The Design Process to Healthcare Applications: Guidelines Mapping to Integrate User´s Contexts and Abilities

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Abstract. In this paper we present a set of guidelines to support the designer's activities during the development process of healthcare applications. The presented guidelines conduct the work of designers in the stages of collection and analysis of requirements and in the construction stage of the design process model, focused on the different contexts of users of these applications and their abilities. The design process is a multidisciplinary activity involving techniques and expertise in human factors, ergonomics, and the context of use. The consideration of these elements in the application design increases effectiveness and use efficiency, improves human labor conditions, and counteracts possible adverse effects of use by professionals in areas of healthcare, security, performance, among others. Adopting a design process model involves not only defining functional aspects and application features, but mainly being aware of the user's needs, knowledge, and abilities, as well as his/her limitations and resources. The motivation for developing this project emerged from the difficulty of finding directions on how to conduct the design process of applications for healthcare professionals and meet the specific characteristics of such professionals, who are nomadic, have long working hours, and blend personal and social activities with professional ones. This mix of activities and contexts increases especially when it comes to healthcare professionals looking after patients who require continuous care, for these professionals, in addition to shared activities with their peers, still need to support daily activities of patients, both personal as therapeutic ones. This lack of guidance for designers, often caused by the characteristics of the healthcare professional's activities, expands itself by the fact that designers are not ready to consider such peculiar characteristics of these users and they are not attentive to the mixing of contexts that happens naturally in their work. These facts make the design process of applications for healthcare professionals more complex and require a new perspective, wider than the one proposed by classical development process models. Thus, our proposal is the creation of guidelines to support the designer´s work in the application of a design process model that considers users' contexts, their needs, and abilities, facilitating the adoption and allowing the appropriation of the developed design solutions. The guidelines that we present were mapped for a design process model of applications for healthcare professionals. Such model allows and encourages the integration of contexts and considers the healthcare professional's abilities through the experience of use of technological resources

and exchange of experiences among them, favoring the adoption and the appropriation, and providing the experience of new abilities for the healthcare professional. Following the tendencies of Bring Your Own Device (BYOD) and Bring Your Own Application (BYOA), the presented guidelines conduct and stimulate the use of personal technological resources, like mobile devices, in the professional environment, allowing that the experience of use of such resources is utilized to promote personal, social, and professional integration in the workplace. The guidelines presented here consider the different contexts of healthcare professionals, integrating them in order to facilitate the management and execution of their professional, personal, and social activities and encouraging the use of technological resources to support this integration without harming the workflow of the professionals. Additionally, the guidelines consider the healthcare professional's previous knowledge and abilities to facilitate the search for improvement and the support for the addition of new abilities for these professionals, stimulating the support for the communication and information practices and promoting the formalization and documentation of the practices in the work of the professionals. A case study was conducted to validate the guidelines and map them in the adopted design process model, with the participation of application designers and healthcare professionals in a partner hospital. The purpose of the study was to follow the activities of the stage of collection and analysis requirements and the construction stage of the adopted model, applying the guidelines to propose a design solution, the prototype of an application that meets the wishes and needs of a group of healthcare professionals, so that the solution can be naturally adopted, according to users' knowledge and workflow and not only considering the best practical use of the technological resources. After the validation and analysis of the results obtained in the case study, the guidelines were mapped for the adopted model, conducting the employment of the guidelines in every stage and activity of the model. As a result, we present (1) the conducted case study and the final prototype developed during this study, (2) the healthcare professionals' impressions on the design process, (3) the considerations, obtained through interviews, of designers who participated in this study, related to the use of the guidelines during the development of the design solution, highlighting the positives points perceived by the designers and found problems, and (4) the mapping of guidelines for the steps and activities of the adopted model.

