Towards a "Humans-First" Computer Science Curriculum

D. Scott McCrickard
Department of Computer Science
Virginia Tech
Blacksburg, VA 24061
+1 540 231 6698
mccricks@cs.vt.edu

Charles J. Fowler
Department of Computer Science
Gainesville College
Gainesville, GA 30503
+1 770 718 3803
cfowler@gc.peachnet.edu

C. M. Chewar
Department of EECS
United States Military Academy
West Point, NY 10996
+1 845 938 6911
christa.chewar@usma.edu

ABSTRACT
Traditionally, computer science education has considered "objects-first" or "imperative-first" approaches, with the focus of the course on teaching design of programs starting with data objects or imperative program flow, respectively. Yet with the number of computer science majors dwindling, and with the percentages of women and minorities on the decrease, it is time to consider a new approach that will encourage a larger and more diverse population to the computer science undergraduate major. In our work, we propose a "humans-first" approach, where core principles of human-computer interaction (HCI) are integrated in the computer science and information technology curricula—from the earliest stages of each curriculum through graduation—to provide a coherent, connected experience for students.

Categories and Subject Descriptors
K.3.2 [**Computers and Education**]: Computer and Information Science Education–*accreditation, computer science education, curriculum, information systems education, self-assessment.*

General Terms
Human Factors, Languages

Keywords
HCI, education, claims, scenarios, humans-first

1. PROBLEM AND MOTIVATION
Compared to many other fields of study, computer science is a relatively young discipline, still searching for core approaches to guide the teaching of undergraduate students. While educators generally use "objects-first" or "imperative-first" approaches [1], with the dwindling number of computer science majors—particularly among women and minorities—it seems prudent to consider alternate approaches that maintain and reflect the dynamic nature of the field. In our work, we propose a "humans-first" approach, where core principles of human-computer interaction (HCI) are integrated in the computer science and information technology curricula to provide a coherent, connected experience for students. By assembling researchers at diverse and different institutions—a Research I university, a four-year academy, and a two-year college—we seek to address the needs of students and instructors of many and varied backgrounds.

2. BACKGROUND AND RELATED WORK
The project will improve student learning of important STEM principles related to design and evaluation of notification system user interfaces, as an applied design topic. Coverage of this sub-topic will broadly introduce computer science and information technology students to the multidisciplinary concerns of the experimental psychology and human factors communities. Selection of this sub-topic is based on the conclusions of the 2001 ACM/IEEE Task Force on Computing Curricula [1], which states additional emphasis should be placed on teaching the scientific method through formal laboratory experiences and adds eight core in-class hours of HCI to the computer science body of knowledge for undergraduate programs. The minimum HCI topic coverage includes human-centered development and evaluation, human performance models, engineering tradeoffs, and toolkits creation of interactive interfaces. Since HCI and a humans-first approach is unfamiliar to many current educators, they need tools that students can readily use with minimal instructor overhead. Material that will deliver design and HCI instruction to small colleges is greatly needed; in joining this effort, Fowler summarized the status quo in his 2-year program:

"*Building usable user interfaces and thinking about design issues should be part of an OOP [Object Oriented Programming] class. Seems as if most of the GUI [graphical user interface] programs my students write look like somebody said 'oops' when they wrote them.*"

3. APPROACH AND UNIQUENESS
To address these problems, we are working to integrate a "humans-first" approach to instruction using the theories and practices of John M. Carroll applied to undergraduate computer science and information technology curricula. Carroll's work provides design cycle processes, which would be used in the development of software or other computer-mediated systems to encourage human-centric, deductive reasoning [5]. His processes involve creation and iterative revision of scenarios of use and positive/negative claims about the impact of design decisions, transcending development phases of requirements analysis through product testing.

We focus our efforts around an area that is gaining increased emphasis within the software engineering and HCI communities--design and software reuse. Although software engineering practice seems to be settling on approaches to support code component reuse, there is increased focus on reusing design knowledge for accurate requirements specification. One

promising vehicle for design knowledge reuse is *claims*, or concise expressions of positive and negative effects on users associated with specific design choices (e.g. use of particular colors, animation techniques, input methods, etc). Perhaps the most valuable aspect of claims is that they may summarize highly concentrated findings from disciplines associated with actual design artifacts and usage scenarios. Claims and claim reuse have been advocated by Carroll and his colleagues within the HCI community [5], but are not yet fully used in practice, and certainly have not been employed centrally in undergraduate education.

