TURF – A Unified Framework
For EHR Usability

Jiajie Zhang & Muhammad Walji

National Center for Cognitive Informatics & Decision Making in Healthcare
Research Goals for TURF

• Language for
  – defining usability

• Theory for
  – describing, explaining, and predicting usability differences

• Methods for
  – evaluating
  – measuring
  – designing usability

• Software tools for
  – partially automating the methods
What is Usability?

• Usability refers to how
  – useful,
  – usable,
  – satisfying

• a system is for the intended users to accomplish goals in the work domain by performing certain sequences of tasks

TURF Framework for EHR Usability

- **Intrinsic Complexity**
- **Extrinsic Difficulty**
- **Electronic Health Record**

**Usability Problem Identification**
- Collaborate with GCREC & Vendors

**Usefulness**
- Clinical settings
- Design and redesign

**Usable**
- Laboratory based
- Focus on usableness

**Satisfying**

**Rapid Usability Assessment**

**Comprehensive Usability Assessment**

**Useful**
- Useful

**System Usability**

**Tasks**

**Functions**
- Also includes:
  - Usefulness
  - Clinical settings
  - Design and redesign
Rapid Usability Assessment
Stage 1 Meaningful Use Objectives

Core Set Objectives (selected from 15)

1. CPOE
2. E-prescribing
3. Demographics
4. Problem list
5. Medication list
6. Medication allergy list
7. Vital signs, BMI, growth chart
8. Smoking status
9. E-Copy of health information
10. Clinical summary
Usability Violations

Consistency & Visibility
1. Window shown is called the Patient Select popup but the Alerts being shown are for the physician and not specific to a patient and there is no indication to the user that these are for the user logged on to the system.

Memory & Match
2. The user has to remember that the Alerts are for all patients. The user has to know where to look for the Alerts
3. The icons do not match the expected use of these symbols.
Task Analysis - Keystroke Level Model

<table>
<thead>
<tr>
<th>Operator Sequence</th>
<th>KLM Code</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find the &quot;Orders&quot; tab</td>
<td>M</td>
<td>1.2</td>
</tr>
<tr>
<td>Point to &quot;Orders&quot; tab</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;Orders&quot; tab</td>
<td>B</td>
<td>0.1</td>
</tr>
<tr>
<td>Find the &quot;Common Orders&quot;</td>
<td>M</td>
<td>1.2</td>
</tr>
<tr>
<td>Point to &quot;Common Orders&quot;</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;Common Orders&quot;</td>
<td>BB</td>
<td>0.2</td>
</tr>
<tr>
<td>Wait for the system to show &quot;Common Orders&quot; pop-up window</td>
<td>W</td>
<td>0.1</td>
</tr>
<tr>
<td>Find the &quot;LAB ORDERS&quot;</td>
<td>M</td>
<td>1.2</td>
</tr>
<tr>
<td>Find the &quot;Search All Labs&quot;</td>
<td>M</td>
<td>1.2</td>
</tr>
<tr>
<td>Click &quot;Search All Labs&quot;</td>
<td>B</td>
<td>0.1</td>
</tr>
<tr>
<td>Wait for the system to show &quot;Order a Lab Test&quot; pop-up window</td>
<td>W</td>
<td>0.2</td>
</tr>
<tr>
<td>Find &quot;Available Lab Tests&quot;</td>
<td>M</td>
<td>1.2</td>
</tr>
<tr>
<td>Point to &quot;Available Lab Tests&quot; field</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;Available Lab Tests&quot; field</td>
<td>B</td>
<td>0.1</td>
</tr>
<tr>
<td>Type &quot;CBC&quot;</td>
<td>K(3)</td>
<td>0.84</td>
</tr>
<tr>
<td>Point to &quot;CBC&quot; on the lab test list</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;CBC&quot; on the lab test list</td>
<td>B</td>
<td>0.1</td>
</tr>
<tr>
<td>Point to &quot;Order&quot; button</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;Order&quot; button</td>
<td>B</td>
<td>0.1</td>
</tr>
<tr>
<td>Point to &quot;Close&quot; button</td>
<td>P</td>
<td>1.1</td>
</tr>
<tr>
<td>Click &quot;Close&quot; to close the &quot;Order a Lab Test&quot; pop-up window</td>
<td>B</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Total Time | 39 | 35.06 |
Findings from Expert Reviews

[Bar chart showing the number of usability problems and average severity for various categories such as Demographics, Vital Signs, Body Mass Index, Growth Chart, Problem List, Medication List, Allergies, Smoking Status, Clinical Summary, E-Copy of Health Info, E-Prescribing, and CPOE.]
Findings from Expert Reviews

- Undo: 90
- Document: 343
- Visibility: 355
- Memory: 362
- Feedback + Error: 426
- Match: 508
Findings from Task Analysis - Time on Task (seconds)

- CPOE: 349 seconds
- Average User Time: 194 seconds
- Optimal Time after Redesign: 97 seconds

<table>
<thead>
<tr>
<th>Task</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital Signs</td>
<td>44</td>
</tr>
<tr>
<td>Demographics</td>
<td>27</td>
</tr>
</tbody>
</table>
Comprehensive Usability Assessment

Moving from the lab to the field
TURF in Action: Redesigning EHR

Harrington, Wood, Breuer, Pinzon, Howell, Pednekar, Zhu, & Zhang (AMIA 2011) – AMIA Session S85 @ 8:30am on Wed 10/26
TURF Architecture

Presentation layer

Data Collection

Mapping editor

Data Capturing
- Representation data: Screenshot, video, widget
- Interaction data: Keystroke & mouse movement
- User data: Profiles
- Function Data: Work domain ontology

Modeling
- Data integration
- Populate TURF models
- Modeling engine
- Repository management

Analysis & Report
- Model-Driven Analysis
  - Usability Metrics
  - Usability Benchmarks
  - Usability & safety patterns
  - EHR domain ontology

Business layer

Data Layer
- Data access components
- Data utilities
- Service agents
- Entity-relational database
  - Ontology database

Usefulness of TURF models

Data utilities

Service agents

Other usability test/analysis services (e.g., Cogtool, Ulog, Noldus, etc.)
TURF – Video / Screen Shots here
# Acknowledgements

## SHARPC Project 1 Personnel

<table>
<thead>
<tr>
<th>Project Leaders:</th>
<th>Project Co-Is:</th>
<th>Consultants:</th>
<th>Postdocs, GRAs, Programmers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiajie Zhang</td>
<td>Amy Franklin</td>
<td>Ali Bahrami</td>
<td>Min Zhu</td>
</tr>
<tr>
<td>Keith Butler</td>
<td>Debora Simmons</td>
<td>Ellen Bass</td>
<td>Thomas Kannampallil</td>
</tr>
<tr>
<td>Muhammad Walji</td>
<td>Brent King</td>
<td>Chris Esposito</td>
<td>Louis Lee</td>
</tr>
<tr>
<td></td>
<td>Yan Xiao</td>
<td>David Kieras</td>
<td>Yingliu (Meg) Gu</td>
</tr>
<tr>
<td></td>
<td>Ali Mokdad</td>
<td>Mark Musen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emeka Okafor</td>
<td>David Woods</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Axel Roessler</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Advisor:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark Haselkorn</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## This project was supported by:

1) ONC SHARP Grant for Patient-Centered Cognitive Support

2) ONC Texas Gulf Coast Regional Extension Center for Health IT