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Healthboard: A Graphic User Interface for Patient Centered Healthcare, the "Medical Home" Solution

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KEYWORDS *Electronic health record system, EHR, EMR, GUI, user experience, usability, healthcare, design process, military healthcare system, information visualization*

PROJECT DATE *2010–2014*

ABSTRACT The US military health care services have faced a great challenge of providing primary care to active duty personnel and family members due to resource allocation and other factors. The US *Department of Defense* (DOD) sought novel solutions to provide the primary care services to their beneficiaries using information technology. The *Parsons Institute for Information Mapping* (PIIM), in conjunction with *Telemedicine & Advanced Technology Research Center* (TATRC) and *Walter Reed National Military Medical Center* (WRNMMC), had a unique opportunity to research and develop possible solutions for *Patient Centered Medical Home* through the capacity of graphic user interface design (GUI), user experience design (UXD), and information design. The efforts were centered on creating a visual interface tool—this paper focuses on the method and process taken during the performance period of 2010–2014 in response to this initiative. In addition, it highlights design challenges, approaches, and lessons learned.

INTRODUCTION

In the Fall of 2010, the *Parsons Institute for Information Mapping* (PIIM) initiated a multi-year project entitled, "Visual Dashboard and Heads-up Display of Patient Conditions" funded by the *Telemedicine & Advanced Technology Research Center* (TATRC) of the US *Department of Defense* (DOD). The goal was to elicit design and prototyping efforts to support a novel technology system for the *Patient Centered Medical Home* (PCMH) department of the *Walter Reed National Military Medical Center* (WRNMMC). PIIM collaborated with TATRC and WRNMMC to identify requirements, implement design parameters, and validate the user experience and utility of the system through PCMH's clinical experts.

After interviews at the executive, decision-making levels of the PCMH department, it was ascertained that the number of visitors each day overwhelmed the primary care services of WRNMMC. In addition to long waiting time each patient had to face, it was very difficult for medical staff to provide quality medical care to all patients within their available resources. Therefore, WRNMMC initiated a program to instill *Patient Centered Medical Home* as part of their protocol. Bringing PCMH to WRNMMC would benefit both providers and patients, as the PCMH is a team-based model based upon the premise that the best healthcare provider begins with a strong primary care foundation, accompanied by quality and resource efficiency incentives. Patients in a PCMH have a personal provider who, along with their team, provides continuous, accessible, family-centered,

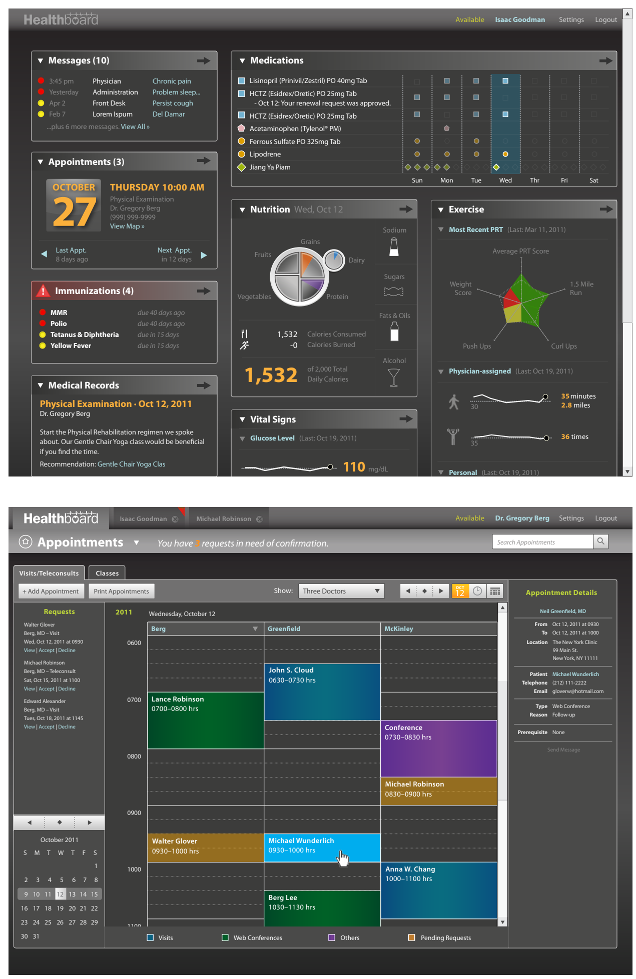

FIGURE 1: *Screen shots from Patient Portal and Providers Portal of Healthboard*

and comprehensive healthcare in order to achieve best outcomes.

PIIM was tasked to bring information design, *Graphic User Interface* (GUI) *Design*, and *User Experience Design* (UXD) to the process and to develop toolsets that could provide the framework through which the strengths of medical home are realized. The *Healthboard* tool (designed to be used in conjunction with *Armed Forces Health Longitudinal Technology Application* [AHLTA]), is a next-generation model supporting both providers and patients within PCMH through effective GUI and UXD solutions. Program leads, GUI designers, UX designers, information designers, information design theorists, usability specialists, medical informatics specialists, and engineers of PIIM worked as a team in order to achieve the objectives of this multi-year program. I, as co-principal investigator and creative lead, orchestrated daily team effort and interfaced with stakeholders.

PROCESS

PIIM utilized a proprietary design process that we refer to as "Visualization Driven Rapid Prototyping" (VDRP)[1]. With this method sequential, fully-resolved visuals are created of the intended highest-level scenarios based upon requirements and deliverables as understood. (As opposed to achieving full functionality in incremental stages, as is a common approach.) This allows all the stakeholders to look at visual models instead of documents and understand what the technology would ultimately generate. The feedback improves the design cycles by updating the requirements, thus permitting another visualization stage. The process is faster, engaging, productive, and directed toward shared goals. The visual materials are also utilized to validate design concept and user testing.

