

Panel Discussion

Data Quality as a Dimension of Usability for Health IT

ABSTRACT

Research has demonstrated that Health Information Technology (Health IT) holds great promise for improving the quality and efficiency of healthcare and for sourcing data for research and discovery. This panel explores how the usability of health IT systems can contribute to or detract from achieving its potential in these areas. Specific areas of focus will include: perspectives on clinical decision support in EHR (Electronic Health Record) systems, including aspects of data accuracy / information quality, usability's relationship to adoption and meaningful use of health IT, usability and the capacity of health IT systems to support research and development of data sets, roles of industry, government and academia to improve the usability of EHRs. The objective of the panel is to facilitate communication and discussions about the current state of data quality as a dimension of usability and its relevance to health IT.

BIOGRAPHY

Wil Yu

Special Assistant of Innovations and Research
Office of the National Coordinator for Health Information Technology



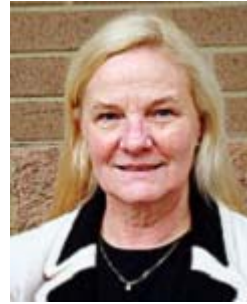
Wil Yu joined the Office of the National Coordinator (ONC) in 2009 as Special Assistant of Innovations and Research, initiating and leading the agency's innovation efforts. He directs several innovation initiatives at ONC/HHS and is also collaborating with several programs and reporting efforts related to the achievement of Meaningful Use and the adoption of health IT.

He is the Senior Project Officer for the Strategic Health IT Advanced Research Projects (SHARP) program, which funds research focused on achieving breakthrough advances to address barriers that have long impeded the critical adoption of health IT and accelerating progress towards achieving nationwide meaningful use of health IT. The program seeks to support dramatic improvements in the quality, safety, and efficiency of healthcare, through advanced information technology. Current SHARP priorities include research focused on achieving breakthrough advances to address well-documented problems that have impeded adoption: 1) Security of Health Information Technology; 2) Patient-Centered Cognitive Support; 3) Healthcare Application and Network Platform Architectures; and, 4) Secondary Use of EHR Data.

Wil also manages an ONC study on the availability of Open Source Health IT. He helped establish an HHS mHealth collaborative working group and is ONC's representative on the HHS Innovation Council.

Bettijoyce B. Lide

Senior Advisor for Health Information Technology
Information Technology Laboratory
National Institute of Standards and Technology



Bettijoyce B. Lide is the Senior Advisor for health information technology (health IT) in NIST's Information Technology Laboratory. She serves as program lead for NIST's health IT responsibilities outlined in the American Recovery and Reinvestment Act (ARRA) and for the NIST-Department of Health and Human Services (HHS)/Office of the National Coordinator for Health Information Technology (ONC) collaboration. She leads a NIST team in a broad range of initiatives to help enable the majority of Americans to have electronic health records and the development of a nationwide health information network by 2014.

Prior to that, Bettijoyce Lide was with the Advanced Technology Program (ATP), serving as both Competitions Manager and Program Manager, designing, implementing, and managing the Information Infrastructure for Healthcare Program. Earlier, she served as Scientist, Programmer, and Group Leader of the Data Systems Development Group, Standard Reference Data, leading cutting-edge applications of computer technology to the storage, analysis, retrieval, and dissemination of evaluated chemical and physical data.

Lana Lowry, Ph.D.

Human Factors Lead for Healthcare IT
Information Access Division
National Institute of Standards and Technology



Lana Lowry is NIST's expert and project lead on usability for health IT. Lana has conducted extensive applied research in usability and accessibility for several government agencies, most recently on voting systems in the United States for the National Institute of Standards and Technology (NIST). The goal of her research is to improve systems by developing usability and accessibility standards and testing protocols for laboratories to apply to the certification of the systems. Lana has published and presented extensively in the areas of human factors and ergonomics worldwide. Her expertise is in the design of complex systems and software for mission-critical and real-time environments; in the application of human reliability analysis and human error analysis to complex human-machine interactions in automated systems and software; and in the development of standards and methods for evaluating, testing, and improving system and application interfaces.

