Emerging Approaches to Usability Evaluation of Health Information Systems:

Towards In-Situ Analysis of Complex Healthcare Systems and Environments

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Usability Engineering in Health Care

Usability Testing – Observing users of a system carrying out representative tasks to assess “ease of use” of a system

1. Learning
2. Effectiveness
3. Efficiency
4. Enjoyability
5. Safety

Questions:
- How can we extend usability testing approaches to in-situ testing of systems? (i.e. in real-life settings)
- Is doing this effort cost-effective?
A Continuum of Usability/Simulation Studies and Settings: From Laboratory to In-situ Testing

LABORATORY
- Usability testing
- Experimental laboratory tasks
  - “think aloud”
- Clinical simulations in the lab

IN-SITU
- Clinical Simulations in real setting
- Recording the real clinical situation
  (naturalistic studies)
Usability Testing Throughout the SDLC

- **Previous Findings:**
  - The *earlier* usability testing is considered in the System Development Life Cycle (SDLC) the better
  - Best cost-benefit ratio early on
  - *In-situ* testing often proves to be most cost-effective and also highest fidelity (i.e. closest to real work)
  - Our early projects often took place too late in the design cycle – we have since worked backwards (even to procurement)
Low-cost Rapid Usability Testing
(Kushniruk & Borycki, Healthcare Quarterly, 2006)

- Recording users with system in actual setting
- Does not require an expensive fixed usability laboratory
- Highest fidelity clinical simulations when conducted in real setting (can be lowest cost)
- Can be used to predict errors and problems with system – using qualitative/quantitative video coding
- Can also be extended to analysis of real (naturalistic) uses of systems to verify predictions made in laboratory or simulation studies – Will identify issues not seen in laboratory testing
Low-cost Rapid Usability Testing Equipment

- Video camera to record user physical actions
- Microphone to record user verbalizations
- Screen cam to record user facial expressions
- Recording of computer/PDA screens to CD using screen capture software e.g. Hypercam

From: Kushniruk & Borycki (2006), Low-cost rapid usability engineering, Healthcare Quarterly
Can We Extend Low Cost Rapid Usability Testing to Predict Impact In-situ PRIOR to System Release?
From the Laboratory to Real Work Contexts and Naturalistic Testing

**Objective:**
- Improving usability and error prediction

**Assessment of impact of systems on workflow before they are released**

**Need for low-cost portable approaches for conducting clinical simulations in complexity of realistic and real settings**
- Emergency rooms
- ICUs
- Hospital wards
- Doctor’s offices
Example: Clinical Simulation of Electronic Health Record Use Conducted In-Situ

- Studies of medication ordering, administration and documentation systems in situ in a Japanese hospital room
  - Including integration of bar coding and EMR

- Subjects – 5 nurses, 11 doctors

- Setting: Conducted in-situ (real setting)
  - Used “dummy” in one condition (as well as real patients in naturalistic analysis)
  - After predictions made from simulation, testing continued with real cases (to verify simulation predictions)

- Testing Scenarios: check list of orders, hang bags, record
  - Record all computer screens, actions, dialogues
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医師の診察画面を背景に、患者の情報を表示している。
FIRST ORDER:
00:14.3 SEARCH FOR PATIENT ON COMPUTER
00:45.7 VIEW ORDER LIST
00:51:9 SELECT ORDER
00:55:.3 VERIFICATION SCREEN APPEARS

MOVES OVER TO PATIENT
00:59:6 TALKING TO PATIENT S. “Nice to meet you. Is your name Toridai, right? I will now give you an IV drip”
01:09.5 SCAN PATIENT ID (FROM WRIST)

MOVES BACK TO COMPUTER
01:25:2 VIEW EXECUTION INFORMATION

MOVES OVER TO PATIENT AND SETS BAG

SECOND ORDER:
02:24.6 SEARCH FOR PATIENT ON COMPUTER
02:40.2 VIEW ORDER LIST
E: Do you find any difficulty with handling the barcode reader?

S: In today’s operation there were no problems. But in the real situation, sometimes the scanner doesn’t respond to the barcode. Also sometimes the cord of the scanner is too short to reach the patient.

E: Do you find any difficulty with entering the data?

S: Sometimes in the emergency we have to skip this procedure due to its time-taking process and someone might need urgent help, but with this system I don’t think I’d be able to do that ...
Findings

- Testing identified basic changes in workflow in simulation and naturalistic testing
  - From parallel order of activities to rigid “serial” flow
  - As result added emergency “override” function

- Approach involved limited data collection and low data analysis costs (under $5,000 total)

- Predicted serious safety issues (and errors) that would arise prior to releasing the system
  - However, we did not estimate possible $ benefits, either from cost of fixing usability errors or potential medical errors
Cost-Benefits of Low-Cost In-Situ Testing

- Masters thesis of Tristin Baylis
- **Objective:** To determine cost-effectiveness of low-cost rapid usability approach conducted in-situ
- **Method:**
  - Collect all start up costs (equipment etc.)
  - Apply low cost approach to assess a disease management application (using two patient case scenarios, 8 subjects)
  - Collect all data collection and analysis costs
  - Quantify estimated benefits
  - Calculate cost-benefit ratio
### Disease Management System Tested

**Patient Details**

**Booth, John**

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**Excluded From Recall Report:** No

#### Patient's Diagnosis

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#### Co-Morbid Conditions

- **Warning:** Click on the pulldown menu next to each disease to view the available actions. Select the desired action, and click "Go" to continue.

**Back to Patient List**

Version: 1.5.0

Deployed: 2009-08-20
Results of Cost-Benefit Analysis

- Total cost of conducting and analyzing the data (applying low-cost rapid usability method): $8,362.91

- Rapid analysis (using 2 scenarios) detected range of problems, both usability errors and safety issues (e.g. implications of not calculating body mass correctly)

- Safety issues were identified by a medical expert and potential cost of errors going undetected estimated
Benefits of Testing

- The most conservative cost savings based just on cost of fixing surface level usability problems found in this one cycle (not counting potential cost of medical error resulting from using the system) was $15,774.45.

- A total percent savings of 60%.

- If the extreme case was considered (i.e. each potential medical error costing $600,000) cost savings increases considerably!
Advantages of In-situ testing

- Provides results that take into account context of system use
  - Environmental context (e.g. interfacing technologies)
  - Geographical context of use (rather than context of some central usability lab, which likely does not mirror reality of local settings)
  - Social and regulatory context

Can be done in a cost-effective manner
Conclusions

- To ensure system usability and safety, need for dissemination of low-cost in-situ methods
  - to *both* vendors and healthcare organizations

- Laboratory-based testing clearly *not* sufficient
  - as evidenced by systems that were tested in labs elsewhere, deemed usable and safe, but can be shown to lead to error in local organization!!
  - Therefore, local in-situ testing is needed to ensure both safety and efficiency

- Low-cost, high-fidelity approaches to usability engineering now exist - need to take testing into context of system use!