Using the *Visualization Driven Rapid Prototyping* protocols as underlying concept for the design process and presentation of *HealthBoard*, the team undertook activities and development methods under the following ten areas:

1. INITIATE HIGH-LEVEL SYSTEM REQUIREMENTS DOCUMENT

Through site visits to WRNMMC and meetings with executives of the PCMH program, an outline of key features required for the next generation system was created. As this was a healthcare tool, aspects such as generating appointments were expected; other, more customized requirements included secure two-way messaging, and wellness diagramming.

2. CREATE INITIAL TAXONOMY OF SYSTEM INFORMATION THROUGH DIVISIONS OF PORTALS AND MODULES

The design team analyzed high-level system requirements; working in conjunction with the client it was decided to divide *Healthboard* is into two portals. These were to be the *Patient Portal* and the *Provider Portal*. As named, the *Patient Portal* is designed to support patients who view and update their own health information. They can make and modify appointments for office visits, or classes, and they can communicate with the team of *Medical Home*. The *Provider Portal* allows the *Medical Home* team member to track and manage patients, coordinate appointments, and communicate with patients and other team members though a very flexible data entry and retrievable architecture.

Each portal is separated into modules. A module in Healthboard is a mini application serving specific purpose. For examples, the *Messages* module provides UI where the user retrieves and sends messages. The *Exercise* module allows the user enter records of recent physical activities as well as retrieve past records already stored in the system. Organizing each portal with multiple modules allows the user to activate and deactivate contents. If a patient does not want to track the records for physical activities, for example, he or she can disable the *Exercise* module, which will no longer be displayed on the screen. (Certain modules cannot be turned off, such as *Appointments* and *Messages*—these determinations were established early on, and rapid prototypes confirmed the value of its decision).

3. DEFINE USER REQUIREMENTS FOR EACH MODULE

As the modular components were developed for each portal, the team defined user group identity and the privileges of data relative to that group. In addition to the patient groups and key providers, we developed components for system administrators.

With the high-level system requirements and list of modules, we were able to create a schedule and shared this with team members and stakeholders. Starting from *Patient Portal*, we started building one module at a time. The first step in designing a module was to define requirements and develop use cases. For example, when we were designing *Medications*, the team consulted pharmacists of *Walter Reed* to define what to display on the UI, the data to be reported by the patient (e.g., over-the-counter medications), when to display warnings (e.g., overdose, conflicting medicine or food), and turning patient's current medication record into a medication reconciliation form so the patient does not need to fill out form at each doctor visit. The design team also contributed ideas to bring in novel and useful features and functions. One goal of the project was to model a futuristic system without being constrained by the current technology, business rules, and workflow approach as applied to current tools. Again, the rapid prototyping process greatly facilitated this. We enriched user requirements by combining the initial requirements (i.e., the high-level objectives), ones based on the needs of clinical experts, and ones defined by UI/UX design experts. These requirements were documented in *Product Requirements Document* of *Healthboard*.

4. BUILD THE PROTOTYPE USER INTERFACE

Based up on the list of requirements, the design team began building the UI prototype for each module. The team applied the consistency in typography, color treatment, and graphic-treatments, along with the screen layout rules, universally. There was a unique and universal style guide created; these were continually updated and refined. Establishing and following the style guide were particularly significant and also challenging for this project because several designers were building an extensive and complex system at once and persons were entering into the program as it was ramped up in scale.

5. PRESENTATIONS AND STAKEHOLDER FEEDBACK

PIIM held weekly review sessions with clinical experts and stakeholders. These were coordinated through videoconferences supported by toolset demonstrations of the developing modules. The team presented screens as partially or totally sequenced mod-ules. We were able to communicate with reviewers effectively because our prototypes self-explanatorily simulate what the actual user would experience quite accurately. Reviewers' feedback was recorded and documented to support the development.

6. REVISE AND REFINE

After each review, the design team applied changes to the screens. Some changes were requested during reviews, and some changes were voluntary enhancements initi-ated and defined internally. We moved forward to next module without additional reviews and verifications when changes were simple and small. We had additional reviews when we redesigned major features. We documented all change requests and revision status in our formal *Product Requirements Document* (PRD). The final design signed off by reviewers was documented in *Detailed GUI Design Volume*. Within this document, each page consists of one screen, description of contents and user interaction, and a flowchart/workflow of the module with a you-are-here indicator. This works as a storyboard would, and indicates exactly what the user can achieve and what they must see. The reason for packaging each screen with user interactions, description, and flowchart is to guide developers who build the interactive prototype following the identi-cal contents and screen activities. The purpose of *Detailed GUI Design Volume* is to allow developers to fully comprehend the structure of the system, UI contents, user activi-ties, and user experience without having designers guide them through in person. They must be fully self-evident

