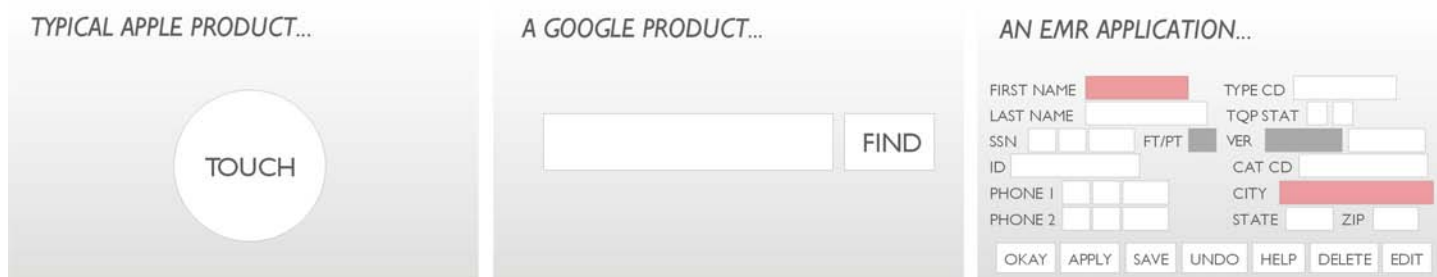


How to design a usable and meaningful EMR application

EMR application usability evaluation methodology

Executive Summary



This scribble posted in a blog by Eric Brook (www.stuffthathappens.com) perfectly sums up the usability challenges of EMR applications or any other HIT applications, and also clarifies the underlying reason for the lack of user adoption of an EMR especially in the US healthcare.

Think of how the search engines were before Google came into picture, or how cumbersome was it to use a MP3 player before Apple came up with iPod. The task of a MP3 player (allow user to listen to music) or a search engine (provide relevant search results) has always been the same, but what Google or Apple did was made those tasks easier for the users to use, by designing an interface which is, simple, effective and efficient. Now in this context think of the user interface of any EMR or Healthcare IT application that you have used or seen, the contrast is pretty obvious and self explanatory.

Multiple causes have been suggested including cost, resistance to change, fear or avoidance of technology, and ingrained patterns of behavior. Increasingly, however, usability has been considered as one of the key factor that has that has been hindering widespread adoption of EMR.

In this paper we will focus on how usability and better user experience can increase the user adoption and meaningful use of EMR application. In this paper we will try to:

- Define usability in the context of healthcare
- Provide a User Centered Design(UCD) framework to evaluate usability and user experience of EMR
- Discussion on emids' usability evaluation approach to Healthcare IT application (a case study)
- Provide a basic checklist (Heuristic evaluation checklist) of usability best practices for EMR application design

Introduction

Healthcare worldwide is a costly enterprise. It is most expensive in the US, where 16% of gross domestic product (GDP) goes to healthcare costs. Most of the developed nations have been able to reduce the healthcare cost by adopting Electronic Medical Record (EMR) Systems. The adoption rate of EMR applications in US has been significantly lower than European countries. A survey conducted by Linder (Linder, Schnipper, Tsurikova, Melnikas, Volk, & Middleton, 2006), thirty-five percent of the primary care physicians indicated lack of usability as one of the key reasons for not adopting EMR application. Most common reasons were:

- Forceful changes to established and successful work flows
- Longer training times
- Excessive time spent serving the computer rather than providing care to patients. The rush to automate the clinical environment has met significant resistance from clinicians, resulting in some major implementation failures
- Problems in screen navigation
- Concerns about data being lost

If you look at all the major concerns that the physicians normally raise about EMR, you will notice all these issues have its root in Usability. Usability has a strong, often direct relationship with clinical productivity, error rate, and user fatigue and user satisfaction.

Clinicians lose productivity during training days and for months afterward as they adapt to new tools and workflow. Some productivity losses are sustained, mostly due to longer time needed for encounter documentation for complex cases. After reviewing different medical literature and usability related research materials we came up with eight key areas that directly impact EMR usability:

- Simplicity
- Naturalness
- Consistency
- Cognitive load
- Interactions
- Error handling and feedback
- Use of language
- Information architecture, data visualization and presentation

Why EMR adoption is critical? : The business perspective

US government has mandated Healthcare IT adoption for all providers within the next 5 years (2015).

