Categorization of Critical User Interactions for Pediatric EHR — A TURF Model

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And The SHARPC Team
Outline

- What is TURF?
- A TURF Model for Critical User Interactions
What is TURF?
TURF - A Unified Framework of EHR Usability

- **An Acronym for**
  - Task, User, Representation, & Function

- **A Theory for**
  - defining, describing, explaining, and predicting usability

- **A Method for**
  - evaluating and measuring usability
  - designing usability
  - categorizing usability and safety problems

- **A Software Tool for**
  - (partially) automating usability evaluation
  - conducting user testing
  - building EHR ontology
  - generating evidence-based designs
  - conducting usability and patient safety analytics
What is Usability?

- Under TURF, usability is defined as how
  - useful,
  - usable,
  - satisfying
  a system is for the intended users to accomplish goals in the work domain by performing certain sequences of tasks
Dr. Townshend prescribes 90 day supply of Metformin 500 mg tablets by mouth twice daily to patient John Doe who is a pre-diabetic patient with a glucose level of 110.
Dr. Townshend prescribes 90 day supply of Metformin 500 mg tablets by mouth twice daily to patient John Doe who is a pre-diabetic patient with a glucose level of 110.
Measuring Extrinsic Difficulty -- Usableness: Task Time and Usability Problems
Measuring Extrinsic Difficulty — Usableness: Mental Workload

- CPOE
- ePrescribing
- Clinical Summary
- Smoking Status
- Problem List
- Growth Chart
- BMI
- Vital signs
- Demographics

Comparison of physical and mental workload for different tasks.
Measuring Intrinsic Complexity -- Usefulness: Overhead Function

Overhead in EHR

<table>
<thead>
<tr>
<th>Domain Functions in EHR</th>
<th>Overhead Functions in EHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPOE 1</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>CPOE 2</td>
<td>64%</td>
</tr>
<tr>
<td></td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>
Measuring Intrinsic Complexity -- Usefulness: Domain Function Completeness

Domain Function Completeness = \frac{\text{#Domain Functions in EHR}}{\text{#Domain Functions in Entire Work Domain}}

A Small EDR System

\(\frac{37}{80} = 46\%\)

(From Chen, 2008)
TURF Software Tool Architecture

Presentation layer

Data Collection

Modeling

Analysis & Report

Business layer

Data Capturing

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

Mapping editor

Modeling engine

Repository management

Model-Driven Analysis

Usability Metrics
Usability Benchmarks
Usability & safety patterns
EHR domain ontology

Data Layer

Data access components

Data utilities

Service agents

Entity-relational database
Ontology database

Other usability test/analysis services
(e.g., Cogtool, Ulog, Noldus, etc.)
TURF Software Tool: Assess, measure, and improve EHR usability

- Semi-automate usability expert reviews
- Build cognitive models to predict clinical task performance times
- Capture user testing data
- Build EHR ontology from usage data
- Generate evidence-based designs

TURF 1 Beta Release: Summer 2012
TURF Model for Critical Risks
A TURF Model of Critical Risks for Pediatric EHR

**Intrinsic Complexity**
- Physical characteristics
  - Weight, height, Body Surface Area (BSA), Body Mass Index (BMI)
- Developmental issues
  - Fetal to postnatal to adulthood
  - Gestational age and actual age
  - Change of organ systems with age
  - Age, weight, and height dependent disease states, symptoms, exam findings, lab results, and treatments
- Complexity of medications
  - Change of dosage with age, weight, and BSA
  - Rounding of dosage
- Patient identification issues
  - Date of birth, names, temporary names, pre-admission identification
- Unique information requirements
  - Growth chart
  - Vaccination history
  - Parental and sibling information
  - Information from third person
  - Graph variables over time
  - Genetic information
  - Privacy

**Extrinsic Difficulty**

**Pediatric Electronic Health Record**

**Tasks**
- Task goals
- Task sequences
- Individual operations
- Temporal constraints

**Users**
- Pediatricians
- Nurses
- Patients
- Parents

**Functions**
- Dosage support
- Growth chart
- Vaccine schedule
- Medication order
- Alerts for abnormal values
- Privacy
- Other pediatrics-specific functions