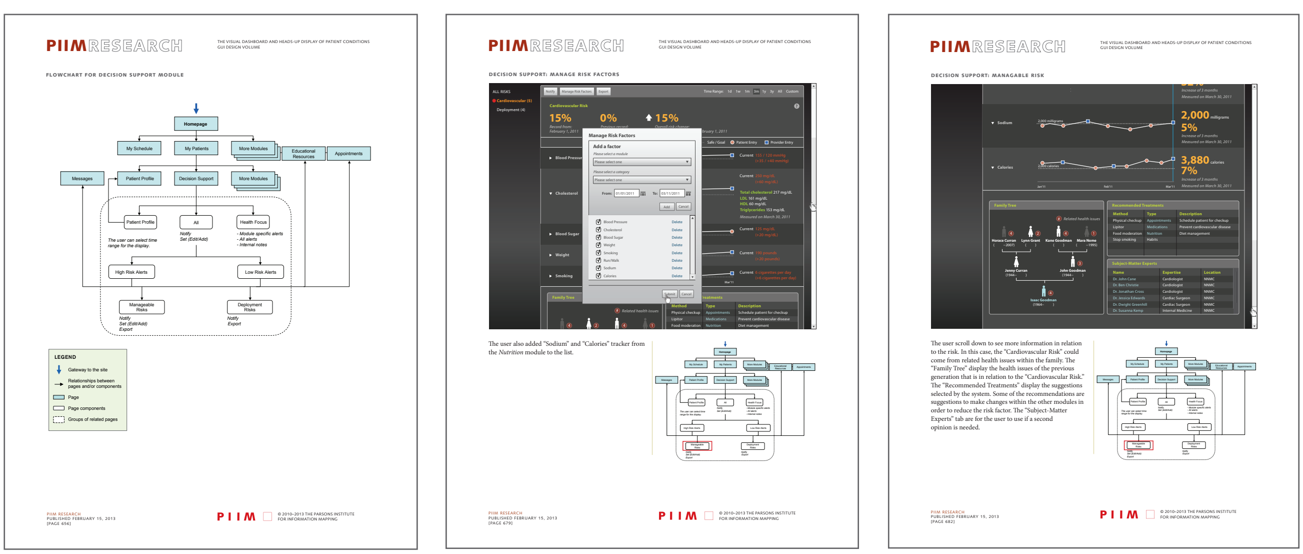

FIGURE 2: *Pages from "Detailed GUI Design Volume" for Healthboard*

in terms of visual assets and sequence-to-sequence functionality (FIGURE 2).

7. BUILD INTERACTIVE PROTOTYPE

As the final design of each module became ready, the engineering team of PIIM, led by Damian Bendersky, started building the interactive prototype using *Flex*. Because this project was highly design-centric, developers often paid very close attention to the visual treatments articulated in the design volume.

The implementation began with the *Patient Portal*. The team implemented one module at a time. Certain features were obviously more difficult and time-consuming to implement than others. For example, the summary of vital signs shows all active vital trackers, which can be expanded individually to display its temporal display (e.g., line graphs) on a single screen. They can also be reordered based on what the user prefers to see first. Both design and engineering teams amended some unique graphs and charts for easier and faster implementation.

8. USABILITY TESTING

While the implementation of the interactive prototype was in progress, PIIM's usability team, led by Anthony Ina, began preparing for usability tests for the *Patient Portal*. The team divided the modules into two separate groups: non-medicine-specific modules, and medicine-specific modules. The test for the first group included relatively simpler activities such as finding/composing messages, making a new appointment, and high-level navigation. The second group had more complex and health-specific tasks to un-dertake, such as updating medicine intakes, self-reporting specific vital signs (e.g., weight, blood pressure), entering new exercise data and nutrition data, etc. We planned four test sets in total. The first two sets tested both groups organized as above, from which the teams would revise and refine contents based on the "lessons learned," then we conduct two additional tests with the same protocol per group in order to validate the fixes made after the first users responded (FIGURE 3).

The team put together an extensive usability testing plan consisting of test protocols, testing environment, target participants, data to be captured, recruitment method, incentives, etc. This planning document was submitted the internal review board (IRB) of both *The New School* and to the DOD to assure compliance within both agencies.

The usability team worked with twenty-four participants through four test sets to identify usability problems. We did not capture any personal data (e.g., participants names per recording), live video of participants' faces, or voices as they were not needed nor did we did want to trigger higher levels of usability compliance. Using the usability testing software *Morae*, we captured the screen with mouse movement and mouse clicks. Participants were encouraged to think out loud while the team was monitoring task results (whether or not the user successfully completely each task), errors, and satisfaction survey which the tester fills out at the end of each task.

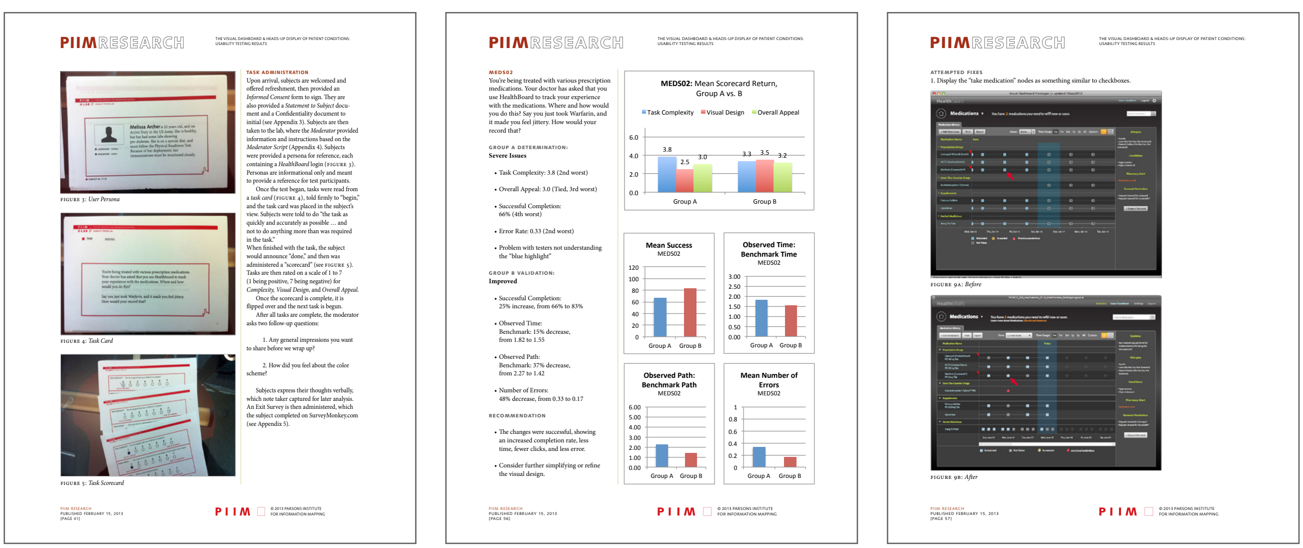

FIGURE 3: *Pages from "Assessment Volume for Healthboard": showing the process and the results of the usability tests, as well as recommendation for modification and redesign*

9. CORRECT PROBLEMS AND ISSUES

After each test, the team analyzed the outcomes to determine where and how the user struggled. The team also discussed how to fix problems. Some usability problems could be fixed through simple tweaks such as changing labels, or reordering or rearranging contents, while other, bigger problems required redesign. The design team documented tweaks, redesigned screens, and presented to the reviewers. Signed-off items were delivered to the engineering team who would then apply changes into the prototype.

