Pursuing Usability in a Nicaraguan Demographic Surveillance System - A Case Study

Nils Assarsson

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Lund University
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Abstract

Pursuing usability in a Nicaraguan demographic surveillance system (DSS) or any computerized system used by humans, means designing a system so it is intuitive for its actual users to use, rather than developing what is convenient for the developer and the system, and then asking the users to adapt to the system. But even the most insightful designer can only create a usable system through a process that involves getting information from the people that actually uses the system. To develop a usable system, developers have to know, understand and work with the people that represent actual users of the system.

This master thesis is a case study where the actual end users play an active role in the design process of a graphical user interface, used for data collection at the Centre for Demographic and Health Research[1] (CIDS) in León, Nicaragua. After several iterations of user-centered design the interface is subject to a usage study in its natural working environment in Nicaragua. Finally the interface is evaluated using benchmark standards.

The main results from this report are presented in terms of relevance, effectiveness, attitude and learnability and show an interface with acceptable level of usability and with most of its functionality implemented. Results from benchmarking give a good idea of how the interface usability might be improved.

[1] Centro de Investigación en Demografia y Salud, CIDS.

Preface

This thesis is part of the final examination in Master of Science in Information and Communication engineering at the Institute of Technology in Lund (LTH). The case study presented in this report has been conducted during six month at the CIDS in León, Nicaragua, (Map 1*)*.

This report is a case study on how to develop GUIs and how to pursue usability in an environment different from what we are used to in developed counties; regarding the user group, the physical conditions and cultural differences.

In this work modern design principles are used in Latin America to develop a graphical user interface in an organization whose main objective is demographic and health research. Some of the results would be expected in any development of graphical user interfaces and some of the results are specific to the working environment and to the user group.

Usability testing of the graphical user interface has been performed in temporary laboratories at the centre and during usage on the field. This case study has mainly used exploratory testing and assessment testing and a blend of methods in an ad-hoc but innovative manner to evaluate the design. Due to constraints in time most attention has been paid to the software's look and feel, navigation, and functionality and little attentions has been paid to fine tuning the software.

The author of this thesis is educated within computer science majoring towards human-computer-interaction and has been living and working in Nicaragua at several occasions.

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1 Introduction

Developing software and systems in an organisation whose main objective is demographic and health research is a difficult task. Designing graphical user interfaces for handhelds computers with high usability in such organisations is even more difficult. One limitation is the display space that the normal handheld provides which makes the development of usable interfaces complicated. The other limitation is the end user; in a sub developed country like Nicaragua the average inhabitant has very little experience of using personal computers and most Nicaraguans has never even seen a handheld computer.

Last couple of year's computer usage has grown in Nicaragua. According to a census[2] in November 2005 about 2.1 % of the population or 125 000 Nicaraguans are regular internet users in some way. Today it is possible to find internet cafes in almost any big city, PCs at schools and universities, at hospitals and in offices. Even the airport in the capital Managua now provides wireless connection to the internet like any other modern airport. Mobile phones are getting more and more common. Unfortunately these services are only available for the people that can afford them, meaning that the average Nicaraguan will have to continue dreaming of using such services or devices.

Most researchers on usability agree on that development of usable graphical user interfaces in any environment requires a high level of participation from end users and with an early focus on the user and tasks. This case study implements user-centered design and usability testing to develop a user interface for a group of people that have little or no experience of computers. The level of usability of the interface is described in terms of REAL; relevance, effectiveness, attitude and learnability.

The key point to note is that usability is defined in relation to specified users performing specified tasks. In other words it is impossible to answer the question: "How usable is computer system X?" without first asking: "By whom?" and: "To perform what task(s)?" (Redmond-Pyle, Moore, 1995) [1].

This paper starts with a preliminary design of a user interface for a handheld computer, used for gathering information for a DSS, used by CIDS. Through an iterative user-centered design process the different interfaces are developed and repeatedly tested on real end users. When a testable release of the software is reached, the equipment is tested during real information gathering on the field, by the four, so called, least competent users[3] (LCU) working at the centre.

A blend of different usability methods, techniques and practices has been tried out, in a somewhat ad-hoc but innovative way during the user-centered design process depending on available equipments, personnel, constraints in time and most of all, needs. The final testable version was reach thanks to the creativeness, fantasy and the eager of the participants in this software project. Eleven iterations of user centered design has been conducted including almost sixty different test occasions, done in laboratory or on the field in Nicaragua. Only actual users, in this case data collecting field worker at CIDS has participated in the tests.

[2] In Latin America only Cuba has fewer users, 1.3 % of the population and Chile has most users about 36 % of the population (2005).
[3] The least competent user is defined as the least skilled person who potentially could use the system.

1.1 Background

CIDS is managing an epidemiological database[4], which enables studies of reproductive events and child mortality. The database has been used in inter- and multidisciplinary studies on fertility and monitoring trends and social determinants of infant and under-five mortality. The database was also utilized in various sub-studies on maternal mortality, teenage sexuality and reproduction, sexual behaviour, domestic violence and impact of women's access and control over resources on child survival. A follow-up and continuation of these studies are planned. The database has also been used as a sampling frame for studies of other research projects at the Medical Faculty at León University[5] (UNAN), (Map 1*).*

Map 1. Nicaragua, with León in north-west.

This database offers the opportunity to develop a model for a continuous surveillance of demographic events; registering births, deaths and mobility in the León area, constituting a platform for epidemiological studies. Apart from educational purpose, the database will serve as an instrument for applied social politics and health care planning.

Through two extensive household surveys in 1993 and 1996 the original database was created. Almost ten thousand household are now included in a 50-cluster sample of the community, covering both urban and rural areas (CIDS, 2003) [2].

During the period 2002-2003 the registers from the earlier surveys were actualized and from this a baseline of the surveillance system took its start. The system aimed at a vital

[4] Demographic Surveillance System Database.
[5] Universidad Nacional Autonoma de Nicaragua in León.

events register which at the same time could give information for actions or interventions in the study area (Photo 1) as well as it would serve as a platform for the training of students in epidemiology (Peña, Meléndez, Pérez, Källestål, 2005) [3].

Photo 1. Typical scenes from the study area in León.

1.1.1 Data collection

The DSS contains data about citizens in the León area. The core database is built on four basic events and is described in Figure 1; birth, migration in, migration out and death.

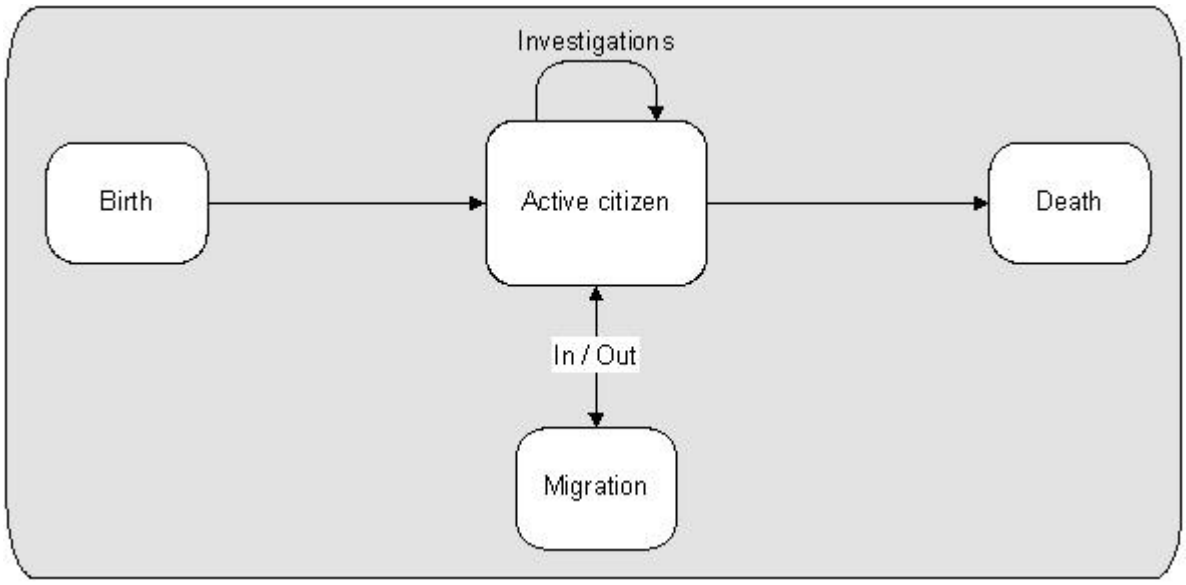


Figure 1. State diagram of the core database.

CIDS has a goal to actualize the core database every three month. In these quarterly rounds field workers are sent to each household in the study area. Each fieldworker is responsible for between 1800-1900 household in an assigned sector. Normally a rural area field worker has fewer households assigned. During a day one fieldworker might perform up to 40 interviews. The field worker brings a folder with the necessary paper forms and/or printouts that will be used throughout the day.

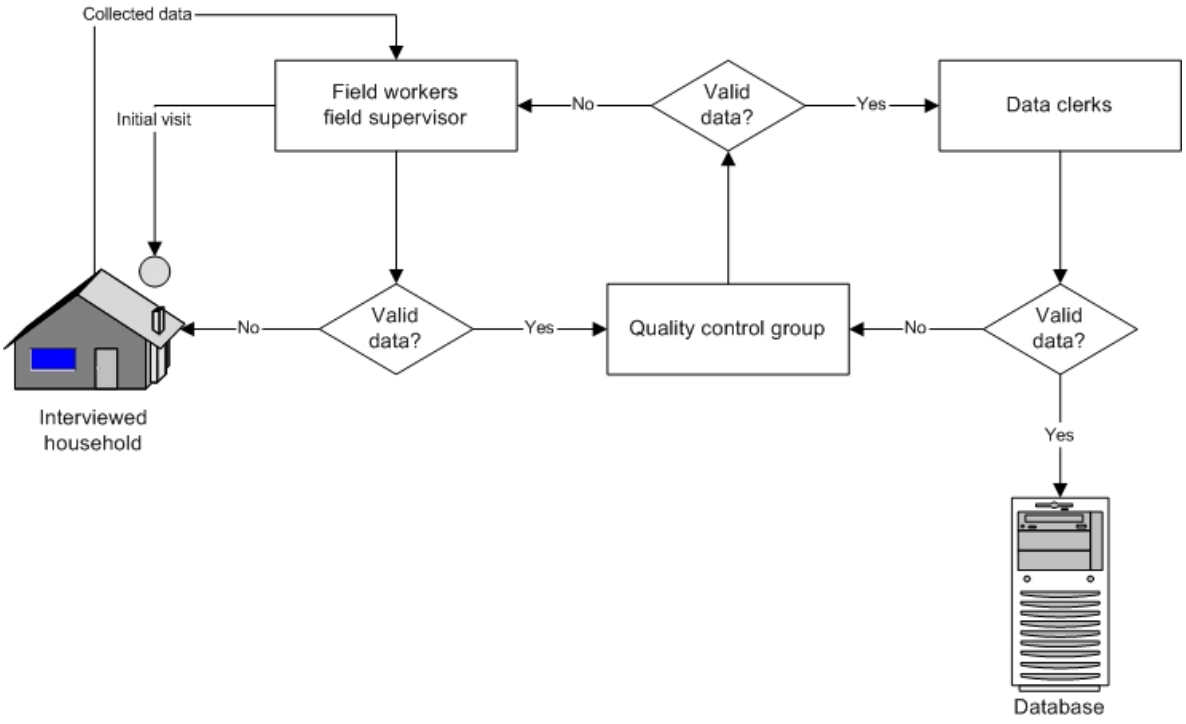


Figure 2. Conceptual model of data collection in the present paper form system.

Today fieldworkers at CIDS are collecting data through interviews with people living in the study area. The data collection could be described as a fill in task, where copies of interview forms are used. The forms belong to the household, family or person in the study area, depending on the actual study. At the CIDS office the collected data is passed through

a quality group and registered in the demographic surveillance system database (DSSDb). Erroneous data is sent back to the field, (Figure 2, Photo 2 & Photo 3).

Photo 2. Typical scene from the study area in León. Field workers collecting data in Barrio Subtiava.

During the development of the present version of the DSS lots of design decisions has been taken that makes the system hard to use. Greatest emphasis has been on the system activity component and less emphasis on the human and the context components[6]. The relation to each other has also been neglected. The developing organisation at CIDS has treated usability as common sense, making design and implementation of user interfaces the same

[6] Bailey's Human Performance Model: human, context and activity components. Typically designers, engineers and programmers places the greatest emphasis on the activity component and less emphasis on the human or context component.

task (Rubin, 1994) [4]. An inspection[7] of the present DSS shows a time consuming system that is hard to use and prone for errors.

Photo 3. Quality control of collected data, at CIDS office in León.

Since 2003 LTH Campus/Helsingborg has been involved in the development of the DSS and its peripherals, (Figure 3). During the spring 2005 a prototype for data collection was developed including low-level design and implementation of communication channels between the PDA and the server database. Later on the same year a testable HiFi prototype of the PDA GUI was implemented by students in multimedia engineering at Campus Helsingborg. This HiFi prototype was used as a foundation for the user centered design and usability evaluation throughout this case study.

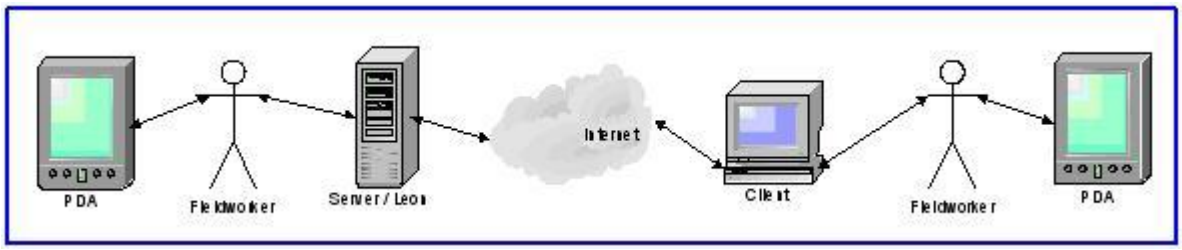


Figure 3. Conceptual model of data collections system

[7] Usability inspection done at the start of this development process.