Lana served as a senior research scientist on a program providing human factors for the Earth Observing System Data and Information System (EOSDIS) Core System, part of the National Aeronautics and Space Administration's (NASA) Mission to Planet Earth. Later on, at NCR Corporation's Government Systems Division, Lana led a team of usability engineers for ten years, applying her knowledge and expertise in HCI and usability through product innovation in the retail markets, e-commerce solutions, and government systems environments.

Matthew Quinn, M.B.A.

Special Expert, Health IT
Agency for Healthcare Research and Quality (AHRQ)



Matthew Quinn is a Special Expert in the AHRQ Healthcare IT group. Before joining AHRQ, Mr. Quinn was the Healthcare Program Manager for Teradata, the global leader in data warehousing and analytic technologies, and was responsible for healthcare strategy and partnerships for the company. Prior, he led marketing for Quantros, a patient safety and clinical outcomes improvement software company, managed GE Healthcare's "Six Sigma for Healthcare" clinical outcomes performance improvement consulting services and data analytic products, helped build an early Personal Health Record (PHR) company, and served as an Army Engineer Officer.

Mr. Quinn's published work can be seen in a variety of healthcare and technology publications and journals, and he has spoken at the World Health Care Congress, eHealth Initiative's HIT Summit, and other national and international venues.

Matthew Quinn earned a B.S. from the United States Military Academy at West Point and an M.B.A. from Colorado State University.

Ellen Voorhees, Ph.D.

Group Leader, Information Access Division
National Institute of Standards and Technology



Ellen Voorhees is a Group Leader in the Information Access Division of the National Institute of Standards and Technology (NIST). Her primary responsibility at NIST is to manage the Text REtrieval Conference (TREC) project, a project that develops the infrastructure required for large-scale evaluation of text search and other natural language processing technology. She received a B.Sc. in computer science from the Pennsylvania State University, and M.Sc. and Ph.D. degrees in computer science from Cornell University.

Emily S. Patterson

Assistant Professor
College of Medicine, School of Allied Medical Professions
Division of Health Information Management and Systems
The Ohio State University



Emily S. Patterson, PhD, is an Assistant Professor in the College of Medicine, School of Allied Medical Professions, Division of Health Information Management and Systems, at The Ohio State University. Her primary research interests are applying human factors engineering to improve patient safety with health information technology and during patient handoffs. She currently serves on the advisory board for the Center for Innovation at the National Board of Medical Examiners, for the Joint Commission Journal on Quality and Safety, and formerly on the Centers Communication Advisory Group for the Joint Commission International Center for Patient Safety.

Improving and Measuring EHR Usability: NIST Guidelines and Test Methods

Lana Lowry, Project Lead



llowry@nist.gov



Health Information Technology Adoption

- ▶ Offers potential for improvements in the quality of patient care
- ▶ Addresses many persistent service quality problems
- ▶ Helps control spiraling costs in the healthcare system



NIST Health IT Initiative

The National Institute of Standards and Technology (NIST) is playing a key role in many Health IT initiatives, including interoperability, security, privacy, certification, testing, and usability.



Usability is a Key to Health IT Adoption

- ▶ Usability is a key factor in the meaningful use
 - No matter what functionality is provided, that functionality is for naught if not used effectively, efficiently, and safely by its human users
- ▶ People are a very important (and complex and unpredictable) part of any IT system
 - They are the ones that ultimately make use of and act on the information being provided
- ▶ Poor usability of Electronic Health Record (EHR) applications has a substantial negative effect on clinical efficiency and quality



NIST Usability Project Objectives

- ▶ To establish a framework that defines and assesses Health IT usability and accessibility
- ▶ To develop the detailed specification of an objective, repeatable procedure for measuring and evaluating the usability of Health IT systems



Overview of Current State of EHR Usability

Healthcare professionals report various usability issues with EHRs:

- ▶ Inefficient workflows that do not closely match clinical processes
- ▶ Confusing warning messages that could be ignored among the other demands of clinical care
- ▶ Screens designed with excessive data that may obfuscate potential issues with patient care
- ▶ Alert fatigue (both visual and audio)
- ▶ Frustration with what is perceived as clicks during common tasks



These usability issues may contribute to frustration, fatigue, and ultimately may impact patient care.



