20

Iterative user interaction design for wearable and mobile solutions to assess cardiovascular chronic diseases

Elena Villalba Mora, Dario Salvi, Manuel Ottaviano, Ignacio Peinado, Maria Teresa Arredondo Waldmeyer
Life Supporting Technologies, Technical University of Madrid
Spain

1. Introduction

Cardiovascular diseases (CVD) are the leading source of death in western world, causing 45% of all deceases. Besides, heart failure, considered the paradigm of CVD, affects mainly people older than 65. The proportion of old people (aged 65 or over) in the European Union is predicted to rise from 16.4% in 2004 to 29.9% in 2050 (Eurostat, 2005). This will increase the number of elderly suffering from chronic diseases and state a significant strain on personal heath care services with new technologies, such as wearable and mobile systems (Gatzoulis & Iakovidis, 2007) (Lamberis and Dittmar, 2007).

Ambient Intelligence (AmI) vision implies the creation of intelligent environments where users interact with the surrounding naturally without additional effort. The technology is integrated into the user's daily life. The environment is adapted to the users in a pro-active context (ISTAG; 2001).

This new social and technological paradigm (i.e. AmI) claims for a new way of designing user interaction and systems which enables services to be ubiquitous and adaptable to the user's particularities. Although personalization offers the possibility to adapt the system execution to the users' preferences, this new interaction model needs adaptation in real time to the user context.

The research reported in this book chapter is based on the iterative design, development and validation of a new model to improve the quality of life of people who live with chronic diseases following Ambient Intelligence principles. The model is validated in a solution to assess heart failure patients remotely. The interaction is natural and the system adapts to the patient dynamically by means of complex intelligent mechanisms. The chapter focuses on the patients' interaction.

The methodology used is ad-hoc adapted following the design principles of User Centred Design (ISO, 1999) and Goal Directed Design (Cooper, 2007) together with an Iterative Software Design (ISD) and Agile Modelling (Sotirovski, 2001) (Ambler, 2002).

The methodology has 3 iterative phases (modelling, implementing and deploying phases) which focus on observing and interviewing stakeholders such us medical experts and

patients in all stages of the global process. More than 80 people participated in an intensive validation along the three phases.
The proposed model of the patient interaction is applied to a use case: a solution to assess remotely heart failure based on daily monitoring of body signals and vital signs, both with wearable and mobile technologies.
This solution, called Heart Failure Management (HFM), makes use of the latest technologies for monitoring heart condition, with wearable garments (for measuring ECG, and respiration); and portable devices (such as weight scale and blood pressure cuff) with Bluetooth capabilities (see Fig. 1).
HFM aims to decrease the mortality and morbidity of the HF population. The system intends to improve the efficiency of the healthcare resources, maximizing the cost-benefit rate of the heart failure management.
The main users of the system are two: a) an HF chronic disease management service provider, with cardiologists and nurses; and b) patients with HF.

Fig. 1. Heart Failure Management solution.

The system consists of a user interaction platform and a professional interaction platform. The sensor used are a blood pressure, a weight scale, bed garments to monitor during night

and wearable garment such a vest or bra to monitor electrocardiogram, respiration and activity during exercising and resting daily.
The user platform groups all sensors and a personal digital assistant device (PDA) which receives data from the monitoring devices, processes it and encourages the patients in their daily healthcare. The professional platform includes the processing server to analyze all data, databases and a portal which provides ubiquitous access of the professionals.
The daily routine data are processed and evaluated for the detection of functional capacity, heart failure worsening and other complications. Motivation strategies must be taken into account in order to provide patients with relevant information, according to their physical and psychological status.

2. Background

In 1999, the IST Advisory Group (ISTAG, 2001) described the vision on Ambient Intelligent as the orientation for the workprogramme of 2000 and incoming years. ISTAG agreed on a single guiding vision wherein the citizen's everyday surroundings became the interface.
Gillian Crampton Smith, from the Interaction Design Institute Ivrea said, "In the same way that industrial designers have shaped our everyday life through objects that they design for our offices and for our homes, interaction design is shaping our life with interactive technologies – computers, telecommunications, mobile phones, and so on. If we were to sum up interaction design in a sentence, I would say that it's about shaping our everyday life through digital artefacts – for work, for play, and for entertainment" (Moggridge, 2007). This way she states what is interaction design. Besides, Michael Schrage, from MIT Media Lab, stated "Innovators don't change the world. The users of their innovations do".
These statements converge in one vision: the necessity of putting the customer, the patient, the person, the user in the centre of research and innovation. The person of the future is surrounded by advanced computing and networking technology that is aware of his presence, his personality, his needs and response intelligently.

2.1 HCI models

People have interacted with computers from the start, but it took time for human–computer interaction (HCI) to become a recognized field of research. Related journals, conferences, and professional associations appeared in the 1970s and 1980s. HCI is in the curricula of research universities, primarily in computer science, yet it has not coalesced into a single discipline. Fields with researchers who identify with HCI include human factors and ergonomics, information systems, cognitive science, information science, organizational psychology, industrial engineering, and computer engineering. (Grudin, 2005)
Human-computer interaction studies the interactions and the relationships between humans and computers. HCI is more than user interfaces; it is a multidisciplinary field covering many areas (Hewett, 1996). In the first ten to fifteen years of its history, HCI has focused on interfaces (particularly on the possibilities and design criteria for graphical user interfaces (GUIs) using windows, icons, menus, and pointing devices to create more usable systems. As interface problems were better understood, the primary HCI concerns started to shift beyond the interface (to respond to observations as articulated by D. Engelbart: "If ease of use was the only valid criterion, people would stick to tricycles and never try bicycles"). More recent HCI research objectives are concerned with tasks, with shared understanding,

and with explanations, justifications, and argumentation about actions, and not just with interfaces. The new essential challenges are improving the way people use computers to work, think, communicate, learn, critique, explain, argue, debate, observe, decide, calculate, simulate, and design. (Fischer, 2001)
Jonathan Grudin (Grudin, 2005) identifies three faces of human-computer interaction. First one extended human factors or engineering psychology to computing. Another developed when mainframes spawned business computing in the 1960s. The third, focused on individual use, arose with minicomputers and home computers and burgeoned with personal computing in the 1980s.
The first thread is the Human Factors and Ergonomics (HF&E). The second focuses on information systems (IS) management. The third one arose in the 1980s with personal computing, it is known as computer-human interaction (CHI) within this chapter.
Although they share some issues and methods, these research efforts have not converged. They emerged within different parent disciplines, at different times, and comprised different generations of researchers. Approaches, attitudes, and terminology differed. Two—computer operation and information systems (IS) management— embraced the journal-oriented scholarly tradition of the sciences; the third—comprising cognitive and computer scientists— has placed greater emphasis on conference publication. In addition, each thread initially emphasized a different aspect of computer use: mandatory hands-on use, hands-off managerial use, and discretionary hands-on use. Designing for a use that is a job requirement and designing for a use is discretionary can be very different activities.
Traditionally, computer usage was modelled as a human-computer dyad (see Fig. 1) in which the two were connected by a narrow explicit communication channel, such as text-based terminals in a time-sharing environment. The advent of more sophisticated interface techniques, such as windows, menus, pointing devices, colour, sound, and touch-screens have widened this explicit communication channel. In addition to exploring the possibilities of new design possibilities for the explicit communication channel, knowledge-based architectures for HCI have explored the possibility of an implicit communication channel (see Fig. 2). The implicit communication channel supports communication processes which require the computer to be provided with a considerable body of knowledge about problem domains, about communication processes, and about the agents involved.

