

User-Centered Design of Health Care Software Development: Towards a Cultural Change

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Abstract

Health care software gets better user efficiency, efficacy and satisfaction when the software is designed with their users' needs taken into account. However, it is not trivial to change the practice of software development to adopt user-centered design. In order to produce this change in the Health Informatics Department of the Hospital Italiano de Buenos Aires, a plan was devised and implemented. The article presents the steps of the plan, shows how the steps were carried on, and reflects on the lessons learned through the process.

Keywords:

User-Centered Design; User-Computer Interface; Software Design.

Introduction

Health professionals and patients value health care software, but they demand better products that help them satisfy their clinical information needs [1]. According to reviews, many of the issues that prevent adoption and satisfactory use are related to poor design and low usability [2, 3, 4]. Usability is a measure of the efficacy, efficiency, and user satisfaction [5], and usability has been established as a key factor of applications that provide the needed support while letting them be focused on their tasks [6]. Usable applications are easy to learn, efficient to use, easy to remember, not prone to errors, and subjectively pleasing to use [7]. User-centered design (UCD) is an approach to achieve usable products introduced by Norman and Draper [8]. UCD has evolved from the research field of human-computer interaction, with the contribution of cognitive psychology, software engineering, sociology, and other disciplines that influenced it and developed methodologies that embody their points of view [9]. Usability engineering presents an iterative cycle of design and evaluation until the fulfilment of established quantitative goals measured on lab tests [10]. Contextual design includes ethnographic methods for user research while participatory design involves users to set goals and explore design solutions, instead of just taking part of evaluation [11]. UCD has been applied successfully to enhance adoption and success of products [12].

The Health Informatics Department of the Hospital Italiano de Buenos Aires (HIBA) includes an area of software engineering and a residence for health informatics. The department has been designing and developing administrative and health care software since the late 1990s. However, these applications presented the usability challenges described in the literature mentioned above. While the users valued the availability of online health records and tools for administrative tasks, they also noted lack of desired functionality and difficulties to learn and use the tools.

Therefore, according to the recommendations on the cited reviews, the department decided to implement UCD, applying usability engineering, participatory design, contextual design and a user-centered framework for redesigning health care software [13].

The goal of this paper is to describe the process of changing the culture of design and development of health care software at the HIBA, setting UCD at its core.

Methods

Following Schaffer's approach to institutionalization of usability [14], the head of the department devised a plan of three phases.

The first phase was to introduce UCD through an internal course for health informatics residents and software developers and other personnel of the department. The course load was 16 hours of classes, plus extra activities.

The second phase was to demonstrate the feasibility of UCD, applying it to a pilot project. The team for the project would be taken from the attendees of the course that show more interest and developed skills.

The third and current phase is aimed to the widespread implementation of UCD on the mainstream projects of clinical software. It was planned to create a UX team, formed by a group of UX professionals. It has a double function: to offer the service of designing new applications or new versions of existing ones, and to disseminate UCD as a new culture of work.

Results

UCD introductive course

In January 2011, the planned course of UCD was given and it was mandatory for health informatics residents, developers and other personnel from the department. It was a program of 1 class of 2 hours per week, for 8 weeks. User interviews, prototyping and usability testing were required as practical activities outside the class.

Although approximately 30 people attended this course, its impact was mixed since very few developers showed interest on usability. The resistance arguments were that: (1) users have to adapt and learn; (2) health domain is complex and is impossible to make it easier; and (3) UCD would be the right thing to do, but is not possible given the conditions of work in the department.

On the other hand, most of the health informatics residents welcomed the new approach centered on users. But, they usually stay 2 years on the department and new residents have to participate on UCD courses every year. Another challenge

is their few design skills, so they have to learn almost from scratch.

Pilot project

After the course, a team for a project was taken from the attendees of the course that show more interest and developed skills. The team was formed by a health informatics resident, a MD student, and a part-time user experience (UX) professional. Its goal was to redesign the HIBA's patient health portal and it was a test of UCD techniques. That project involved real patients for interviewing and testing usability and proved the worth of this approach by giving new insights that helped to focus the development. The team took a transdisciplinary approach, looking forward that all of its members could develop UCD skills and view health issues from an assistive technology perspective. The result was a revised version of the application, that included a new menu structure, functionality and visual style. Findings of this project are shown on Table 1. After that pilot project, UX professionals were hired by the hospital in a full-time basis and are taking part in several projects.

The UX team

Since January 2014, the User Experience (UX) team at the HIBA is formed by 3 professionals with different skills that complement each other. Its leader was formed and worked in information systems analysis and development, and later studied human-computer interaction. Two members were chosen and they worked on graphic design, usability and accessibility. Their job is to lead the UCD process and

promote that methodology among their colleagues in the department. In this way, UX members plan and perform tasks of user research, prototype design and usability evaluation, along with HI residents and developers. Non-UX professionals take part on basic training given by the UX team, and this training allows them to understand the UCD's point of view and its techniques. Due to high demand of projects, each member works on several projects at a time, and delivers different levels of attention for each one. Before implementation, applications get at least design advices and revisions by the UX team. Priority projects get the most attention, which involves thorough user research and testing.