<http://www.nist.gov/standards/healthcare/blog/why-do-most-physicians-complain-about-e-hr-issues-02-2010>

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

R&D Questions

- ▶ **What does it mean to have a usable application?**
 - Users can perform their tasks effectively, efficiently, and are satisfied with the system
- ▶ **How can we make EHRs easier to use?**
 - By incorporating User-Centered Design (UCD) Process into system development cycle

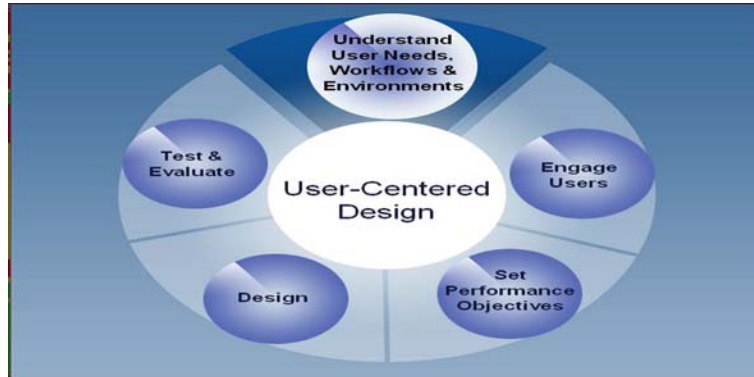
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User-Centered Design Process

- ▶ User-centered design can be characterized as a multi-stage problem solving process
- ▶ User-centered design optimizes the product around how users can, want, or need to use the product, rather than forcing the users to change their behavior to accommodate the product

User-Centered Design Process

- ▶ The users are involved early in the design: setting objectives for, doing detailed design, testing, evaluating, and changing the application
- ▶ The process cycles can go through many iterations at each step and can cycle repeatedly from understanding through testing
- ▶ Very important step in the user-centered design process is the validation study



User-Centered Design Process

Validation and Error Analysis

Following summative human factors testing procedures,

- ▶ Validation study engages a large sample of representative users doing representative tasks along with an error analysis
- ▶ Error analysis is a critical component because each use-related error must be explained and its remediation explained

EHR Usability Program (EUP)

The EUP focuses on identifying and eliminating risks to patients due to poor user interface design.



Lessons from FDA CDRH

- ▶ The proposed EHR usability program (EUP) is in compliance with the current Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH) device validation procedure
 - Emphasis is on ensuring that necessary and sufficient usability validation and remediation has been done to minimize use errors
- ▶ The FDA CDRH process provides a firm foundation to build the usability validation for EHRs



NIST Publications

NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)

- Guide to support EHR system developers in the use of key user-centered-design principles

Customized Common Industry Format Template for Electronic Health record Usability Testing (NISTIR 7742)

- This guide provides a standard CIF for testing EHR systems and reporting the results of summative usability testing

Usability in Health IT: Technical Strategy, Research, and Implementation (NISTIR 7743)

- Summary of workshop held by NIST/ONC/AHRQ on July 13, 2010 at NIST

Human Factors Guidance to Prevent Healthcare Disparities with the Adoption of EHRs (NISTIR 7769)

- Provides technical guidance for the design, development, implementation of EHR systems to prevent the creation of healthcare disparities in the workplace and among patients and national adoption and utilization of EHR systems



NIST Customized CIF for EHR

- ▶ This guide provides a standard reporting format, Common Industry Format (CIF)
 - CIF was adopted and customized for testing EHR systems and reporting the results of summative usability testing
- ▶ Intended Audience
 - EHR vendors
 - Usability administrator(s), usability engineers
 - Healthcare providers, researchers
- ▶ Intended Purpose
 - Help vendors demonstrate evidence of usability in their final product in a format that allows both independent evaluation of a single product and comparison across multiple products