Fig. 2. Human-computer interaction dyad (From Fischer, 2001)

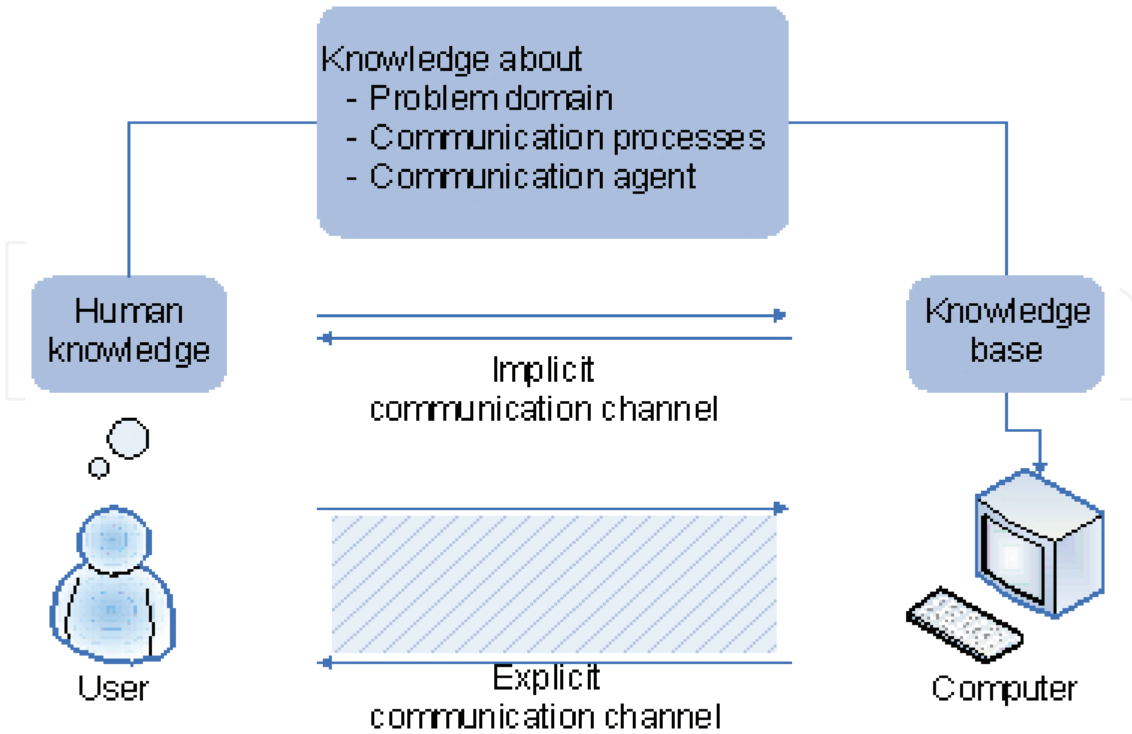


Fig. 3. Knowledge-based HCI (From Fischer, 2001)

As stated in Fig. 3 the knowledge comprises three different types of knowledge (Fischer, 2001):

- Knowledge about the problem domain: Shared knowledge builds upon large amounts of knowledge about specific domains. This knowledge constrains the number of possible actions and describes reasonable goals and operations in the domain of specific users, thereby supporting human problem-domain interaction and not just human-computer interaction.
- Knowledge about communication processes: The information structures that control communication should be accessible and changeable by the user. A knowledge-based HCI system should have knowledge about when and whether to assist the user, interrupt the user and volunteer information to the user contextualized to the task at hand.
- Knowledge about the communication agent: The "typical" user of a system does not exist; there are many different kinds of users, and the requirements of an individual user usually change with experience. Simple classification schemes based on stereotypes such as novice, intermediate, or expert users, are inadequate for complex knowledge-based systems because these attributes become dependent on a particular context rather than applying to users globally. One of the central objectives of user modelling in HCI is to address the problem that systems will be unable to interact with users cooperatively unless they have some means of finding out what the user really knows and does. Techniques to achieve this include: (1) being told by the users (e.g. by questionnaires, setting preferences, or specification components); (2) being able to infer it from the user's actions or usage data; and (3) communicating information about external events to the system.

There are several HCI models in which the interaction occurs always in an explicit way, that is to say, the user directly enter the data into the system and receives feedback. See Schomaker, 1995 for a basic HCI model.
Explicit interaction requires always a kind of dialog between the user and a particular system or computer the user is currently interacting with. This dialog brings the computer inevitably to the centre of the activity and the users focus is on the interface or on the interaction activity. This form of interaction is obviously in contrast to the visions of calm and Ubiquitous Computing. Also the idea of a disappearing computer [9] and ambient intelligence is hard to imagine with explicit interaction only. The realization of these visions can only be achieved when parts of the interaction between the computer and the human are transparent and not explicit, as stated above (Schmidt, 2005).
There are many things that influence the interaction between humans that are not contained in traditional "human computer interaction". The influence of situation, context, and environment offers a key to new ways of HCI. To come closer to the aim of creating interaction between humans and systems that is closer to natural interaction it becomes crucial to included implicit elements into the communication in addition to the explicit dialog that already used.
The following definition (see Table 1) characterizes the new paradigm of implicit human computer interaction (iHCI).

Implicit Human-Computer Interaction (iHCI)	iHCI is the interaction of a human with the environment and with artifacts which is aimed to accomplish a goal. Within this process the system acquires implicit input from the user and may present implicit output to the user.
Implicit Input	Implicit input are actions and behavior of humans, which are done to achieve a goal and are not primarily regarded as interaction with a computer, but captured, recognized and interpret by a computer system as input.
Implicit Output	Output of a computer that is not directly related to an explicit input and which is seamlessly integrated with the environment and the task of the user.

Table 1. Implicit Human Computer Interaction definitions (Schmidt, 2005)

The basic idea of implicit input is that the system can perceive the users interaction with the physical environment and also the overall situation in which an action takes place. Based on the perception the system can anticipate the goals of the user to some extent and hence it may become possible to provide better support for the task the user is doing. The basic claim is that Implicit Human Computer Interaction (iHCI) allows transparent usage of computer systems. This enables the user to concentrate on the task and allows centring the interaction in the physical environment rather than with the computer system.

To support the creation of systems that use implicit interaction it is important to provide a simple model that reflects this interaction paradigm. In Fig. 4 an abstract model of implicit interaction is shown.

