

Understanding Trust in Medical Technology: Using the Example of Obstetrics

Enid Nicole Headen Montague

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Industrial and Systems Engineering

Dr. Brian M. Kleiner, Co-Chair
Dr. Woodrow W. Winchester III, Co-Chair
Dr. Bernice L. Hausman
Dr. Tonya L. Smith-Jackson

25 March 2008
Blacksburg, Virginia

Keywords: Trust, Technology, Automation, Health Care, Medical, Obstetrics, Human Factors, Instrument Development

© 2008, Enid N. H. Montague

Understanding Trust in Medical Technology: Using the Example of Obstetrics

Enid Nicole Headen Montague

(ABSTRACT)

Understanding how patients and operators trust medical technology will provide insight into the role, implementation and use of technology in health systems. Models developed in aviation and manufacturing that predict operators' trust or distrust in technology (Biros, 2004; Jian, Bisantz, Drury, & Llinas, 1998; Lee & See, 2004; Muir & Moray, 1996; Parasuraman, 1997) may not be applicable to medical technology and health systems. The first objective of this research was to empirically define the construct trust in medical technology by differentiating it from trust in technology and providing a model of its factors. The second objective of this research was to generate a theory of how patients and health care providers construct trust in medical technology in an applied context. The third objective of this research was to develop and validate an instrument to measure patients' trust in medical technology. The results of these combined studies identified 30 factors of trust in medical technology and provided evidence to support the hypothesis that trust in technology and trust in medical technology are different constructs. A grounded theory was developed that shows that patients' trust in medical technology is based on a combination of characteristics from the technology, providers and how the providers use the technology, while physicians' trust is constructed from the trustworthiness of the system and trust in their own abilities. An 80 item instrument for measuring trust in medical technology was developed and validated. Recommendations for the design of obstetric work systems are discussed.

DEDICATION

I dedicate this dissertation to my grandparents who taught me to love and respect life, all people and the earth.

Enid Ferguson
Tommy Ferguson
Robert Headen, Sr.

ACKNOWLEDGEMENTS

Mountains should be climbed with as little effort as possible and without desire. The reality of your own nature should determine the speed. If you become restless, speed up. If you become winded, slow down. You climb the mountain in an equilibrium between restlessness and exhaustion. Then, when you're no longer thinking ahead, each footstep isn't just a means to an end but a unique event in itself. This leaf has jagged edges. This rock looks loose. From this place the snow is less visible, even though closer. These are things you should notice anyway. To live only for some future goal is shallow. It's the sides of the mountain which sustain life, not the top. Here's where things grow.

Robert M. Pirsig
Zen and the Art of Motorcycle Maintenance

I would like to thank my committee members who have generously given their time and expertise to better my work. I thank them for their contribution and unwavering support. I am grateful to my advisors Dr. Brian Kleiner and Dr. Woodrow Winchester III, who have supported my growth as a scholar and person. Their guidance was invaluable to the completion of this dissertation. I would like to thank Dr. Bernice Hausman for serving on my committee and for the many hours we spent engaging in discourse on childbirth and technology. I would also like to thank Dr. Tonya Smith-Jackson for introducing me to cultural ergonomics and for serving on my committee.

I would like to acknowledge the many friends, colleagues, students, professors, and librarians who assisted, advised, and supported my research and writing efforts over the years. I am truly thankful for my lab mates in the Laboratory for User-Centric Innovations in Design (LUCID) and Macroergonomics and Group Decision Systems and my Women's Studies graduate certificate cohort who were always available to discuss ideas, be an audience and support my work. I would like to thank Dr. Edward Wolfe for mentoring me in the process of instrument development. I especially would like to thank my academic friends who have guided me through this process, Carl Smith, Ricardo Prada, Chiquita Howard, Sharon Elber, Sharnia Artis, Miranda Capra, Kayenda Johnson, Will Lee and Deb Young. Thank you for the words of encouragement, practical advice and critique.

This work would not have been possible without my family. I thank my parents DeLaine and Robert Headen who have always hoped for great things for me and continue to do all they can to help make my dreams come true. I thank my sister Whitney Headen for her unwavering admiration and support. I thank my grandmother Enid Ferguson for creating dissertation camps and all the poems and songs she wrote to keep me motivated. Most of all I must thank my partner Dru Montague who has stood beside me through this journey and always reminded me to enjoy the sides of the mountain. Thank you Dru for the sacrifices you have made so that I could have a room of my own and luxury of complete focus.