Related HIT Usability Efforts

- ▶ Human Factors Guidance to Prevent Healthcare Disparities with the Adoption of EHRs
 - Providing technical guidance for the design, development, and implementation of EHR systems to prevent the creation or exacerbation of healthcare disparities in the workplace and among patients, with the national adoption and utilization of EHR systems
- ▶ The Relationship between Health Information Technology Usability and Patient Safety
 - Developing a framework linking usability to patient safety



Collaborations

Grants: Chicago Regional Extension Center with User-Centric, University of Wisconsin,, Johns Hopkins

Federal Agencies: ONC (Office of the National Coordinator for Health IT), HHS/AHRQ (Agency for Healthcare Research & Quality), HRSA (Health Resource Services Administration), VHA (Veterans Health Administration), FDA (Food and Drug Administration)

Others: British National Health Service (NHS), HIMSS (Healthcare Information and Management Systems Society, Indian Health Service, University of Texas-Houston (and other SHARPC grantee ins Westat, AAFP (American Association of Medicine)



Contact Information

Lana Lowry
Usability Project Lead
Information Technology Laboratory
National Institute of Standards and
Technology
llowry@nist.gov



Questions



AHRQ and NIST - EHR Usability Roadmaps

Matt Quinn



matt.quinn@nist.gov



Agenda

- ▶ Roles of AHRQ and NIST
- ▶ What's at Stake
- ▶ Current State of Usability in Certified EHRs
- ▶ Projects to Support Improved Usability
- ▶ Moving Forward
- ▶ Questions

Research in HHS *What is AHRQ's "Space"?*



NIH

Biomedical research to prevent, diagnose and treat diseases



CDC

Population health and the role of community based interventions to improve health



AHRQ

Long-term and system-wide improvement of health care quality and effectiveness

Mission and Role of NIST

- ▶ NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life
- ▶ NIST Laboratories conduct research that advances the nation's technology infrastructure and is needed by U.S. industry to continually improve products and services

Risks – What’s at Stake?



- ▶ Lack of adoption
- ▶ Lack of meaningful use
- ▶ Inability to perform critical functions
- ▶ Exacerbate staffing shortages / create divides
- ▶ Hamper broader health reform efforts

- ▶ System-caused / contributed errors
 - Patient harms
 - Privacy & security
 - Financial impacts

- ▶ Cynicism, resistance to change, exhaustion
- ▶ Fail to learn from experience

Current State of Usability

- ▶ “Usability” is an oft-cited limitation in the use of health IT
- ▶ Shortcomings in usability can contribute to:
 - poor uptake of EHRs in the market
 - new categories of errors in care delivery
 - barriers to entry in the workplace
- ▶ Usability, while recognized as critical for successful adoption and meaningful use, has not historically received the same level of attention as software features, functions and technical requirements
- ▶ Lack of understanding at all levels of usability as a scientific discipline (vs. opinion of users)

Vendor Practices Report

- ▶ Use of user-centered design processes, and specific resource personnel with expertise in usability engineering not common
- ▶ Specific best practices and standards of design, testing, and monitoring not readily available
- ▶ Usability viewed as competitive differentiator – collaboration almost nonexistent
- ▶ Reported perspectives on critical issues such as allowable level of customization by customers varied dramatically
- ▶ Vendors reported a variety of formal and informal processes for identifying, tracking, and addressing patient safety issues related to the usability of their products.
- ▶ Usability and accessibility of systems not currently addressed in certification

Perceived problem with regulating EMR usability

“measuring usability – it is so subjective. It is somewhat like judging art or architecture – what is beautiful (or useful) to one person, is ugly or un-useful to another. Trying to have an independent group judge your product’s useability [sic] is like putting the federal government in charge of something – you will ultimately have standards that are broad, whitewashed, mired in legal ramifications and which render a system utterly “unuseful.”

– Veteran of Healthcare IT, MrHISTalk Blog

Key Points from NIST Workshop

- ▶ **Usability is often misunderstood and we need education now**
 - Among vendors and purchasers, usability is often equated with user satisfaction
 - People use systems that they like, comfortable with, give them value w/out overload
 - Helping people avoid and recover from errors (easy-to-follow paths vs. alerts)
 - Educating and providing resources for both developers vendors and buyers

- ▶ **We know a lot about usability and can provide (some) guidance now**
 - Developers do not have to start from scratch for either accessibility or usability
 - Many resources already exist that provide relevant guidance on issues such as user interactions, cognitive load, screen design, message design, etc.