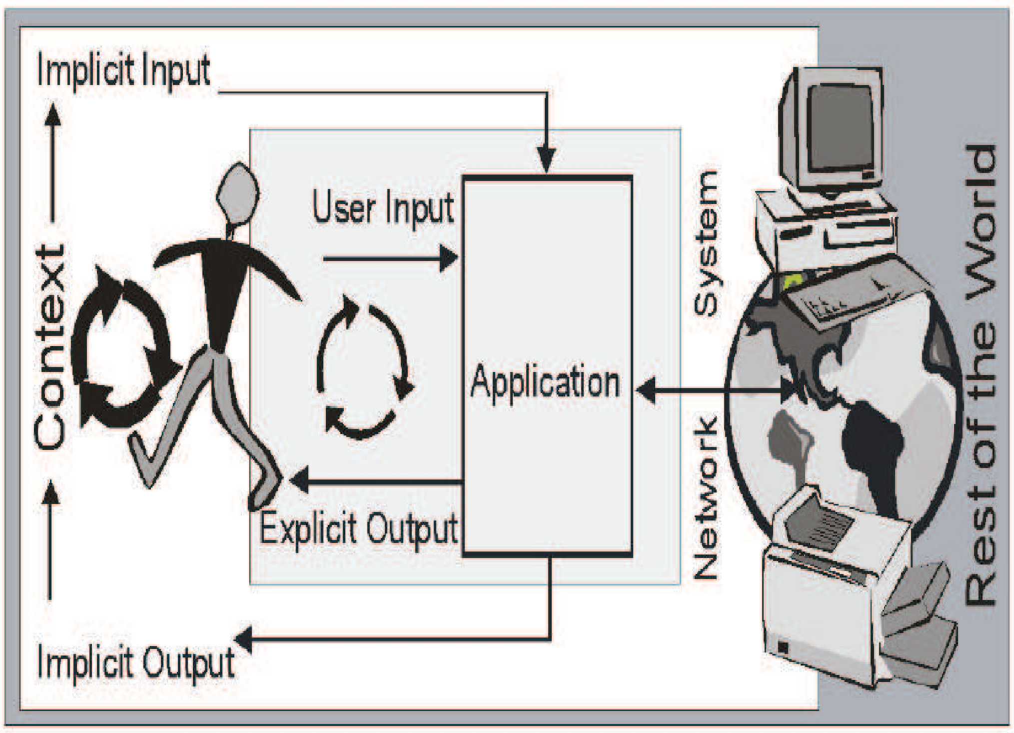


Fig. 4. Implicit Human Interaction Model (Schmidt, 2005)

All actions carried out by a human are taking place in context – in a certain situation. Usually interaction with our immediate environment is very intense (e.g. sitting on a chair, feet on the ground, garment on the body, moving books on the table, drinking from a glass, etc.) even if we don't recognized it to a great extent.
All contexts and situations are embedded in the world, but the perception of the world is dictated by the immediate context someone is in. Explicit user interaction with an application is embedded into the context of the user and is also a way of extending the context of the user, e.g. by having access to the network.
Applications that make use of iHCI take the context into account as implicit input and also have an influence on the environment by implicit output. The proposed model is centred on the standard model in HCI where the user is engaged with an application by a recurrent process of input and output. In the iHCI model the user's centre of attention is the context – the physical environment where the task is performed. The interaction with the physical environment is also used to acquire implicit input. The environment of the user can be changed and influenced by the iHCI application.
The system and also the network are to some extent part of the context but are also accessible by the application directly.
The Holistic Patient Interaction Model is based on the iHCI. Following sections explains the methodology and all models that form the hPIM.

3. Methodology

Since there were no previous documented work on this topic, the methodology used needed to be really user-centered. Besides, stakeholders were involved in all stages, from the early conceptualization till the final validation.

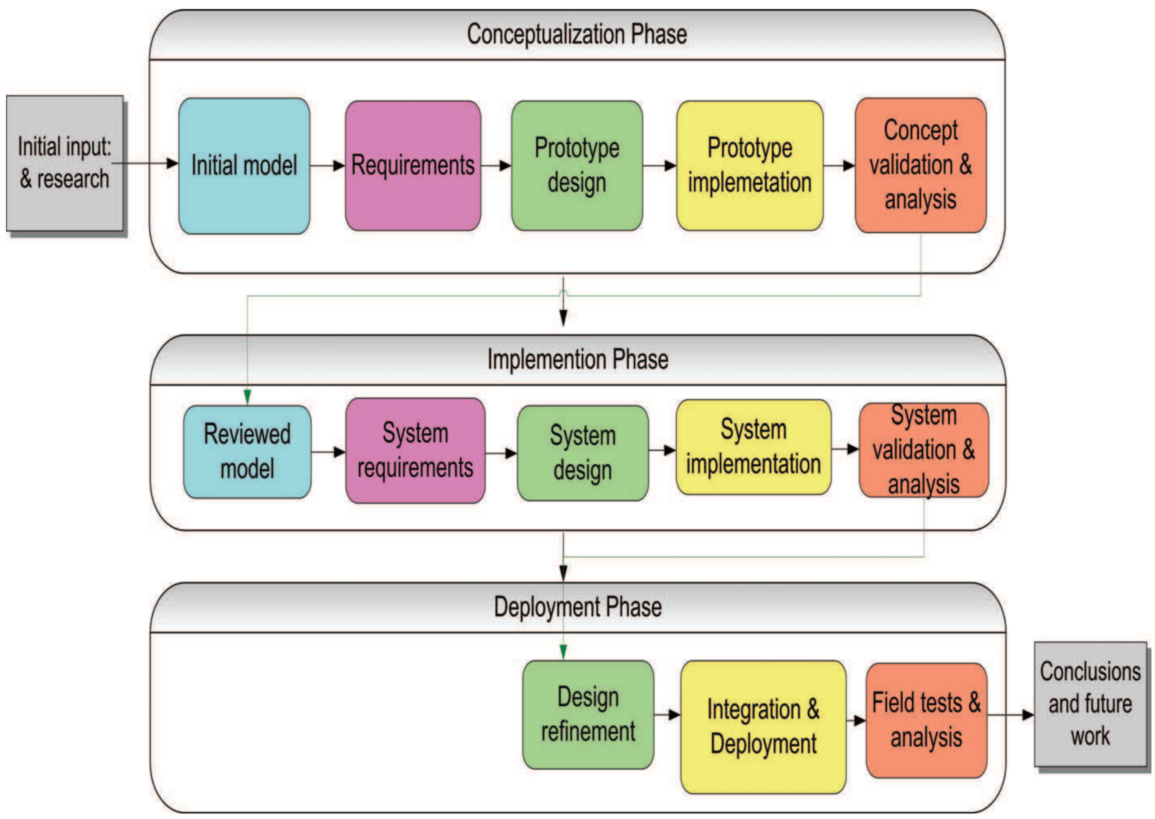


Fig. 5. Iterative process in three phases to design and to validate solutions to assess chronic conditions in AmI.

The whole process (see Fig. 5) is divided into three iterative phases: Conceptualization Phase, Implementation Phase and Deployment Phase.
Each phase follows the design principles of User Centered Design and Goal Directed Design (GOD) (Cooper, 2007). This last design is divided into Research, Modeling, Requirements, Framework and Design and is based on ethnographic techniques to people research.
The requirements, the definition of persona, scenarios and key paths are based on GOD techniques.

4. Holistic Patient Interaction Model

To assure the success of solutions to self-manage the healthcare by chronic patients at their own homes, we need to understand all actors and interactions that occur in a holistic framework. The Holistic Interaction Model comprises three contexts that round the patient. Fig. 6 illustrates the conceptual model.