An incentive program has been launched which will incentivize medical practitioners and providers who can demonstrate “Meaningful Use” of EMR starting 2011.

Providers and practitioners who fail to demonstrate meaningful use will have to pay a penalty.

What is “Meaningful Use”?

The term “Meaningful Use” is still vague. The entire US healthcare industry is waiting for ARRA to come up with the final Meaningful Use criteria. However according to User Centric (www.usercentric.com) a usability consulting firm, the term “Meaningful Use” have two aspects. One is the technical aspect and the other is the human aspect (i.e. to say how easy or difficult it is for the users to actually use an EMR system). In order to address the human aspect of “Meaningful Use”, EMR certification bodies like CCHIT have recently introduced usability rating as part of their certification process.

How to measure usability of an EMR application?

What is usability?

International standards bodies (e.g., NIST, ISO) define usability as follows (NIST 2007):

Usability is the effectiveness, efficiency, and satisfaction with which the intended users can achieve their tasks in the intended context of product use. Let’s take this definition and see what it means in the context of Healthcare IT system or to be more precise EMR application.

In Healthcare environment, a clinician’s primary concerns or questions while interacting with EMR application are:

- Will the application provide necessary assistance in clinical decision making?
- Will it help in minimizing user error?
- Will it reduce time to complete a task?

Definition of usability in Healthcare

A system that provides adequate assistance and support for the clinician to take correct medical decision, reduce the chances of user error by providing right information and feedback, and increase clinician’s efficiency by reducing time to complete a task. This can be achieved by designing an application with seven key principles discussed earlier. -

Simplicity: Simplicity means adopting “Less is more” philosophy. Simplicity means inclusion of only those functionalities, features and information that is relevant for the user in the context of completing a task.

Learnability: Learnability is critical to clinical applications since it is extremely difficult to provide extensive training, especially to clinicians whose time is limited. The system should provide support to its users for better adoption and learning to complete various tasks.

Consistency: Consistency refers to using themes, navigational models, or icons which users are already familiar with, or have used somewhere; so that it’s easier for users to relate.

Minimizing Cognitive Load: In simple terms it means “don’t make users think”. This is even more important for clinicians, as they are almost always performing under significant time pressure and in environments bursting with multiple demands for their attention. So provide them appropriate guidance and instruction about the task in hand.

Efficient Interactions: One of the most direct ways to facilitate efficient user interactions is to minimize the number of steps it takes to complete tasks and to provide shortcuts for use to frequent and/or experienced users.

Error Handling and Feedback: The application should provide just in time and appropriate feedback to the users to minimize the chances of critical error.

Effective Use of Language: All language and terminology used in an EMR should be concise and unambiguous with familiarity and meaningful to the end users in the context of their work.

Information Architecture, Data Visualization and Presentation: As all EMR applications are information dense, reduce information overload by providing summary with drill down option where ever possible. Research shows that 80% of the time, the information (if well organized) at summary level is adequate for clinical decision making.

How to objectively evaluate usability and measure user performance for an EMR application?

The common perception about usability is that it’s very subjective, and depends upon individual user preferences, so it’s impossible to measure usability. Another line of thought is usability is only about designing good looking screens. Some schools on the other hand define three clear parameters which are measurable:

- Assistance in clinical decision making: Effectiveness
- Minimizing user errors: Efficiency
- Reduce task completion time: Productivity & Efficiency

All of these parameters can objectively measure following some scientific structured data gathering techniques that are rooted in UCD Methodology.

UCD is a design approach which considers users at the center of any product and gives a framework which can improve the effectiveness, efficiency and user satisfaction of any product or application.

In this section we will discuss in detail about how we can use UCD process in designing an EMR application and how we can objectively measure usability of an EMR application.

Step 1: Evaluation of the existing application

A Usability consultant reviews the existing application against pre-defined usability standards and comes up with critical gaps and user challenges.

Step 2: Identify key user groups and contexts

A critical step in the process is to clearly specify user groups and contexts. In this phase data is gathered for different users of the application. Data is gathered primarily around three areas:

- User profile
- Environmental profile
- Task profile

These data helps to classify the users into different user groups and define the context of the application usage for different user groups. User profiles and personas are created for each user group.