- ▶ **Usability can be measured**
 - Usability can be measured. Both qualitative and quantitative measures exist
 - A single usability score does not give enough information to help vendors or buyers
 - Many factors impact usability, incl workflow, time pressure, physical & social environments

Research Gaps

The panel recommended funding research on:

- ▶ Documenting patterns of clinician information use in EHR systems.
- ▶ Developing and evaluating “use cases” and tools for evaluating EHR implementations for adherence to usability principles and best practices.
- ▶ Developing an understanding of, and ways to measure the impact of usability and information design on ergonomic and cognitive workload, data awareness and comprehension, patient safety, clinician decision-making, and efficiency of care delivery.
- ▶ The effectiveness of adaptive displays, defined as those data displays that change the nature or format of information presented for viewing on specific patient characteristics or physician preferences.
- ▶ Assessing current vendor and health care organization practices with regard to information design in EHR product development lifecycle and implementation.
- ▶ Identifying and evaluating existing evidence-based style sheets and guidelines for EHRs
- ▶ Identifying and evaluating innovative ways to display complex information in EHRs.
- ▶ Identifying best practices in the use of shared (patient-clinician) EHR views, including applicable privacy and confidentiality issues.
- ▶ Promoting fellowships in the area of EHR usability and information design.

Policy Recommendations

The panel recommended the following policy actions:

- ▶ **Establishing certification requirements for EHRs, based on a practical and fair process of usability evaluation**
 - Include usability as an essential part of the certification process
 - Require/strongly recommend that vendors establish and document their programs for testing the usability of their systems (people and processes), including evaluating potential impacts on quality and safety.
 - Include EHR design and functionality in standards and guidelines
- ▶ **Developing a National EHR usability laboratory to:**
 - Support public-private collaboration and sharing of best practices in this area.
 - Develop tools and processes to support evaluation of products and implementations.
 - Assist health IT vendors in product development and health care organizations in effective implementation of EHRs.

AHRQ & NIST Activities

- ▶ Establishment of Technical Expert Panel
- ▶ EHR Usability: Evaluation and Use Case Framework
- ▶ EHR Usability: Interface Design Considerations
- ▶ NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records (NISTIR 7741)
- ▶ Customized Common Industry Format Template for Electronic Health Record Usability Testing (NISTIR 7742)
- ▶ EHR Usability Framework

- ▶ Vendor Processes & Practices Report
- ▶ EHR Usability Evaluation Toolkit
- ▶ NIST-Funded Grants

EHR Usability Evaluation Toolkit

- ▶ Synthesize available guidelines into objective usability rules
- ▶ Develop a toolkit for evaluating usability of primary care practice implementations
- ▶ Test toolkit in practices, vendors, certification body
- ▶ Disseminate tool through NRC, RECs and Professional Organizations



NIST EHR Usability Framework Contract

- ▶ Purpose: to develop a set of guidelines for EHR usability and a framework for assessing EHR usability
 - Understanding of EHR users and tasks, contexts of use, and the impact of EHR systems design features on usability & accessibility
- ▶ Broader goal: Detailed specification of an objective, repeatable procedure for measuring and evaluating
- ▶ Contract will cover
 - EHR User Characteristics
 - Cognitive Task Analysis
 - Usability Analysis of a Representative Sample of Existing EHR Systems
 - Usability Testing
 - Document EHR Usability Engineering (Organizational) Best Practices
 - "NIST Usability Guidelines and Evaluation Framework for EHR Systems"

NIST-Funded Grant Research

- ▶ Human Factors Guidance to Prevent Healthcare Disparities with the Adoption of EHRs
- ▶ EHRs and User Centered Design: Guidelines for Improving Usability for Regional Extension Centers and Professional Societies
- ▶ The Relationship Between Health IT Usability and Patient Safety: A Human Factors Engineering Framework for Action

Where Do We Go From Here?