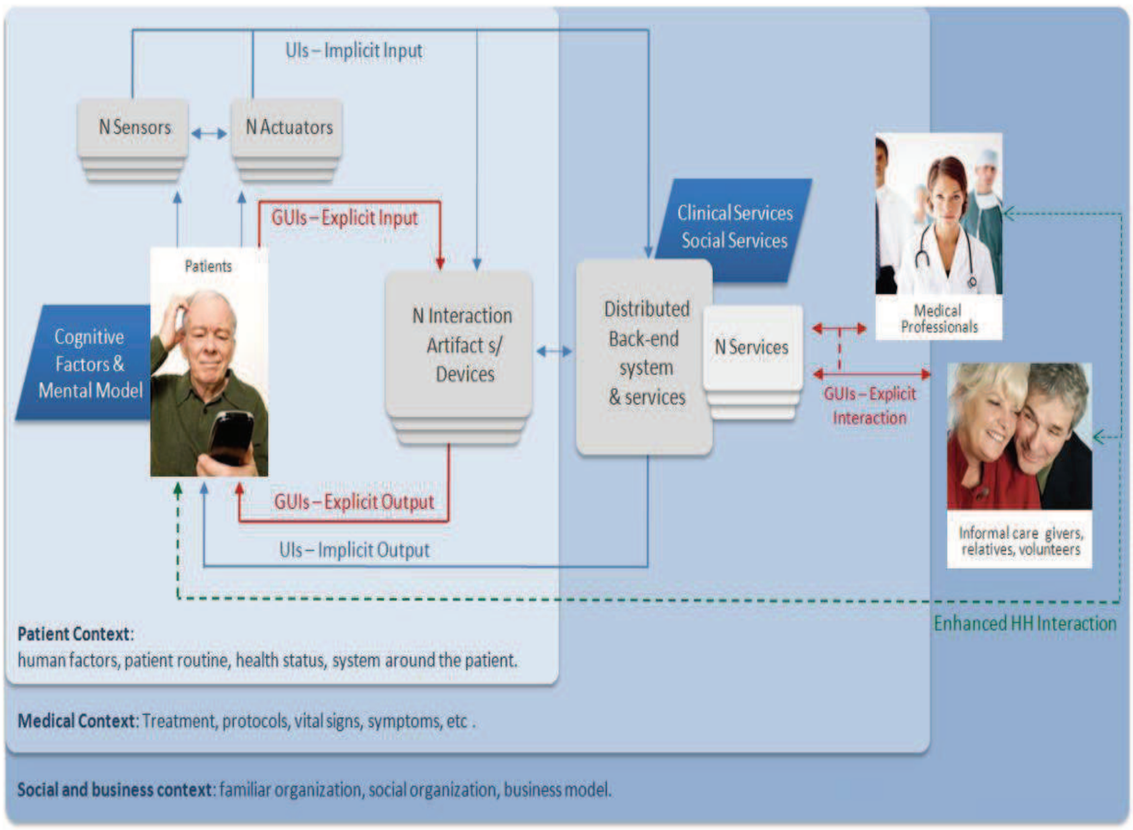


Fig. 6. Conceptual view of the Holistic Patient Interaction Model

In a generic scope, the interaction is modelled as several contexts and several interaction loops. The holistic Patient Interaction Model is organized in three contexts, the Patient Context which defines the human factors or the patient personal routine. Sensors around the patient play important role in their interaction since allows implicit interaction without specific patient input. Around this first context, the Medical Context comprises also the services which provide the patients with a remote monitoring assessment. This context groups all medical professionals. Social and Business Context appears around all. This context states the social and clinical rules that must be taken into account. With this holistic approach all actors are studied enhancing also the human-human interaction.
Adaptation to personal routines is the most important user requirement. Specifically, each user will have a different daily health schedule according to particular health status, preferences, mental status and recommended medical protocol.
Adaptability to user preferences and routines is achieved via dynamic workflow execution (which depends on the context information). First, we defined taxonomy: a session is a day using the system; a day is divided in contexts (e.g. morning, exercise, evening, and night). Each context comprises a set of activities requiring user participation at the same temporary term (i.e. a task or activity is the measurement of blood pressure). It is done while measuring the subject's weight and the morning questionnaire. Thus, we have the morning context. Each context is defined by a beginning and ending time that sets the validity period, restricts the context execution, sets activity performances, and describes the current context state. The state can be inactive, active, performed, aborted and incomplete. Following this scheme,

after the application is turned off, all contexts are inactive. Fig. 7 shows the flow interaction model based on contexts.

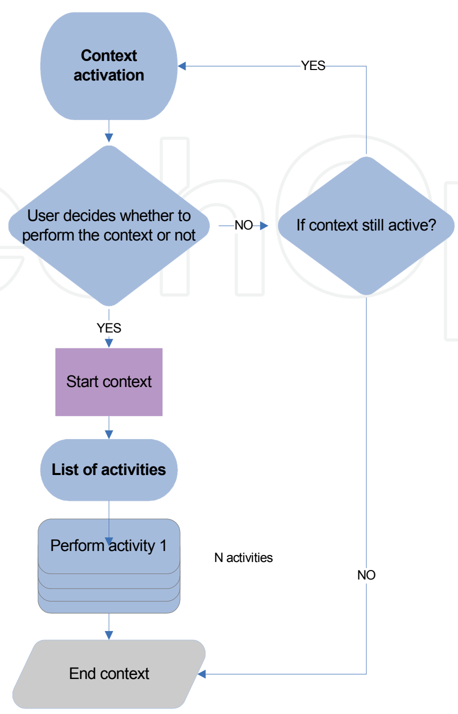


Fig. 7. Dynamic flow of the Holistic Patient Interaction Model.

Different rules govern context activation (i.e. they are performed between starting and ending time). They also have restrictions in the medical protocol (i.e. exercise must be finished two hours after medication).

Following context activation, the alarm is launched and executed with the user acknowledgement. The context execution equates the activity execution in the list. Each manager controls each activity, thus allowing modularity. The manager invokes all necessary SW and HW modules (e.g. sensors).

Restrictions are events-based occurring in real time. They are triggered either by the user via direct interaction (user voluntarily stops an activity) or by the system. The system launches events coupled to the health status from the study of vital information or the environmental status (patient location, etc.).

The activities execution dynamically occurs depending on the current context: period status, user dialogue, and the health status together with other contextual information.

All gathered data, raw processed raw signals, notifications are sent to the Back-end for further processing and management.

The professionals access all data via the portal. The first available information is an outline of every user highlighting crucial events. The professionals can also consult and edit the information for specific uses. Thus, professionals close the loop and enhance their relationship and interaction with patients.

In order to complete the Holistic Interaction Model, Personas and scenarios are defined following GOD principles. To conclude, the interaction is modelled as key-paths and variations of key-paths or workflows. They represent all interaction flows that occur in a real situation based on context activation (Cooper, 2007).

4.1 Persona for Heart Failure Management

The generic user ("persona") of HFM is Carlos Gómez, 72 years old. He is retired and has heart failure. His awareness of his heart condition leads him to be proactive in his health. He can use an electronic device following an intuitive system. He requires no special needs regarding accessibility (e.g. blind people).

His chief goals are self-assurance and self-confidence when performing his daily routine. He must feel unperturbed and lose his fear of a sudden death. He also aims to control his own health evolution by self-managing his health.

He wishes to live normally, thus making it crucial to give him a system that is non-intrusive that invisible from public view while under treatment. Namely, the system must adapt to his daily routine.

4.2 Scenarios and user requirements within Heart Failure Management

The team creates stories about ideal user experiences, describes how the system fits into the personas' life and their environment, and helps them achieve their goals. We based the method on the description of scenarios or contexts of daily use.