1   Introduction

It is a hard task to follow the evolution and advance of the concepts, methods, and applications related to information and communication technologies, which are always in transformation. Such transformations have happened mainly in the forms of user interaction with computational applications and the professionals, who work with interaction design, according to [1], need continuous update on design models and approaches, mainly for applications that use technologies in the interaction, like technologies by gesture, touch, sound, movement, among others. In order to create

good interaction designs – the ones that allow to access characteristics and functionalities in a pleasant way [2] –, and that the process of adoption and appropriation of new technologies is effective and may expand the users' abilities, it is important to think about the process of appropriation of technological innovation. During the process of appropriation the user realizes clearly his/her abilities, the best way of interacting with technologies, how to adapt them to new uses and contexts, and what he/she is capable of doing and which aspects he/she can improve [8, 20–24]. An interaction design model is pertinent to assist and guide designers during the process of conception, development, and validation of applications with natural interaction, since it utilizes the user's personal, social, and professional experiences with technological resources, which he/she already knows and use, to make interactions more natural and close to such experiences, thereby being able to support the professionals' experience of new abilities.

To do so, it is necessary that the design process integrates different contexts in which the user is inserted, personal, social, and professional ones, searching their experiences and abilities through the stimulus of the use of personal devices that the user is already familiarized with. In this paper, we present a set of guidelines mapped in the stages and activities of a design process model with such focus. The Design Process Model for Application in Healthcare: Integrating Contexts and Adding Abilities (ICAH, initials in Portuguese), which is adopted here, emerged departing from the observations and experimentation with collaborative work between designers and users and allowed to create an assistance instrument to the interaction design [3–7]. The model and the guidelines contribute to facilitate the task of the designer during the development of applications with natural interaction that considers the use of new technologies, experience of use, adoption and appropriation to enable the healthcare professional's experience of new abilities, integrating the different contexts of such professional.

2   Design Process Model for Applications in Healthcare Field

The need to create the Design Process Model for Application in Healthcare: Integrating Contexts and Adding Abilities (ICAH) came from the Laboratory of Advanced Interactions (LIA, initials in Portuguese) team's experiments conducted in a partner hospital CAIS Clemente Ferreira situated in Brazil [4, 5, 8–17]. Such need also came from the field study performed with the COLLAB application [6, 7], the data analysis on the design process of applications that integrate contexts and add abilities to users, and the characteristics of interactive applications in the healthcare field. The ICAH model was developed from the identification of the flow of necessary tasks during the design process. Such activity allowed to structure the cycles of the process that groups the tasks in accordance with the techniques and approaches used in each one of them. With the definition of the cycles and the observations and experiments conducted in the partner hospital, we realized that the stages of collection and analysis of requirements of more traditional design process models do not consider, widely and adequately, the users' characteristics necessary to integrate their different contexts, nor they assist in the extension or allow the addition of abilities. Therefore a survey research was
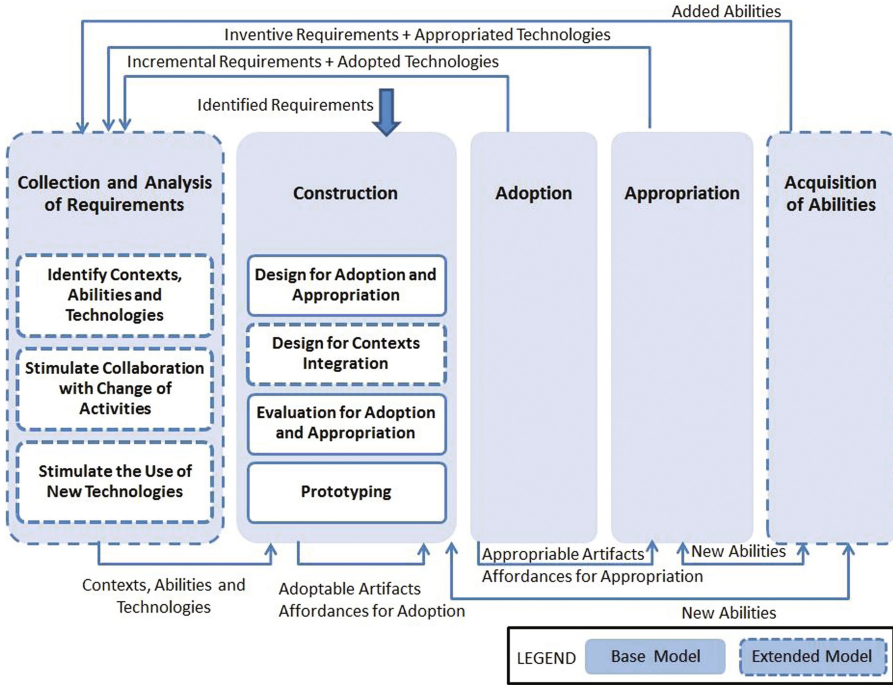
Fig. 1. ICAH model stages and activities

conducted with developers of applications/software in general and also from the healthcare field in order to verify how the stages of collection and analysis of requirements are being performed during the design process. After the analysis of data obtained with the survey research, it was possible to elaborate the process model adopted in this paper and, parallelly, creates a set of guidelines to direct the designers on how to perform the integration of different contexts, in which users are inserted and which they blend, naturally, during their professional activities. Finally, the guidelines and the created process model were validated.

