UNIVERSITY OF CALIFORNIA,
IRVINE

Large-Scale Collection of Application Usage Data and User Feedback to Inform Interactive Software Development

DISSERTATION

submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in Information and Computer Science

by

David Michael Hilbert

Dissertation Committee:
Professor David Redmiles, Chair
Professor David Rosenblum
Professor Jonathan Grudin

1999

The dissertation of David Michael Hilbert is approved
and is acceptable in quality and form
for publication on microfilm:

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Committee Chair

University of California, Irvine
1999

DEDICATION

To

my wife and friend Sara Armstrong

for her spirit, love, patience, and encouragement,

and my parents Robert and Angela Hilbert

and brother Daniel

for their love and encouragement.

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CURRICULUM VITAE

1 Education

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Master of Science (1996, Cumulative GPA: 4.00 out of 4.00)
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Bachelor of Arts, *Magna Cum Laude* (1991, Cumulative GPA: 3.68 out of 4.00)
Tufts University
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Major: Philosophy

2 Honors, Awards, Fellowships

1998	UCI Regents' Dissertation Fellowship
1995-96	GAANN Graduate Fellowship
1994-95	MICRO Graduate Fellowship
1991-Present	Phi Beta Kappa
1991	Philosophy Department Prize, Tufts University
1987-1991	Dean's Honor List (7 of 8 semesters), Tufts University

3 Professional Associations

Association for Computing Machinery (ACM)
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ACM Special Interest Group on Computer-Human Interaction (SIGCHI)
Institute of Electrical and Electronics Engineers (IEEE)

4 Professional Experience

6/98 - 8/98
Program Manager, Word 2000 Instrumented Version
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5 Publications

Refereed Journal Articles

David M. Hilbert and David F. Redmiles. “Extracting Usability Information from User Interface Events”. ACM Computing Surveys (In Review).

David M. Hilbert and David F. Redmiles. “Collecting User Feedback and Usage Data on a Large Scale to Inform Interactive Software Development”. ACM Transactions on Computer-Human Interaction (In Review).

Jason E. Robbins, David M. Hilbert, and David F. Redmiles. “Extending Design Environments to Software Architecture Design”. Automated Software Engineering, 5, 1998.

Refereed Conference Publications

David M. Hilbert and David F. Redmiles. “Agents for Collecting Application Usage Data Over the Internet”. In Proceedings of the Second International Conference on Autonomous Agents (Agents'98).

David M. Hilbert and David F. Redmiles. “An Approach to Large-Scale Collection of Application Usage Data Over the Internet”. In Proceedings of the 20th International Conference on Software Engineering (ICSE'98).

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Refereed Conference Demonstrations

David M. Hilbert, Jason E. Robbins, David F. Redmiles. “EDEM: Intelligent Agents for Collecting Usage Data and Increasing User Involvement in Development”. Formal Demonstration at the 1998 Conference on Intelligent User Interfaces (IUI'98).

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Jason E. Robbins, David M. Hilbert, David F. Redmiles. “Argo: A Tool for Evolving Software Architectures”. Formal Demonstration at the 19th International Conference on Software Engineering (ICSE'97).

Refereed Workshop Publications

David M. Hilbert and David F. Redmiles. “Separating the Wheat from the Chaff in Internet-Mediated User Feedback”. In Proceedings of the Workshop on Internet-based Groupware for User Participation in Product Development (CSCW'98).

Jason E. Robbins, David M. Hilbert, and David F. Redmiles. “Using Critics to Analyze Evolving Architectures”. In Proceedings of the Second International Software Architecture Workshop (FSE'96).

Non-Refereed Publications

David M. Hilbert. “A Survey of Computer-Aided Techniques for Extracting Usability Information from User Interface Events”. Technical Report UCI-ICS-98-13, Department of Information and Computer Science, University of California, Irvine, Mar. 1998.

David M. Hilbert and David F. Redmiles. “Why Let Perfectly Good Usability Data Go to Waste?”. Boaster Paper at the Human-Computer Interaction Consortium Meeting (HCIC'98). Technical Report UCI-ICS-98-12, Department of Information and Computer Science, University of California, Irvine, Mar. 1998.

David M. Hilbert and David F. Redmiles. “Agents for Collecting Application Usage Data Over the Internet”. Technical Report UCI-ICS-97-41, Department of Information and Computer Science, University of California, Irvine, Oct. 1997.

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David M. Hilbert, Jason E. Robbins, and David F. Redmiles. “Supporting Ongoing User Involvement in Development via Expectation-Driven Event Monitoring”. Technical Report UCI-ICS-97-19, Department of Information and Computer Science, University of California, Irvine, May 1997.

ABSTRACT OF THE DISSERTATION

Large-Scale Collection of Application Usage Data and User Feedback
to Inform Interactive Software Development

by

David Michael Hilbert

Doctor of Philosophy in Information and Computer Science

University of California, Irvine, 1999

Professor David F. Redmiles, Chair

The two most commonly used techniques for evaluating the fit between application design and use — namely, usability testing and beta testing with user feedback — suffer from a number of limitations that restrict evaluation scale (in the case of usability tests) and data quality (in the case of beta tests). They also fail to provide developers with an adequate basis for: (1) assessing the impact of suspected problems and proposed solutions on users at-large, and (2) deciding where to focus scarce development and evaluation resources to maximize the benefit for users at-large.

This dissertation demonstrates technical and methodological solutions to enable usage- and usability-related information of much higher quality than currently available from beta tests to be collected on a much larger scale than currently possible in usability tests. Such data is complementary in that it can be used to address the impact assessment

and effort allocation problems in addition to evaluating and improving the fit between application design and use.

This research has been subjected to a number of evaluative activities including: (1) the development of two independent research prototypes at the University of Colorado and the University of California, (2) the incorporation of one prototype by independent third party developers as part of an integrated demonstration scenario performed by Lockheed-Martin Corporation, and (3) observation and participation in two industrial development projects, conducted at NYNEX and Microsoft Corporations, in which developers sought to improve the application development process based on usage data and user feedback.

The approach described herein involves a development platform for creating software agents that are deployed over the Internet to observe application use and report usage data and user feedback to developers to help improve the fit between design and use. The data can be used to illuminate how applications are used, to uncover mismatches in actual versus expected use, and to increase user involvement in the evolution of interactive systems. This research is aimed at helping developers make more informed design, impact assessment, and effort allocation decisions, ultimately leading to more cost-effective development of software that is better suited to user needs.