In the HFM context, the end users are prompted to follow a daily routine consisting of a set of activities (i.e. symptoms questionnaires, measurements using wearable garments and portable devices). The vital signs assessed are ECG, heart rate, and respiration. The portable devices are a blood pressure cuff for systolic and diastolic blood pressure and weight scale. All devices and garments have communication capability (i.e. Bluetooth). Moreover, the user can perform a light exercise of 5-6 minutes, several days a week to improve their health. This routine varies for every patient but must follow some rules for medical reason (e.g. blood pressure must be taken every morning). The routine can be personalized for each patient despite the light constraints.

There were two scenarios detected within the system: indoors and outdoors. The former contains a set of measurements, using the wearable garments and portable devices at home. The user answers two questionnaires defined by the medical team. The later contains an exercise scenario (e.g. a short walk) that promotes a healthy lifestyle and improves cardiovascular capability. The professional checks the status of all patients via portal.

Adaptation to personal routines is the most important user requirement. Specifically, each user will have a different daily health schedule according to particular health status, preferences, mental status and recommended medical protocol. Furthermore, the user application must be intuitive, user-friendly, and must allow natural interaction. The PDA with a touch-screen allows these requirements.

4.3. Graphical user interface as interaction driven within Heart Failure Management

According to the results of the interviews during the validation phase in Eindhoven, using metaphors such as arrows to represent backwards and forward or "X" to skip was generally confusing. The users suggested that buttons had to be button-shaped and labeled with the action that would take place when pushed. It was decided to implement a color code that makes use of the average user mental model.

Table 2. describes the aim of each functional block in the graphical user interface.

Header area	The header area includes information about the current context and activity, the application logo and a "Skip" button that will let the users exit the fore mentioned activity.
Information Area	The most important portion of the screen, the "Information Area" supports the interaction through messages and instructions.
Navigation area	The navigation area comprises the navigation buttons that will help the user navigate through the screens.

Table 2. Functional groups of the GUI

Table 3. describes the three types of buttons that are used.

Green buttons	The green buttons are associated to the key path.
Gray buttons	Gray buttons represent variants of the key path.
Red buttons	Red buttons are intended for exceptional situations, such as stopping the application.

Table 3. Buttons' types of the graphical user interface

With all this design, the resulted GUI was text based, with no extra pictures or methaphores and based on haptical input (see Fig. 8).

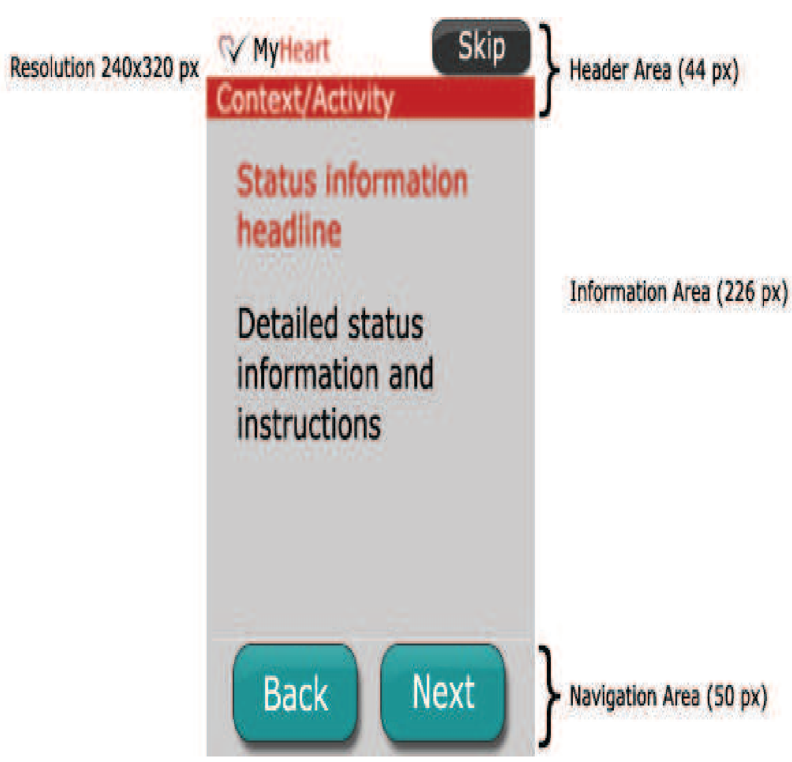


Fig. 8. Functional blocks for the user interface after usability validation

To finalize with the modelling, the patient interaction flow is described in a set of screen and the transition among them in a key path and complete paths (Cooper, 2007). See Fig. 9.

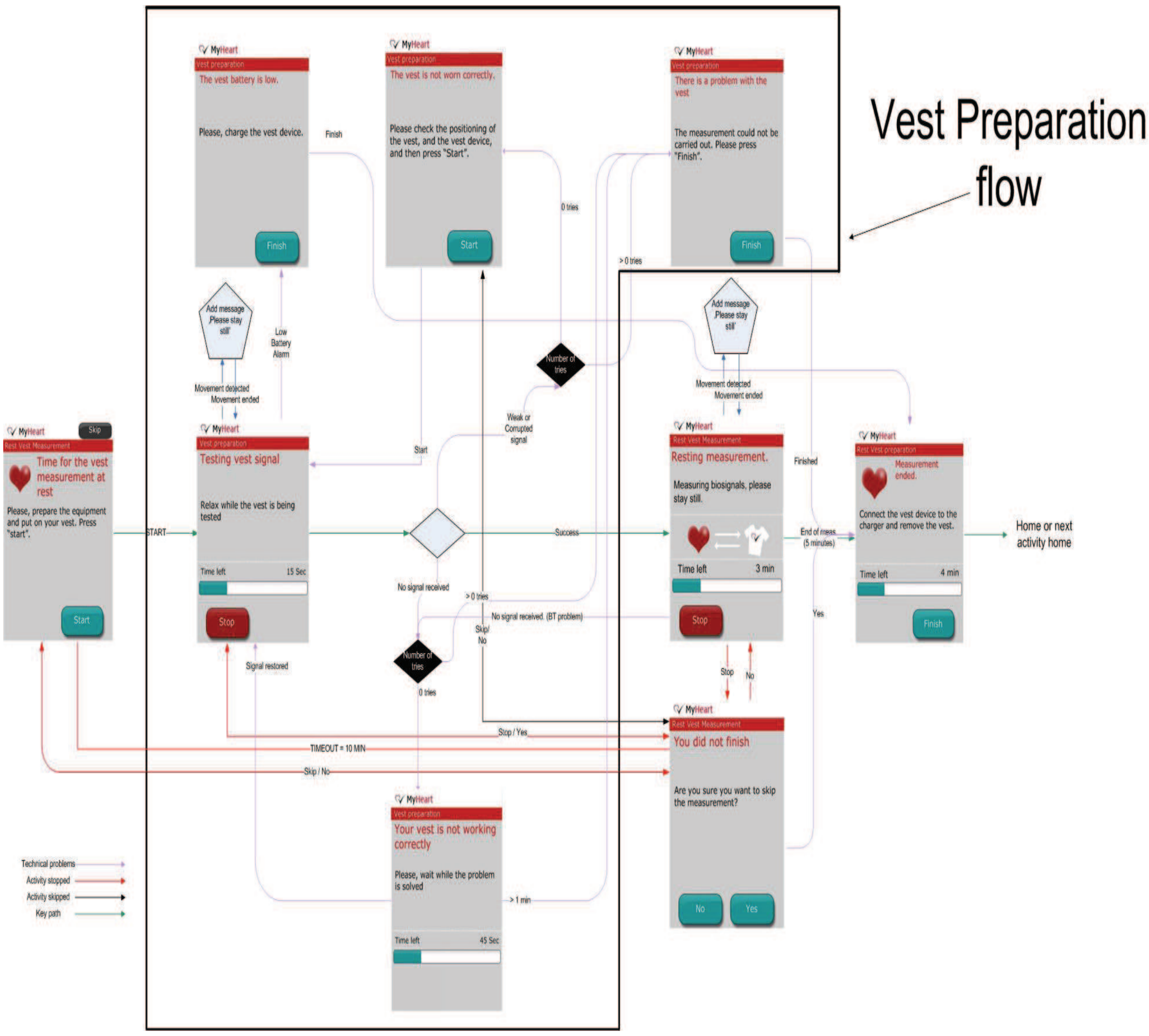


Fig. 9. Complete path to describe the user interaction in the vest activity which permits the patient to measure the heart condition thought the wearable garment implemented in a vest.

