Human Factors Engineering & Health IT Design

Rollin J. (Terry) Fairbanks, MD, MS
Director, National Center for Human Factors Engineering in Healthcare
Director, Simulation & Training Environment Laboratory (SiTEL)
MedStar Health, Washington DC, USA

www.MedicalHumanFactors.net ; @TerryFairbanks

Associate Professor of Emergency Medicine, Georgetown University
Attending Emergency Physician, MedStar Washington Hospital Center

Usability and User Centered Design

- **Usability**: Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

- **UCD**
The Two Bins of Usability

1: User Interface Design
   - Displays and Controls
   - Screen Design
   - Clicks & Drags
   - Colors & Navigation

2: Cognitive Task Support
   - "Workflow Design"
   - Smart Data Visualization
   - Support Cognitive Work Functionality

Bin 1 – User Interface (UI)

- Anatomically oriented
- Is this the best way?
Focus #1: Bin 2 – Advanced
Applied Cognitive Systems Engineering
NIBIB K08, AHRQ R01, AHRQ R18
Complex Adaptive Systems

**WORK AS IMPLIED**
*How managers believe work is being done (rules)*

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**GAP**

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**WORK AS PERFORMED**
*Every-day work: How work IS being done*

Adapted from: Ivan Pupulidy
Audit: 50% Compliance with Hospital VTE guideline…

WHY are these doctors so non-compliant?

Multiple inpatient PE's occur over 2 years

Bin 2: Cognitive Decision Support

CPOE Pathway: Screen #1

CPOE Pathway: Screen #2
Result of CPOE Pathway

- Readily accepted by physicians
- Increase in appropriate prophylaxis rates
  
  50% → 66% → 93%


Human Factors “Bin 2” Considerations

- Ideal systems- built to support the cognitive work of the end users
  - This is complex- we should do together
- For safety- remember skills based (automation) error
  - Education & Training NOT effective
- Make it easy to do the safest & best thing
Focus #2: ONC-sponsored work (Published in June)

Vendor User Centered Design (UCD)

- Objective:
  - Understand vendor UCD processes and challenges
  - UCD: any formalized process for incorporating user needs throughout design, development and implementation

- Method:
  - Onsite meetings primarily with:
    - Usability experts
    - Business Analysts
    - Product Managers

Vendor Demographics

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Est. Revenue</th>
<th>Est. Employees</th>
<th>Est. Usability Team Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor 1</td>
<td>$1 billion+</td>
<td>6000+</td>
<td>15 ppl</td>
</tr>
<tr>
<td>Vendor 2</td>
<td>$1 billion+</td>
<td>6000+</td>
<td>30+</td>
</tr>
<tr>
<td>Vendor 3</td>
<td>$1 billion+</td>
<td>6000+</td>
<td>NA</td>
</tr>
<tr>
<td>Vendor 4</td>
<td>$100 million+</td>
<td>2200</td>
<td>30+</td>
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<tr>
<td>Vendor 5</td>
<td>$100 million+</td>
<td>6000+</td>
<td>NA</td>
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<tr>
<td>Vendor 6</td>
<td>$100 million+</td>
<td>2000</td>
<td>30+</td>
</tr>
<tr>
<td>Vendor 7</td>
<td>$40 million+</td>
<td>500</td>
<td>5+</td>
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<td>Vendor 8</td>
<td>$40 million+</td>
<td>500</td>
<td>5+</td>
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<td>Vendor 9</td>
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<td>Vendor 10</td>
<td>$10 million+</td>
<td>10</td>
<td>NA</td>
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<tr>
<td>Vendor 11</td>
<td>$300,000+</td>
<td>10</td>
<td>NA</td>
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<tr>
<td>Range</td>
<td>$300,000+ - $1 billion+</td>
<td>10-6000+</td>
<td>0-30+</td>
</tr>
</tbody>
</table>
Focus #3: Analysis of SED Reports:
Do Vendors & ACBs Adhere to Policy?

- Tremendous variability in evaluation of 50 CHPL
  - As few as 3 participants (some with 20)
    - Violates usability standards & creates double standard
  - Diverse range of participant expertise
    - Some with no clinical expertise (eliminates bin 2)
  - Diverse experience levels
  - Variability in amount of training on the system
- Not at all ACBs are posting the SED results

Ratwani RM, Benda N, Hettinger AC, Fairbanks RJ. Electronic Health Record Vendor Adherence to Usability Certification Requirements and Testing Standards. JAMA (Letter, in press)

Focus #4: How do end users & buyers know who is good at UCD?

- No good way for people to make comparisons
- ACB analysis extremely complex for experts
- Working on scorecard so non-usability folks can better understand & evaluate usability
  - How many participants should you run?
  - What is a rigorous use case?
  - Who should the participants be?
  - NIST effectiveness, efficiency, satisfaction: what is a good metric??
Focus #5: Implementation

- Implementation processes:
  - Variability in implementation processes across vendors/providers
  - Few guidelines (AHRQs SAFER guides are a start)

Acetaminophen (Tylenol)
User Centered at every level

- Example: How are orders searched for in the system?
  - Urine Sodium
  - Urine NA
  - NA Urine
  - NA Level Urine