Most recent researches in the interaction design process models and many studies [21–23, 28–30] have demonstrated that appropriation is a concept worth of investigation, particularly in terms of its nature for interactive design and collaborative computing. The ICAH model is an extension of the Model for Appropriation proposed by [8, 18] and Fig. 1 shows the stages and activities of ICAH and the relation among them, highlighting with dotted lines the new stages and activities proposed in ICAH and with continuous lines the original stages and activities of the Model for Appropriation.

Considering that an interaction design process is not a top-down activity, the ICAH Model describes an iterative sequence of stages, in order to guide the application designer during the whole process of development. The model allows the designer to get a global vision of the design process, its stages and activities of each one of the

stages, and conduct a structured, systematic, and organized work. The stage of Collection and Analysis of Requirements begins the sequence of stages and the activity Identify Contexts, Abilities, and Technologies is the spotlight of such stage, which is provided with the requirements, technologies, and adopted, appropriated, and added abilities that result from the stages of Adoption, Appropriation, and Acquisition of Abilities.

3   Presentation of the Employed Guidelines for the Design Process Model

To facilitate the employment of the ICAH model, it was elaborated a set of guidelines that assists the integration of the personal and social contexts to the professional one and provides users in the involved contexts the experience of new abilities, allowing that, during the design process, the appropriation of technologies is encouraged and the users' abilities are widened.

The guidelines were created considering two domains to guide the designers: (1) support for the integration of contexts and (2) addition of abilities for the user. Such domains present common objectives to facilitate the appropriation: inasmuch as the integration of contexts happens, users become aware of the use of technologies and applications in different contexts, in addition to the effective adoption of these technologies. Besides that, the extension of the use of such technologies favors the exchange of experiences and expands the abilities of the users involved in the design process. And in this sense, the concepts of BYOD and BYOA [16, 25, 26, 27] gave support to the elaboration of the guidelines.

These domains and the set of 12 guidelines initially created were published and presented in [3, 19]. The guidelines were refined and complemented after validating them and the model, totalizing 18 guidelines, 10 guidelines of the addition of abilities domain and 08 guidelines of the integration of contexts domain (Table 1).

The presented guidelines make the monitoring of the design process activities clearer and facilitate the work of the developers and designers during the process of development of applications.

3.1   Case Study for Validation of the Guidelines

For the validation of the presented guidelines it was elaborated a case study involving application developers in the healthcare field. The purpose of the study was to follow the activities of the stage of collection and analysis of requirements of the ICAH model, employing the design guidelines to propose a solution, the prototype of an application that meets the wishes and needs of a group of healthcare professionals. Seven healthcare professionals and three teams of designers participate in the study, following the ICAH model and employing the guidelines. The study was divided into four moments: (a) presentation meetings and initial collection of requirements at the users' workplace (Fig. 2); (b) meetings and encounters outside the users' workplace for refinement of requirements, creation of personas and scenarios; (c) meeting for