- ▶ Establish foundational understanding
- ▶ Develop foundational standards
 - Use what we know
 - Share tools and resources
- ▶ Refine & execute research agenda
- ▶ Establish and build partnerships
 - Government
 - Industry
 - Academia



➤ **Contact Information**

Matt Quinn
matt.quinn@nist.gov
phone: 301-975-5936

Electronic Health Records & Natural Language



Ellen Voorhees



Text REtrieval Conference (TREC)

Premises

- Natural language is the most convenient way for humans to communicate many kinds of information
- Using data capture methods that are natural and convenient greatly increases the quality of the data so captured

Ergo

- Free-text fields in health records are both inevitable and desirable

Text REtrieval Conference (TREC)

But a problem

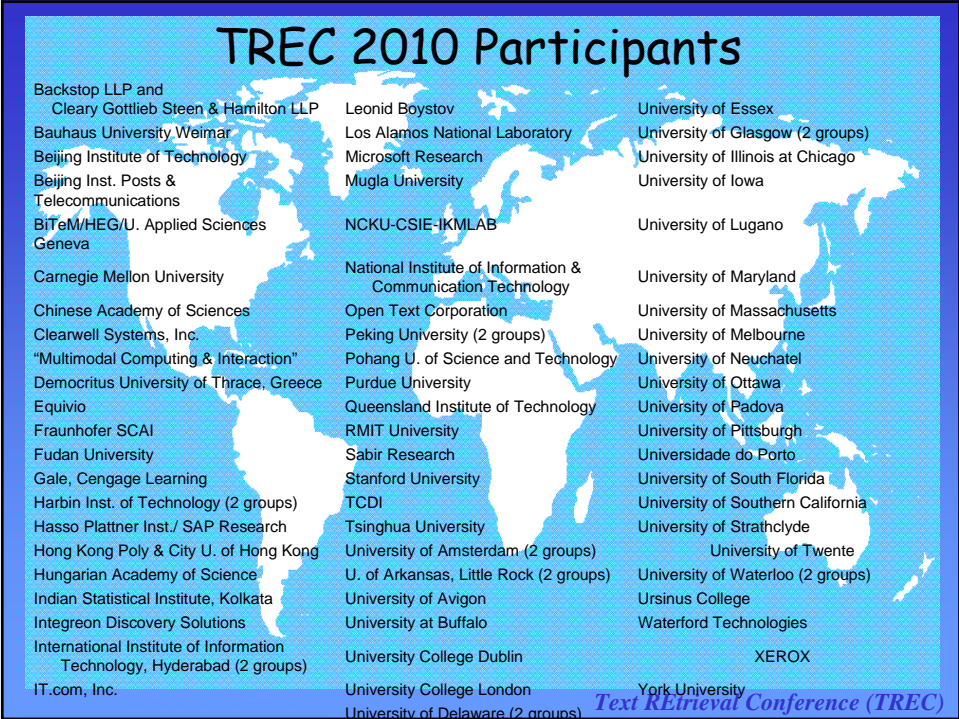
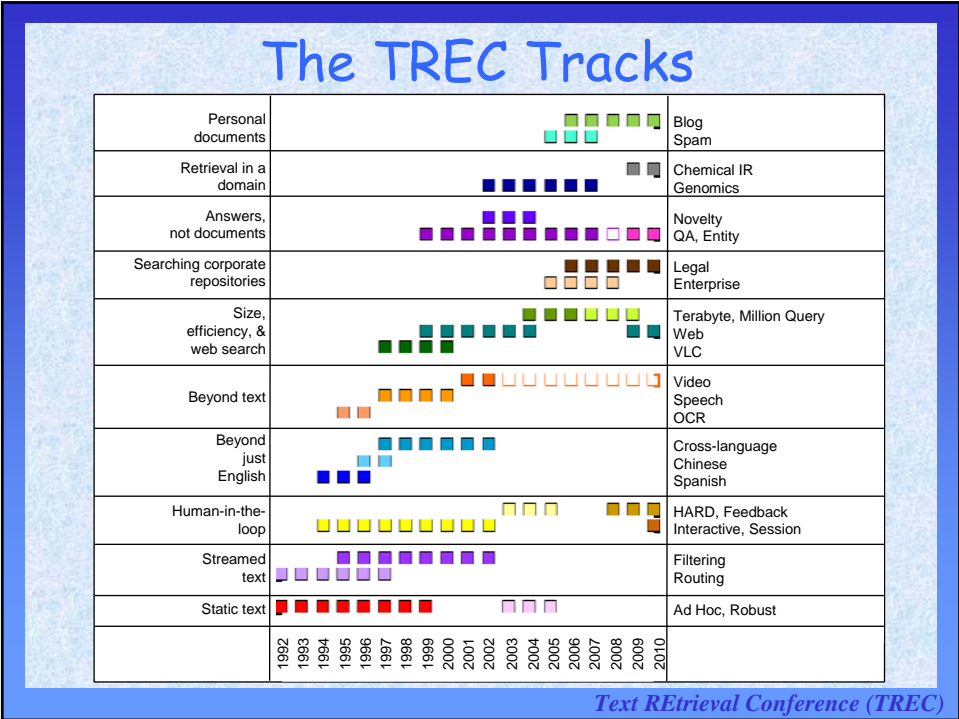
- While free-text fields are convenient and natural for input, subsequently finding records based on their semantic content is problematic
 - seldom well-formed, grammatical sentences
 - highly specialized vocabulary
 - many non-word terms such as abbreviations, measurements, symbols, etc.
 - often highly elliptical references to other parts of record
- Foster research through TREC track