10. QUARTERLY, ANNUAL, AND STATUS REPORTS

When working with government agencies, and through efforts to be consistent when working with NGOs and other clients to the University, PIIM generates quarterly reports capturing all the areas above in brief, as well as associated costs of the design endeavor. The entire process and all deliverables are discussed in these reports along withe the hours expended and the tasks associated with each participant. These were amalgamated into yearly reports. The yearly reports tend to be reviewed by higher level individuals within an organization and are often supplemented with diagrams that assist in a more quantitative, rather than strictly qualitative, reporting. A final report then collects all this data. All stakeholders are then given access to these materials through a reporting website.

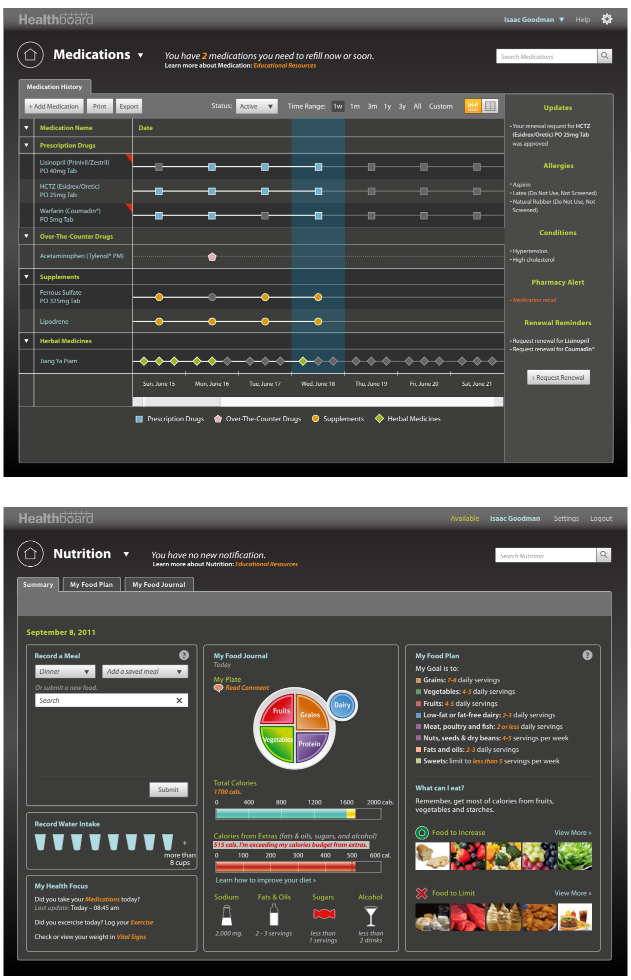

FIGURE 4: *Screens of the Medications and Nutrition modules. These were designed in collaboration with subject matter experts.*

DEEPER DESIGN CONSIDERATIONS

The above points provide an overview of the process and refer, as well, to our general approach. Of course, each project requires far greater attention in some areas as well as procedures that might be unique in order to advance a particular feature or requirement. Following is a more in-depth discussion of the design logic deployed on this project as well as some of the challenges unique to the program. As is increasingly common today, we followed a user-centered design (USD) protocol.

Healthboard was designed based on the user-centered design principles of working with users and understanding users' needs. We built use cases and user requirements based on users' needs; these are identified via interacting with the end-users. The team worked with providers, nurses, nutritionists, pharmacists, system administrators, and program managers of *Walter Reed National Military Medical Center* (WRNMMC). The team defined specific user types and objectives that each user group must accomplish using *Healthboard*. This investigation led us to determine the high-level system structure: two portals and the multiple modules within them. The team collaborated with subject matter experts to identify specific use cases and requirements for each of the modules.

For example, the team consulted a pharmacist, in addition to physicians, in order to specify user interface (UI) contents for the *Medication* module. To design the Nutrition module, the team worked with registered dietitians who provided necessary data to be reported by a patient, as well as the data which a patient should view such as suggested meals, and foods to increase and/or limit (FIGURE 4). With these requirements for each module, the team built the user experience flowchart that served as the blueprint for the UI prototypes (FIGURE 5).

DATA COLLECTION & VISUALIZATION

Healthboard collects complex medical data as well as self-reported personal health-related activities from patients. Patients do not have to track their health data. However, Healthboard does provide tremendous benefits to those who choose to track their health data. For example, patients can track vital signs by entering their *weight*, *blood pressure*, *pulse*, *temperature*, etc. By entering such data, patients can see each measure temporally displayed. Patients may see the relationship between measures, (e.g., weight vs. blood pressure). Patients may track other measures not part of the default setting such as cigarette smoking, pain, and more. The design team invested considerable effort to keep the data entering process as effortless as possible. If such a process were difficult or time-consuming, the user would be discouraged to continue or even initiate the data entry in the first place (FIGURE 6).

We also encourage patients to enter their data for practical benefits. Because this appli-cation is primarily targeting the active-duty military members, we thought it would be beneficial to add a component to the *Exercise* module that helps them prepare for *Physical Readiness Test* (PRT) (FIGURE 7). This way they can track their latest PRT result and readiness for the next test based on the current self-reported data. If a member has a record for *1.5-mile run* that does not meet the passing score, it will automatically trigger an alert so the member can train to improve the record before the actual test. Patients may also choose to track their food consumption using the *Nutrition* module. If a patient has specific goals such as limiting calorie intake or sodium intake, or drinking at least eight cups of water per day, this module can assist patient better track the live status and achieve goals.

