Human-Computer Interaction (HCI) Specialization Track
Masters of Software Engineering (MSE) Program

Carol L. Hoover
March 1, 1995
CMU-CS-95-123

School of Computer Science
Carnegie Mellon University
Pittsburgh, PA 15213-3890

This report is a revision of an internal report written and distributed within the CMU community by Carol L. Hoover in August, 1994.

Author's Internet Address: clh@cs.cmu.edu

Abstract

There is an increasing demand for software to implement human-computer interfaces. Software engineers who develop these interfaces need an understanding of the interactions between the human, the available computer technology, and human tasks. They should also understand empirical methods used to evaluate the usability of existing human-computer interfaces. The Human-Computer Interaction Specialization Track, which is an option within the Masters of Software Engineering (MSE) Program at Carnegie Mellon University, enables graduate software engineering students to obtain knowledge and skills related to the design, implementation, and evaluation of interactive computing systems. Students can acquire hands-on experience in the design of computer technology to support individual users as well as group interactions. The track is flexible in that it allows students to choose their own set of track courses from a list of approved HCI courses. This report describes the track rationale and requirements and presents educational guidelines to help students select courses. The report includes a list of approved courses and brief course synopses. The report is based on the author's work in developing specialization tracks for the MSE program. The author started this work during the spring of 1993.

Table of Contents

1 Rationale

Students who pursue the *Human-Computer Interaction (HCI) Specialization Track* will acquire knowledge and skills needed to develop software for state-of-the-art interactive computing systems. They will become knowledgeable about the usability of human-computer interfaces and methods for evaluating usability. After completing a specialization in HCI, students will be able to apply their understanding of the interactions between the human, the available computer technology, and human tasks to the design of software to support an interactive computer system.

Students will have the opportunity to learn fundamental HCI concepts under the direction of faculty who are experts in their fields. In particular, they will develop expertise in the following areas.

- What it means for a human-computer interface to be usable.
- Psychological factors such as perception, cognition, and problem-solving which affect the usability of a design for a human-computer interface.
- Evaluation of the usability of human-computer interfaces.
- Computer technologies used to design human-computer interfaces.
- Design of interactive systems to meet user requirements.
- Validating an interactive system design with respect to user requirements.
- Nature of group communications and computer technologies to support group interactions (groupware).

In addition, students can select courses to focus on topics, such as those listed below, which are important to the design of interactive computer systems.

- Visual aspects of designing user interfaces (color, shape, and spatial location).
- Media technology.
- Impact of information technology on work procedures, job roles and organizational structure and computer technology to support office automation and decision-support.

2 Track Requirements

Students pursuing an *HCI Specialization Track* will complete four or more full-semester (9-12 unit) approved courses including *Special Topics in Computer Science: Human-Computer Interaction* (15-499X/15-829). The reader should refer to *Section 3: Approved Courses* for the list of approved courses and to *Section 4: Course Descriptions* for brief course descriptions. Students who want to take courses which are not on the approved list to satisfy the four-course requirement must seek his/her advisor's permission.

Two half-semester or two 6-unit courses count for one full-semester course. *Human Interface to Business Computer Systems* is a 6-unit course. Completion of this course and a 3-6 unit independent study is equivalent to the completion of one full-semester course.

A student should discuss with his/her advisor the content of an HCI course which he/she has taken in the past. In this case, the student's goal should be to select HCI courses which cover concepts that are different from and/or more advanced than those that the student has already studied. For instance, a student may have taken an undergraduate HCI course similar to the *Special Topics in HCI* course. In this case, the student may receive permission to substitute another course from the approved course list.

Students should select approved courses that correspond to their educational objectives. *Table 1: Mapping Educational Objectives to Approved Courses* is a guide for selecting appropriate courses. The student should find the desired educational objective in the first column and then select the corresponding course which is shown in the second column of the same row.

Table 1: Mapping Educational Objectives to Approved Courses

Educational Objective	Corresponding Approved Course
Acquire an understanding of fundamental concepts needed to empirically evaluate human-computer interfaces with respect to human behavior. Develop an understanding of how humans interact with computers to complete tasks.	Special Topics in Computer Science: Human-Computer Interaction (15-499X/ 15-829)
Acquire an understanding of how groups of humans interact to solve problems and of computer technology to support group interactions.	Advanced Topics in HCI: Computer Supported Cooperative Work (15-820X)
Acquire an understanding of ways to compare HCI techniques for their usefulness and usability.	Advanced Topics in HCI: Comparative HCI Analysis Techniques (15-820X)
Develop the knowledge and skills needed to design and implement interface software using state-of-the-art software development methodologies and tools.	User Interface Software (15-820X)