Text REtrieval Conference (TREC)

TREC

- A workshop series that provides the infrastructure for large-scale evaluation of (text) retrieval technology
 - realistic test collections
 - uniform, appropriate scoring procedures
 - a forum for the exchange of research ideas and for the discussion of research methodology

Text REtrieval Conference (TREC)



TREC 2011 Medical Records Track

- Data: set of de-identified clinical records assembled by U. of Pittsburgh's BLULab NLP repository
 - <http://nlp.dbmi.pitt.edu/nlprepository.html>
- Ad hoc search queries developed and evaluated by medical students
- 50+ research groups have expressed interest in participating

Text REtrieval Conference (TREC)

Benefits of Community Evaluations

- Form/solidify a research community
- Establish the research methodology
- Facilitate technology transfer
- Document the state-of-the-art
- Amortize the costs of infrastructure

Text REtrieval Conference (TREC)

Adding Data Quality to Usability Evaluations

July 2011



Improving People's Lives
through innovations in personalized health care

Emily S. Patterson, PhD



Overview of Presentation

1. Traditional Usability Testing
2. Human Factors: A Related Perspective
3. Example: Adding Data Quality to Usability Test
4. Levels of Scenario Design
5. Complicating Factors for Data Quality



Traditional Usability Test Method

- **Purpose:** Formatively improve usability of software prior to release
 - Perform tasks while talking out loud
 - 5 users identify 85% of usability problems
- **Output:** Report with design recommendations
- **Metrics:**
 - Effectiveness: “Think aloud” verbal protocol
 - Efficiency: Time
 - Satisfaction: Questionnaire



Human Factors: A Related Perspective

Human Factors:
interdisciplinary human-centered approach to addressing design challenges

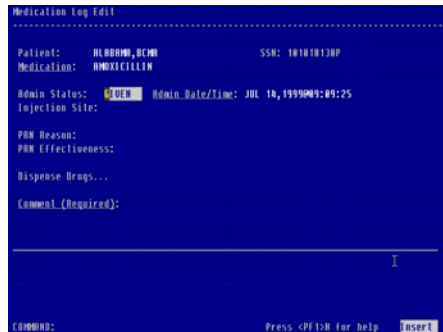
Usability:
how well users can learn and use a product to achieve their goals and how satisfied they are with that process



Workflow:
tasks, procedures, people, input and output information, and tools for each step in a sequence (distinction: ideal vs. actual)



Example: Adding Data Quality to Usability Test



Comments:

"It is so hard to change this that I often do not go back and change it if it is refused or held after I scan it."