Step 3: Identify critical and frequent tasks

Critical and frequent tasks can be identified through previous experience, interviewing client stakeholders, product owners, user interviews and/or observation.

Example of a key task: Create an appointment for a new patient, check the status of a specific claim, check patient eligibility for Medicare. (User Group: Nurse)

Step 4: Benchmark key tasks' usability

In this stage one should clearly outline quantifiable usability goals against which usability will be measured. Example: if in an existing EMR application your user study shows that administrative staff (User Group) takes two minutes to check patient's eligibility with 75 % accuracy, your effectiveness and efficiency goals for that specific task can be set as follows:

- Effectiveness : 100%
- Efficiency : 1 minute

Step 5: Conduct user research and usability testing

This is the most critical step in the whole process. In this stage the data is gathered from the actual users. The focus is always to gather inputs around the key tasks identified for the user groups. Different data gathering methods or usability testing techniques can be used depending on the situation, time, cost, etc. Most commonly used data gathering techniques are:

- User observation and interview
- Usability walkthrough approach
- Focus group studies
- Remote usability testing

Step 6: Estimate relative usability for competing products

If one is evaluating several different EMR systems then this step is effective as it saves time and cost by using the technique of benchmark testing and usability walkthrough, without taking the costly route of conducting extensive usability testing of every application independently.

In this exercise after completing each task in the walkthrough, users rate the effectiveness, efficiency, and subjective satisfaction for that task. Then, the ratings can be averaged together for all of the tasks for each EMR system.

Step 7: Measure usability

Once the data is gathered from the usability testing the measurement or evaluation of usability is done against the usability goals set forth at the beginning. For an independent application the data gathered is measured against the available current benchmark or a competitive rating scale is used for measuring usability of multiple applications.

Tasks	Measuring usability relative to goals		
	Effectiveness	Efficiency	Satisfaction
Create an appointment for a new Patient	Goal - 100% EHR A - 90% EHR B - 100%	Goal - 2 min EHR A - 4 min EHR B - 1.5 min	Goal - 4.0 EHR A - 3.0 EHR B - 4.5

Figure 1.0: Usability measurement table: Multiple applications

emids usability evaluation case study

At emids we have conducted several user research and usability evaluation especially for EMRs and HIT systems. In this section we will discuss in detail our approach with respect to a recent usability consulting project.

Context of use: The application that we evaluated is currently being used by over 150 doctors and nurses across different prisons spread across different states in US. The purpose is to maintain the health information record of the inmates living in these prisons.

emids Technologies were engaged to conduct usability evaluation of the current system, and provide recommendations to improve the performance based on usability evaluation. The business goals that were identified after interviewing the medical management team and other stakeholders were:

- Increase accuracy of clinical decision making - Effectiveness
- Reduce task completion time for users- Efficiency

The usability evaluation approach

- emids first did an expert review and heuristic evaluation of the existing application. At this stage we reviewed the application based on certain heuristic usability principles .The output was a set of short and long term recommendations which can improve the effectiveness and efficiency of the application
- As a next step emids conducted usability testing and user observation for specific task to understand the current task completion time and accuracy. One such task that emids evaluated out of many was filling up the intake forms for the patient by administrative staff and nurses.

- emids conducted user study across five locations in the US. Interviewed 3 nurses, 2 doctors and 1 administrative staff in each location. So with the sample size of 30 users we observed that the average time to complete intake form was 15 minutes and accuracy was 70%. Lot of errors was created as the system did not provide right kind of feedback for error prevention. The time to task completion increased because of too many clicks (20 pages to complete a form)
- Based on our evaluation of the application and initial usability study emids came up with clickable low fidelity prototype (using Axure). Then again tested different set of 30 users from the same user group across the same five locations. emids noticed significant improvement in both efficiency as well as effectiveness. Average task completion time came down to 10 minutes and accuracy improved from 70% to 85%. emids used remote usability testing followed by telephonic user interviews and also gathered user satisfaction ratings
- Based on the feedback received from the 2nd round of user testing emids modified the design in specific areas where user was challenged. Provided better feedback mechanism, more visual emphasis for buttons, icons, and also accommodated multiple navigational aids and switching between different tasks, which were some of the critical inputs from usability tests
- The last round of usability testing result saw a significant improvement. Average task completion with the final high fidelity prototype was 6.5 minutes and the accuracy was 95%