Keeping data accessible and actionable is as important as is the capability of collecting data. There are many complex datasets which many "untrained" patients may struggle comprehending. Therefore, the design team utilized information visualization techniques. The first step was to identify where we could

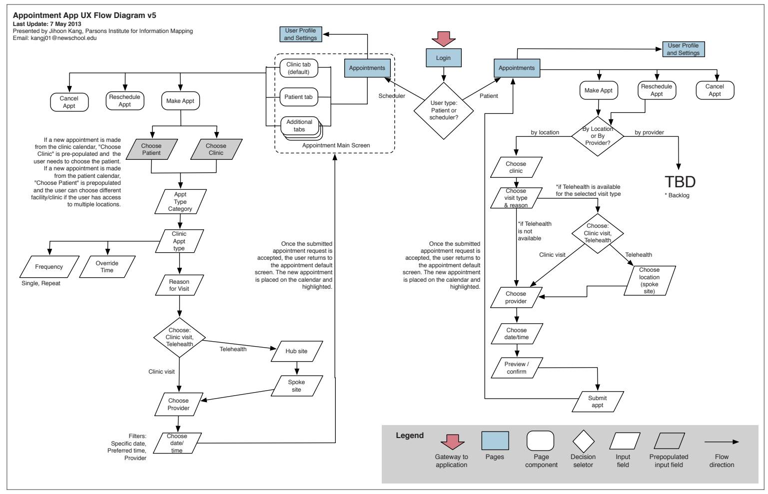

FIGURE 5: *A sample UX flowchart that served as the blueprint for communicating the site/module structure and content organization.*

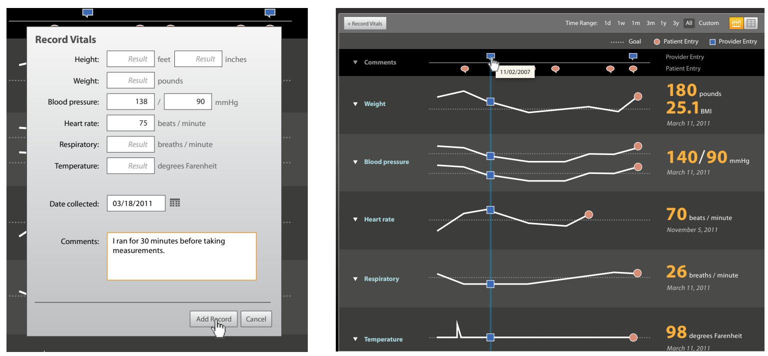

FIGURE 6: *Components of the Vital Signs module with an intuitive data-entry process. The juxtaposition of graphs allows the patient to observe the interrelationship of the attributes presented.*

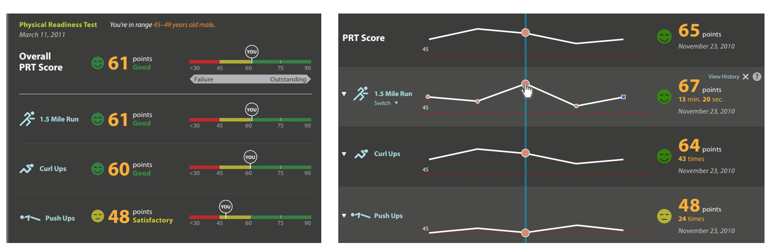

FIGURE 7: *The* PRT *components of the Exercise module is designed to help patients better prepare for their next tests.*

apply quality data visualization. Certain quantitative content was better displayed in charts and graphs. However, some content was more effective as simple text or tables. Other content could be displayed with both formats, but unless a graphical display provided obvious benefits we reserved the engineering time and effort it might have taken to create these. Finding the most appropriate areas for data visualization required good design decisions. Once these contents were identified, the next hurdle would be choosing the most effective type of data visualization. We first had to look at the data to categorize. Some of them were temporal (e.g., vital signs over time); some of them were relational (e.g., a family tree); and some of them were multivariate (e.g., food intake status per nutrition group per day). Finally, once graphs were rendered, we had to validate the quality and ease of use, considering the fact that not all users would be comfortable reading graphs.

EDUCATING PATIENTS FOR IMPROVED HEALTH LITERACY

Helping patients gain health literacy while they use Healthboard was another goal that we had to achieve through design. The usual approach was applied by enabling content/context-sensitive help directly through the system. If the patient does not understand, for example, the difference between *systolic* and *diastolic* pressure while entering blood pressure, the help menu is available to clarify this. This *Help* feature satisfies two goals: helping the user complete the task and helping the user learn about the subject matters. Ultimately, we want users to gain knowledge on various subject matters for their own benefits.

To increase the effectiveness of quantitative data display, it often needs to be combined with its context. Here is an example: some patients—including myself—would say, "now what?" when looking at *180 mg/dL* for LDL cholesterol. It, however, starts making contextual sense if the measure is combined with references such as "Optimal" (less than 100 mg/dL), "Near optimal" (100–129 mg/dL), "Borderline high" (130–159mg/dL), "High" (160–189 mg/dL), and "Very high" (190 mg/dL and above)[2]. It would be even better to have risk explanation per category so users are given opportunities to gain deeper knowledge of the subject. The design team visualized such references where applicable. Although the primary intent for presenting data with proper references is to keep data meaningful, it also helps the user gain deeper knowledge about the subject (FIGURE 8).

As another example, the *Educational Resources*

FIGURE 8: *This is a weight diagram mapped the BMI classes. This is an example of displaying data within a context that allows the user to gain deeper knowledge of the subject.*

module, as the name indicates, is the most obvious content used to educate patients. The idea behind this module is to re-place handouts given to patients when they are discharged from hospital or after appointments. This module is a library of health resources that also includes handouts for patients. When there are particular handouts that the provider would like the patient to read after an appointment, such chapters can be selected and bookmarked. These will be saved as "Bookmarked Items" in this module, and they will also appear as part of reminders.