Impact of UCD on real projects

After three years of the formation of the UX team, we can see its achievements on the design of health care software. Table 1 lists the projects that got some contribution from the team, the insights found through user research and its impact on the final design.

Mobile usability lab

The core of the UX team's work is to listen and observe what users say and do on interviews, workshops and tests. So, it is necessary to record their words and actions to be analysed afterwards. The team uses small cameras and cellphones to take pictures, videos and audio on contextual interviews. The team uses a notebook for on-location usability tests. The first notebook used for tests was a Dell Latitude E5510, with a 15.6" screen and 1,366x768 pixels resolution. Its display was smaller than screens installed in doctor's and nurse's offices, so it was replaced by a another notebook, a Dell Precision

Table 1- Projects with contribution from the UX team

Project	Findings of user research	Impacts on the interaction design
Patient health portal [15]	The application is valued even by users with IT challenges. Registering and navigating was difficult. Patients with chronic diseases, including senior citizens, are the most intensive users.	The menu was revised using card sorting technique with participants profiled on age and chronic diseases. A style guide was created, taking into account recommendations for older users.
Problem selection [16]	On problem search, relevant results act as suggestions for selecting more specific problems.	The list of results was ordered by relevance and classified by categories to stimulate the selection of more precise problems.
Anesthetic record [17]	Understanding how anesthesiologists record their actions during an surgical intervention.	Interaction design of touch-screen based application created from scratch. Interactive and real-time visualization of vital signs and administered medication.
Evolutions and documents [18]	While writing evolutions, doctors usually read results and other data. Doctors usually look for evolutions written by colleagues of their specialty. Documents were difficult to find.	A floating window that allows to navigate the EHR while writing evolutions was designed. Faceted browsing was added, including filters by type of document and specialty.
Drug-drug interactions alerts [19]	It is difficult to understand and follow recommended actions embedded on text.	Specific buttons to perform recommended actions were added, customized for each drug-drug interaction case.
Nursing process [20]	Large and complex forms hinders completion of tasks.	Forms were rearranged according to the hierarchy of items to minimize perceived complexity and completion times.

M6800 with a 17.3' and 1,920x1,080 pixels, to avoid distortion of prototype and similar legibility as the user's monitors.

The notebook is equipped with Morae 3.2 software to record the user's face expressions, the application on display, the mouse movements, and the keyboard typing.

Discussion

The plan to adopt UCD in the department has achieved its first goals after 4 years. The projects implemented show quality improvements that were welcomed by sponsors and users. This methodology is now valued and demanded by health informatics residents and software developers. Below, we discuss specific considerations about the lessons we learned in the process.

Teaching UCD in organizations to change the software development culture

We found out some reasons behind the resistance faced during the course. As developers had almost no free time for classes, and many of them were not initially motivated to learn UCD, we believe that elective and shorter courses could have better results.

Health is effectively a complex domain and it is difficult to reach a usable and useful design. UCD instructors have to be careful and avoid putting themselves in the place of 'gurus' that know exactly how to do the right thing, while developers do not. Instead, before teaching UCD it would help to expose developers with real users interacting with the applications and expressing their difficulties. Thus, developers would learn from their users that UCD is necessary for developing applications that deal better with the genuine complexity of health domain. This is based in an essential principle of UCD: to know the users [21]. In our case, there is a great variety of users, regarding their profiles, demographics and roles: patients, clinicians, surgeons, nurses and other health professionals. For each project listed on Table 1, the user's capabilities, needs and goals were inquired. The profiling of these users can be consulted on the respective cited publications.

It is necessary to know more about how projects are carried on at the organization before proposing a new process of design. Learning UCD is, above all, learning a new way to work. For that reason, the instructor, along with the course attendees, have to find out the necessary steps to get from the current situation to the desired one. The know-how has to be constructed, not imposed, if we want it to be embraced rather than resisted.

UCD as service

UCD became accepted when developers recognized its valuable contribution to their projects. The UX team helps the work of developers by designing the interaction and the user interface. Now, they can focus more on the difficulties of systems, database and communications. Users and sponsors show more satisfaction; therefore, developers get more recognition for their work. When this virtuous circle was evident, developers begin to ask the UX team for help on their projects, even in informal ways.

The key factor for the change in the developers' attitude towards UCD, from resistance to demand, was that the UX team is at their service to work with the developers.

UCD as culture

Progressively, UCD is becoming pervasive, and it is not just the UX team's job. Developers and HI residents are conscious that their goal is to get satisfactory user experiences. The department is getting a common view of UCD as a key of success of its work. This goal was achieved primarily by practicing methodologies and showing good results in user performance and satisfaction. Since the first attempts in teaching UCD faced resistances, the team's main effort was not on telling but showing its value. The change of culture was not immediate, but durable and contagious. Now, very few developers still resist UCD.