Although Carroll has extensively developed his theories and promotes the benefits of scenario-based design for object-oriented design, usability engineering, and reuse, few tools exist to assist students with using his processes in their project work. We are implementing such tools as a web-based system, referred to as LINK-UP, that will allow the development and maintenance of a design record that is progressively extended through a "humans-first" approach in a computer science or information technology program. While the flexibility of LINK-UP allows it to be integrated with many classes, we will develop, test, and disseminate materials that will enable instructors to readily include Carroll's processes and our humans-first approach in their programs. Consider the following scenario that captures the envisioned progression of an undergraduate student Toni.

When Toni first arrived at college, she worried that all computer science majors had spent their formative years locked in a basement staring at computer screens. However, in her freshman CS 1 class, she was intrigued by weekly activities that focused on integrating computing into real world objects for use in public settings. Using the LINK-UP system, Toni browsed numerous claims stored by students and researchers in previous semesters, combining several to create a message alert board for her hall.

As a sophomore in the notorious OOP weed-out course, Toni encountered an assignment asking her to manage a database of names and numbers—just like the problem she considered for her CS 1 assignment. In completing the assignment, she returned to LINK-UP and traced through claim relationships to engineer other tasks the message board could be used for and ways that the supporting data could be structured. Seeing examples from others, including a senior she knows, helped Toni not only master the material but appreciate its place in computer science.

As a junior in HCI, Toni refocused her message board idea for the Water Safety Office where she interned the previous summer—important because so many of the workers spend time on off-site field work. She was intrigued by the interdisciplinary stages of design in the project—requirements gathering where she surveyed future users, activity design where she studied tasks her system must support, information and interaction design that required creativity, and evaluation to explore her hypotheses. Helping to guide her learning experience is LINK-UP, providing a supportive learning and exploration environment. Toni built on concepts learned in her freshman and sophomore years, both conceptually and through code reuse, while learning core principles of usability engineering and interface design.

Empowered with a breadth of knowledge from her HCI class, Toni elected to undertake a senior design project that overlaps the fields of databases and HCI—creating an information monitoring and management program for the Water Safety Office. Her focus was on building a notification network to coordinate information sharing with handhelds between field workers and home office personnel. She determined that the types of tasks field workers perform is best supported by a very different interaction model than the traditional desktop system, and her evaluation showed an order-of-magnitude anticipated speedup in task completion. As she entered in her final evaluation notes, she is pleased to see that some portions of her project made sharable through LINK-UP have accumulated 93 hits and several comments from other students and researchers. She is proud to see a comment from a freshman in the information technology program, who cited her project as an example of cutting-edge use of handhelds.

4. RESULTS AND CONTRIBUTIONS

To date, we have developed and pilot tested [3,4] a searchable claims catalog—LINK-UP—to capture and search design knowledge [2]. Using understanding of user task requirements and critical parameters that articulate user goals, designers search the catalog for applicable claims. The knowledge encapsulated in the claim is reusable as design inspiration (motivating directions that would otherwise not be taken), rationale/justification (using the claims and associated theory to back decisions), and selection of hypotheses for further evaluation. True to Carroll's intent, these activities seem very promising as a way to practice the scientific method as it applies to HCI.

Of course, we view our effort as ongoing, and in the early stages. There is a large gap between a promising proof-of-concept system such as the one we have developed and a classroom-ready learning environment to be used throughout the curriculum. In its current form, LINK-UP has mainly been used by HCI professionals with significant knowledge and training in the methods it employs—a far cry from the broad and diverse undergraduate populations that we ultimately target. Our vision of the usefulness of LINK-UP extends beyond a resource that should be accessed during requirements engineering—we believe that it should develop into a resource where students contribute their own knowledge, building on the work of peers and mentors.

5. REFERENCES

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