Table 1: Mapping Educational Objectives to Approved Courses

Educational Objective	Corresponding Approved Course
Acquire knowledge about media representation, storage, communication, and digital processing of audio, still images, and video.	Special Topics in Computer Science: Media Technology (15-820X)
Acquire knowledge and/or skills in an individually selected area of HCI.	Independent Study of an HCI Topic (17-799)
Gain an understanding of problems that individuals and organizations encounter when using computerized information systems and of the impact of computer technology on work procedures, job roles and organizational structure.	Human Interface to Business Computer Systems (45-975)
Develop skill in the visual aspects of designing user interfaces such as color, shape, and spatial location by studying principles that focus on visual communication, cognitive psychology, linguistics, and system design.	Human Computer Interaction Design (51-404)
Gain experience in the design and implementation of a human-computer interface to satisfy an industrial customer.	Industrial Design Project Course (51-TBD)
Acquire an interdisciplinary understanding of the relationships between humans and their designed environment by studying related concepts from psychology, physiology, engineering, and design.	Human Factors (85-793)

3 Approved Courses

The student will select the equivalent of 4 or more full-semester (9-12 unit) courses from those listed in sections 3.1-3.4 including *Special Topics in Computer Science: Human-Computer Interaction* (15-499X/15-829).

3.1 School of Computer Science

15-499(X)/ 15-829	*Special Topics in Computer Science: Human-Computer Interaction (HCI)*
12 units	Instructor: Bonnie John
Fall	Required Course
15-820(X) 12 units	*Advanced Topics in HCI: Computer Supported Cooperative Work*
Spring	Instructor: Robert Kraut
15-820(X) 12 units	*Advanced Topics in HCI: Comparative HCI Analysis Techniques*
Spring	Instructor: Bonnie John
15-820(X) 12 units	*User Interface Software*
Spring	Instructor: Brad Myers
	The availability of this course is flexible. The course may be offered during a fall semester in the future and may be offered on alternating years.
15-820(X) 12 units	*Special Topics in Computer Science: Media Technology*
Spring	Instructor: Roger B. Dannenberg
17-799 3-24 units	*Independent Study of an HCI Topic*
Fall/ Spring/	Advisors: Individually arranged.
Summer	The student and his/her independent study advisor will determine the topic to be studied and/or project to be completed.

3.2 Graduate School of Industrial Administration

45-975 6 units	*Human Interface to Business Computer Systems*
Spring	Instructor: F. Javier Lerch

3.3 Design Department

51-404
9 units
Fall

Human Computer Interaction Design

Contact: Dan Boyarski

51-TBD
Spring

Industrial Design Project Course (Apple, NCR, etc.)

This course involves the design and implementation of a human-computer interface to satisfy an industrial customer. Contact: Dan Boyarski.

3.4 Psychology Department

85-793
9 units
Spring

Human Factors

4 Course Descriptions

4.1 Special Topics in Computer Science: Human-Computer Interaction (15-499X/15-829)

This course introduces the field of Human-Computer Interaction. There are three main goals in this course. First, we seek to foster an appreciation for the three-pronged approach to the design of computer systems, involving computers, human users and the tasks that are performed. Second, we aim to increase the students' awareness of bad design through observation of computer systems in the world around them. Finally, we want the students to learn and practice several HCI skills involving analytical and empirical evaluation of system designs with respect to human performance.

4.2 Advanced Topics in HCI: Computer Supported Cooperative Work (15-820X)

Most of the work that people do requires some degree of coordination and communication with others or some kind of teamwork. This course will use theories and empirical studies of group behavior to identify the problems that groups need to solve to be successful. It will survey recent computer and communications systems that have been built to aid group work, examining both their technological underpinnings and their utility. Finally, group projects will provide practice in the skills needed for designing and evaluating groupware.

4.3 Advanced Topics in HCI: Comparative HCI Analysis Techniques (15-820X)

Over the past decade, several techniques for analyzing user interfaces have been developed in the field of Human-Computer Interaction. In this course, we will compare these techniques for their usefulness and usability. We will choose one existing interface (the original interface) that we wish to improve by using HCI techniques. Each student will then choose an HCI technique and attempt to apply it to the original interface and keep a log of their experience applying the technique. The log will include such things as: ease of finding and obtaining papers about the technique, ease of applying the technique and how any difficulties were resolved (e.g., simply discussing the technique with a friend or having to call the author of the technique), predictions made by the technique about the usability of the original interface, and the design changes suggested by the technique to improve the interface. In parallel with the class analyses, the professor will conduct empirical usability studies of the original interface against which we can compare the predictions of the analyses.

4.4 Advanced Topics in HCI: User Interface Software (15-820X)

This course will cover the design and implementation of user interface software. After a quick overview of the design of user interfaces, we will concentrate on how to implement the chosen design. Particular emphasis will be placed on user interface software tools, such as windowing systems, toolkits, interface builders, prototypers, and advanced user interface development environments. Students will study and use reusability engineering development methodologies and state-of-the-art commercial user interface tools to implement interfaces.

PREREQUISITES: 15-212 Introduction to Computer Programming or considerable programming experience. Experience with object-oriented programming and/or software engineering is desirable. Prior experience with user interface design is NOT required.