5. Resulted patient interaction system

Taking as input all information from the models, we implemented a solution based on a context workflow engine.

The resulted distributed system is composed of a patient interaction which comprises all necessary sensors and interaction device (i.e. a PDA) and the Back-end with all servers, databases and a portal to allow the professional interaction.

The final user platform is a modular architecture running on Microsoft's .NET Framework (Rubin & Yates, 2003). The Session Context Engine is the core element that provides flexibility in the protocol that users follow. We based it on the workflow engine that invokes the tasks the user performs according to a workflow that varies with every patient. The varied tasks are organized in contexts.

Fig.10 illustrates the user platform's architecture whose modules are further explained below.

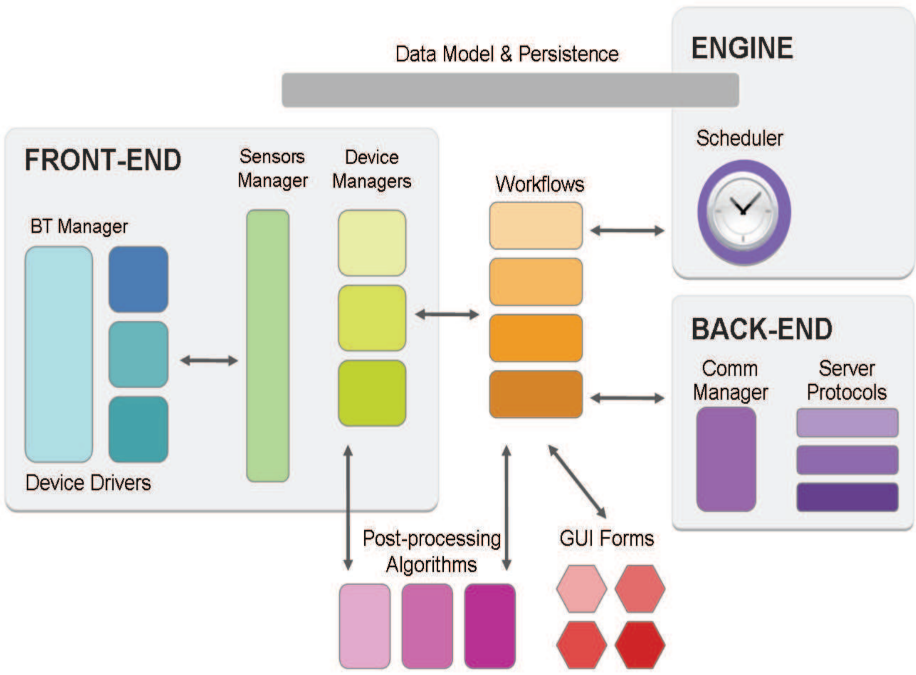


Fig. 10. Modular architecture of the user platform

The architecture is divided into 4 main areas: a) the Front-end module, b) the Workflows, c) the Engine and d) the Back-end module. The PDA is also composed of Post-Processing Algorithms, a set of programming Tools and GUI Forms that allow user interaction.
The Front End module provides a standard interface to the sensors. This module isolates the complexity of the communication protocols towards the different sensors. The sensors are a blood pressure monitor, a weight scale and wearable on body sensors to take information from electrocardiogram, respiration and activity.
Workflows define the user interaction via displayed messages and actions taken when the user presses the button. Events from the scheduler trigger the workflows when a context requires performance; the related workflow starts showing the correct user interface. Activity workflow communicates with the device manager and receives the measured data plus events relating to activity status during the activity's execution. The workflows use the graphical user interface via opening and closing formularies, and setting their text fields. The workflows use a Localization module that gathers the local language's textual information from an .xml file to provide internationalization into the application.
The engine module covers a) the application data meaning and storage, b) a scheduler, c) some modules for the application configuration and d) an error management module. This engine implements and manages the Session/Context/Activity model. The application runtime information is stored on Tabloid, a data structure. A tabloid implements the table containing the list of actions the application performed and will perform during the day.
A scheduler persistently updates the tabloid. The scheduler checks the system clock and decides the actions the user performs. It manages contexts, sends information, and launches events warning the user of pending action. Fig. 11 sketches the scheduler.
Thus, two programming threads work within the scheduler: the scheduler thread updates tabloids and main forms thread handles the events that activate the GUI.

Context execution is managed on the tabloid. Each context is defined via starting and ending time that sets the validity period, a set of restrictions constraining the context situation, a set of activities the user will be performing, and a variable describing the current context state.

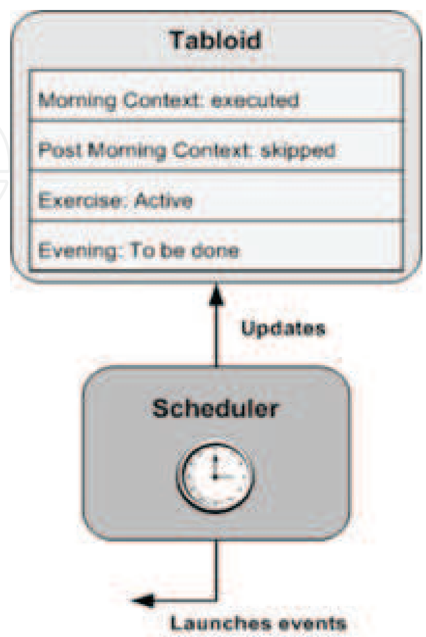


Fig. 11. The Scheduler updates the Tabloid and launches events

Some possible states are described in Table 4:

State	Description
INACTIVE	when a context has not begun yet
ACTIVE	when a context can be performed and is waiting for an event to be started
PERFORMED	when a context has been completed correctly
ABORTED	if the context execution has been aborted by the user
UNCOMPLETE	when the context has been executed, but not finished

Table 4. Possible states of a context.

Following this scheme, when the users' application sets off, all contexts are inactive. Context activation follows the following rules:

1. Each context can be performed between its starting and an ending time.

2. If a context has no restrictions, only the time is checked to know when to activate the context.
3. If the context has restrictions, all of them must be matched.

An alarm is launched and executed via user acknowledgement once a context is activated. The context execution means the execution of activities included in the list. Activity managers control each activity: a questionnaire activity manager supervises the questionnaire's extraction from a configuration file, fills the questionnaire data structure and manages the answers.

Graphical user interaction is provided as .Net formularies (forms). Each form represents an application screen, with static, graphic elements (text/pictures) and dynamic and interactive elements like buttons and slides. User interaction and workflows manage the forms via events.