1.2 Nicaragua

Nicaragua is a republic in Central America. Although it is the largest nation in the region, it is also the least densely populated. The country is bordered on the north by Honduras and on the south by Costa Rica. Its western coastline is on the Pacific Ocean, while the east side of the country is on the Caribbean Sea.

According to the 2005 census, Nicaragua has a population of about 5.5 million an increase of 20% on the 1995 census figure of about 4.4 million.

Nicaraguans of European or mixed European and indigenous stock make up a combined 86% of the population, with about 69% being mestizos and 17% being of European descent (mostly Spanish, German, Italian and French).

In the nineteenth century, there had been a substantial indigenous minority, but this group was also largely assimilated culturally into the Hispanic mainstream. Primarily in the 19th century, Nicaragua saw several waves of immigration from other European nations. In particular the northern cities of Esteli and Matagalpa have significant 4th generation German communities. Most of the Mestizo and European descent population live in the western regions of the country as in the cities of Managua, Granada and León.

Photo 4. Nicaraguan ethnic groups : afronicaragüense, mestiza, indian and European descendent

About 9% of Nicaragua's population is black, or afronicaragüense, and mainly resides in the country's sparsely populated eastern or Atlantic coast. The black population is mostly of West Indian origin, the descendants of indentured labourers brought mostly from Jamaica and Haiti when the region was a British protectorate. Nicaragua has the second largest black population in Central America after Panama. There is also a smaller number of

Garifuna, a people of mixed Carib, Angolan, Congolese and Arawak[8] descent. Different ethnic groups are shown below in Photo 4.

The remaining 5% is comprised of the unmixed descendants of the country's indigenous inhabitants. Nicaragua's pre-Colombian population consisted of the Nahuatl-speaking Nicarao people of the west after whom the country is named, and six other ethnic groups including the Miskitos, Ramas and Sumos along the Caribbean coast.

Spanish is spoken by about 90% of the country's population; Nicaraguans speak standard Iberoamerican Spanish with some similarities to Galician Spanish - structurally similar to Argentinian Spanish which uses “vos” instead of “tu” along with the “vos” conjugation, but with a different intonation. The black population of the east coast region has English as its first language. Several indigenous peoples of the east still use their original languages, the main ones being the Miskito, Sumo, and Rama indigenous groups.

Roman Catholicism is the major religion, but evangelical Protestant groups have grown recently, and there are strong Anglican and Moravian communities on the Caribbean coast.

90% of Nicaraguans live in the Pacific lowlands and the adjacent interior highlands. The population is 54% urban. An estimated 2 million Nicaraguans live outside of Nicaragua.

Nicaragua's economy has historically been based on the export of cash crops such as bananas, coffee and tobacco. Nicaragua’s rum is renowned as among the best in Latin America, and its tobacco and beef are also well regarded. During the Contra War in the early 1980’s, much of the country's infrastructure was damaged or destroyed, and inflation ran for a time at several thousand per cent. Since the end of the war almost two decades ago, many state-owned industries have been privatized. Inflation has been brought to manageable levels, and the economy has grown quite rapidly in recent years.

As in many other developing countries, large segments of the economically poor in Nicaragua are women. In addition, a relatively high percentage of Nicaragua’s average homes have a woman as head of household: 39% of urban homes and 28% of the rural ones.

Nicaragua is considered to be the second poorest country in Latin America. The country is still a recovering economy and it continues to implement further reforms, on which aid from the International Monetary Fund (IMF) is conditional. In 2005, finance ministers of the leading eight industrialized nations (G-8) agreed to forgive Nicaragua’s foreign debt, as part of the Heavily Indebted Poor Countries (HIPC) program.

The Nicaraguan unit of currency is the Córdoba and was named after Francisco Hernández de Córdoba its national founder. (Wikipedia: Nicaragua, 2006) [5].

1.2.1 Some important indicators

Following table show some important Nicaraguan core health indicators[9], compared with the same indicators from Sweden (World Health Organization, 2006) [6].

Table 1. World Health Organization: core health indicators, Nicaragua – Sweden.

Indicator	Nicaragua	Sweden
Population (in thousands) total	5,487 (2005)	9,041 (2005)

[8] The term Arawak was used to designate the Amerindians encountered by the Spanish in the Caribbean.
[9] More indicators can be studied at www.who.org .

Indicator	Nicaragua	Sweden
Annual population growth rate (%)	1.8 (2004)	0.2 (2004)
Total fertility rate (per women)	3.2 (2004)	1.7 (2004)
Adolescent fertility proportion (%)	18.5 (1999)	2.1 (2001)
Life expectancy at birth (years) males	67.0 (2004)	78.0 (2004)
Life expectancy at birth (years) females	71.0 (2004)	83.0 (2004)
Infant mortality rate (per 1 000 live births)	31.0 (2004)	3.0 (2004)
Neonatal mortality rate (per 1 000 live births)	18 (2000)	2 (2000)
Maternal mortality ratio (per 100 000 live births)	230 (2000)	8 (2000)
Deaths due to HIV/AIDS (per 100 000 population per year)	<500 (2003)	<100 (2003)
Physicians (density per 1 000 population)	0.37 (2003)	3.28 (2002)
Net primary school enrolment ratio (%) males	86.0 (2003)	100.0 (2003)
Net primary school enrolment ratio (%) females	85.0 (2003)	99.0 (2003)
Population below the poverty line (% of the population living on less than $1 a day)	45.1 (2001)	------
Per capita GDP in international dollars	2,832 (2004)	30,336 (2004)

2 Theory

The average field worker at CIDS has little or no experience of using personal computers and they don't have any experience of using handheld computers at all. Some of the fieldworkers are used to other electronic equipment like mobile telephones and television remote controls that might help them to understand the hand held computer. All the field workers at CIDS have a clear mental model of how data collection is carried out, which probably is an important ability. With user-centered design and usability testing it might be possible to develop an interface with an acceptable level of usability, though conditions seems to be hard at the beginning, adjust it to the field workers mental model of data collection, and describe its level of usability in terms of REAL.

Most researchers on usability agree on that "To develop a usable product, you have to know, understand, and work with people who represent the actual or potential user of the product. No one can substitute for them" (Dumas, Redish, 1999) [7]. In other words development of graphical user interfaces requires a high level of participation from several end users throughout the development process.

2.1 Usability

Usability addresses the relationship between tools and their users. In order for a tool to be effective, it must allow intended users to accomplish their tasks in the best way possible. The same principle applies to computers, websites, and other software. In order for these systems to work, their users must be able to employ them effectively.

Usability depends on a number of factors including how well the functionality fits user needs, how well the flow through the application fits user tasks, and how well the response of the application fits user expectations. We can learn to be better user interface designers by learning design principles and design guidelines. But even the most insightful designer can only create a highly-usable system through a process that involves getting information from people who actually use the system. Usability is the quality of a system that makes it easy to learn, easy to use, easy to remember, error tolerant, and subjectively pleasing.

From the user's perspective usability is important because it can make the difference between performing a task accurately and completely or not, and enjoying the process or being frustrated. From the developer's perspective usability is important because it can mean the difference between the success and failure of a system. From a management point of view, software with poor usability can reduce the productivity of the workforce to a level of performance worse than without the system. In all cases, lack of usability can cost time and effort, and can greatly determine the success or failure of a system. Given a choice, people will tend to buy systems that are more user-friendly.

The key principle for maximizing usability is to employ iterative design, which progressively refines the design through evaluation from the early stages of design. The evaluation steps enable the designers and developers to incorporate user and client feedback until the system reaches an acceptable level of usability.

The preferred method for ensuring usability is to test actual users on a working system. Achieving a high level of usability requires focusing design efforts on the intended end-user of the system. There are many ways to determine who the primary users are, how they work, and what tasks they must accomplish. However, clients' schedules and budgets can sometimes prevent this ideal approach. Some alternative methods include user testing on system prototypes, a usability inspection conducted by experts, and cognitive modelling.

Usability is one of the focuses of the field of Human-Computer Interaction. As the name suggests, usability has to do with bridging the gap between people and machines. A user interface (or human-computer interface) refers to the parts of a hardware and/or software system that allow a person to communicate with it. This includes output devices (the way the computer talks to a user) and input devices (the way a user talks to the computer). Typical "output devices" include computer monitors and the windowing systems that run on them, but also include speakers and other devices that provide feedback. "Input devices" include peripherals like keyboards, mice, and joysticks, but also include microphones and even eye movement devices. Each of these interface components have devices corresponding to the visual (sight), aural (sound), and haptic (touch) channels of the brain. Usability engineering studies these elements of the user's experience (Usability First, 2006) [8].

Two common definitions of usability are: "Usability (is) the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component." (IEEE 90, 1990) [9]. "The usability of an interface is a measure of the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment with that interface." (ISO 13407:1999) [10].

2.1.1 REAL

Some user interfaces are easy to learn and effective to use. Others are difficult to learn and confusing and tedious to use.

User interfaces which are easy and pleasant to use are often described as "user-friendly", but this is a journalist's term which is not properly defined and is not measurable, so it is not suitable as a design objective.

"Usability" is a clearer and more appropriate concept for describing the quality of a user interface. Usability is an abstract concept, nut need not to be vague.

According to Löwgren, usability is a result of Relevance, Efficiency, Attitude and Learnability (REAL) (Löwgren, 1993) [11] . REAL is often used to define the users point of view of a system. The REAL model is said to be relative to the user group.

- **Relevance** – to what degree does a system enables the user to achieve his/her goals.
- **Effectiveness** – how easy to use is the system for the user, defined in quantitative measurements.
- **Attitude** – the user's perception, feelings and opinions of the system.
- **Learnability** – the user's ability to operate the system to a defined level after a defined period of training.

2.1.2 Eight Golden Rules of interface design

The pioneer in user interface design, Ben Shneiderman proposed this collection of principles that are derived heuristically from experience and applicable in most interactive systems after being properly refined, extended, and interpreted (Shneiderman, 1998) [12].

To improve the usability of an application it is important to have a well designed interface. Shneiderman's "Eight Golden Rules of Interface Design" are a guide to good interaction design.

- **Strive for consistency** - Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.

- **Enable frequent users to use shortcuts** - As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviation function keys, hidden commands, and macro facilities are very helpful to an expert user.
- **Offer informative feedback** - For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.
- **Design dialog to yield closure** - Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.
- **Offer simple error handling** - As much as possible; try to design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.
- **Permit easy reversal of actions** - This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.
- **Support internal locus of control** - Experienced operators strongly desires the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.
- **Reduce short-term memory load** - The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

2.2 User-centered design

Creating user interfaces that meet the user’s needs and expectations requires careful consideration of the actual context of usage. Especially in complex software or web designs it is hard to predict all user requirements and make specifications without thoroughly analysing the context of usage and visualising possible design solutions.

In broad terms, user-centered design (UCD) is a design philosophy and a process in which the needs, wants, and limitations of the end user of an interface or document are given extensive attention at each stage of the design process. User-centered design can be characterized as a multi-stage problem solving process that not only requires designers to analyze and foresee how users are likely to use an interface, but to test the validity of their assumptions with regards to user behaviour in real world tests with actual users. Such testing is necessary as it is often very difficult for the designers of an interface to understand intuitively what a first-time user of their design experiences, and what each user's learning curve may look like.

The chief difference from other interface design philosophies is that user-centered design tries to optimize the user interface around how people can, want, or need to work, rather

than forcing the users to change how they work to accommodate the system or function. (Wikipedia: Usability, 2006) [5].

Pursuing usability means designing the system so that it is intuitive and convenient for the user to use (i.e. adapting the system to the user), rather than developing what is convenient for the developer and the system, and then asking the user to adapt to the system.

Trying to achieve high usability for end-users has three important implications for the design process:

- The designer needs to understand in detail who the end-users will be, what tasks they will perform, and what their specific usability requirements will be. Without this information the GUI design cannot be organized around the user.
- End-users play an active role in the design team throughout the analysis and the design process. It is not sufficient to interview some users at the beginning for their requirements, and to ask them to review the design once it is complete. The end-users perspective of ´how will I use this to do my job?´ is an important contribution to every activity in the analysis and design process
- The designer and end-users jointly evaluate the usability of proposed design as early as possible, and modify the design repeatedly in the light of this feedback.

It is important to distinguish user-centered design from “designed by users”. The designer should not get the users to design the GUIs nor is the user’s opinion of which design alternative is better always the right one. Users know their tasks and know whether they find a GUI easy to learn and pleasant to use, but the typically have less understanding of and experience in GUI design then the software developer.

2.3 Usability requirements

Usability is an example of a non-functional requirement. It is a requirement that may not explicitly be specified in a contract between the customer and the system developer, but it affects the general performance of the system and thereby it’s overall quality. It may therefore also be known as a quality factor.

As with other non-functional requirements, usability cannot be directly measured but must be quantified by means of indirect measures or attributes such as, for example, the number of reported problems with ease-of-use of a system [5].

2.4 Conceptual metaphors

A metaphor is the use of one idea or object to represent another; making an implicit comparison between concepts to provide insight into those concepts.

Metaphor is used widely in graphical user interfaces to help set users expectations and make the behaviour of computers clearer. The “desktop metaphor” is used to suggest that a computer screen is like a physical desk, with papers and folders to shuffle around and various desk accessories, such as calculators, printers, and notepads. A general physical world metaphor is what allows a bevelled border to suggest a button and allows close parallel lines to suggest that something is draggable.

Metaphors are also useful techniques for designers to explore representations of concepts and the behaviour of interface elements. Designers may also apply wild and unrelated metaphors as a useful brainstorming device. [5]

2.5 GUIDE process

This is a high level overview of the process GUI design (GUIDE) and evaluation, according to D.Redmond-Pyle and A.Moore,[1]. The diagram, Figure 4, is an idealized representation of the processes and how they are related to each other. D.Redmond-Pyle and A.Moore recognizes that real word projects are more complex.