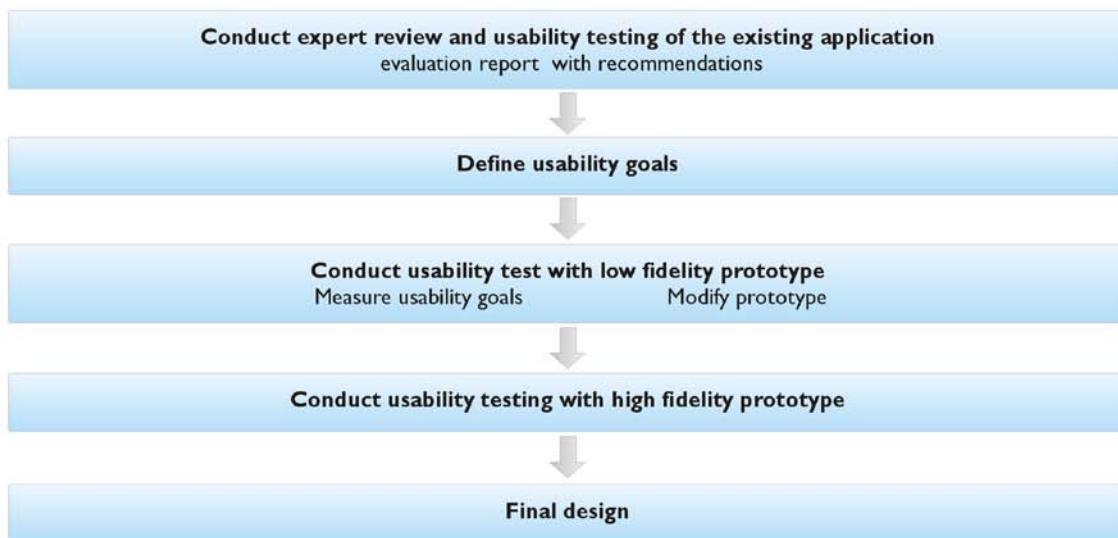
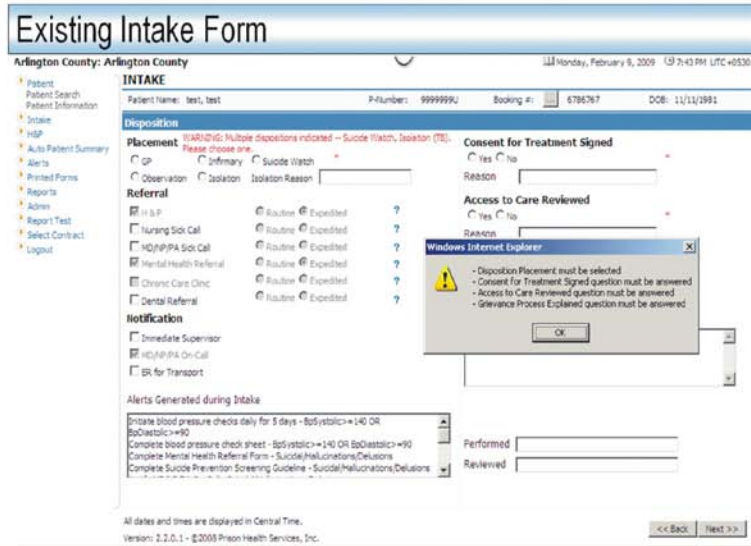