Alarm Fatigue- Not well controlled

<table>
<thead>
<tr>
<th></th>
<th>Removed</th>
<th># Cancelled</th>
<th># Overridden</th>
<th># Total alerts</th>
<th>% Overridden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug-Dose</td>
<td>606</td>
<td>0</td>
<td>12,689</td>
<td>14,429</td>
<td>88%</td>
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<tr>
<td>Drug-Allergy</td>
<td>455</td>
<td>0</td>
<td>1,742</td>
<td>4,497</td>
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</tr>
<tr>
<td>Drug-Disease</td>
<td>40</td>
<td>0</td>
<td>2,093</td>
<td>2,435</td>
<td>86%</td>
</tr>
<tr>
<td>Duplicate Drug</td>
<td>1,388</td>
<td>0</td>
<td>32,919</td>
<td>37,259</td>
<td>88%</td>
</tr>
<tr>
<td>Duplicate Ther. Class</td>
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<td>0</td>
<td>22,100</td>
<td>25,439</td>
<td>87%</td>
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<tr>
<td>Drug-Drug</td>
<td>89</td>
<td>0</td>
<td>14,063</td>
<td>15,250</td>
<td>92%</td>
</tr>
<tr>
<td>Pediatric</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>29</td>
<td>86%</td>
</tr>
</tbody>
</table>

Matt Scanlon MD, Professor of Pediatrics, Medical College of Wisconsin, USA

Factors Contributing to Successful Implementation and Long Term Use

- Customization
- Design Choices
- IT Support
- Training & Awareness
- Successful EHR Implementation
- Hardware & Environment
- Surveillance & Optimization
- Factors Contributing to Successful Implementation and Long Term Use
Shared Responsibility for EHR Usability

Impact of EHR Implementation on Practice

- Observational study of EM physicians:
  - Pre EHR: few weeks prior to introduction of EHR
  - GoLive: Week of the new system in place
  - Post EHR: 3 months after golive date
- Tracked physician tasks on a minute by minute basis
  - Computer, patient, paper etc
- 2 hour samples from 14 different EM physicians in each phase

Pre EHR Compared to GoLive
Customization

- Adhere to design principles

<table>
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<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>Consistency</td>
<td>Internal and external consistency in the methods by which you interact with the system</td>
</tr>
<tr>
<td>Cognitive Load</td>
<td>Cognitive/memory load requirements should be reduced.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Explicit and specific feedback should be provided to the user.</td>
</tr>
<tr>
<td>Visibility</td>
<td>The user should know the state of the system (e.g., goal state)</td>
</tr>
<tr>
<td>Information</td>
<td>Information should be effectively presented to facilitate cognitive performance (reduce clutter, meaningful use of color)</td>
</tr>
<tr>
<td>Efficient Interaction</td>
<td>The system should be easy to interact with</td>
</tr>
</tbody>
</table>

HIMSS, 2009; AMIA, 2012; Hong & Adj
Customization

- Ask the vendor and other providers for guidance
- Push vendors to share their experience from other implementations
- System updates don’t always play well with customization

Focus #6: Safety Monitoring and Analysis

- Machine learning (NLP) to analyze HIT related safety events (>70,000)
  “A prescription was written under the wrong ED patient’s name... patient unable to read the medication label to me over the phone... continual problem in the ED because the [EHR] whiteboard screen resets itself to the patient at the top of the list even when a doctor is trying to print discharge papers or a prescription on a different patient."
- Analyze these events in the context of UCD practices to provide insights on how to improve UCD
- Early data showing many downtime events — Focus #7

Our Proposed Roadmap of Safety Opportunities from a Usability Perspective
Map of Safety Opportunities from a Usability Perspective

- Vendor guidance on integrating UCD with the development cycle (engage partners)
- Clearer guidance on specific UCD aspects to the vendor and the ACBs (engage partners)
- Improved reporting of UCD results
- Modification to SED requirements
- Inspect process OR provide summative testing results

Map of Safety Opportunities from a Usability Perspective

- Education on usability, UCD
- Facilitate the ability to compare vendor products by providing greater detail about the UCD process being employed
- Scorecard to help non-usability folks understand where the good usability is

Map of Safety Opportunities from a Usability Perspective

- Provide best practices for customization, implementation, and software updates.
- Build on the SAFER guides to provide guidelines for the composition of IS/IT teams.
- Downtime management
Our approach to Health IT

- Immersed in the clinical environment with robust access
- Embrace a multi-disciplinary approach
- TRUE systems approach: Embedded with health system, know vendors, understand policy, know usability, we are developers, users, implementers, testers
- Simulation and Technology
  – Eye trackers, Google Glass, Sensor Tech, RFID
Research: From Theory to Practice

Funded by:
- NIH
- AHRQ
- ONC
- Foundations

Policy
Application
Theory
Individual
Team
Unit
System

OB Serious Games
ED Cognitive Engineering for HIT
ECG Interpretation and Training
Patient Safety Event Dashboards
Social networks for safety
RCA Review
Trauma Coordination

Acknowledgments

Raj Ratwani, PhD
Scientific Director

Zach Hettinger, MD MS
Medical Director

Rollin J. (Terry) Fairbanks, MD, MS
Director, National Center for Human Factors Engineering in Healthcare
Director, Simulation Training & Education Lab (SiTEL)
MedStar Institute for Innovation, MedStar Health / Washington DC USA
Associate Professor of Emergency Medicine, Georgetown University
Attending Emergency Physician, MedStar Washington Hospital Center
www.MedicalHumanFactors.net
www.SiTEL.org
Fairbanks.au@MedicalHFE.org (until 8/20/15)
Terry.Fairbanks@MedicalHFE.org
Twitter: @TerryFairbanks