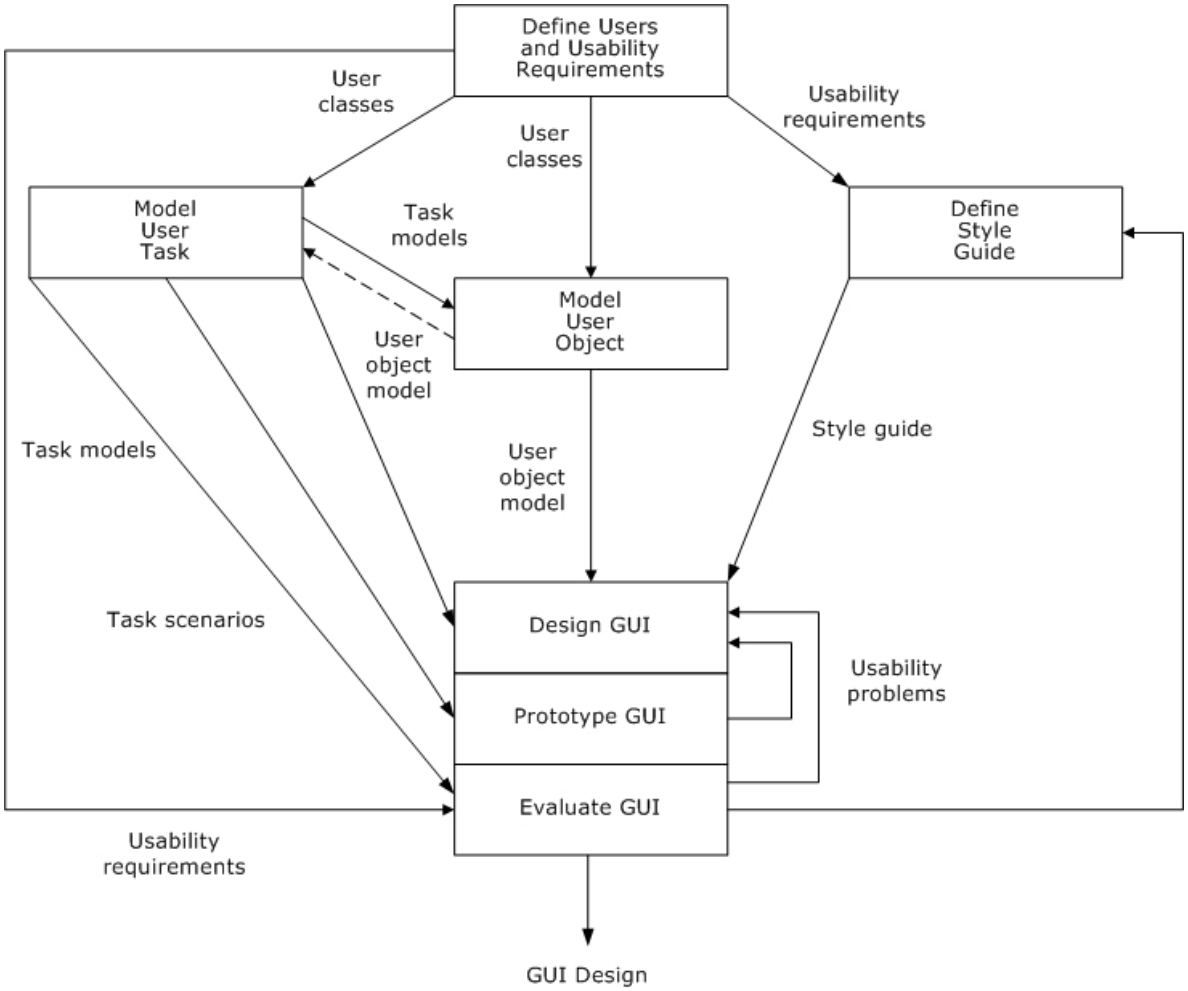


Figure 4. GUIDE process.

The process of design, prototype and evaluate the GUI overlap and are in practice merged into each other. The process is profoundly iterative, and the final GUI design evolves through an ongoing process of feedback from prototyping and evaluation.

3 Methods

User centered design with usability testing has been the overall methodology used for developing the graphical user interface on the PDA. Inside this methodology several other different techniques, methods and practices have been used.

This section describes and gives an introduction to these techniques and methods.

All methods are well known and recognized as effective methods to develop graphical user interfaces with high usability. For further descriptions see “Handbook of Usability Testing” (J.Rubin, 1994) [4] and “Graphical User Interface Design and Evaluation” (D.Redmond-Pyle, A.Moore, 1995) [1].

3.1 Usability requirements on the PDA software

At an early stage of the development process usability requirements for the PDA interface where elicited and agreed upon.

Following requirements has then served as guidelines throughout the whole procedure of developing the graphical user interface for the PDA:

- 7 out of 10 users shall think that the prototype works as a better aid to gather information than the present system.
- Use of the digital system shall not be more time consuming than the present system using paper forms.
- There shall be a clear resemblance between former used forms and the PDA interface.

3.2 The household metaphor

The idea with using a metaphor is to design of the PDA software is to take advantage of the field workers previous knowledge about registering demographic data. The idea with the household metaphor is that the field worker working with the PDA gets the sensation of actually being in a household, and everything registered at the moment is only concerning this household. If the field worker wants to register something concerning another household, she/he would have to close the interview (step out of the household) and initiate another interview (enter another household).

3.3 User-centered design principals

The focus in UCD is the relationship between the product and the human.

User-centered design of the PDA GUIs has been an approach that tries to make the design fit the end user, the field worker, considering a balance between the human, the context and the activity. The outcome of the UCD approach is supposed to be a product that is usable for the field worker.

3.3.1 Early focus on the field worker and her tasks

A user-centered design process at CIDS involves the participation of the field worker from the very first stage of development, and continues to involve the field worker at each step of the process. The goal of UCD is to create a product that works for the field worker and is well-designed for that user group. The first step in this process is to identify the target audience and to meet with them. By conducting interviews, watching field workers complete tasks in their working environment and listening to them talk about their work it is possible to find out:

- what the field workers need

- what their work environment is like
- what is important to them
- what tasks they do both frequently and infrequently
- how they accomplish these tasks now
- how do they think about their tasks (the mental model)

By understanding the field workers and their tasks, it is easy to devise representative scenarios for the different tasks to test the PDA GUIs. The field worker then walks through these scenarios to test new design ideas and design assumptions.

In the beginning of the design process the design walkthrough can be done on cheap paper mock-ups of the different PDA GUIs that the field workers will use. Later on when the conceptual idea of the GUI is set, the design walkthrough can be done on more advanced equipment like PDA simulators. Finally when only small changes to the GUI are required the walkthrough can be done on real hardware and in its working environment.

3.3.2 Measurement of product usage

Throughout the whole design process behaviour measurements of ease of learning and ease of use has been taken. The result from each measurement has passed to the coming iteration for further development of the GUI prototype.

All tests of prototypes have been with actual users and measurements have been taken through video recordings, discussions with the test participant, focus groups and test questionnaires.

3.3.3 Iterative design, modification and testing repeatedly

The PDA GUIs has been shaped through a process of iterative design, modification and testing. The iterative thinking has been a part of the development process since the start of the GUI design. In the beginning of the process the conceptual models and design ideas where tested repeatedly. In the end of the development cycle the iterative design was more of a fine tune of the GUI design.

3.4 Review of techniques, methods and practices used in UCD

This section briefly describes techniques, methods and practices that have been used in this case study [4].

3.4.1 Usability testing

Usability testing is the mainstay method when it comes to finding usability problems. Nothing is more convincing than watching person after person encounter difficulties with the same part of a software or information system. The difficult areas that repeat themselves between multiple test participants reveal areas that should be studied and changed by the developers. Usability testing can often uncover very specific areas needing improvement, where focus groups and task analysis often find more general areas needing improvement.

Trained observer conducts usability testing with the assistance of software developers. People who are representative of the target audience are asked to perform representative tasks with the software. The observer writes a usability testing report listing the problems and offering recommendations based on their findings.

In this report usability testing refers to a process that employs participants who are representative for the target population to evaluate to which degree the PDA software meets

its usability requirements. In this case the target population is represented by the field workers at CIDS who are supposed to use the PDA in their daily work collecting data.

Some of the methods that have been used to develop the PDA user interface could be defined as other methods than usability testing; however in this report usability testing refers to a method with high involvement of the target population.

Exploratory testing (Photo 5) gathers input from participants in the early stages of software development. Based on the experience and opinions of target users, the development team can decide the appropriate direction for the software's look and feel, navigation, and functionality.

In this report exploratory testing refers to a process early in the development cycle and with extensive interaction between the participant and the test monitor.

Exploratory testing has been used to define requirements and preliminary high-level design and some of the early different graphical user interfaces on the PDA.

The main objective with the exploratory testing has been to explore the field worker's conceptual model of the PDA software and to make a solid foundation for GUI development. During exploratory testing the techniques in use has primary been different walkthroughs on cheap paper mock-ups and LoFi prototyping (see 3.4.7) in focus groups (see 3.4.6).

Midway in the development process special attention had to be paid to the pregnancy history and the new birth event in the PDA navigation structure. Exploratory testing where again used to elicit functionality through a focus group meeting and a pluralistic walkthrough.

Photo 5. Typical scene from exploratory testing in laboratory at CIDS office. Field workers testing the early design concepts using simulator and hyper cam.

Assessment testing (Photo 6) occurs when the software is close to launch. This kind of testing gives feedback on issues that might present huge problems for users but are relatively simple to fix. Assessment testing has been used repeatedly midways in the development cycle with the objective to evaluate the usability of lower-level operations and aspects of the PDA software. The test persons have been performing full-blown realistic tasks to identify usability deficiencies.

All assessments test has been recorded with camcorder. In the beginning at a PDA simulator was used and recorded with hyper cam. All recordings on the camcorder and the hyper cam was analysed together with the test group and the results was used in a short and effective iterative development of the PDA software.

Photo 6. Typical scene from assessment testing in laboratory at CIDS office and a temporary laboratory on the filed. Field workers testing the PDA software using simulator and hyper cam.

The PDA simulator, Figure 5, works with the development environment Metrowerks CodeWarrior and is captured with the hyper cam[10].

Figure 5. PDA simulator captured with hyper cam.

All test has had limited test objectives with a top down approach; starting with the initial form in the first iteration and working its way down through the navigation hierarchy and adding new structure in each iteration. Finally assessment testing has been done on the PDA where the complete navigation hierarchy has been tested using only the software implementation on the PDA.

3.4.2 Usability inspection

A usability inspection is a review of a system based on a set of guidelines. The review is normally conducted by a group of experts who are deeply familiar with the concepts of

[10] The hyper cam is software that works as a camera integrated in the screen and captures all movements on the screen, all mouse clicks and sound.

usability in design. The experts focus on a list of areas in design that have been shown to be troublesome for users.

Usability guidelines are usually derived from studies in human-computer interaction, ergonomics, graphic design, information design, and cognitive psychology. Some areas that get evaluated are the language used in the system, the amount of recall required of the user at each step in a process, and how the system provides feedback to the user. In particular, issues such as clarity, consistency, navigation, and error minimization are analyzed. Once the problems are discovered, the experts make recommendations for resolving these issues [8].

Usability inspection has been used during analyze of the present paper form system.

3.4.3 Participatory design

Participatory design is an approach to design that attempts to actively involve the end users in the design process to help ensure that the product designed meets their needs and is usable. Participatory design is a democratic approach to design that encourages participation in the design process by a wide variety of stakeholders, such as: designers, developers, management, users, customers, salespeople, distributors, etc.

This approach has taken the field workers from being a subject of user testing, to actually become a part of the design and decision-making process. This empowerment of the field worker is somewhat unorthodox in Latin American culture, where normally highly educated people take all important decision at any jobsite[11].

With this in mind participatory design has been one of the most important components throughout the whole development process, since it has worked as stimuli for all the field workers.

3.4.4 Design walkthrough

Design walkthroughs are performed at any stage of design using a prototype, a conceptual design document, or the final product.

Based on a user's goals, a group of evaluators steps through tasks, evaluating at each step how difficult it is for the user to identify and operate the interface element most relevant to their current sub goal and how clearly the system provides feedback to that action. Design walkthroughs take into consideration the user's thought processes that contribute to decision making, such as memory load and ability to reason.

This approach is intended especially to help understand the usability of a system for first-time or infrequent users, that is, for users in an exploratory learning mode.

Design walkthroughs has been the fundamental testing technique throughout the whole development of the PDA user interface. This kind of walkthrough has been used both on LoFi and HiFi prototypes, while testing new design concept, features or functions.

3.4.5 Pluralistic walkthrough

Pluralistic walkthrough is a method of usability inspection where a diverse group of stakeholders in a design are brought together to review the design, including user interface designers, users, developers, and management. The walkthrough is conducted by identifying primary tasks for the system and stepping through those tasks, identifying

[11] In the case of CIDS this is not any problem since Nicaraguan management are trained in Sweden and they are all used to a democratic job culture. However field workers are not used to very democratic structures in their daily life.

usability problems along the way. The purpose of bringing together various stakeholders is that each one brings a certain perspective, expertise, and set of goals for the project that enables a greater number of usability problems to be found.

Pluralistic walkthrough has been implemented during focus group meetings identifying usability problems, eliciting requirements and testing new design ideas.

3.4.6 Focus group

Using focus groups to evaluate a system is a very efficient way to get user feedback and gauge initial reactions to a design. Focus groups are also good at discovering how the system being tested differs from the user's current expectations. Generally speaking focus groups provide two major benefits. First, they are less expensive, faster and easer to conduct than conducting interviews with the same number of people. Second, they rely on group interaction to trigger memories that may not come up during interviews.