USER EXPERIENCE DESIGN

A good user experience often appears as the top item of the non-functional system requirement list no matter what entity is taking on system development tasks. The PIIM team set the same objective, obviously, as it has been virtually the goal of anyone designing or redesigning an application that is to deliver a usable, learnable, and adoptable application. However, developing a system that provides a pleasurable user experience is rather complex because many aspects of UI/UX design must come together and work together in order to achieve this goal. The most of important aspect, as the discipline's name intimates, is to understanding the user. It is crucial to find the comfort level for the user with consideration to workflow, daily tasks and goals, working environment (e.g., individual, collaborative, or both), communication method, computing skills, etc. Unfortunately, it has been a big challenge to find the universal comfort level for

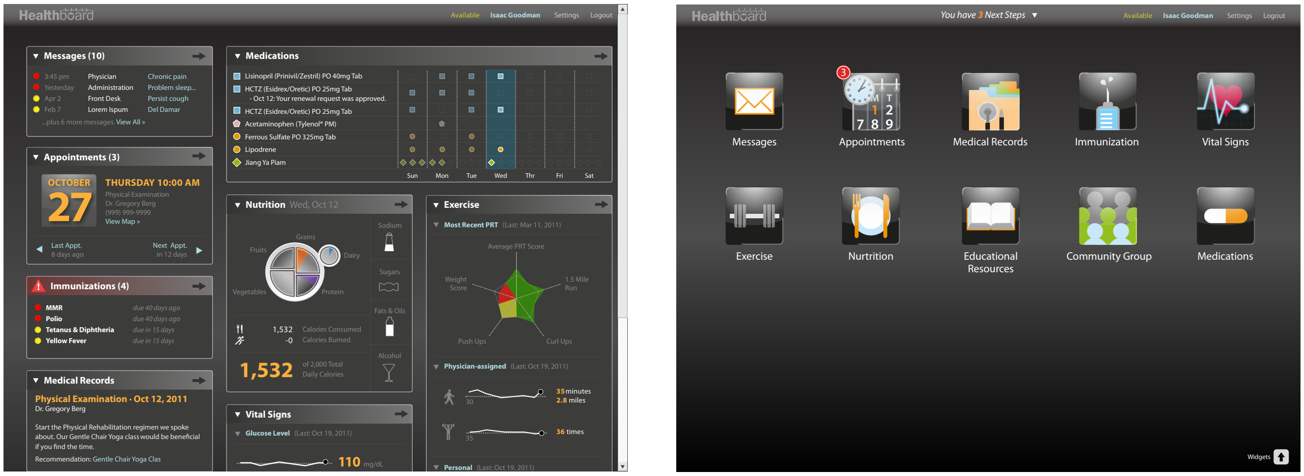

FIGURE 9: *Healthboard offers two different options for the homepage: the Widget View (right) or the Button View (left)*

Healthboard users because there are multiple user types: medical practitioners, nurses, schedulers/operators, system administrators, and patients. Each user type has different interests and goals to achieve while using *Healthboard*.

When the team visited the medical center to meet with the *Medical Home* team, we conducted interviews, observed our target users, assessed the facility, workstations, and related equipment. We also closely interacted with the medical professionals throughout the project. Such activities helped us learn about the target users of *Healthboard* and also helped us explore ways to provide them a good user experience.

As noted previously, there are multiple user types for *Healthboard*. Each user type is interested in particular content to interact with and possesses unique goals to accomplish while using *Healthboard*. The *Patient Search* module, as an example, is a crucial feature. PIIM invested a lot of time and design effort into this area, as it is one of the most frequency used functionalities for both the providers and administrators. However, it never even appears in *Patient Portal*, as it is irrelevant to this user type. Although we would encourage all patients to activate the *Exercise* and *Nutrition* modules and track their entries to maintain healthy life style, there are patients who will choose not to use such features. This is why we kept the interface modular and allowed the users to select contents through the dashboard-like homepage. This dashboard interface displays the summary of activities and updates per module via widgets (add widget view screen). For example, the widget for the *Appointment* module displays a reminder of upcoming appointments. As some users might find this widget view homepage overwhelming—despite that most users we have tested found this useful—we also provide an alternate homepage style, *Button View* (FIGURE 9).

There are some features that *Healthboard* provides that are above the basic requirements; these offer enhanced user experience and educating opportunities. There is a component called, *Next Steps*, which provides relevant reminders and alerts to all user groups. For the patient, this component displays warnings and alerts such as: scheduled appointments, immunization overdue, follow-ups recommended by the doctor, etc. (FIGURE 10). For providers, this component displays the highlight of patient's conditions and summary and follow-ups from recent visits. Whenever the user makes an update, the result and status are clearly displayed on the status bar located at the designated area (top center) of the UI.

Healthboard has many form-based screens throughout

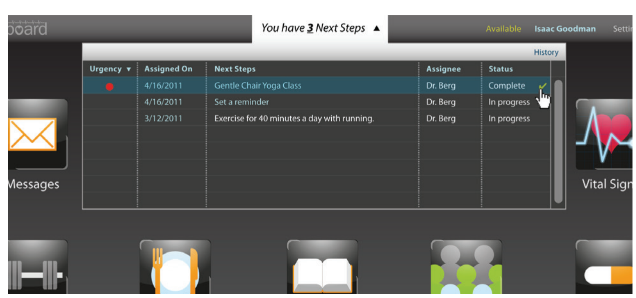

FIGURE 10: *This is Next Steps consisting of warnings, alerts, and reminders.*

the system as it collects varying kinds of self-reported data from users. We integrated appropriate form elements such as: text forms, checkboxes, radio buttons, and drop downs to keep the data-input process sensible and accessible for users. We also added instant validation to many inputs. This helped users recognize errors, as well as to prevent input errors. In addition, the context-sensitive help is available throughout the system—particularly user-friendly for novice users.

Conducting usability tests is a common way to assure and measure the quality of user experience. PIIM's usability team conducted four usability testing sets over the course of the initial program phase. First, we wanted to be certain that the *Patient Portal* could be used easily by the tester-patients (i.e., military members and spouses). We were able to capture very valuable information from each test. We identified areas, components, and elements that hindered the user experience. We compared the task duration and number of mouse clicks per task with the benchmark testing results—these were developed through standards set by the expert users. We wanted *Healthboard* to provide an equally pleasurable experience for both advanced and novice users. The first two rounds of user testing allowed us to identify and fix problems and issues. We conducted the second round with the identical tasks given new participants to validate the usability of the enhanced version. Some issues remained, but none of them were severe problems. We repeatedly debugged and fixed remaining problems over the rest of the performance period.