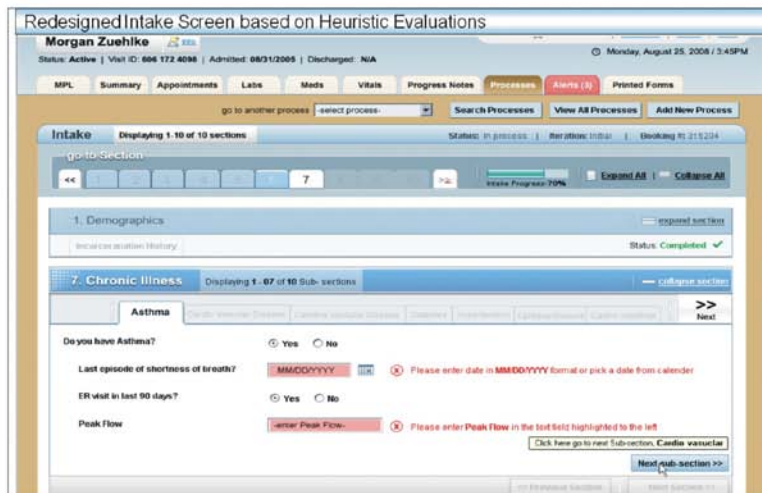
Figure 1.1 emids usability evaluation model for existing application

Existing application evaluation



Key Findings	Results
Too many screens to navigate	Task completion 15 minutes
Poor feedback mechanism	Incorrect information filled in more than 20% of the cases
Information overload	Users took too much time to find out right information necessary to complete a task
Navigational aid not clearly visible	User not very sure where to go and how. Increased time to complete a task

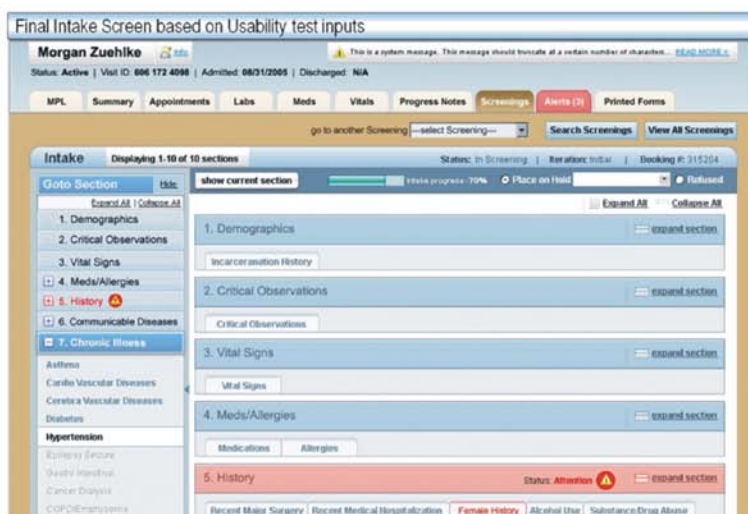
Usability study with low fidelity prototype



However there was a significant improvement in efficiency and effectiveness, there were some key observations which helped us to eliminate some of the key user challenges in the final design.

Key Findings	Results
Secondary navigation was confusing for users	Task completion time was reduced to 10 minutes from 15 minutes
Co-relation between the numbers at the top and the section bar was difficult for the users to understand. It added cognitive load and visual search time	Task accuracy level increased from 70% to 85%
Subsection and section navigation was not easily understood. Users were confused with too many next previous buttons	Users spent on an average 2 minutes to identify the secondary navigation
Active/inactive button states were not easily understood. Out of 20 users almost 50% of them clicked on inactive buttons during the task	80% of the users missed the section number based navigation on the top

Final intake screen



Design changes based on the user input

- Additional left navigation panel was added
- Section subsection navigation was simplified
- Next & Previous buttons were removed from the screen and replaced with tab along with left navigation

Final usability test result

When emids conducted remote usability test with 20 users, with the modified design we saw the impact immediately. The new interface reduced visual clutter, provided proper assistance and feedback, and navigational aid for the user to complete the task efficiently and effectively. The new interface also was emotionally appealing to the user and was able to build more trust. On the user satisfaction rating scale all users rated the new design at 7.5-9 on visual appeal, branding, trust, learnability, simplicity, while the existing system scored 2-4.5 on all the above factors.