Where task analysis often discovers the standard way people interact with information systems, focus groups can bring out exceptions to the rules. These exceptions are often very important interactions that users simply do not think of in one-on-one sessions.

Conducting only a single focus group can be misleading, however, as some groups are affected by "group-think" or may simply have irregular views. For this reason, at least two groups should be evaluated for any one project.

The focus group leader writes up the impressions and comments of the groups and recommends areas for improvement.

3.4.7 Prototyping

Prototyping techniques involve developing representations of a target system for evaluation and testing purposes.

Prototyping is an essential element of an iterative design approach, where designs are created, evaluated, and refined with the results of testing at each cycle feeding into the design focus of the next cycle.

Prototypes can range from extremely simple sketches (low-fidelity prototypes) to full systems that contain nearly all the functionality of the final system (high-fidelity prototypes).

LoFi testing with paper prototypes makes it possible to verify the structure of the system and to find the most obvious errors made in the conceptual model. Early in the systems development process, this is especially valuable and is a very cheap way of verification since paper prototypes are very easily changed.

HiFi testing with computer "executable" prototypes is to be used later in the testing for navigation and possibility to simulate feedback from a system which looks more or less like the final product. A HiFi prototype is still easily changed since it does not contain many actually implemented system services.

During the whole development life cycle of the PDA GUIs prototypes has been used; early in the design process cheap paper mock ups where used and in the end full blown implementations with nearly 100% functionality on the PDA.

3.4.8 Usage study

Opposed to usability testing, which typically brings people into a lab to examine specific usability questions against often predetermined benchmarks, a usage study examines how a system is actually being used in its actual work setting, which may entail discovering that it

is being applied to unexpected problems and in unexpected circumstances and also provides a sense of how the work context affects usability issues.

In this report a usage study refers to a test of the PDA GUIs and its usage during real interviews in the CIDS study area. The test has been conducted by the same field workers that normally conduct the interview, since a requirement on field workers is that they have to live in their assigned area.

3.4.9 Usability audit

A usability audit is a review of the PDA GUIs based on a set of guidelines. The review of the PDA interface has been conducted as a heuristic evaluation by a group of expert users and a psychologist that are instructed in the concept of usability in design. The evaluation group focus on a list of areas in design that have been shown to be troublesome for users.

This section evaluates the compliance with Ben Shneiderman's "Eight Golden Rules of interface design" (see 2.1.2) to establish the quality of the PDA GUIs using benchmark standards, through a usability audit.

The main objective with this usability audit has been to evaluate the GUIs on the PDA hopefully without any interference of subjective thinking.

Through several focus group discussions with the group of expert users and supervisors at the centre, the compliancy to each design rule is measured. A scale from 0 to 100 is used to measure the degree of compliancy to each rule and in each form, where 0 equals 0 % of compliancy and 100 equals 100 % of compliancy. These measurements are finally put together and used to measure the total compliancy of the GUI and the average compliancy of each form.

At the start of the audit all GUIs are given 100% compliancy with all eight design rules (i.e max compliance in each form is then 800). Through several focus group discussions compliancy is evaluated. Breaking design rules subtracts points from the usability measurement.

These measurements are only suitable for comparing this product with itself in the future, or to establish new usability requirements[12].

3.5 Methods of measuring outcomes and identifying usability problems

This section describes different methods for measuring outcomes and identifying usability problems.

3.5.1 User-centered design

Following quantitative measurements has been taken after nine UCD iterations:

- Time to complete tasks.
- Total number of mayor changes to the design of the user interface during the UCD process according to all test reports.
- Numbers of capture forms in the preliminary design in the first iteration, compared to numbers of capture forms after the ninth iteration.

Following qualitative measurements has been taken after nine UCD iterations:

[12]A usability requirement could establish that each new form added to the product should have at least an X degree of compliancy to a specific set of design rules or no rule should be complied with a degree lower then Y.

- Field workers attitude to the usage of PDA.
- Field workers opinion about ease of use.
- Field workers attitude to the PDA GUIs.
- Field workers opinion about ease of learning.
- Field workers opinion of the “household metaphor”.
- Field workers opinion of resemblance between former used forms and the PDA interface.

The outcomes from the usage study have been measured through evaluations of the different recordings from the test. To every separate test at a specific household, there have been a number of typical usability measures taken, mainly in terms of REAL. Since these usability measures are difficult to quantify, the measuring method has been a determination of positive or negative measures. This method only shows that the GUI has both good and bad qualities, where the user has encountered problems in the GUI design and where the impact of a redesign probably would be most effective.

3.5.2 Relevance, Effectiveness, Attitude and Learnability

REAL has been measured through a pre and a post test questionnaires before and after the usage study. Both questionnaires where developed together with a psychologist, a sociologist and a statistic working at CIDS. The psychologist has participated in several investigations at the centre. The sociologist and the statistic have both been working several years with data collection in different projects at CIDS. They all have very high knowledge about field-workers, their living and working situation.

3.5.2.1 Relevance

- Is it possible for the field worker to achieve her goals?
- Is it possible for the field worker to accomplish with her tasks in the field?
- Has the field worker any reason to use the PDA instead of the present system?
- Does the PDA make the field workers daily job easier in any way?

3.5.2.2 Effectiveness

The PDA implementation should be easy to use and the accomplishment of the different tasks is measured in terms of effectiveness. The effectiveness is calculated through different quantitative measurements:

- How long time does it take to for the field worker to accomplish her tasks, compared to the present system?
- How many errors are done, accomplishing a task?
- How many times during a test must the field worker ask the test monitor how to proceed?

3.5.2.3 Attitude

- The attitude relates to the field workers perception, feelings and opinions about the PDA software.
- The goal is to design capture forms that avoids misunderstanding for the field workers and instead creates a positive first time impression.

- The graphical user interface should have a nice and clean layout that not requires much concentration so the field worker doesn't get annoyed.

3.5.2.4 Learnability

- Learnability is related to how easy it is to start using the PDA software and how well the conceptual model of the software works.

3.5.3 Outcomes from Usability audit

The usability audit has measured how much the GUI complies with the Ben Shneiderman´s "Eight Golden Rules of interface design" (see 2.1.2).

This method only shows that the GUI has problems, where the GUI has problems and where the impact of a redesign probably would be most effective. It is also useful for comparing results from other usability audits of this GUI in the future. The measurements show a general compliance with a well known standard and could be used to compare this GUI with another design or similar product.

3.6 Questionnaires

Good questionnaire construction is critical to the success of a survey. Inappropriate questions, incorrect ordering of questions, incorrect scaling, or bad questionnaire format can make the survey valueless. A useful method for checking a questionnaire for problems is to pretest it [5]. For further descriptions of questionnaires see "A practical guide to Usability Testing" (J.S.Dumas, J.C.Redish, 1999) [7].

3.6.1 Pre test questionnaires

The purpose of the pre test questionnaire is usually to gather background information to help to interpret data from the test or to verify the qualifications of the test participants.

Both pre test questionnaires were developed together with the field supervisor. She has a university degree in social science and 12 years experience of field working, knowledge of interviewing technique and some experience of making questionnaires. Questions, criteria and scale in the first pre test where checked by one of the statistics working at CIDS. The second pre test questionnaire mainly served as a pilot test for the final post test questionnaire, and less important was paid to the results; however the results are presented in the result section.

3.6.2 Post test questionnaire

When the participants have completed the tasks, the post test questionnaire is a final opportunity to gather data. After spending time, often two or three hours, using the product, the participants have had the opportunity to gain some perspectives about their impressions of its usability.

The post test questionnaire was developed together with a psychologist working at mental health department at CIDS, who has extensive knowledge of interviewing technique and making of questionnaires.

3.7 Method of determining the least competent user

This section describes how the four least experienced user (LCU) where selected. Together with the field supervisor different criteria that affect the possibilities to manage the PDA software where selected. To each criteria an importance factor where assigned. These criteria and important factors where discussed with the one of the statistics working at CIDS. As an example: prior use of PDAs gives a high score while the age factor gives a lower score.

3.7.1 Test participant inventory

Only actual end users have been used as test participants during usability testing and an inventory of the participants has been done in an attempt to define the least competent user.

During the user-centered design test participants has filled in two pre-test questionnaires and one post-test questionnaire. Pre test questionnaires have had questions about test participant's former experiences with personal computers and handheld computers.

3.7.2 Selection of LCU

The first objective with this pre test questionnaire has been to, in a deterministic way; find the four least competent users among the field workers and supervisors at CIDS. These four LCUs were then the users who were going to participate in the final usage study.

Selection scheme:

- one fieldworkers from user group "urban"
- three fieldworkers from user group "rural"

The second objective has been to collect information and testing the questionnaire design before the final usage study. The information in the questionnaire has been evaluated together with researchers and statistics at CIDS according to the following criteria:

3.7.2.1 Computer usage (CU)

Importance: Low

Scores: 0 points for no experience and 7 points for daily usage in four different sub groups; computer, internet, email and cybercafé. Maximum score; 28 points

Comments: The different test has shown that computer knowledge and former experience of computer has little effect on the PDA usage. Some of the users that don't have much or any experience of computers still are able to use the PDA in a reasonable way after only a short introduction[13].

3.7.2.2 Experience with PDAs (PDA)

Importance: High

Scores: 0 points for no experience and 100 points for daily usage

Comments: Since the model of the data collecting system is build on PDA usage former experience gives a very high score.

3.7.2.3 Knowledge about data collection (DC)

Importance: High

Scores: 10 points for every year of experience.

Comments: Since the conceptual idea and navigation structure of the PDA software is a model of the present data collecting system, experience of the present system gives high scores.

3.7.2.4 Educational level (EL)

Importance: Medium

Scores: Primary school 1 point, high school 2 points, university 10 points.

[13] One reason might be that most field workers have cellphones which helps them to understand the PDA. (Authers opion and by no means proven in this thesis.)

Comments: The educational level in the different user groups vary from primary school to university level. Users with a university degree are supposed to learn more quickly then users without university degree.

3.7.2.5 Living situation (LS)

Importance: Medium

Scores: Urban 5 point, rural 0 point.

Comments: Users living in an urban situation have more access to electronic equipment like: television, cell phones, internet etcetera. In some rural districts in the study area there is still no electric power supply.

3.7.2.6 Age

Importance: Medium

Scores: 20-25 years 3 points, 25-30 years 2 points, 30 years and above 1 point.

Comments: Younger people “normally” learn new technology faster then older people. However there is no really young user or really old user in the different user groups.

3.7.3 Results from pre test questionnaire I

Before the different usability tests the field workers and supervisors has been asked to fill in a small pre test questionnaire. The pre test questionnaire 1 has been used to extract the 4 least competent users according to the criteria in 3.7 Method of determining the least competent user.

Table 2. Supervisors

Nr	CU	PDA	FW	EL	LS	AGE	Total
0	28	25	0	10	5	1	**69**
1	26	0	60	10	5	1	**96**
2	14	0	15	2	5	1	**37**
3	14	5	50	10	5	1	**85**
4	2	0	50	10	5	1	**68**
5	0	5	2.5	10	5	1	**23.5**

Table 3. Urban area field workers

Nr	CU	PDA	FW	EL	LS	AGE	Total
6	0	0	15	2	5	1	**23**
7	2	0	15	10	5	1	**33**
8	11	5	20	2	5	1	**44**
9	0	0	10	10	5	1	**26**

Nr	CU	PDA	FW	EL	LS	AGE	Total
10	2	5	10	10	5	2	**34**

Table 4. Rural area fieldworkers[14] (pre test questionnaire I).

Nr	CU	PDA	FW	EL	LS	AGE	Total
12	0	0	2.5	2	0	2	**6.5**
13	0	0	15	1	0	1	**17**
14	0	0	15	1	0	3	**18**
15	2	5	15	10	0	1	**33**

[14] Rural area fieldworkers number 11, 16, 17 and 18 were not available to fill in the pre test questionnaire.

4 Tests compilation

This section is a description of the different tests that has been done throughout the user centered design process and the development process (see 2.5).

4.1 Usability inspection of present system

The main purpose of the evaluation has been to document and analyze the design concepts of the present system, the tasks performed by the field worker and to meet with the target audience.

4.1.1 Summary

System developers have never thought about usability and greatest emphasis has been on the system activity component and less emphasis on the human and the context components. The developing organisation at CIDS has treated usability as common sense, making design and implementation of user interfaces the same task. In terms of the usability triangle the data collecting system works and provides some value for the user.

In terms of Ben Schneiderman´s eight golden rules of interface design, the main problem with the system is that it is not providing any feedback or error handling at the moment of collecting data. It is possible to collect erroneous data that might be entered to the main database at CIDS creating problems for investigators, data-clerks and the database manager. Erroneous data that are discovered by the quality control group has to be corrected, often by first visiting the corresponding household.

Another problem is that there is no clear resemblance between the data collecting system and the main database, and redundant data appears in several paper forms. The design of the database does not 100 % correspond to the design of the data collecting system.

Finally the data collecting with the present paper form system is a time consuming process which is prone for errors.

4.1.2 Test participants

In this usability inspection participated: supervisor nr 1, 2 and 4, urban area fieldworker nr 6 and 7 and rural area fieldworker nr 18. Characteristics for test participants are shown at 3.7.3.

4.1.3 Objectives

The field worker uses copies of paper forms to collect data about citizens in the study area. During cycles printouts from the database is used to verify and update collected data.

Each fieldworker is responsible for between 1800-1900 household in an assigned sector. During a day one fieldworker might perform up to 40 interviews. The field worker brings a folder with the necessary paper forms and/or printouts that will be used throughout the day.

The objective with this evaluation has been to document how the fieldworker uses the present system and how well the system serves the field workers needs.

4.1.4 Method

The method has been a usability inspection (see 3.4.2) of the present system.

The data collecting system and its features has been discussed in terms of the Bailey's Human Performance Model[15]. Data collecting paper forms have been analyzed and discussed in a Ben Schneiderman´s "Eight Golden Rules of interface design" perspective (see 2.1.2).