Table 1. Guidelines for the design process model

	#	Title	Guideline
Guidelines to integrate the user´s context domain	1	Make clear the purpose of sections design	Before beginning the first session of the interaction design process, it is important to talk with the users group and explain how the design process and their activities will be performed. Before each design session, present the activities that will be performed, the expected objectives and results and the duration of the session
	2	Promote a fast socialization before the design sessions (ice breaking)	Design sessions must be initiated with a socialization activity and each participant must be encouraged to expose what they expect to happen in the end of the session/day/week/month. In case the design process already got results, the participant must comment about the design activities that already happened and the perceptions they had
	3	Identify which e-communication services user participates or knows	Designers must know how the users interact among them, mainly if they user any electronic device to this end, if they do it outside the workplace environment and in which situation
	4	Use group sessions techniques to understand what kind of messages users usually share	It is interesting to know what kinds of messages, annotations, information, and reminders users share among them in workplace environment or outside it and dynamics techniques may facilitate the designers' work
	5	Provide quick breaks/intervals between sessions of design with the user (coffee breaks)	Small breaks during design sessions proportionate relaxing moments between activities and must be used by designers to observe the users' behavior and how it is the interaction among them
	6	Design for appropriation	t is important that the design process is flexible and robust enough to allow the technological resources appropriation
	7	Observe and promote integration among users in professional context and outside it	The integration among users happens naturally in professional activities, but it is important to propitiate integrated cooperation among users in different contexts, mainly social relationship to stimulate the appropriation
	8	Identify the lead user	The lead user is the one that will be able to point out the potential needs and good solution ideas. They direct the validations during the solution development and encourage the use of adopted innovations

(*continued*)

Table 1. (*continued*)

	#	Title	Guideline
Guidelines to extend the user´s abilities domain	1	Don´t waste the user´s time	Design sessions must be planned with antecedence and there must be a beginning and an end – delays in starting and ending the session must be avoided
	2	Ask user what technological resource he/she knows	It is important to ask which resources the user knows and uses to facilitate in the choice of solutions to be proposed in the design solutions
	3	Ask user which application he/she uses in everyday activities	The user experience with some applications may assist in the acceptance and adoption of new applications that have similar forms of interaction
	4	Encourage communication among users and designers through new technological resources besides of the presence meetings	Designers must encourage and proportionate the use of communication environments and applications that users do not know or are not familiarized with. This is an opportunity for the users to know a new technology and/or communication form
	5	Observe and use language and terms the user knows	Designers must use a vocabulary familiar to the user's environment, synonyms and popular terms and also observe the terms the users employ among them to refer to technological resources and applications. Users may say they do not know some technological resource or application, but it is common they just know such resources or applications by other names
	6	Program design sessions to be performed in the user's workplace environment	Designers must consider the user's workplace environment as an adequate place for design sessions, respecting the timetable and users' workplace rules, without disturbing or interfering in the workplace environment
	7	Program design sessions to be performed outside the user's workplace environment	Design sessions outside the workplace assist in the discovery of the user's abilities and knowledge on hardware and software technological resources that may be incorporated in the design solution. Besides, it proportionates the sharing of experiences, favoring the adoption and appropriation
	8	Stimulate the cooperation and change of activities among users	During tests with the evolutionary prototype, stimulate the change of

Table 1. (*continued*)

| #	Title	Guideline
		activities among users. The designer must monitor how the activities will be performed by the user who was changed and verify if appropriations and new forms of performing the activities occurred
9	Encourage the use of new technologies	It is important to offer new resources and forms of use of performing the tasks which are already consolidated in the professional environment, so that users realize the different ways of using the technological resources and their different purposes
10	Observe the things that users carry	Understand that the user may not be willing to carry one more item or material, or even due to their activities it is impossible, what may restrict the adoption of the chosen design solution
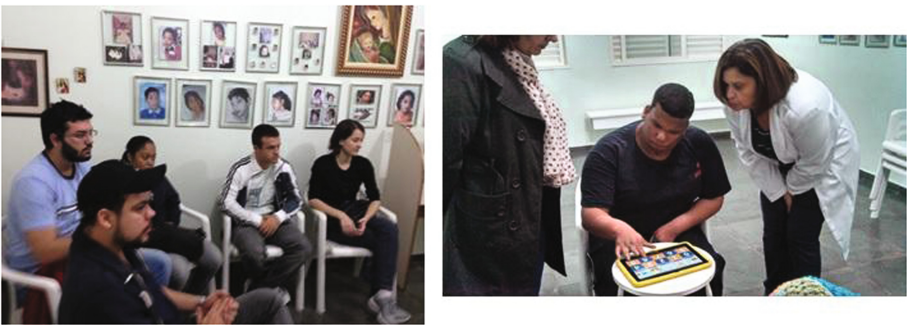
Fig. 2. Meetings at the healthcare professionals' workplace

presentation of initial prototypes and incremental refinements; (d) encounter for presentation of final prototypes and interview with users. After the interviews, users chose a prototype to be developed (Fig. 3).