Finally, the design and usability teams have applied usability heuristic principles throughout the design cycle. These principles served as the backbone while the team made large, as well as detailed, design decisions.

STYLE (AESTHETICS)

Style, like function, is a critical aspect of GUI design. A team of UI, UX, and information designers developed the *Healthboard* GUI. There is some risk that things can rapidly become complex, or delayed when designers with different taste, strengths, and weaknesses collaborate on the same system. One of my duties was to establish very clear guidelines that the design team could follow. At the early phase of the project, the initial teams created style guides for all designers and engineers to reference during the entire performance. This style guide specified how each screen should be laid out and each element should be created respecting rules of thumb for four design areas: *color*, *typography*, *composition*, and *general graphics* (FIGURE 11).

Color

Color as applied to GUI design has always been a challenging element. In my experience, color immediately sets the look and feel. What the user associates with a color theme is often subjective; it is affected by personality and culture. However, color can serve as a useful communication tool if applied correctly. For example, color codes are an effective way to convey meanings. Certain colored objects can draw a user's attention through visibility—controlled by saturation, brightness, and contrast. This is particularly useful for

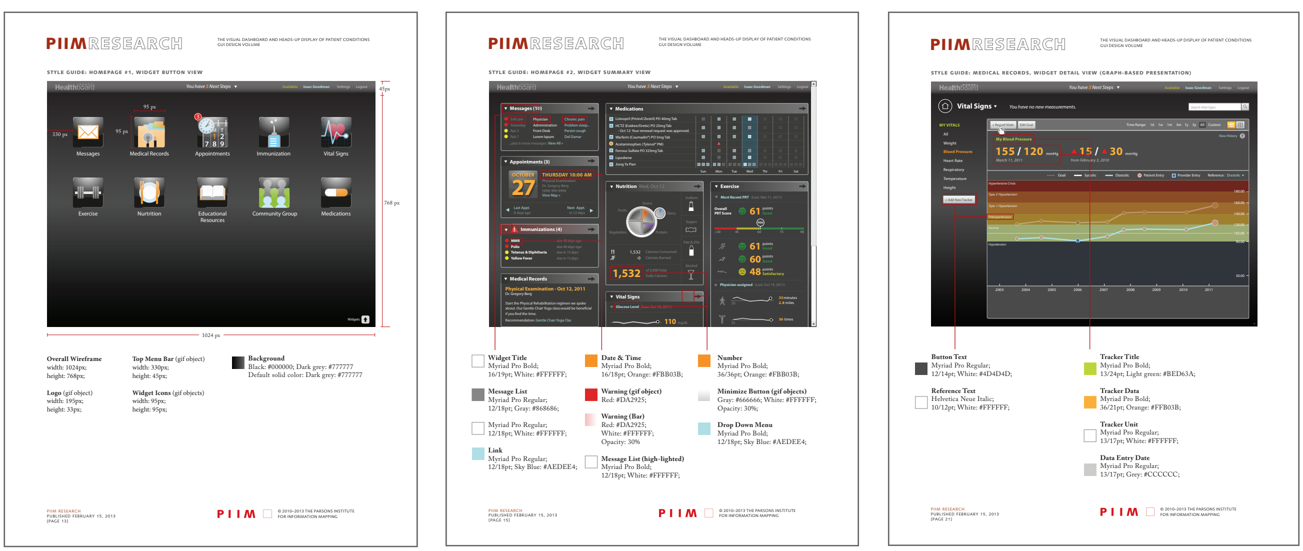

FIGURE 11: *The style guide articulates detailed treatment protocol for color, typography, composition, as well as general graphics.*

an electronic health records (EHR) interface as it often contains warnings and alerts for the user to acknowledge.

The color use for *Healthboard* focuses more on practicality, rather than upon open aesthetics—this, however, does not mean the GUI is unappealing to look at. The overall color pallet is neutral and mostly grey. The canvas is dark and foreground elements are lighter—(this is reversed for text-based screens, however). This dark background maximizes the visibility of the objects that serve as warnings and alerts, or the active status—these are displayed in bright colors as would be expected. There is also an alternative color theme that user can choose via *User Preferences*.

Typography

Readability was of very high concern during the development of the style guide; this is where basic type treatment specifications were established. The choice of typeface, font size, alignment, as well as managing the space within, and around the letterforms, can have immediate impact on the effectiveness of the interface. These factors are critical for presenting information in a pleasing manner to the user. As a precursor to the typographic design initiative, we first identified every possible (or planned for) textual element and classified them as titles, subtitles, text, labels, instructions, hyperlinks, etc. When this was completed we then carefully applied articulated styles to each class in such way that users could easily realize and leverage.

Composition and General Graphics

Composition reflects the overall organization of the user interface, the use of positive vs. negative space, and the overall layout consistency within and between different screens. Each screen has been composed on grids allowing us to position items systematically. Based on the grid there is a high-level of spatial division, say, between universal and local and module specific attributes.

The optimal use of primary graphic elements and icons, as well as the rendition of graphics must be carefully integrated. Secondary graphic elements, including ornaments and identity elements (such as logos), are also assessed within this area. The application of icons requires careful consideration; having too many icons taxes user's memory load. However, when used correctly, screens composed with icons can bring better communication and visual appeal. The *Button View* homepage is purely composed with a juxtaposition of icons allowing the user to navigate and manage contents. Icons have been utilized to represent certain subjects, conditions, and activities throughout the system. It is beneficial to have icons, but it was a necessary for us to come up with specific guidelines for uniform rendition and application of icons. The first rule was to limit the number of icons where applicable. We did not want to overwhelm and puzzle the user with screens filled with a bunch of pictograms and ideograms. When icons are drawn, they should follow the uniform size, proportion, composition, color theme, and the like. Where applicable, we often paired icons with labels for additional clarity of communication (FIGURE 12).