Photo 7. Usability inspection of present data collecting system.

4.1.5 Results

A discussion with the fieldworkers and analyzes of recordings from the field gave the following evaluation results:

- Provides value for the user
- Prone for errors
- Time consuming
- No informative feedback
- No error handling
- Redundant data is collected

[15]Human, context and activity components. Typically designers, engineers and programmers places the greatest emphasis on the activity component and less emphasis on the human or context component

4.1.6 Discussion

The present system or its similarity has been used for quite some time and the field workers have almost never participated in the development of new forms for data collection. For cultural and organizational reasons field workers have always been treated just as “users” of the system without any knowledge or not even an opinion on how to make the system more useful. However since most field workers have used the system for quite some time they have learned to cooperate with all the usability deficiencies, and they find the system fairly easy to use.

4.2 Usability evaluation - pilot test

The main purpose of this test was to explore the early design concepts of the graphical user interfaces on the PDA (shown in the navigation structure below, Figure 6).

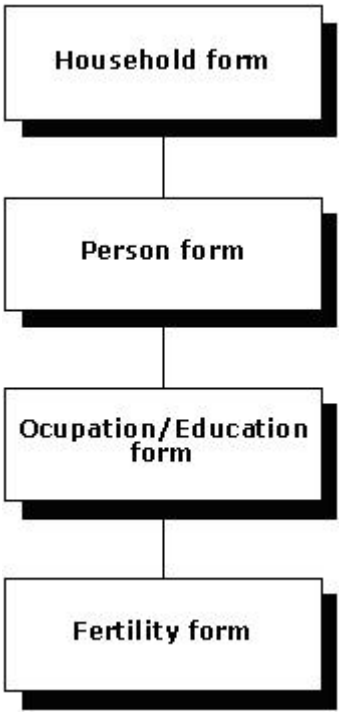


Figure 6. Early prototype navigation structure

4.2.1 Test summary

The test has revealed that the overall design concept of the graphical interface work all right, but several important functions are missing.

4.2.2 Test participant

In this pilot test the database manager (DBM) at CIDS was the only test participant. Characteristics for test participant are shown at 3.7.3.

4.2.3 Test objectives

The field worker uses the “household” as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

One requirement on the PDA software states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker. The PDA GUI is supposed to put the household concept in centre. A paper mock-up of the PDA GUIs was developed for this test.

The main test objective is to check whether or not the user feels that the household is in centre.

4.2.4 Test method

The test method has been design walkthrough (see3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to talk aloud and pause between scenarios. This test has been performed in a simple single room setup at CIDS office on a paper mock-up.

4.2.5 Results

- Scenarios should be written in Spanish.
- Scenarios should be printouts.
- There should be one test monitor and one camera man.
- The camcorder should be put on a tripod, and managed by remote control.
- Observers should not sit to close to the test person.
- A test should consist of 4-6 scenarios.

4.2.6 Suggested improvements

- Scenario descriptions should be translated to Spanish (if the test person's first language is Spanish). Scenarios should also be printed out before the test.
- The test monitor and the camera man must have separated rules. It would be less disturbing for the test person if the camcorder is on a tripod and managed by remote control.

4.2.7 Discussion

This test has mainly been a pilot test with the main subject to "test the test". No deeper analyze of the interface design has been done.

In future tests, the interface design should be analyzed and discussed in a Ben Schneiderman´s "Eight Golden Rules of interface design" perspective, using important keywords like visibility, mapping, affordance and feedback. Future tests should also be analyzed in a REAL perspective.

4.2.7.1 Example of GUI used in this test

At this early stage of the design process we were only working with cheap paper mock-ups, Figure 7 - Figure 10. All together 4 different GUIs where tested.

Figure 7. Household GUI

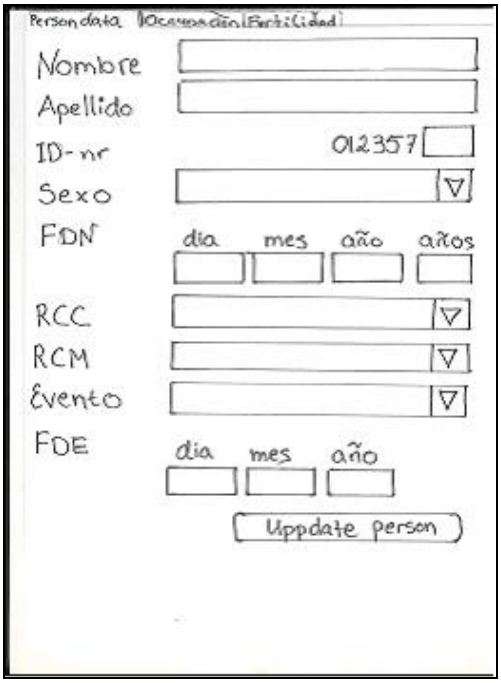


Figure 8. Person GUI

Figure 9. Occupation GUI

Figure 10. Fertility GUI

4.3 Usability testing of initial, household and enter member info

The main purpose of this test was to explore the early design concepts of the graphical user interfaces on the PDA (shown in the navigation structure below, Figure 11). This test has partly been executed as a pilot test for further testing of the different GUIs.

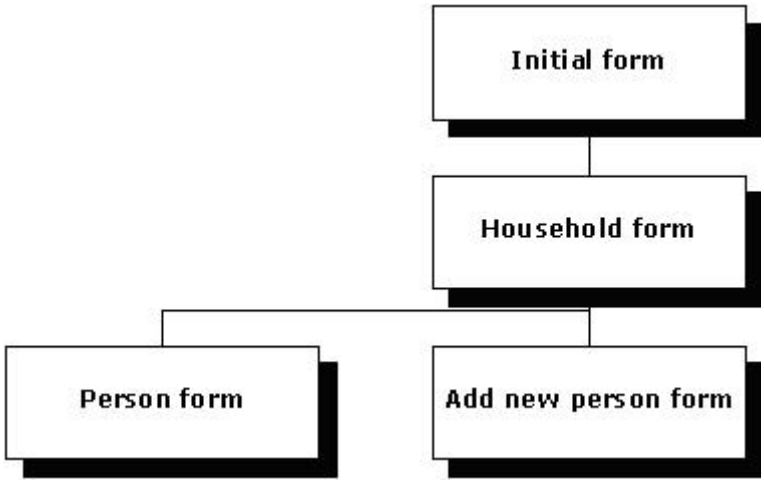


Figure 11. Navigation structure used in this test

4.3.1 Test summary

The pilot test of equipment, user manual and scenarios revealed some minor problems that were corrected before the main test with field workers.

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor. The test also revealed that the user understands the artefact and that the artefact is usable. In REAL terms this test has given some input, which positively affects the relevance and the attitude factors.

According to Ben Schneiderman´s "Eight Golden Rules of interface design" the main test also revealed some problems in the different graphical interface that has to be corrected.

The test method; first pilot testing and then design walkthrough works very well. Some minor changes were required in the test setup.

4.3.2 Test participants

In this usability test participated: supervisor nr 1, urban area fieldworker nr 6, 7 and 10. Characteristics for test participants are shown at 3.7.3.

4.3.3 Test objectives

The field worker uses the "household" as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the different scenarios in this test the field workers had to work her way down in the navigation structure of software and the following GUIs were tested:

- initial form
- household form
- enter member info
- add new member form

One of the usability requirements states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker. The PDA GUI is supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the navigation structure and the product for erroneous of dubious behaviour.

4.3.4 Test method

The test method has been design walkthrough (see 3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to inform the test monitor about every change of scenarios. This test has been performed in a simple single room setup at CIDS office with a PDA simulator on a standard notebook. The whole test has been recorded on a camcorder. Use of the software has been recorded with hyper cam.

4.3.5 Test result

The test participants completed all the tasks successfully.

Number of participants: 4

Time of completion (min): 6.03 - 11.42

Average (min): 7.55

Standard deviation (min): 2.37

During the debriefing following issues were discussed; field workers opinion about the PDA concept, PDA software and if they recognized the household metaphor. Field workers said that with more practice the PDA could be very useful on the field. They found the software intuitive and no part of the software really hard to use or really troublesome, and they confirmed the household metaphor.

One field worker commented that the PDA physically will make their job easier: today field workers have to bring lots of paper forms in heavy folders and drinking water out on the field[16]. They also said that, since it is possible to load a whole week's work in the PDA, the rural area field workers wouldn't have to go downtown to the CIDS office that often[17].

Another unexpected comment was that on field worker thought that this equipment might ease up the contact with the interviewed persons and the access to households. As she expressed it: "People are curios. They think that just because we enter data in a computer it is a higher probability that the data really will be used for something in the future. We often get comments of the kind when we are interviewing people; this is just another investigation that will end up in some bookshelf."

In terms of REAL: The relevance was positively affected by the fact that the field workers thought that the PDA probably will make their job physically easier and that they can move

[16] Normal daytime temperature in the León area is 32˚-35˚C. Field workers travels long distances on foot and normally don't have access to other transportation. This is especially troublesome for the field workers in the rural study area where transportation is really bad and sometimes there is quite some distance between households. Drinking water in the rural area is not always reliable and the field worker has to bring tap water to not risk contaminations and dehydration.

[17] Hence public transportation doesn't access rural areas very frequently

faster on the field. The attitude factor was positively affected by the fact that the field workers gave lots of input to the next iteration; comments, asking about the storage capacity and that they participated with lots of interest in the debriefing. This test didn't show anything significant about the effectiveness or the learnability.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- Initial GUI needs to be changed. Field workers seem to have problems finding households and to start the interview. Mapping between the household list and the "Vista general" button and the "Buscar vivienda" button is not very clear.
- In the "Personal form" mapping between the person list and the "Elija" button is not clear.
- Inconsistency: Several navigation techniques seem to be in use in different GUIs, which confuses the user.
- The seek function in the initial form did not have a very logical construction.
- The calendar is in English which seems to confuse the user.
- Field workers miss a form for adding a new household.
- Field workers told that they need more time to try out the software. Before this test they were only allowed to briefly test the different GUIs.

4.3.6 Suggested improvements

- Make the initial form more consistent with the rest of the software.
- Eliminate the "Elija" button on the initial form.
- Change the list menu "Personas en vivienda", to a list menu with faster response.
- Make the navigation techniques more consistent in the whole software. This must be done in the four forms tested and kept in mind in future development.
- The calendar has to be in Spanish.
- Make a "Add new household" form.

4.3.7 Discussion

The method with first a pilot test and then a main test seems to be an efficient model to use. Since scenarios has to be in Spanish it is necessary to check scenarios for spelling or grammatical errors that might put the test in risk.

The use of camcorder on a tripod and managed by a remote control was an improvement since the first pilot test. The hyper cam together with the camcorder also works very well.

All though field workers complained about to little time to test an learn about the software before the actual test, trial out time will still be set to 3-4 minutes to the next test. The reason is to see if the software is intuitive or not.

The debriefing, which was somewhat spontaneous, gave some unexpected comments.

4.3.8 Example of GUI design

In this test a HiFi prototype, Figure 12 - Figure 23, running on a PDA simulator on a standards notebook were used. The prototype was developed according to the results from a prior development team from LTH/Campus Helsingborg working at CIDS.

Figure 12. Initial form

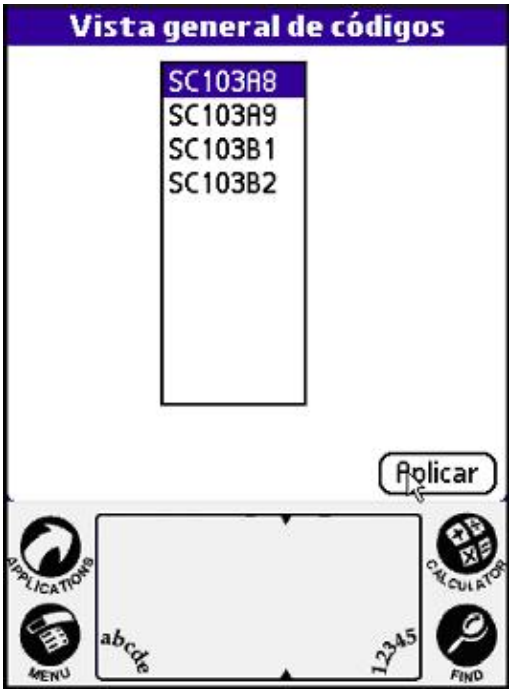


Figure 13. Household look-up list

Figure 14. Initiating interview

Figure 15. Household form

Figure 16. Water look-up list

Figure 17. Person look-up list

Figure 18. Person form

Figure 19. Education look-up list

Figure 20. Add new person form

Figure 21. Select birthday control

Figure 22. Reference to head list

Figure 23. Finishing interview

4.4 Usability testing of immigration and emigration events

The main purpose of this test was to explore the early design concepts of some of the graphical user interfaces on the PDA (shown in the navigation structure below, Figure 24). This test was partly executed as a regression test of changes done after the previous test. The test also included a pilot test with one of the supervisors.