At the end of the study, designers reported their experiences with the use of the model and the guidelines, and described how and in which stage and phase each one of the guidelines assisted the development process. The designers reported that observations and direct questions to the users helped in the identification of abilities, knowledge, and personal technological resources in use, mainly at the meetings that happened outside the users' workplace. Besides, they said that knowing the users' workplace allowed to verify their real routine and activities, as well as choosing technological resources to be used in the design solution.
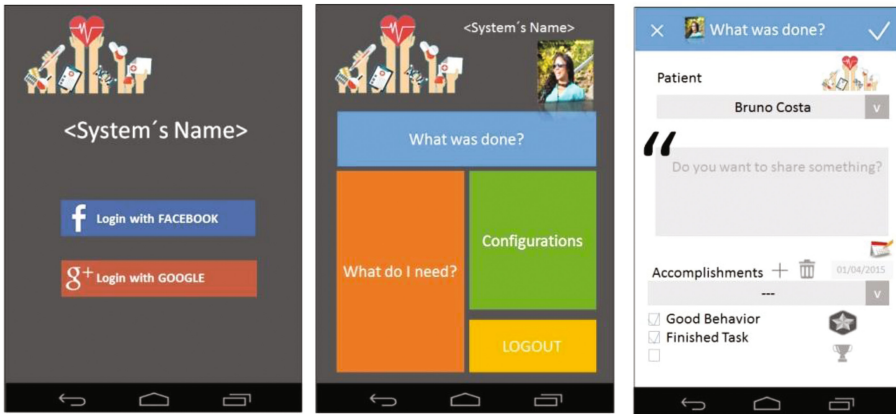
Fig. 3. Final prototype chosen by the healthcare professionals

We monitored the study and observed the employment of the guidelines in order to understand how the designers used them effectively. Such monitoring and the conducted interviews with the designers who took part in the study made possible mapping each one of the guidelines for the stages and activities of the model.

4   Mapping of the Guidelines for the Design Process Model

The guidelines were mapped for the stages and activities of the ICAH model, according to the results obtained in the case study for the validation of the guidelines. Thus, we present the mapping in every stage.

The stage of Collection and Analysis of Requirements is divided into the activities: Identify Contexts, Abilities, and Technologies; Promote the Collaboration with Change of Activities; and Encourage the Use of New Technologies. Such stage aims to identify how the different contexts integrate themselves at the user's workplace, which previous knowledge and abilities the user has, which technological resources are provided at the workplace, and which ones are the user's. And it also tries to identify how, when, and what for the technological resources are used. Therefore, for this stage the following guidelines were mapped:

– Integration of Context Domain: guidelines 1 and 8.
– Addition of Abilities Domain: guidelines 1, 2, 5, 6 and 10.

For the activity "Identify Contexts, Abilities, and Technologies", the guidelines 2, 3, 4, 5 and 7, from the integration of contexts domain, were mapped. For the activity "Promote the Collaboration with Change of Activities", the guideline 8, from the addition of abilities domain, was mapped. And for the activity "Encourage the Use of New Technologies", the guidelines 4 and 9, from the addition of abilities domain, were mapped. Table 2 presents the mapping for such stage.

Table 2. Mapping of the guidelines for the stage collection and analysis of requirements

STAGE	Activity	Integration of context	Addition of abilities
Collection and analysis of requirements		1, 8	1, 2, 5, 6, 10
	Identify contexts, abilities, and technologies	2, 3, 4, 5, 7	3, 7
	Promote the collaboration with change of activities		8
	Encourage the use of new technologies		4, 9

The stage Construction is divided into the following activities: Project for Adoption and Appropriation; Project for Integration of Contexts; Prototype; and Evaluate for Adoption and Appropriation. It is in this stage that the design solutions are elaborated, prototypes are evolutionally created and evaluated after. This stage is iterative, starting with project activities: for adoption and appropriation, and for the integration of contexts, prototyping, and evaluation. Consequently, new abilities can be incorporated in the user's routine and new appropriations can happen. For this stage the following guidelines were mapped:

– Integration of Context Domain: guidelines 6 and 8.
– Addition of Abilities Domain: guidelines 3 and 7.