6. Validation along the process

According to the philosophy of participatory design and involvement of users in all stages of the process life cycle, the validation was performed along the three phases (ISTAG; 2004). Table 5 summarizes all evaluations and testing.

Process phase	Validation	Place	N patients	N non-patients
Conceptualization	Conceptual validation	Spain	10	16
Implementation	Experts – Heuristics evaluation	Eindhoven, The Netherlands		4
	Usability tests with final users	Eindhoven, The Netherlands	5	
	Field tests with final users	Basel, Switzerland	4	
Deployment	Field tests with final patients	Madrid, Spain	37 (31 + 6)	
	Field tests with final non- patients users	Aachen, Germany		6
TOTAL			82	

Table 5. Iterative validation along the whole process

The conceptual validation consisted of a set of personal interviews to respondents of identified stakeholders. These interviews lasted between one hour and two hours and had several sections. This evaluation was done during first half of 2005 (Villalba, 2007).
During the Implementation Phase, firstly a Heuristic evaluation (Nielsen, 1994) with experts was performed in October 2006. Direct afterwards, the interfaces were confronted to real old patients, in total 5. Both testing were done in Eindhoven, The Netherlands.
The interaction was then revised and re-implemented in the next prototype. The new system was validated with 4 patients in a field test, where the patients used the solution at their own homes during one week. This validation occurred in July 2007 in Basel, Switzerland.
We held the field test during the implementation stage with Medgate in Basel throughout July 2007 with 4 old ladies. The study's primary objective was to validate the global system for Heart Failure's assessment in a real environment with real users who will use the system in their homes. We tested version 1 of the system (Villalba, 2007).
Patients performed all tasks until technical problems occurred. Only one patient, whose PDA malfunctioned from the third day, didn't complain.
We started the field text at home and the day they returned all devices. We prompted all patients to fill in a user-experience questionnaire.
The patients initially felt intimidated by the device. After the pilot, they felt more positive although they were still unsure how it will fit into their daily routines.
In the Deployment Phase, the system was again validated with patients and non-patients users. This last validation phase took place in Aachen, Germany and Madrid, Spain from January to March 2008.
In total 37 people were interviewed, 31 at the Hospital Clínico de Madrid (HCM) and 6 in Getafe, Madrid at patients' homes. All of them were cardiovascular patients. People in Getafe were post-event patients, both angina and myocardial infarction. Patients from HCM were heart failure patients. Tests at HCM were performed under the supervision of technical people, user interaction experts and medical professionals. The test occurred during January 2008.
Fig. 12 shows the distribution of the sample of population involved in the test of Getafe, Madrid (left) and HCM, Madrid (right). The mean age is 60,3 years and the standard deviation is 5,75. The average age at HCM is 67,13 years and the standard deviation is 12,32.

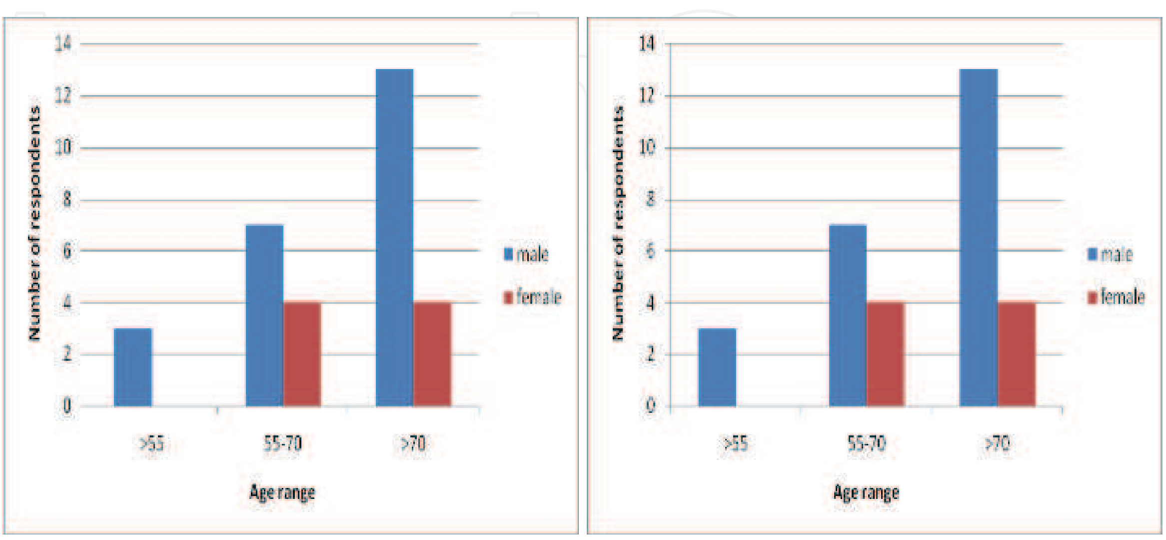
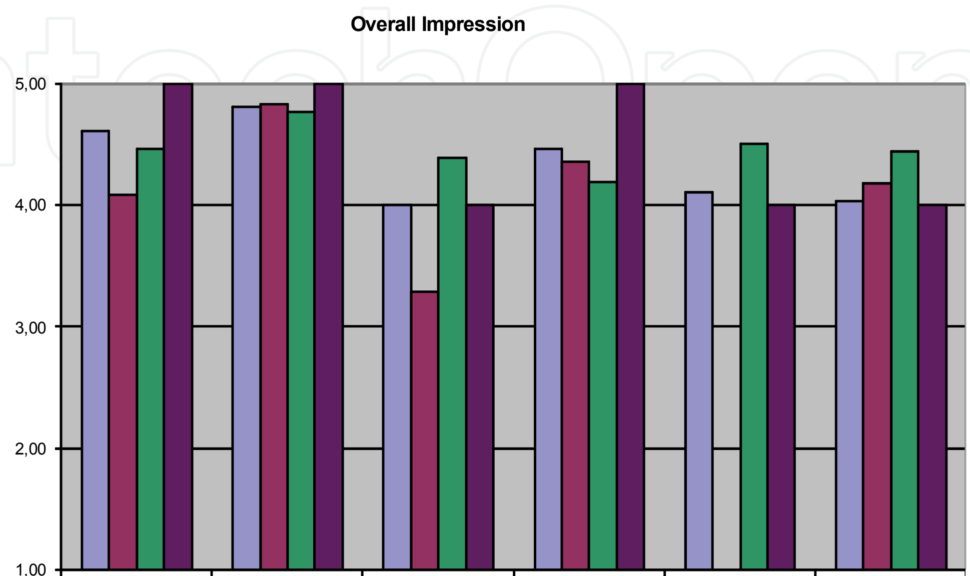


Fig. 12. Population sample of the field test in Getafe (left) and Madrid (right)

The interviews lasted 60 minutes in which the patient had to use the system for 15 minutes and to fill in a final questionnaire to extract objective data.
The results of this test, specially the 31 patients had very positive results. All usability and acceptability problems seem to be solved after all iterations with stakeholders and re-design (see Fig 13 and Fig. 14).



	Interesting	Not scary	Pretty	Fun	Simple	Easy
General concept	4,61	4,81	4,00	4,46	4,11	4,04
Vest	4,08	4,83	3,29	4,36		4,18
PDA	4,46	4,77	4,38	4,19	4,50	4,44
BP	5,00	5,00	4,00	5,00	4,00	4,00

Fig. 13. Overall impression of the testing at HCM.