4.5 Advanced Topics in HCI: Media Technology (15-820X)

This course teaches the fundamentals of media representation, storage, communication, and processing by digital means, with an emphasis on audio, still images, and video media. It begins with an introduction to sampling theory and various representation techniques. This is used to describe and explain a variety of real devices, formats, and standards. Students will learn to analyze media technology in terms of critical properties such as resolution, noise, bandwidth, latency, and computation.

Topics to be covered include: audio sampling theory and processing, 2D image sampling, color spaces, audio compression, image compression, video compression, storage devices including CD-ROM, RDAT, and holographic storage, storage formats including CD-I and HyTime, time codes and synchronization, communication technology including ATM, ISDN, and cellular radio, input technology, and application examples.

4.6 Human Interface to Business Computer Systems (45-975)

This course serves as an introduction to the difficulties that individuals and organizations have in interfacing with computerized information systems. On the individual level, students learn how to apply knowledge about human strengths and weaknesses in the design and selection of computer systems for office automation and decision support. On the organizational level, the students are introduced to strategies for managing the impact of information technology on work procedures, job roles and organizational structure.

4.7 Human-Computer Interface Design (51-404)

The user interface for an interactive computer-driven system refers to the means of interaction between the human user and the system. How easy is it to use, and did the person accomplish what she/he set out to do? Designing the user interface is a multi-disciplinary task, one that draws upon the fields of visual communication, cognitive psychology, linguistics, and system design. This course will cover the principles involved with designing user interfaces, focusing on the interactive dimension of the human experience. This course is open to upper-level students from various disciplines across campus. Programming is not required.

4.8 Human Factors (85-793)

Human Factors is the interdiscipline that concerns the relationships between humans and their designed environment. It draws primarily from research in psychology, physiology, engineering, and design. The course goals are to provide a general overview of the field, and to introduce students to basic tools used by human factors researchers and practitioners. An application-based group project will be required. The course has seven basic components: (1) brief introduction to experimental design and statistics, (2) basic human factors, (3) psychological foundations, (4) macroergonomic/sociotechnical foundations, (5) methods of human factors, (6) applications of human factors, potentially including design of tools, workspaces, and user interfaces and (7) research frontiers in human factors.

Acknowledgments

The author's work in specifying the HCI Specialization Track began with the development of the TAP-D Model for developing specialization tracks in the MSE Program [Hoover93]. She applied the model by reviewing the ACM SIGCHI curricula for human-computer interaction and by consulting HCI educators, researchers, and software developers to identify knowledge and skill bases needed by software engineers who develop software for interactive computer systems. With the contributions of several faculty members and researchers, she selected a set of HCI-related courses offered at Carnegie Mellon University whose educational objectives would enable MSE students to acquire knowledge and skills important for the development of interactive software.

The author thanks the following people for their advice regarding the HCI courses that they teach or for their information about HCI courses offered in their departments: Dan Boyarski, Roger Dannenberg, Bonnie John, Roberta Klatzky, Robert Kraut, Brad Myers, and Matt McNally. For their efforts to reinstate a Human Factors course in the Psychology Department, the author thanks Gregory Abowd, Dan Boyarski, Kathleen Carley, Doug Hoecker, Bonnie John, and Roberta Klatzky.

The author also acknowledges the help of the members of the MSE Executive Committee (David Garlan, Phyllis Lewis, Nancy Mead, Mary Shaw, and James Tomayko) for their review of this track. She thanks Mary Shaw for her ideas about specialization tracks. She especially thanks Gregory Abowd for his numerous suggestions and willingness to help facilitate her acquaintance with many of the people listed above.

References

[ACM92] ACM SIGCHI/ACM Special Interest Group on Computer-Human Interaction. *Curricula for Human-Computer Interaction*. New York, N.Y.: Association for Computing Machinery, 1992.

[CMU94] Carnegie Mellon University. *Undergraduate Catalogue*. Pittsburgh, Pa.: Carnegie Mellon University, 1994.

[Dix93] Dix, Alan; Finlay, Janet; Abowd, Gregory; & Beale, Russell. *Human-Computer Interaction*. New York, N.Y.: Prentice Hall, 1993.

[Hoover93] Hoover, Carol L. *TAP-D: A Model for Developing Specialization Tracks in Graduate Software Engineering Education*. Technical Report CMU-CS-93-181. Pittsburgh, Pa.: Carnegie Mellon University, 1993.

[John92] John, Bonnie E.; Miller, Philip L.; Myers, Brad A.; Neuwirth, Christine M.; & Shafer, Steven A. *Human-Computer Interaction in the School of Computer Science* (CMU-CS-92-193). Pittsburgh, Pa.: Carnegie Mellon University, 1992.

[MSE94] Master of Software Engineering Program. *MSE Program Description*. Pittsburgh, Pa.: Carnegie Mellon University, 1994.

[SCS94] School of Computer Science. *Graduate Studies in Computer Science*. Pittsburgh, Pa.: Carnegie Mellon University, 1994.