"I often go in and ask the patient if he will refuse any medications before I scan them because I think the system is punitive if you want to go and change it later."

"There should always be "go back" button or "undo" so that you can change things later."

Recommendation:

Allow nurses to "Mark → Refused" in BCMA after scanning to document medication as refused



Bar Code Medication Administration

File View Reports Due List Tools Help

Missing Dose Add Comment Hist Allergies CPBS Med Order
 Available Bags Virtual Due List Parameters: Stop Time: 09/13@1400
 Display Order F4 Schedule Types: Continuous Qn-Call
 PRN One-Time

Mark Held
 Med History Not Given
 Missing Dose Refused
 PRN Effectiveness Removed
 Drug IEN Code

ALLERGIES: No all

Stat...	Ver	Hsm	Sort By	Dosage	Route	Admin Time	Last Action
***			Refresh F5	100 U/ML INJ NOVOLIN R	SSI, ACHS	09/13@1100	08/30/2002@0929 HELD
***	Q		POTASSIUM CHLORIDE PwDR, RENST-ORAL	20MEQ, NOW	PO		
***	P		POTASSIUM CHLORIDE 20MEQ/PKT ORAL PwD				
***	P		ALBUTEROL INHALANT	2 PUFFS, R-Q4H			
***	P		ALBUTEROL 90MCG 200D ORAL INHL				
***	P		OXYCODONE/ACETAMINOPHEN TAB	1 OR 2 TABLETS, Q4H	PO		
***	P		OXYCODONE 5MG/ACETAMINOPHEN 325MG T...	PRN			
***	P		PAIN				
***	P		ANTACID/SIMETHICONE LIQUID	15ML, Q4H PRN	PO		08/30/2002@0921 GIVEN
***	P		ALOH/MGQH/SIMTH XTRA STRENGTH LIQ				
***	P		indigestion				
***	P		MORPHINE INJ	2 TO 4MG, Q3H PRN	IVP/IM		
***	P		MORPHINE SULFATE 4MG/ML TUBEX				
***	P		NITROGLYCERIN TAB SUBLINGUAL	0.4MG, PRN	SL		
***	P		NITROGLYCERIN 0.4MG SL TAB U.D.				
***	P		GIVE 1 TABLET UNDER TONGUE Q5MIN				
***	P		X3. CALL HO				

Unit Dose IVP/VPB IV

Scanner Status: **Ready** Scan Medication Bar Code:

FICTITIOUS PATIENT RECORD

CINCINNATI Server Time: 09/13/2002 11:48

Levels of Scenario Design

Level	Integrity Target	Indicators of Integrity
Surface validity	Face valid to professionals	Participants recommend participation
Model of support	Justifications for use	Range of performance Includes <i>boundaries of support</i>
Justification for implementation	Clinical significance	Objective performance improvements
Representative complexity	Covers complexity range	Includes complicating factors
Performance observability	Cognitive activities are <i>observable</i>	Utterances and actions



Complicating Factors for Data Quality

Factor	Description
Missing information	Key information not available
Uncertain Information	Accuracy is uncertain
Distributed Information	Information is distributed across roles
“Overturning” Updates	Require integrating conflicting information over time



Challenge Scenario with Complicating Factors

Factor	Example
Attention demands	Multiple interruptions
Missing information	Pt had a severe allergic reaction in past, but to what medication is missing
Uncertain Information	Medication listed twice at two different doses
No predefined plan	Dialog box: "Patient not found in database"
Overconstrained task	Not enough time to do tasks
Workload	High navigation burdens in transferring patient



Significant Investments Are Easier Earlier

With present equipment, flying is so difficult that many individuals cannot learn to pilot an aircraft safely, and...human errors account for a major proportion of aircraft accidents...As aircraft become more complex and attain higher speeds, the necessity for designing the machine to suit the inherent characteristics of the human operators becomes increasingly apparent.



Fitts, 1947, reprinted in
Karsh et al., 2010, p. 621



Thank you for your attention.

Questions?