Existing Application			Low Fidelity Prototype			Hi Fidelity Prototype			
Tasks	Efficiency	Effectiveness	Satisfaction	Efficiency	Effectiveness	Satisfaction	Efficiency	Effectiveness	Satisfaction
Complete Intake	15 min	70%	3	10 min	85%	6	6 min	95%	7.5
Schedule Appointment	6 min	80%	4	4 min	95%	6	3 min	95%	7
View Progress Notes	10 min	60%	2.5	5 min	85%	6	3.5 min	100%	7.5

Figure 1.2: Usability rating table: Measuring effectiveness, efficiency and satisfaction

Existing Application			Low Fidelity Prototype			Hi Fidelity Prototype		
Visual Appeal	Trust	Branding	Visual Appeal	Trust	Branding	Visual Appeal	Trust	Branding
2	4	3	7	5	7	8	6	8

Figure 1.3: Subjective user experience and satisfaction rating

CCHIT® 2011 usability testing parameters

Understanding the importance of usability in accelerating the adoption of Healthcare IT systems, CCHIT® introduced usability rating as part of their certification process. According to CCHIT®

“Performing usability evaluation is essential to our mission because highly usable systems will increase adoption and less usable systems could require more training and decrease adoption.”

Each EMR system would be evaluated based on the following parameters mentioned below and the Jury would provide a usability rating based on their evaluation of the system. The EMR application usability would be evaluated and rated on :

- Content organization
- Workflow
- Feedback and alerts
- Navigation
- Screen layout
- Highlighting

Heuristic evaluation checklist for EMR application

Based on our experience of designing and developing several EMR & HIT applications and extensive research on HHS guidelines; emids have come up with a set of best practices and heuristic guidelines which helps in designing a user friendly EMR system. This usability service line of emids helps organizations in getting a better rating during the CCHIT® certification process.

Text

- Make sure the text is readable and clearly distinguishable from the background. Try using black text on white background whenever possible to increase readability
- The system uses mixed case lettering rather than ALL CAPS in all sections possible



Titles and labels

- Field labels accurately describe what data need to be entered; headings for tables and lists accurately describe data.

Controls

- It is clear which information entry fields are required and which are not.
- Units (for example: milligrams and pounds) are included with the information entry fields so that users are not required to type them in
- Provide large enough list and text boxes to limit scrolling; and preventing the need for frequent switching between keyboard and mouse. The meaning of icons and symbols is either obvious or the icons/symbols are properly labeled
- Labels, information, and alerts are close to the corresponding information entry fields
- Provide good default values to reduce users time and minimize error
- Include auto tabbing to minimize mouse to key board movement

Work flow

- There is an easy and obvious way for users to quickly return to the main screen of the patient record from any point in the system
- Give user clear indication of where they are in the application by using breadcrumbs

Feedback and Alerts

- Error messages are clear. They explain the reason why the error occurred and suggest what the users should do next
- Provide immediate feedback to the user during a task
- Provide clear instructions for all tasks and navigations throughout the task completion steps to guide the user Provide good feedback where applicable to reassure user about this action/decision

Navigation

- The system uses a consistent navigational hierarchy so that users understand where to find information
- Similar objects and controls are used consistently throughout the system

Screen layout

- Items are in consistent locations across screens (For example: Patient Name, Medical Record #, etc.)
- The screens do not require users to scroll left or right (For example: There is no horizontal scrolling)
- Items such as text fields, checkboxes, radio buttons, menus, tables, etc. are neatly aligned on the screens
- Use summary with a drill down option for information dense screens

Consistency

- Similar objects and controls are used consistently throughout the system (For example: Hyperlinks, radio buttons, field labels -system internally consistent)
- The system uses paradigms that are familiar and consistent with commonly used applications and web pages

Use of color and highlighting

- When using color-coding, ensure that the coding scheme can be quickly and easily understood
- Some form of visual highlighting is used to draw attention to important information (For example: exceeds acceptable limits, out of range)
- Avoid using too many colors. Understand the cultural context and the meaning of a color in that context before using a specific color.

Content Organization

- The system uses tables, graphics, and other visualizations to facilitate the understanding of the information
- The meaning of the displayed information is either obvious or explained in the system and users do not need to refer to external documentation. (For example: if results are out of range, users do not have to look to another source to compare ranges)
- Critical information that is used frequently (for example: allergies and active meds) is visible on the screen in a consistent location

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Abbreviations

ARRA

American Recovery and Reinvestment Act

EMR

Electronic Medical Record

ISO

International Organization for Standardization

NIST

National Institute of Standards and Technology

UCD

User Centered Design

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About emids

emids is an industry leader in the 'convergence' of IT and consulting for the healthcare industry. We provide diversified Information Technology (IT) and Business Process Outsourcing (BPO) services.

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