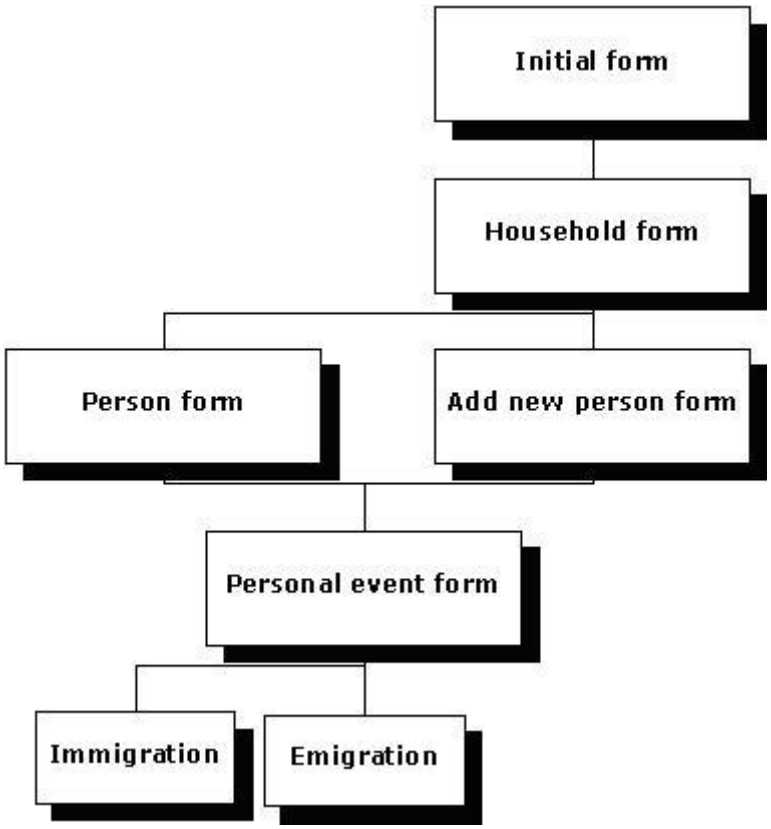


Figure 24. Navigation structure used in this test

4.4.1 Test summary

The pilot test of equipment, user manual and scenarios revealed some minor problems that were corrected before the main test with field workers.

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor.

The main test also revealed some problems in the different graphical interface that has to be corrected.

The test method; first pilot testing and then design walkthrough works very well. The supervisor used in the pilot test has been used to answer questions during tests with field workers.

4.4.2 Test participants

In this usability test participated: supervisor nr 1 and 5, urban area fieldworker nr 7 and rural area fieldworker nr 15. Characteristics for test participants are shown at 3.7.3.

4.4.3 Test objectives

The field worker uses the “household” as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the different scenarios in this test the field workers has to work his/her way down in the navigation structure of the software and the following GUIs where tested:

- initial form
- household form
- enter member info form
- add new member form
- select member event form
- immigration form
- emigration form

On requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the navigation structure and the product for erroneous and dubious behaviour and inconsistency.

4.4.4 Test method

The test method has been design walkthrough (see 3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to inform the test monitor about every change of scenarios.

This test has been performed in a simple single room setup at CIDS office with a PDA simulator on a standard notebook. The whole test has been recorded on a camcorder. Use of the software has been recorded with hyper cam.

4.4.5 Test result

The test participants completed all the tasks successfully.

Number of participants: 4

Time of completion (min): 15.32 -18.55

Average (min): 16.49

Standard deviation (min): 1.31

In the debriefing we used a slightly different approach than the prior test. In this debriefing the field supervisor was interviewing the test participants. Test participants told us that the PDA GUI was pretty easy to use and that they found the navigation structure pretty much the same as in the paper form system. The most experienced field worker with computers said that she liked the forms that have drop down menus since it speeds up the work. She also observed that there is no redundant information registered in the PDA.

On a question about the hardest part, the two least experienced field workers with computer responded that nothing was really hard, but that they had problems with the test equipment.

On a question about the hardest scenario, one field worker said that she found the “add new person” form hard to use, since a persons names has to be added in text fields.

In terms of REAL: The relevance was positively affected by the fact that the field workers recognized the navigation structure. The effectiveness factor was negatively affected; since field workers found it hard to use forms with text fields. The attitude factor was positively affected by the fact that the field workers gave of input to the next iteration; some comments, asking about the PDA and how it works and participated with lots of interest in the debriefing. This test didn’t show anything significant about the learnability more then the fact that this part of the navigation structure corresponds to the field workers mental model of the system.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- Field workers told that they need more time to try out the software. Before this test they were only allowed to briefly test the different GUIs.
- Initial form works smoother and has a faster response than before last test.
- The list menu “Personas en vivienda” have a faster response time that seems to work all right.
- Change of navigation techniques in several forms has made the software more homogenous and consistent.
- The conceptual design of the immigration and the emigration forms must be changed. Field workers are used to fill in the type of immigration/emigration before they fill in the date for the event.
- In the emigration form, list menu “Tipo de emigracion”, some grammatical errors were encountered. For instance “De otro municipio”.

4.4.6 Suggested improvements

- Move the date label “Fecha del evento” to another place on the form. 1st try with after the “Tipo de emigracion/inmigracion”.
- Following changes has to be done in the “Tipo de emigracion” list: De otro municipio = A otro municipio, De otro departamento = A otro departamento, De otro pais = A otro pais.

4.4.7 Example of GUI design

In this test a HiFi prototype, Figure 25 - Figure 34, running on a PDA simulator on a standards notebook were used. The prototype was developed according to the suggested improvements from the prior test.

Figure 25. Initial form

Figure 26. Initializing the interview

Figure 27. Household form

Figure 28. Person form

Figure 29. Personal event form

Figure 30. Event type look-up list

Figure 31. Emigration event form

Figure 32. Emigration look-up list

Figure 33. Emigration registered

Figure 34. Immigration event form

4.5 Usability testing of death event

The main purpose of this test was to explore the early design concepts of some of the newly added graphical user interfaces on the PDA (shown in the navigation structure below, Figure 35) using field workers and supervisors that not yet had tested the software. This test has partly been executed as a regression test of changes done after the previous test. The test also included a pilot test with one of the supervisors.

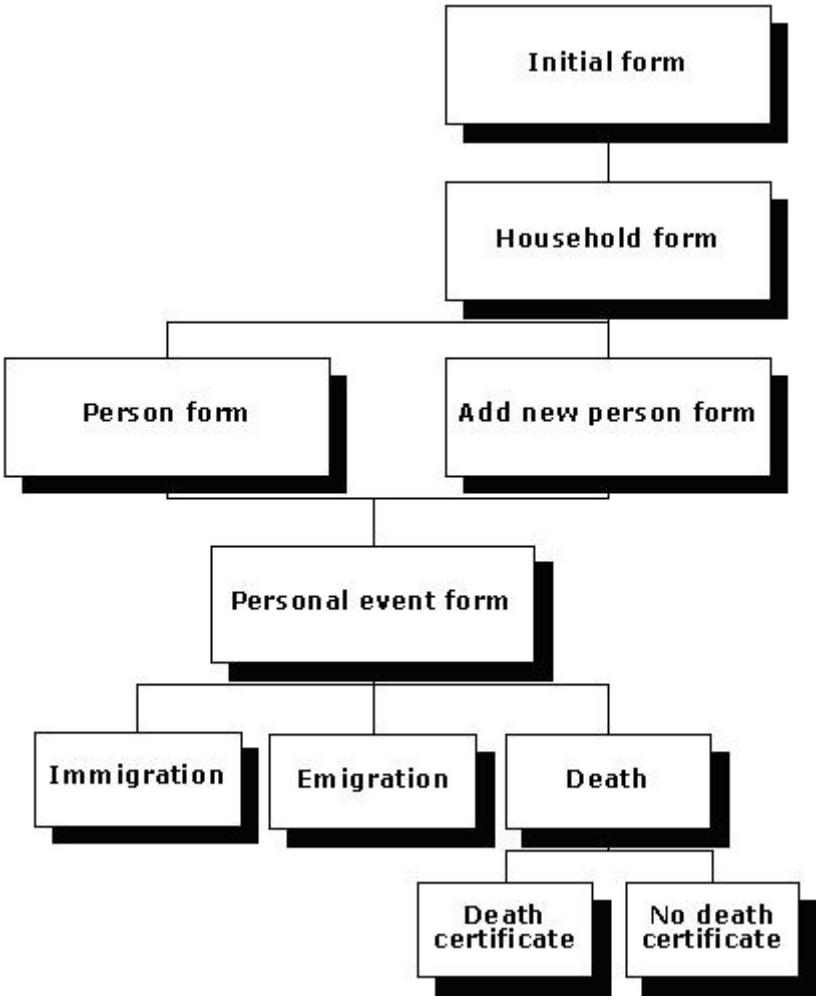


Figure 35. Navigation structure used in this test

4.5.1 Test summary

The pilot test of equipment, user manual and scenarios revealed some minor problems that were corrected before the main test with field workers. For instance some of the scenarios had to be changed.

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor.

The main test also revealed some problems in the different graphical interface that has to be corrected. These problems are described in the test result section.

The test method; first pilot testing and then design walkthrough works very well. The supervisor used in the pilot test has been used to answer questions during tests with field workers.

4.5.2 Test participants

In this usability test participated: supervisor nr 2 and 4 and urban area fieldworker nr 9. Characteristics for test participants are shown at 3.7.3.

4.5.3 Test objectives

The field worker uses the “household” as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the different scenarios in this test the field workers has to work his/her way down in the navigation structure of the software and the following GUIs where tested:

- initial form
- household form
- enter member info form
- add new member form
- select member event form
- immigration form
- emigration form
- death event forms

One usability requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the navigation structure and the product for erroneous and dubious behaviour and inconsistency.

4.5.4 Test method

The test method has been design walkthrough (see 3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to inform the test monitor about every change of scenarios.

This test has been performed in a simple single room setup at CIDS office with a PDA simulator on a standard notebook. The whole test has been recorded on a camcorder. Use of the software has been recorded with hyper cam.

4.5.5 Test result

The test participants completed all the tasks successfully.

Number of participants: 3

Time of completion (min): 07.57 -16.31

Average (min): 12.17

Standard deviation (min): 4.17

In the debriefing we used a slightly different approach than the prior test. In this debriefing another field supervisor was interviewing the test participants and asking them to show the hard parts in the software on the PDA simulator.

The three test participants found the navigation structure very logical. As one test participant expressed it; “the same software guides you into the next step”. Field workers also told us that the main problems were using the key board on the PC.

In the final part of the debriefing we were reviewing one sequence that appeared illogical; the date label in some forms appeared to be in a spot that is not visible.

In terms of REAL: The relevance was once again positively affected by the fact that the field workers recognized the navigation structure in all the new forms. The effectiveness factor was once again negatively affected; since field workers sometimes found it hard to use the key board on the simulator (PC) it is probable that the use of the PDA script board will be even harder. The attitude factor was positively affected by the fact that also these field workers gave lots of input to the next iteration; comments and suggestions and showing interest in participating in the development process (see 2.5). This test didn’t show anything significant about the learnability more then the fact that this part of the navigation structure corresponds to the field workers mental model of the system.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- Field workers told that they need more time to try out the software. Before this test they were only allowed to briefly test the different GUIs.
- In the death event form, “Defuncion” the label “Si causa es debido a lesiones” is missing.
- In the death event form, “Defuncion – Tiene certificado”, the three text fields, “Causa directa”, “Causa intermedia” and “Causa basica” are mandatory, which is wrong. Only the “Causa directa” should be mandatory.
- The date label and button “Fecha del evento” should be placed in a more visible space.

4.5.6 Suggested improvements

- Put a label “Si causa es debido a lesiones” in the “Defunción” form. Just below of the “Certificado de defunción” label.
- Change the Causa intermedia” and Causa basica” in the “Defunción” form to be not mandatory
- Move the date label and button “Fecha del evento” to a more visible space.

4.5.7 Example of GUI design

In this test a HiFi prototype, Figure 36 - Figure 47, running on a PDA simulator on a standards notebook were used. The prototype was developed according to the suggested improvements from the prior test.

Figure 36. Initial form

Figure 37. Initializing the interview

Figure 38. Household form

Figure 39. Person form

Figure 40. Selecting person

Figure 41. Events form

Figure 42. Event type look-up list

Figure 43. Death form

Figure 44. Death certificate selection

Figure 45. Certificate form

Figure 46. Female death event

Figure 47. No certificate form

4.6 Usability testing of pregnancy history and new birth event

The main purpose of this test was to explore some design ideas and concepts of the pregnancy history and the new birth event interfaces on the PDA (shown in the navigation structure below, Figure 48). This test was partly executed as a regression test of changes done after the previous test.

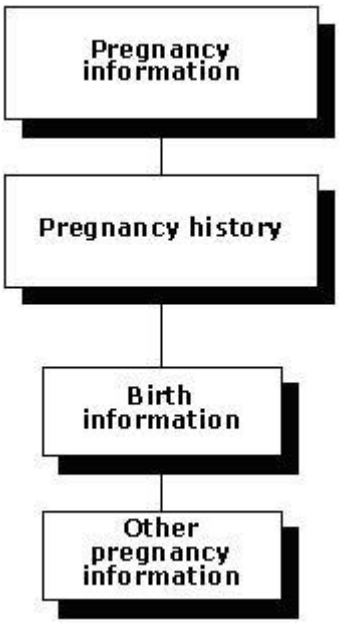


Figure 48. Navigation structure used in this test

4.6.1 Test summary

The main test/focus group has revealed that the overall design concept of the graphical interface doesn't works all right. Field workers miss parts from the navigation structure from the present DSS.

The main test/focus group also revealed that the present paper form system collects redundant information.

These problems are described in the test result section.

The test method; focus group meeting with spontaneous design walkthrough works very well. All test members participated on a very high level.

4.6.2 Test participants

In this usability test participated: supervisor nr 1, 2 and 3 and urban area fieldworker nr 10. Characteristics for test participants are shown at 3.7.3.

4.6.3 Test objectives

The field worker uses the pregnancy history to register the pregnancy history of fertile women between 15 and 49 years of age. The field worker also uses the new birth event to register new births for women between 15 and 49 years of age.

There shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The main test objective is to check whether the forms used for pregnancy history and new birth event meet the product requirements in terms of functionality and usability.

4.6.4 Test method

The test method has been a mix of focus group (see 3.4.6) meeting with pluralistic walkthrough (see 3.4.5). During the test the present paper form system was compared with the new PDA system to analyze and elicit functional and usability requirements.