The stage Acquisition of Abilities happens inasmuch as the design solutions are adopted and appropriated. User's abilities and knowledge are used in other contexts, in other ways and with other technologies. Experiences must be shared between users and designers, and such process allows that new appropriations are observed. Allowing the experience of new abilities assists in the process of adoption of employment and the new abilities acquired and adopted by the users are added to their previous ones. These new abilities will also be able to be used as entrance artifacts in the next collections of requirements for new applications and in the evolution or improvement of solutions already in use. For this stage the following guidelines were mapped:

– Addition of Abilities Domain: guidelines 4 and 9.

The stages of Adoption and Appropriation were incorporated to the ICAH model departing from the model for Appropriation proposed by [8, 18] and guidelines were not mapped for these stages. Figure 4 presents, schematically, the complete mapping of the guidelines for the ICAH model.

For this final mapping, we conducted the case study with developers of applications and healthcare professionals, and the proposed guidelines were utilized during the study for the proposal of an application solution in a hospital. Design sessions and interviews were performed during the employment of the study and design solutions were presented. The healthcare professionals and the developers reported their experiences during the whole process and the latter evaluated the used guidelines.
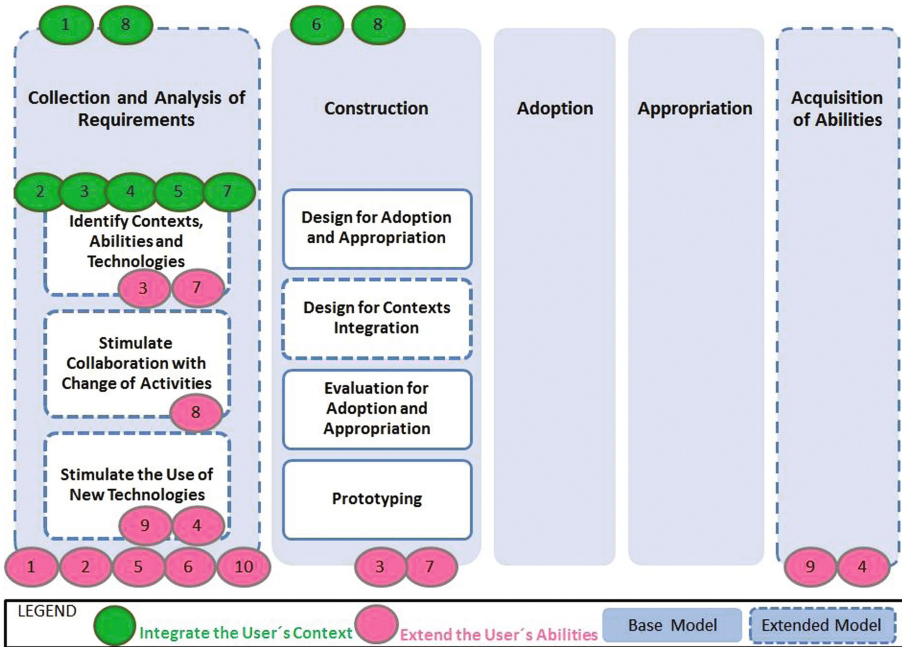
Fig. 4. Mapeamento das Guidelines

Finally, an apparent validation was conducted with specialists in application development to validate the proposed model.

5   Contributions and Future Work

This paper exposes a set of guidelines mapped for the ICAH Process Model of Development for healthcare applications.

The guidelines for Integrate Contexts consider the healthcare professionals' different contexts, integrating them in order to facilitate the management and execution of their professional, personal, and social activities. It also considers the use of technological resources to support this integration of contexts without harming the workflow of the professionals. The guidelines for Add Abilities consider the healthcare professional's previous knowledge and abilities to facilitate the search for improvement and the support for the addition of new abilities for these professionals, stimulating the support for the communication and information practices and promoting the formalization and documentation of the practices in the work of such professionals.

In conclusion, this paper presents a research that contributes and assists designers in the development of interactive applications for healthcare professionals, especially in long-term and constant care, integrating the personal and social contexts to the professional one and supporting the addition of abilities for these professionals through the offered assistance. It still contributes for future researches that may be conducted to

refine or extend the proposed solutions for other professionals, particularly the ones who execute long-term activities, like teachers who monitor the same students during many years, bank managers who take care of clients' accounts for many periods, elderly and special needs caregivers, among others.

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