Perspectives of UCD for health care software

The practice of UCD for health systems has to be transdisciplinary in order to be viable and effective. Projects are better run by teams formed by staff with diverse knowledge and skills, including medicine, nursing, UX and development. The methodology includes aspects of participatory design, since each member learns the basics of the others' disciplines.

The design of applications should integrate in an overall service that offer a continuous experience for professionals and patients. If not, there is a risk of getting well designed but disconnected touchpoints, that may pose risks as well as dissatisfaction.

Conclusion

This article shows the process taken in the Health Informatics Department of the Hospital Italiano de Buenos Aires to set UCD at the core of the design and development culture, in order to enhance usability of health care software. We carried out a plan that included teaching a course, experiencing a pilot project and forming a UX team for service and dissemination. The article reports how it was implemented and the obtained achievements: impacts on the design of health care software applications, and a positive cultural change in the department towards the adoption of UCD as essential for its practice.

References

- [1] Friedberg MW, Chen MW, Van Busum KR, Aunon F, Pham C, Caloyeras J, et al. Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy. *RAND Health, AMA*, 2013; pp. 33–46. Available from: http://www.rand.org/pubs/research_reports/RR439.html
- [2] Zahabi M, Kaber D, and Swangnetr M. Usability and Safety in Electronic Medical Records Interface Design: A Review of Recent Literature and Guideline Formulation. *Hum factors* 2015; Mar 23. DOI 10.1177/0018720815576827.
- [3] LeRouge C, and Wickramasinghe N. A Review of User-Centered Design for Diabetes-Related Consumer Health Informatics Technologies. *J Diabetes Sci Technol* 2013; 77(44): 1039-56.
- [4] Hermawati S, and Lawson G. Managing obesity through mobile phone applications: a state of the art review from a user-centred design perspective. *Pers Ubiquit Comput* 2014; 18(8): 2003-23.
- [5] ISO/IEC 9241-11. Geneva, Switzerland: International Organization for Standardization, 1998.
- [6] Schumacher RM, Patterson ES, North R, and Quinn MT. NISTIR 7804 Technical Evaluation, Testing and

- Validation of the Usability of Electronic Health Records. NISTIR Technical. 2011. Available from: www.usability.gov
- [7] Nielsen J. Usability engineering. Boston: Academic, 1993.
- [8] Norman DA, Draper SW, eds. User Centered System Design. Hillsdale, NJ: Erlbaum, 1986.
- [9] Carroll JM. Human-computer interaction: Psychology as a science of design. *Annu Rev Psychol* 1997; 48: 61-83.
- [10] Nielsen J. op. cit.
- [11] Carroll JM. op. cit.
- [12] Preece J, Rogers Y, Sharp H, Benyon D, Holland S, and Carey T. Human Computer Interaction. Reading, MA: Addison-Wesley, 1994.
- [13] Johnson C, Johnson T, and Zhang J. A user-centered framework for redesigning health care interfaces. *J Biomed Inform* 2005; 38(1): 75-87.
- [14] Schaffer E. Institutionalization of Usability: a step-by-step guide. Reading, MA: Addison Wesley, 2004.
- [15] Goldenberg J, Martínez M, Stanziola E, Gómez A, Luna D, and González Bernaldo de Quirós F. Rediseño centrado en el usuario de un portal personal de salud. CBIS. Curitiba, Brasil, 2012.
- [16] Luna D, González Bernaldo de Quirós F, Stanziola E, Otero C, López G, and Leguizamón G. Diseño centrado en el usuario para mejorar la carga de problemas en una historia clínica electrónica. CBIS. Curitiba, Brasil, 2012.
- [17] Sabalza M, Waldhorn M, Bianco G, Garbino J, Stanziola E, Ortiz JM, Garcia G, Luna DR, and González Bernaldo de Quirós F. Desarrollo e implementación de un Registro Anestésico Electrónico propio. Infolac 2014. Montevideo, Uruguay.
- [18] García, M, Stanziola E, Ortiz JM, Aguirre Ojea MF, Quispe Uznayo M, López GE, Storani FD, Luna DR, and González Bernaldo de Quirós F. Rediseño del módulo de navegación de documentos clínicos de la historia clínica. Infolac 2014. Montevideo, Uruguay.
- [19] Luna DR, Stanziola E, Otero C, Quispe Uznayo M, Bellosillo W, Risk M, and Gonzalez Bernaldo de Quiros F. Diseño participativo de alertas para la Interacción Droga-Droga en una Historia Clínica Electrónica. Infolac 2014. Montevideo, Uruguay.
- [20] Schachner B, Stanziola E, Gassino FD, López GE, Recondo FJ, González ZA, Simón M, Sommer JA, Luna DR, and González Bernaldo de Quirós F. Rediseño de la interfaz de usuario del módulo de enfermería en la historia clínica. Infolac 2014. Montevideo, Uruguay.
- [21] Nielsen J. op. cit.

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