4.6.5 Test result

This test gave lots of input for possible improvement of the REAL factors. Partly we solved the problem with the navigation structure, pregnancy history and the birth event which makes the interface more relevant. The effectiveness factor was positively affected, since we got rid of redundant data. The attitude factor was positively affected by the fact that also these field workers gave lots of input to the next iteration; comments and suggestions and showing interest in participating in the development process (see 2.5). This test didn't show anything significant about the learnability more then the fact that this part of the navigation structure corresponds to the field workers mental model of the system.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- The "Historia de embarazos" form "Informacion del parto" section lacking an input field to register type of birth. "Tipo de embarazo", for instance single birth or twins.
- Field worker lacking a new birth event in the "Personal eventos", "Agregue nuevo evento" list.
- Present paper forms contain some redundancy.
- The "Agregue otro embarazo" don't yet have any functionality.

4.6.6 Suggested improvements

- Put an input field for pregnancy type; "Tipo de embarazo" in the "Informacion del parto" section.
- Put the new birth event in the new events list; "Neuvo nacimiento"in the "Agregue nuevo evento" list.
- Add functionality to the "Agregue otro embarazo" button.

4.6.7 Discussion

This part of the PDA interface seems to be the most complicated to develop. The present paper form system collects redundant data which makes this part even more complicated. Field workers are used to collect redundant data and because of that it is difficult to develop an interface according to usability requirement that states that there shall be a clear resemblance between former used forms and the PDA interface.

The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker. However some of the information in the pregnancy history is redundant and should not be collected more then once. It is interesting that this test revealed the weakness of this requirement. Logically if something is wrong it should not be reflected in the future PDA software.

The method with spontaneous design walkthrough (see 3.4.4) using all available material and experienced computer users, works for eliciting requirements and defining early design concepts. During the focus group participants invented possible scenarios which we tested on different design ideas. This method was taken in use to find some high level design

concepts and to not slow down the development process (see 2.5). It also shows that user centered design (see 3.3) requires flexibility and innovativeness.

After some discussion the test participants realised that it is not effective to collect redundant data, which hopefully makes it easy for them to accept some changes in the conceptual design.

4.6.8 Example of GUI design

In this test HiFi prototypes, Figure 49 - Figure 60, running on a PDA simulator on a standards notebook and an implementation running on the PDA were used. These prototypes were developed according to the suggested improvements from the prior test.

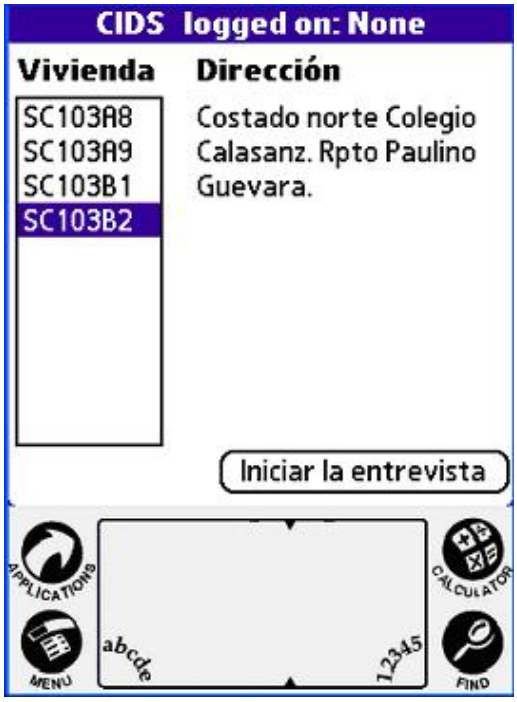


Figure 49. Initial form

Figure 50. Initializing the interview

Figure 51. Household form

Figure 52. Persons in household

Figure 53. Selecting pregnancy history

Figure 54. Fertile females in household

Figure 55. Selecting mother

Figure 56. Adding child to mother

Figure 57. Birth information

Figure 58. Child connected to mother

Figure 59. Selecting other pregnancy

Figure 60. Other pregnancy information

4.7 Usability testing of add new household form

The main purpose of this test was to explore the early design concepts of the "add new household" form on the PDA (shown in the navigation structure below, Figure 61). This test has partly been executed as a regression test of changes done after the previous test.

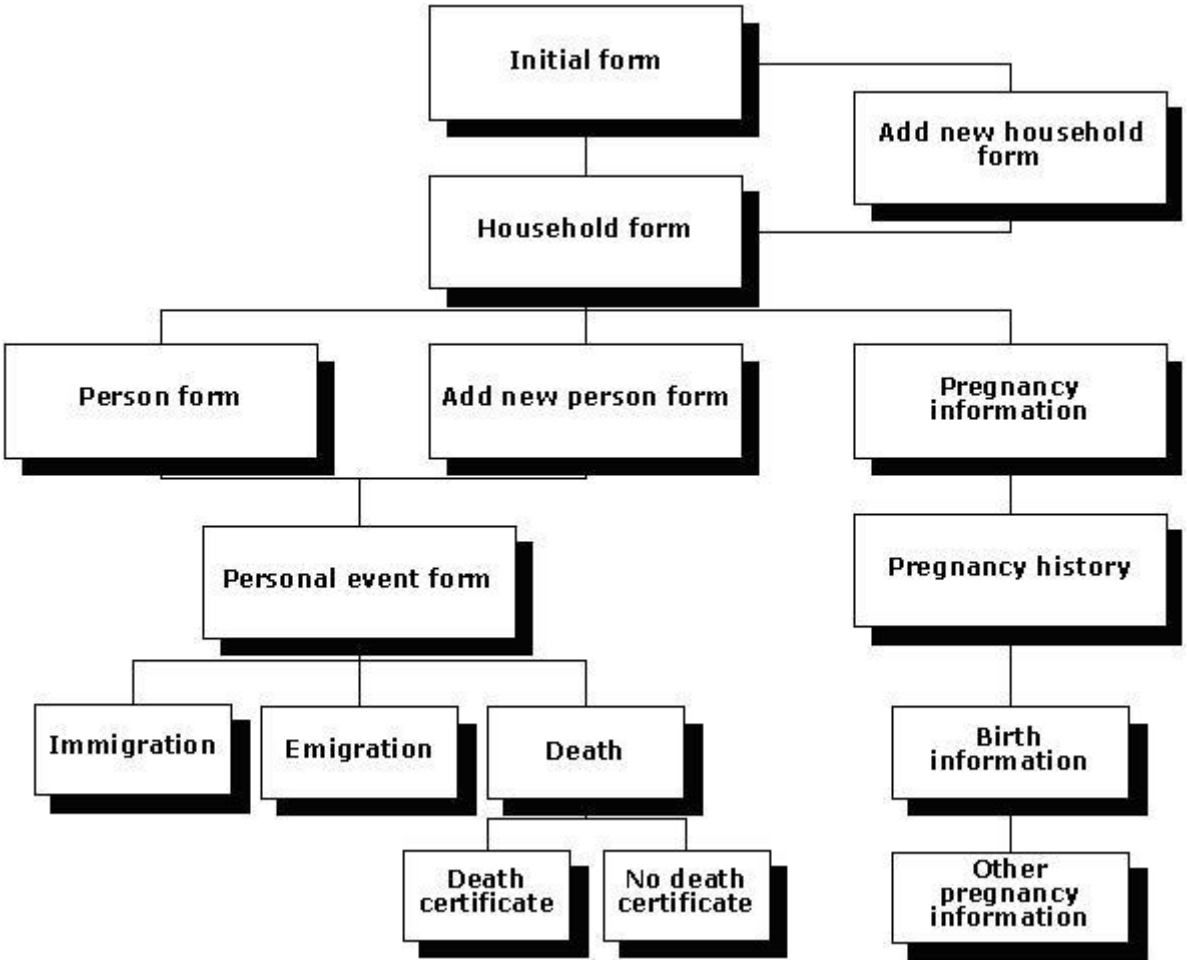


Figure 61. Navigation structure used in this test

4.7.1 Test summary

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor.

The main test also revealed some minor problems in the "add new household" form and some conceptual problems in the sequence of adding a new household that has to be corrected. These problems are described in the test result section.

4.7.2 Test participants

In this usability test participated: urban area fieldworker nr 6, 8 and 10 and rural area fieldworker nr 15. Characteristics for test participants are shown at 3.7.3.

4.7.3 Test objectives

The field worker uses the "add new household" to create a new household that not yet exists in the DSS.

The field worker uses the "household" as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the different scenarios in this test the field workers has to work his/her way down in the navigation structure of the software and the following GUIs where tested:

- Initial form
- add new household form
- household form
- enter member info form
- add new member form
- select member event form
- immigration form
- emigration form
- death event forms

One usability requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the navigation structure of new and old forms and the product for erroneous and dubious behaviour and inconsistency.

4.7.4 Test method

The test method has been design walkthrough (see 3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to inform the test monitor about every change of scenarios.

This test has been performed in a simple single room setup at CIDS office using software implementations on the PDA. The whole test has been recorded on a camcorder.

4.7.5 Test result

The test participants completed all the tasks successfully.

Number of participants: 3

Time of completion (min): 25.40 - 40.40

Average (min): 33.58

Standard deviation (min): 7.38

During the debriefing the field supervisor asked the participants to use the PDA to show where they have had problems with the GUI and some problems with the “Add new household” form were discussed.

In terms of REAL: Once again the relevance was positively affected since adding a new household is an essential part of the job the field worker has to do. The effectiveness factor was negatively affected, since data has to be registered in text boxes, which is a bit troublesome using the small keyboard or script board on the PDA. The attitude factor was positively affected by the fact that also these field workers gave lots of input to the next

iteration; comments and suggestions and showing interest in participating in the development process (see 2.5). The field workers that participated in this test had already tested parts of the software on different occasions before. On the question if they recognized any improvements they all responded positively. The same field worker that already had tested the software also completed her tasks fastest, showing something significant about the learnability.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- The “add new household form” returns to the “initial form” after adding a new household, which confuses the field worker. Field worker thinks that focus is set on the new household, which is the case in the present paper form system.
- The “add new household form” have limited space in the input fields “Territorio”, “Sector”, “Manzana” and “Casa”, but the form gives confusing feedback since the input marker stayes in the current input field.
- Add new household form; it is possible to input lower case and upper case letters as household codes.
- It is possible to input any letter or number in the input field “Territorio” in the new household form.
- In case of a new household; no new events has to be registered.
- Date of “otro embarazo” is inverted.
- The “Esta embarazada ahora?” Yes/No input field in the pregnancy history is sometimes preset.
- In the present paper for system the pregnancy history “Atención del parto” and ”Lugar de atención del parto” is codified.
- In the present paper form system the immigration and emigration “Causa de evento” is codified.
- In the present paper form system the death event “Causa directa”, Causa intermedia” and “Causa basica” are codified.
- Sometimes the field worker gets confused since they don’t know to which person they are registering an event.

4.7.6 Suggested improvements

- After introducing the new household code and the direction of the household, focus should be set on the “Household form”.
- The marker should jump to the next input field when the current input field is filled up in the new household form.
- Inputs of letters should be set to upper case letters and automatically switched to numbers when necessary.
- Input field; “Territorio” should be limited to C, F, M, P, S and T in the new household form.
- In case of a new household; take away the “event button” on the personal form.
- Invert the date of birth and the date of death in the “other pregnancy form.

- Check software or database for erroneous or dubious behaviour.
- Pregnancy history; “Atención del parto” and ”Lugar de atención del parto” should be codified.
- Immigration and emigration events; “Causa de evento” should be codified.
- Death event; “Causa directa”, Causa intermedia” and “Causa basica” should be codified
- All events; the persons name should be displayed on the top of the form.

4.7.7 Discussion

Although this was the longest test so far, the user did not find it to boring. Field workers told us that it was a nice test and that they practically tested the whole software. They also liked that the test was done on the PDA and not on the simulator.

The field worker had some minor problems with the keyboard on the PDA, which basically made the test longer then necessary.

4.7.8 Example of GUI design

In this test a HiFi prototype, Figure 62 - Figure 71, running on the PDA were used. These prototypes were developed according to the suggested improvements from the prior test.

Figure 62. Initial form

Figure 63. Entering new household

Figure 64. Alert message

Figure 65. Updated household list

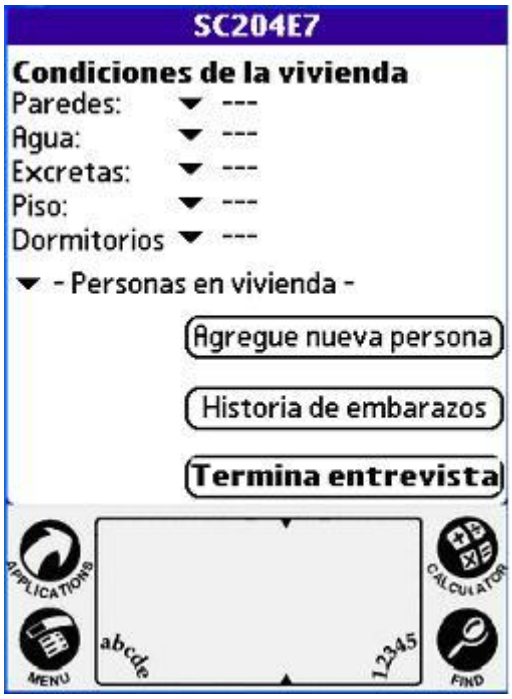


Figure 66. House-conditions unset

Figure 67. House-condition set

Figure 68. Empty inhabitant list

Figure 69. Empty person form

Figure 70. Personal information

Figure 71. Filled in inhabitant list

4.8 Usability testing of the complete navigation hierarchy

The main purpose of this test was been to explore the design concepts of the complete navigation structure of the PDA software (the same navigation structure were used as in the prior test, Figure 61). This test has been a complete regression test of all the changes done during the user centered design (see 3.3).

4.8.1 Test summary

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor.

The main test also revealed some minor problems in the “pregnancy information” form and some conceptual problems in the sequence of adding pregnancy information that has to be corrected. These problems are described in the test result section.

The test method; Design walkthrough with software implementation on PDA works very well.

4.8.2 Test participants

In this usability test participated: rural area fieldworker nr 12, 13 and 14. Characteristics for test participants are shown at 3.7.3.

