

Research Statement

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MOTIVATION

As stated so eloquently by Fred Brooks [1], computer science is a synthesis between engineering and science. Computer science often does not follow the traditional scientific method of observation, hypothesis, validation, and abstraction. Rather, we are in some aspects similar to engineers in that we “study in order to build” [1]. It is this observation that motivates my research work in human-computer interaction (HCI) and software engineering methodologies (SWE). While they may seem unrelated, they are in fact symbiotic. Discovery of new results must proceed in a methodical manner and is subject to the availability of research tools. These research tools are frequently software systems, which must be constructed in an orderly fashion so as to be useful beyond one’s own work. Collaboration and the need to make connections between different research areas are essential to producing tangible results. Also, as academic researchers we cannot neglect our responsibilities as educators and therefore have to continually attempt to advance computer science education.

Presently, my research in HCI and SWE is self-funded through consulting contracts and is conducted with resources provided by the Department of Computer Science at the University of Massachusetts Lowell. Since the completion of my doctorate in April 2006, I have actively continued my research and published four research papers and have three more are being considered for publication. I am looking forward to building upon this foundation and expanding my research activities in these two areas, along with a continuation of work in computer science education.

HUMAN-COMPUTER INTERACTION

My primary interest in human-computer interaction is centered on the construction of user interfaces and engineering models for mobile systems, particularly those used in maritime navigation and ubiquitous environments. The research questions are driven by my own experiences as a maritime professional. Small vessels, especially recreational craft, are increasingly relying on electronic navigation systems, such as radar, GPS, and interactive chart plotting. Based on my own experiences and those of others, many of these systems are frequently not usable *in situ*. For example, touch screen based user interfaces are nearly impossible to control during normal operations while underway. The desktop-oriented user interface design principles and human performance models consulted while constructing those systems do not properly apply when the environment is in motion. My doctoral research has shown that common models, such as Fitts’ law, need to be revised and that new heuristics are required to properly construct mobile systems [10]. As I have shown, the results are frequently transferable to other ubiquitous systems, such as self-service kiosks, in-vehicle navigation systems, medical information devices, health-care informatics, and mobile computing [4][5][6][9]. Recently, some of my results as well as my research workbench have been applied to the development of user interfaces for search-and-rescue robotics [2].

The research has much potential for expansion. The results I have obtained thus far have to be further validated. In addition, usability heuristics for mobile devices must be established. Based on these heuristics, new device prototypes for maritime navigation and mobile environments need to be built and tested in the field.

SOFTWARE ENGINEERING METHODOLOGIES

For the past fifteen years, I have worked as a software architect and chief technologist for several organizations. During this time, I have been involved in constructing many software systems, ranging from small efforts to multi-year enterprise-wide projects involving hundreds of programmers. I have learned that software development processes and methodologies must become more efficient and results-oriented. I believe that agile practices are the key [3]. However, there are few studies that establish the effectiveness of agile practices making it difficult to companies to justify their adoption. Academic software development and tool building provide an ideal environment for conducting such studies.

COMPUTER SCIENCE EDUCATION

As academic researchers we have an obligation to advance computer science education. After all, we are training the next generation of computing professionals, educators, and researchers. I believe that we need to re-introduce scientific exploration into computer science and position experimentation as a way of encouraging creativity and discovery. It is imperative that we foster an excitement about computing, science, and exploration. To further that goal, I have worked on reshaping my research workbench for human performance modeling as an education tool [7][8].

Moreover, I am participating in interdisciplinary research with Dr. Sarah Kuhn at the Department of Regional and Economic Development at the University of Massachusetts Lowell and Dr. Robert Pastel at the Michigan Technological Institute. With Dr. Kuhn, I am investigating novel approaches to teaching object-oriented techniques to students. We are using tinker toys to develop patterns that can be used by educators to explain complex concepts such as abstraction, encapsulation, inheritance, aggregation, and polymorphism. Dr. Robert Pastel and I have developed a course module that uses my research workbench in an undergraduate HCI course. Students are provided scaffolding so that they can derive many of the common HCI performance models, including Fitts' law, interactively and collaboratively. The process encourages them to be creative in empirical modeling and teaches statistical inference and experimental design.

I intend to continue my research in several ways. One, I will work to improve the research platform and turn into an even easier to use educational tool, thus increasing its potential for broader adoption. Secondly, I will investigate novel approaches to teaching complex concepts so that additional students can be attracted to and retained by the computing and information sciences.

RESEARCH PHILOSOPHY

Research must be interdisciplinary and draw upon the insights from other disciplines and researchers. Furthermore, it must balance practical applicability and theoretical contributions to the state-of-the-art. The prospect of turning research results into practical applications increases the funding potential for projects and allows funding procurement from industry as well as government sources. Seeking funding through grants and contracts is a critical

component of research. My experience in industry sales, fund raising, marketing, and product development will be of great value for funding my academic research.

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