TABLE OF CONTENTS

ABSTRACT	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	v
LIST OF FIGURES	vi
CHAPTER 1. INTRODUCTION	1
Purpose	1
Problem statement	4
Research questions and approach	4
Approach	5
CHAPTER 2. REVIEW OF LITERATURE	7
Health care systems	7
Trust	10
Automation	12
Feminist history of obstetrics	18
CHAPTER 3. PHASE I EMPIRICALLY DEFINING TRUST IN MEDICAL TECHNOLOGY	23
Overview	23
<i>Study one: Factor generation</i>	23
<i>Study two: Comparing trust across contexts</i>	28
<i>Study three: Paired comparison</i>	38
Conclusion	44
CHAPTER 4: PHASE II Construction of Trust in Medical Technology by Patients and Health Care Providers in Obstetric Work Systems	54
Overview	54
Introduction	54
Method	57
Findings	59
Discussion	67
CHAPTER 5. PHASE III THE DEVELOPMENT OF A TRUST IN MEDICAL TECHNOLOGY INSTRUMENT	72
Overview	72
Introduction	72
Instrument development	74
Development phase	76
Validation phase	84
Results	87
Discussion	98
CHAPTER 6. CONCLUSION	104
Recommendations	105
Theoretical and practical contributions	109
Future research	110

Works Cited	112
Appendix A. Phase I	123
A.1 IRB Approval Letter	123
A.2 Table Initial word set	124
A.3 Words from both TMT and TT that were dropped or added for Study 2.	126
A.4 Principal Components Analysis Questionnaire Study	134
A.5 Means, Standard Deviations, and Coefficient Alpha Reliability Estimate for the Study's Variables	138
Appendix B. Phase II	149
B.1 Role Analysis Code Summary	149
B.2 Participant Profiles	156
Appendix C. Phase III	160
C.1 Fit Definitions	160
C.2 Fit Statistics for total instrument	162
C.3 Fit Statistics for scale 1	165
C.4 Fit statistics Scale 2	166
C.5 Fit statistics for scale 3	167
C.6 Category Probabilities: Modes - Structure Measures At Intersections For Scale 1	168
C.7 Category Probabilities: Modes - Structure Measures At Intersections For Scale 2	169
C.8 Category Probabilities: Modes - Structure Measures At Intersections For Scale 3	170
C.9 Rasch residuals reported as eigenvectors	171
C.10 Final Instrument	174

LIST OF TABLES

Table 2.1	Human and Machine Capabilities	15
Table 3.1	Words to be Included in the Study	25
Table 3.2	Questionnaire Conditions	28
Table 3.3	Correlation of Trust by Distrust	30
Table 3.4	Summary of Fit	31
Table 3.5	Parameter Estimates	31
Table 3.6	Size and Percent Match of Union Sets	33
Table 3.7	Eigenvalues and Percent Variance for TMT and TT	35
Table 3.8	Number of Participants Per Cluster	40
Table 3.9	Cluster, Factors, and Guidelines for Trust in Medical Technology	42
Table 3.10	Design Guidelines for Trust in Medical Technology Based on Original 30 Factors	43
Table 3.11	Trust Enhancing and Reducing Behaviors	46
Table 3.12	Trust Factors Across Conditions	47
Table 4.1	Code Families of Technology Attributes Associated with Positive and Negative Feelings	61
Table 5.1	Three systematic areas for trust formation; the technology, the user, and how the user uses the technology and the associated factors	79
Table 5.2	Test blue print for factors of trust	82
Table 5.3	Test blueprint for factors of distrust	83
Table 5.4	Eigenvalues of all Components and the Kaiser's	88
Table 5.5	Factor One Eigenvalues, Item Number and Text	89
Table 5.6	Factor Two Eigenvalues, Item Number and Text	90
Table 5.7	Factor Three Eigenvalues, Item Number and Text	91
Table 5.8	Items Flagged for Further Evaluation	93
Table 5.9	Linacre's Rating Scale Guidelines	95
Table 5.10	Rating scale total instrument	96
Table 5.11	Rating scale for scale 1 Technology	97
Table 5.12	Rating scale for scale 2 Technology	97
Table 5.13	Rating scale for scale 3 Technology	97
Table 5.14	KR-20, Real and Modeled Person Reliability, and Real and Modeled Item Reliability for Scales 1-3 and Total Instrument	98
Table 5.15	Summary of Guideline Pertinence	100
Table 5.17	Test Based Validity Evidence	101
Table 5.18	Data Based Validity Evidence	102
Table 6.1	Recommendations for Technology Design	107
Table 6.2	Recommendations for System Design	108

LIST OF FIGURES

<i>Figure 3.1</i>	<i>Pearson correlation between all variables</i>	30
<i>Figure 3.2</i>	<i>Regression lines plotted for trust in technology and trust in medical</i>	32
<i>Figure 3.4</i>	<i>Hierarchical cluster analysis results</i>	39
<i>Figure 3.5</i>	<i>Cluster analysis for individual participants</i>	40
<i>Figure 3.6</i>	<i>Overlap of factors of trust in technology and trust in medical technology</i>	51
<i>Figure 4.1</i>	<i>Relationship between patient, technology, and operator</i>	55
<i>Figure 4.2</i>	<i>Model of patient and provider trust in medical technology</i>	59
<i>Figure 4.3</i>	<i>How technology was experienced by obstetric patients</i>	60
<i>Figure 4.4</i>	<i>Patient's trust in medical technology</i>	63
<i>Figure 4.5</i>	<i>Physician's trust in medical technology</i>	65
<i>Figure 4.6</i>	<i>Patient and physician trust in medical technology</i>	68
<i>Figure 5.1</i>	<i>Diagram of the process of measurement</i>	75
<i>Figure 5.2</i>	<i>Model of trust and distrust in medical technology</i>	77
<i>Figure 5.3</i>	<i>Model of patient's construction of trust in medical technology</i>	78
<i>Figure 5.4</i>	<i>Final trust in medical technology instrument</i>	103