invests into completely changing the way he teaches his curriculum. He consults you as an HCI researcher about how he might assess whether Smart Boards are effective educational technologies.

(a) Design an experiment that will achieve this assessment, identifying valid *baseline conditions*, *manipulations*, and *measurements*. Describe potential *confounding factors* and how you would account for them in your experimental design.

(b) Define the *independent*, *dependent*, *random*, and *control variables*, identifying *factors* and their *levels* for the experiment design you describe for part (a).

(c) Choose the *statistical test* that best fits your experimental design and construct the *statistical model*. Verbally define how each variable will be treated in the model. Exact mathematical formulations are not needed.

Note: Assume that the teacher has access to a sufficiently large student population at his school and can conduct the assessment in any way he needs.

Question 3. *Research Strategy & Design*

Suppose you are preparing a research proposal to submit to your advisor. You are interested in studying the broad area of people's *trust* in technology, but have not yet identified the research strategy, questions, or design.

(a) Briefly explain *substantive*, *conceptual*, and *methodological* domains of research.[3]

(b) Provide *two* distinct but equally valid example research strategies for investigating *trust* in technology, identifying elements of both research strategies in these three domains for your proposal.

(c) Describe the strengths and weaknesses of the two strategies, particularly in their *generalizability*, *precision*, and *realism*.[3]

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[3] McGrath, J. E. (1995). Methodology Matters: Doing Research in the behavioral and social sciences. In R. M. Baecker, J. Grudin, W. A. S. Buxton, S. Greenberg, (eds.), *Readings in Human-Computer Interaction: Toward the Year 2000*, pp. 152–169.

Question 4. *Modeling Interaction & Context*

Consider an HCI researcher who would like to model the workflow and context of a receptionist in order to inform the design of an interactive system that will function as a receptionist. The researcher will have to make decisions about what modeling approach to take and what to capture in the model. Provide answers to the following questions that researcher will have to consider in this process.

(a) Briefly describe how *situated action models*, *distribution cognition*, and *activity theory*[4] might guide the researcher in her study, focusing on the main premise of each approach in modeling context.

(b) Describe what models developed by each approach might capture, specifying the kinds of abstractions that can be defined in these models, and discuss the advantages and disadvantages of each approach in modeling the context in question.

(c) Provide the researcher with a recommendation on which approach might best fit to this context and the justification for your recommendation.

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[4] Nardi, B. (1996) Studying context: A comparison of activity theory, situated action models, and distributed cognition, In B. Nardi (Ed.) *Context and consciousness: Activity theory and human-computer interaction*, pp. 69–102.

Question 5. *Cognitive Modeling*

Cognitive modeling approaches (e.g., keystroke-level modeling) have been widely used to model and predict user behavior with computer interfaces. The widespread use of mobile computing applications and the introduction of complex automotive interfaces have made *driving a car* a richer context for modeling user behavior and for designing computer interfaces. Below you will apply key concepts from cognitive modeling to the context of driving a car.

(a) Briefly define the concept of an *operator*[5] and identify three operators in the context of driving.

(b) Provide a short definition of the *unit task*[5] and its relationship with *working memory*[5] and identify three unit tasks that drivers perform.

(c) Discuss how *critical path analysis*[6] might inform cognitive modeling in the driving context.

[5] 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.

[6] Olson, J. R. & Olson, G. M. (1990). The growth of cognitive modeling in human-computer interaction since GOMS. *Human-Computer Interaction*, 5 (2), 221–265.

Question 6. *Usability Evaluation*

You are employed by a robotics company as a usability analyst and your boss asks you to evaluate a social robot that the company designed as an educational companion for children using *heuristic evaluation.*[7] Adapt <u>three</u> of Nielsen's 10 heuristics to this evaluation problem, providing brief (1) descriptions of these heuristics, (2) examples of how the design of the robot might violate these heuristics, and (3) suggestions for how the robot's design might be changed to address these violations.

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[7] Nielsen, J. (1993) Usability Engineering (Chapter 5). Morgan Kaufmann, pp. 115–163.