**Function Root Causes**
- Data accuracy error
- Data availability error
- Data integrity error

**User Root Causes**
- Unintentional
  - Slips (attention)
  - Lapse (memory)
  - Mistake (knowledge)
- Intentional

**Representation Root Causes**
- Patient identification error
- Mode error
- Interpretation error
- Truncation

**Adverse Events**
- Wrong patient action of commission
- Wrong patient action of omission
- Wrong treatment action of commission
- Wrong treatment action of omission
- Wrong medication
- Delay of treatment
- Unintended or improper treatment

**Root Causes**

**Representations**
- Navigational structure
- User interface entities
  - Objects (information items, e.g., MRN, text, graph, etc.)
  - Operations (actionable items, e.g., buttons, checkboxes, etc.)
- Organizational structures
  - Spatial layouts
  - Color, texture, shape, shade, contour

**Root Causes**

**Task Root Causes**
- Recall error
- Feedback error

**Intrinsic Complexity**

**Extrinsic Difficulty**

**Pediatric Electronic Health Record**

**TURF Components**

**Intrinsic Complexity**

**Extrinsic Difficulty**

**Pediatric Electronic Health Record**

**TURF Components**

**Intrinsic Complexity**

**Extrinsic Difficulty**

**Pediatric Electronic Health Record**

**TURF Components**
## Function Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced data format</td>
<td>Systolic blood pressure values must be entered as 3-digits (060)</td>
<td>Data entry errors</td>
</tr>
</tbody>
</table>
## Function Root Cause

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default Values</td>
<td>This pop-up reverts to prior data if a parameter is entered that is not “in range” with NO WARNING to the user.</td>
<td>Data entry errors</td>
</tr>
</tbody>
</table>

### Units

- **Height/Length**
  - Inch
  - cm

- **Weight**
  - Lbs.
  - oz
  - kg

- **Temperature**
  - F
  - C

- **Pulse**
- **RR**
- **O₂ Sat.**
# Representation Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Examples</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode error</td>
<td>A patient’s weight and height are entered in pounds and inches, and then displayed in kilograms and meters.</td>
<td>Drug dosage miscalculation</td>
</tr>
</tbody>
</table>
## Representation Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Examples</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient identification error</td>
<td>Multiple patients’ data are displayed concurrently. Diagnostic test is ordered for Patient A and thought to be Patient B</td>
<td>Wrong patient procedure</td>
</tr>
</tbody>
</table>
## Representation Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility error</td>
<td>Does not allow entire growth chart in one view. No resizing. Requires 2 slider bars to <strong>mentally</strong> visualize the entire chart.</td>
<td>Missed diagnosis</td>
</tr>
</tbody>
</table>

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**Example**

<table>
<thead>
<tr>
<th>Mother’s Stature</th>
<th>Father’s Stature</th>
<th>Date</th>
<th>Age</th>
<th>Weight</th>
<th>Stature</th>
<th>BMI*</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

*To Calculate BMI: Weight (kg) + Stature (cm) + Stature (cm) x 10,000 or Weight (lb) + Stature (in) + Stature (in) x 703
# Representation Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truncation error</td>
<td>Drop down fields too narrow to allow the user to view the entire entry</td>
<td>Wrong dosage</td>
</tr>
</tbody>
</table>

## Unit

- Kilogram
- Kilogram per Sq
- Kilograms per D
- Kilograms per Cu
- Kilograms per Un
- Kilograms per Mi
- Kilograms per Sq
- Kilograms/Millim
- Kit
- Liter
- Liters per Day
- Liters per Minute
- Lozenge
### Task Root Causes

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Potential Risk/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence context</td>
<td>No drug name or drug strength is listed in the pop-up. Need to memorize information across multiple windows.</td>
<td>Medication error</td>
</tr>
</tbody>
</table>

**Dose Instructions**

- **Dose**
- **Route**
- **Frequency**
- **Pt. Instructions**

<table>
<thead>
<tr>
<th>Dose Instructions</th>
<th>Quantity</th>
<th>Refills</th>
</tr>
</thead>
<tbody>
<tr>
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</table>
Critical user interactions for EHR should be supported by work-centered design addressing root causes associated with users, functions (features), representations (user interface), and tasks (workflow).

Pediatric EHR should be designed with special considerations of the uniqueness and complexity of pediatric care.
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Pre-AMIA Symposium

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Chicago
www.sharpc.org