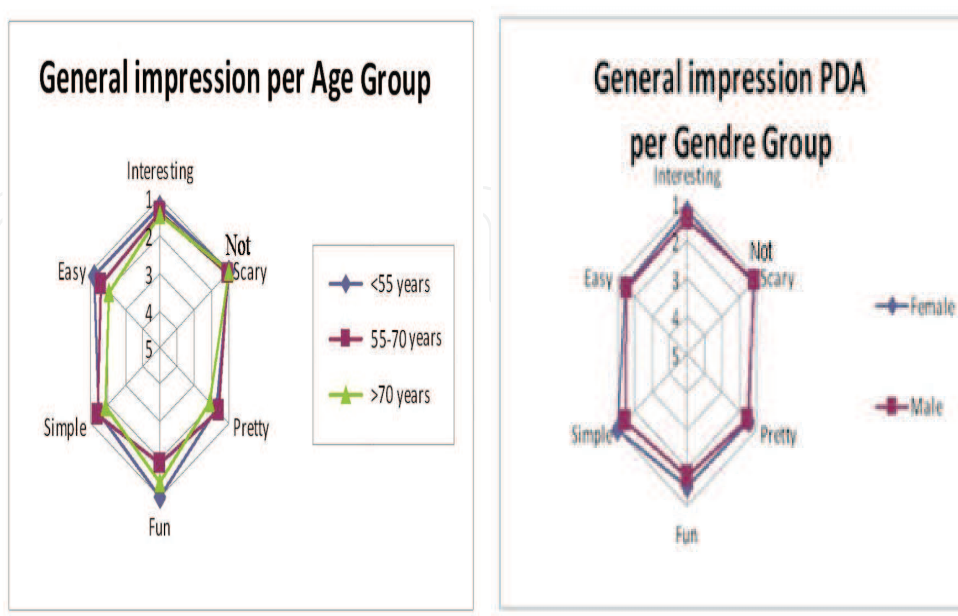


Fig. 14. Representation of the general impression of the overall system and the PDA in a spider graph. We can notice that the results are pretty positive.

Regarding the ease of use, there were some concerns about the use of the wearable garment or vest. However, in general all results are over 3,70 over 5. That is to say, the resulted final solution is suitable to be use by heart failure patients.
Each testing iteration shows a better understanding and better acceptance of the use of the technology by heart failure patients.

7. Conclusion

The research presented within this book chapter has modelled the patient interaction in an Ambient Intelligence environment. This interaction includes all actors, stakeholders and distributed systems that are needed to assess chronic conditions. In the current point of the way, the success of these systems relies mainly in the user acceptance. This acceptance will occur only when the technology, the systems and the interaction are design for and with the real patients and other stakeholders.
The current work was focused on the improvement of the usability, minimizing the interaction requirements and increasing the contextual awareness.
Development of user-friendly interfaces will help users get familiar with the latest technology available in the market. Ultimately the industry will benefit from this as well, as it will boost purchase and usage behaviour. Development of user-friendly systems requires knowledge about factors that influence the user's learning behaviour while handling new systems.
The results are very promising in terms of the interaction modality implemented. A detailed analysis to enhance individuals experience incorporating this system into the daily routine is still lacking. For this reason, an "in depth" study regarding behaviour components towards e-health to create a tailored communication framework, as well as to increase the patient's interest to use such systems is being performed. A framework to be followed considers the analysis of different variables.
Finally, these systems will play an important role on the daily life of chronic patients, supporting a better quality of life and helping to prevent and to treat chronic conditions in a more effective way.
Moreover, there is also the need of involving public authorities in this new technological and social wave. Without their collaboration in the global policies, the success of theses systems will be drastically reduced.

8. References

Ambler S. W. Jeffries R (2002). *Agile Modeling: Effective Practices for Extreme Programming and the Unified Process*. John Wiley & Sons. 1st edition (March 22, 2002).

C. Zwick, B. Schmitz, K. Kuehl, (2005) *Designing for Small Screens*. Edited by AVA publishing SA, 2005.

Cooper A, (2007) *About Face 3.0 The Essentials of Interaction Design*. Edited by Wiley Publishing, Inc. 2007.

Eurostat (2005) *Population projections 2004-2050*.

Fischer, G. (2001). User Modeling in Human-Computer Interaction. *User Modeling and User-Adapted Interaction*, 11, 65-86. Kluwer Academic Publishers. The Netherlands.

Gatzoulis, L. & Iakovidis, I. Wearable and Portable eHealth Systems. *Engineering in Medicine and Biology Magazine, IEEE* Volume 26, Issue 5, Sept.-Oct. 2007 Page(s):51 – 56.

Grudin J (2005). Three Faces of Human-Computer Interaction. *IEEE Annals of The History of Computing*. 2005. Pages 46-62.

Hewett, Baecker, Card, Carey, Gasen, Mantei, Perlman, Strong and Verplank (1996). Chapter 2: *Human-Computer Interaction*. ACM SIGCHI Curricula for Human-Computer Interaction. Association for Computing Machinery, Inc.

ISO 13407. (1999) *Human-Centred Design Processes for Interactive Systems*, Geneva, (Switzerland).

ISTAG (2001) *Scenarios for Ambient Intelligence in 2010*. Edited by European Communities, 2001.

ISTAG (2004) *Report on Experience & Application Research*. Involving users in the Development of Ambient Intelligent. Edited by European Communities, 2004.

Lamberis, A. & Dittmar, A. Advanced Wearable Health Systems and Applications - Research and Development Efforts in the European Union. *Engineering in Medicine and Biology Magazine, IEEE* Volume 26, Issue 3, May-June 2007 Page(s):29 – 33.

Moggridge B, *Designing Interactions*. The MIT Press, Cambridge, Massachusetts 2007.

Nielsen J. (1994), Heuristic Evaluation. In Nielsen, J and Mack, R.L., editors, *Usability Inspection Methods*. John Wiley and Sons, Inc. 1994.

Rubin, E. & Yates R. (2003). *Microsoft .NET Compact Framework*. Edited by Sams Publising, 2003.

Schmidt A. (2005) Interactive Context-Aware Systems Interacting with Ambient Intelligence. *Ambient Intelligence.* G. Riva, F. Vatalaro, F. Davide, M. Alcañiz (Eds.). IOS Press, pp. 159-178, 2005.

Schomaker et al., (1995) Schomaker, L., Munch, S., Hartung, K., 1995. A taxonomy of multimodal interaction in the human information processing system. *A Report of ESPRIT Project 8579 MIAMI, Technical Report*, Nijmegen Institute of Cognition and Information, The Netherlands. February 1995.

Sotirovski, D. Heuristics for Iterative Software Development. *Software, IEEE*. Volume 18, Issue 3, May 2001 Page(s):66 – 73.

Villalba E, Peinado I, Arredondo MT. (2007) User Interaction Design for a Wearable and IT based Heart Failure System. *Lecture notes in Computer Science* Volume 4551/2007.

Human Computer Interaction

Edited by Ioannis Pavlidis

ISBN 978-953-7619-19-0
Hard cover, 522 pages
Publisher InTech
Published online 01, October, 2008
Published in print edition October, 2008

This book includes 23 chapters introducing basic research, advanced developments and applications. The book covers topics such us modeling and practical realization of robotic control for different applications, researching of the problems of stability and robustness, automation in algorithm and program developments with application in speech signal processing and linguistic research, system's applied control, computations, and control theory application in mechanics and electronics.

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821