One unique characteristic of *Healthboard* is that many information graphics, representing various data types, are found throughout the system. PIIM is an entity specializing in information visualization; hence we understand and promote the value of data visualization. The design team carefully assessed all data throughout the application to define areas pertaining to graphical representations. Each dataset was carefully analyzed based on differing taxonomies. This included aspects of the temporal, relational, proportional, geographical, or

FIGURE 12: *The design guidelines for icons and buttons*

FIGURE 13: *UI components related to data visualization*

multivariate. Although one of our reviewers raised a concern that use of data visualizations might increase complexity and overwhelm some users who are less exposed to such charts and graphs, we were able to receive positive feedback from most of reviewers—and testers frequently supported the value of these enhanced graphic assets (FIGURE 13).

OUTCOMES

PIIM completed the design of *Healthboard* along with the working prototype of both *Patient Portal* and *Providers Portal* in 2013. All design assets, usability research outcomes, engineering process, and user requirements were fully documented (as per our, and government, protocols) and reported to TATRC and WRNMMC in Summer of 2014.

The following modules/UI features have been identified and designed to enhance communication between the patient and providers:

- Messages
- Live Chat (video, audio, text)
- Appointments
- Reminders
- Medications (requesting Renewals)

The following modules/UI features have been identified and designed to allow the patient to gain easy assess to his/her health records:

- Medical Records (visit summary, test results, procedure/surgery records)
- Immunization
- Medications (prescription medications)
- Vital Signs (taken during visits)

The following modules/UI features have been identified and designed to enable heath data self-reported by the patient:

- Vital Signs (taken by the patient)

- Nutrition
- Medications (over-the-counter, supplements, herbal medicines)
- Exercise

The following modules/UI features have been identified and designed to help the patient gain health literacy and awareness:

- Educational Resources
- Nutrition (provider-entered recommendations and nutrition guides)
- Context-sensitive help and tips

We were honored to present Healthboard at the following IT and design conferences as listed below. In addition, the visual assets and storyboard attributes of Healthboard are now open source.

- 29th Annual HCIL Symposium, Human–Computer Interaction Lab (HCIL), University of Maryland, MD, 2012
- IEEE VisWeek 2012 "Visual Analytics in Healthcare—Open Health Data," Seattle, WA, October 17, 2012
- The 1st Annual OSEHRA Summit & Workshop, Bethesda, MD, October 18, 2012
- 2013 Healthcare Information and Management Systems Society (HIMSS) Annual Conference & Exhibition, New Orleans, LA, 3–7 March 2013
- Health Hacking NYC, Blueprint Health, New York, NY, June 7, 2013
- The 2nd Annual OSEHRA Summit & Workshop, Bethesda, MD, September 6, 2013
- Data Visualization Summit, Innovation Enterprise (IE), Boston, MA, September 13, 2013

CONCLUSION

It is not so common for a not-for-profit organization specializing in design like PIIM to undertake a large-scale project to deliver EHR design. We knew it was a well-deliberated decision for the stakeholder to select PIIM, as there was not significant precedence that a design lead group would succeed in creating an EHR system. Nevertheless we had confidence that PIIM's unique design approach would bring valuable outcomes to the healthcare community. The process and method that we had estab-lished years prior would benefit a broad range of entities seeking a logical and intuitive system. We could point to better user experience in our other projects, and work for the healthcare industry would be no exception. The more I learned about users and their missions while closely interfacing with them over the course of the project, the more I found myself gaining motivation to support them. Concurrently, I was able to educate clinical experts about design and promote the value of design. This has been a privilege and meaningful experience.

I find the most valuable characteristic of Healthboard to be its promotion of a better life-style for users. Assessing one's own well-organized health records, lab results, medications, appointment history, and so forth, can truly empower patients. Additionally, patients are encouraged to self-report their daily exercise, food journal, vital signs, and medication intake. This information is then easy to share with their healthcare providers toward the improvement of healthcare services through efficient, cost-effective methods. *This is significant.* As is the fact that these patients, now surrounded by health and health-related information, can raise their health literacy and self-awareness toward better health and better life style. The gained knowledge and health literacy will lead them to informed decisions. Perhaps some of them will cut down their intake of "drive-thru" fast food and voluntarily make more health-conscious food choices—not merely because doctors or other health conscious individuals told them to do so. Perhaps some will exercise regularly and see how this positively affects their vital signs over time as seen through our infographics. *This is more significant* because maintaining health while preventing illnesses is so much easier and cheaper than treating illnesses. This is my favorite lesson of many that I have learned from this project.

Finally, working on a project for the healthcare industry has given me a special sense of accomplishment as the effort was contributing to an entity responsible for saving people's lives, treating and prevent illnesses, and promoting well-being.

CREDITS

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Angela Laurio: *Medical Informatics Specialist*

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BIOGRAPHY

Jihoon Kang is a communication designer and illustrator. He currently serves as *Associate Director* at the *Parsons Institute for Information Mapping* (PIIM), *The New School*, New York. His background experience includes creative and program leadership, project management, information design, Graphical User Interface (GUI) Design, and User Experience Design (UXD). At PIIM, he has worked on projects form the *National Geospatial-Intelligence Agency* (NGA), *Defense Advanced Research Projects Agency* (DARPA), *US Department of Veterans Affairs* (VA), *Center for Disease Control and Prevention* (CDC), *Telemedicine and Advanced Technology Research Center* (TATRC), US *Navy*, *United Nations Development Programme*, and *Macmillan Publishers*. He has taught design courses at *Parsons The New School For Design*. He received BFA and MFA from *Parsons*, New York.

NOTES

1 *Visualization Driven Rapid Prototyping* (VDRP): http://piim.newschool.edu/about/the-PIIM-process

2 LDL Cholesterol levels are from the NIH website: http://www.nlm.nih.gov/medlineplus/magazine/issues/summer12/articles/summer12pg6-7.html

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