4.8.3 Test objectives

The field worker uses the DSS software to register data collected on the field. In this test the complete navigation structure is tested on field workers with very little experience in use of computers.

The field worker uses the “household” as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the different scenarios in this test the field workers has to work his/her way down in the navigation structure of the software and the following GUIs where tested: initial, add new household, household, enter member info, add new member, select member event, immigration, emigration form ,death event and the pregnancy information forms.

One usability requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the complete navigation structure of new and old forms and the product for erroneous and dubious behaviour and inconsistency.

4.8.4 Test method

The test method has been design walkthrough (see 3.4.4) with several scenarios that are common in the daily work of the field worker. The test person has been told to inform the test monitor about every change of scenarios.

This test has been performed in a simple single room setup at CIDS office using a software implementation on the PDA. The whole test has been recorded on a camcorder.

4.8.5 Test result

The test participants completed all the tasks successfully.

Number of participants: 3

Time of completion (min): 24.16 - 40.22

Average (min): 32.49

Standard deviation (min): 8.06

During the debriefing the test participant where asked if the navigations structure follows the same logic as the paper forms, i.e. if there is a clear resemblance between former used forms and the PDA interface. All test participants confirmed that the navigation structure well corresponds to the present paper form system.

In terms of REAL: Once again the relevance was positively affected since the PDA software seems to capture the required information. One of the rural area field workers reminded us about the risk with carrying valuable equipment on the field. Theft is a big problem in Nicaragua and of course the PDA might be a temptation for criminals. However the PDA was initially selected because of its relative low value and discrete appearance. Effectiveness factor was both positively and negatively affected, some parts are more effective than the paper form system and other parts are not. Main problem is that still data has to be registered in text boxes, which is a bit troublesome using the small keyboard or script board on the PDA. Though the PDA software eliminates manual quality control and manually registering data in the database, it is probable that the PDA system is more effective than the system CIDS uses right now. The attitude factor was positively affected; all test participants showed a great attitude during the tests and they made comments and suggestions. About learnability; one field worker had tried the software before, and she worked through the scenarios faster than the other two.

According to design rules; analyzes of recordings from the test, and a discussion between the test participant and test team members gave the following result:

- The user sometimes gets confused in the pregnancy information form. In some cases the “Agregue hijo/a” drop down list covers the “Agregue otros embarazos” button.
- In the “Historia de embarazos” list only appears pregnancies that has resulted in a living child.

4.8.6 Suggested improvements

- Change the design of the “Historia de embarazos” form. Move the “Agregue otros embarazos” button a little bit further down in the form.
- Make all pregnancies appear in the list.

4.8.7 Discussion

After a discussion with de software developer we agreed on not making these changes at this moment.

The “Historia de embarazos” form is already quite full. Instead we will try to teach the field workers to work with the form in its present way.

Since it is not possible to connect to the database the pregnancy list will not be filled up with its real values. Sooner when the system is working the way it is supposed to do, the pregnancy list will automatically be filled up, with data from the database.

4.8.8 Example of GUI design

In this test a HiFi prototype, Figure 72 - Figure 82, running on the PDA were used. The prototype was developed according to the suggested improvements from the prior test.

Figure 72. Initial form

Figure 73. Entering new household

Figure 74. Alert message

Figure 75. Start interview messages

Figure 76. House-conditions unset

Figure 77. House-condition set

Figure 78. Empty inhabitant list

Figure 79. Empty person form

Figure 80. Personal information

Figure 81. Filled in inhabitant list

Figure 82. Updated household list

4.9 Usage study – pilot testing PDA software

The main purpose of the test was to explore the design of the final test "Usage study – DSS using PDA for data collection".

4.9.1 Test summary

The main test has revealed that the overall design of the test works all right.

The test method; Design walkthrough with software implementation on PDA, filmed with camcorder works very well.

Photo 8. Field study – pilot test in Barrio Subtiava

4.9.2 Test participants

In this usability test participated: urban area fieldworker nr 6 and 10. Characteristics for test participants are shown at 3.7.3.

4.9.3 Test objectives

The field worker uses the DSS software to register data collected on the field. In this test the complete navigation structure was tested on field workers with the most experience of computer usage.

The field worker uses the "household" as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In the pilot test the field workers has to work his/her way down in the navigation structure of the software and the some of the following GUIs where tested:

- initial form

- add new household form
- household form
- enter member info form
- add new member form
- select member event form
- immigration form
- emigration form
- death event form
- pregnancy information forms

One usability requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the test design.

4.9.4 Test method

The test method has been design walkthrough (see 3.4.4) with real scenarios that are common in the daily work of the field worker.

This test has been performed in the natural working environment of the PDA, at a household in the study area. The whole test has been recorded on a camcorder.

4.9.5 Test result

A discussion between the test participant and test team members presents the following test results:

- Test design works all right
- Important to record in a shady area

4.10 Usage study – DSS using PDA for data collection

The main purpose of this test has been to explore the design concepts and functionality of the PDA software used in its natural environment during live interviews collecting data for the DSS. Test participants have been the so called four least competent users (see 3.7).

This test was also used for testing changes done after the last test to the:

- initial form
- household form
- enter member info form
- add new member form
- emigration form
- immigration form
- death event forms
- pregnancy history forms

4.10.1 Test summary

The main test has revealed that the overall design concept of the graphical interface works all right. Field workers recognize the navigation structure from the present DSS and adopted the household metaphor (see 3.2).

In REAL (see 2.1.1) aspects the user interface works quite satisfactory but some changes are necessary;

- **Relevance** - the user interface and the PDA system are relevant for data collection and with further development it might be a great help for the field worker in the future.
- **Effectiveness** - the user interface is not yet as efficient as the paper form system in all aspects. The new household sequence and adding new persons in a household requires more time then the paper form system. Other parts of the GUI are more efficient, for instance the pregnancy history. The main problem seems to be the key board on the PDA and the lack of a usable copy-paste function.
- **Attitude** - all the test persons have shown a great attitude for the user interface and the PDA system. No one seems to have any problems in accepting the new system. Test participants showed great interest for the digital system and makes suggestions of improvements.
- **Learnability** - the design and the navigation structure seem to correspond to the field workers mental model of the data collecting system. The main problem is the key board, which probably will be the hardest part to learn for the field worker.

The main test also revealed some minor problems in some of the different digital forms and some minor conceptual problems that have to be corrected.

The test method; Design walkthrough with software implementation on the PDA in its natural environment worked very well.

Photo 9. Field study in Chacraseca.

4.10.2 Test participants

In this usability test participated: urban area fieldworker nr 6 and rural area fieldworker nr 12, 13 and 14. Characteristics for test participants are shown at 3.7.3.

4.10.3 Test objectives

The field worker uses the DSS software to register data collected on the field. In this test the complete navigation structure is tested on field workers with very little experience in use of computers.

The field worker uses the “household” as starting point for collecting data. Data about the persons and the different events are always related to a specific household.

In this test the field workers has to work his/her way down in the navigation structure of the software according to what happens in a real interview. Following GUIs where tested: initial, add new household, household, enter member info, add new member, select member event, immigration, emigration form ,death event and the pregnancy information forms.

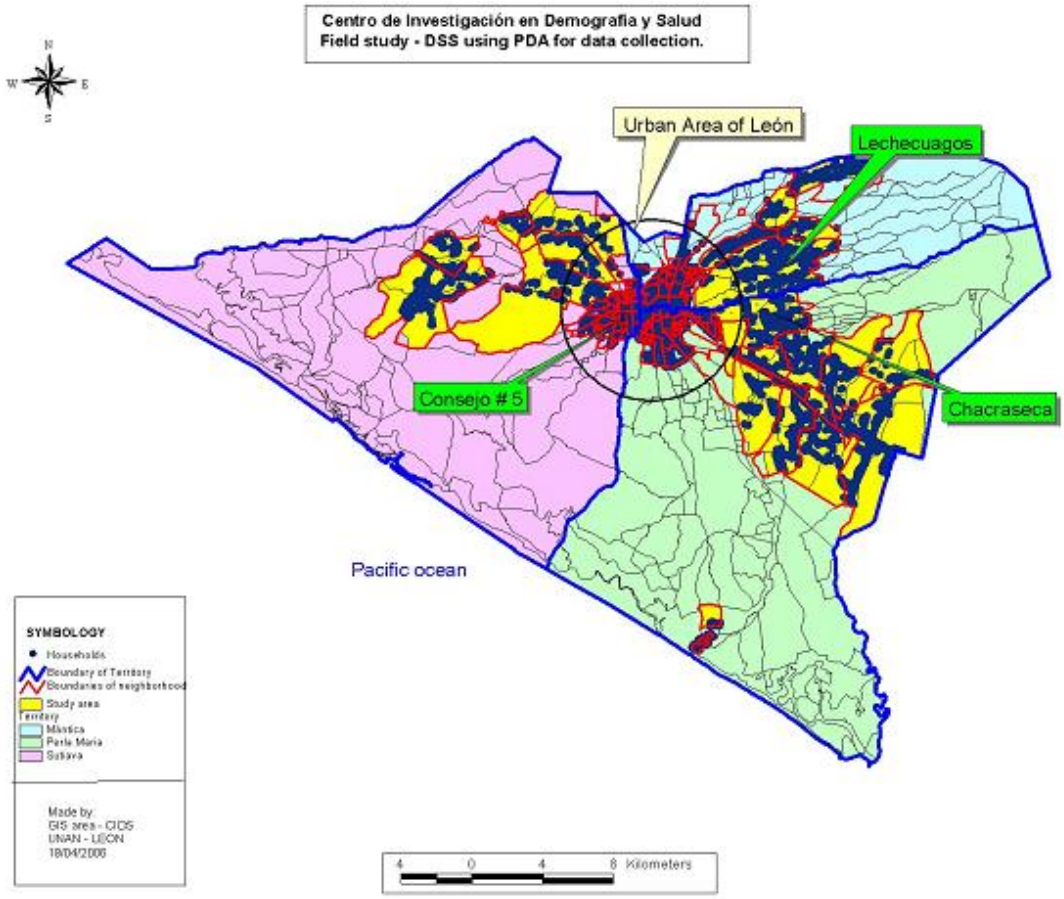
One usability requirement states that there shall be a clear resemblance between former used forms and the PDA interface. The objective with this requirement is to build up a well known mental model of the interface that will lessen the cognitive load of the field worker.

The PDA GUIs are supposed to have a logical navigation structure not very different from the present used paper form system.

The main test objective is to check the complete navigation structure of new and old forms and the product for erroneous and dubious behaviour and inconsistency in its natural working environment..

4.10.4 Test method

The test method has been design walkthrough (see 3.4.4) in the natural working environment where the PDA is supposed to be used, during interviews in the CIDS study area. Before and after the usage study the four LCUs were asked to fill in a pre and a post test questionnaire (see 3.6).



Map 2. Overview of CIDS study area and where tests were executed.

4.10.5 Results from pre test questionnaire II

Before the usage study the four LCUs, were asked to fill in a small pre test questionnaire which mainly served as a pilot test. This questionnaire has also been used to estimate the REAL before the usage study and the following results where achieved:

- **Relevance** - The common opinion is that use of a PDA for data collection in the field is relevant; the DSS software has capacity to collect all the necessary information but the field workers feels that they need more training. The DSS software needs improvements. Not all fieldworkers feel secure collecting data with the PDA, with the present software implementation. A user manual also should be a part of the system and it should be integrated in the software.
- **Effectiveness** - The PDA method is considered effective but the field worker needs more practice and training. The software needs some improvements to make it more effective. The main problem is the PDA keyboard.
- **Attitude** - All field workers are positive to the PDA usage and think it is going to be an improvement of their working situation.
- **Learnability** - The software is well mapped to the field workers mental model of the data collecting system.

Table 5. The result table shows how many of the field workers that gave a specific answer, a suggestion and/or a comment[18].

Instructions to complete this form:	Likert scale[19]				
This questionnaire is anonymous. This questionnaire is for evaluating the design of the graphical user interface used on the PDA.	1 = I don't agree at all . . . 5 = I fully agree				
User manual:	**1**	**2**	**3**	**4**	**5**
The manual contains the necessary information to run the handheld computer.	0	0	0	2	2
A portable digital version of the user manual in the handheld computer could be useful.	0	0	0	1	3
After reading the manual I feel like I am able to run the handheld computer better.	0	0	1	2	1
More studies of the manual would make me understand the handheld computer even better.	0	0	0	0	4
Suggestions and comments:	1. More workshops to learn more about the handheld computer. 2. It would be useful to have some more workshops to learn more about the machine.				

[18] Questionnaires originally in Spanish

[19] Likert scale is a scale on which the test participants register their agreement or disagreement with a statement.

Scripting:	1	2	3	4	5
Scripting with letters is easier then scripting with the PDA pen.	0	0	0	1	3
The workshop improved my abilities to use the script board.	0	0	0	1	3
With more training I think I would improve my scripting even more.	0	0	0	0	4
If it was possible I would like another method of scripting to register data.	0	1	1	0	2

Suggestions and comments:

1. More practise
2. To have more training and would make us to have less problems with some things.

Interviews:	1	2	3	4	5
There was enough time to make an interview (during training).	0	0	1	2	1
Normally a real case takes more time, than during the training.	0	0	2	0	2
My opinion is that all the interviews reflected the reality and all scenarios are possible.	0	0	0	1	3

Suggestions and comments:

Capture forms:	1	2	3	4	5
The use of the digital capture forms is similar to the use of the paper forms.	0	0	0	0	4
The digital forms capture enough information.	0	0	0	0	4
I feel secure about the information that I register.	0	0	0	0	4
I feel that some important functions are missing.	2	0	1	1	0
I get the impression that it is easy to commit errors, using the digital forms.	2	1	1	0	0

Suggestions and comments:	1. It is less probably to make errors using the PDA. 2. Improve the digital capture forms “Pregnancy history”, regarding date of birth, where an errors occurs while connecting the mother to the child.

Handheld computer:	1	2	3	4	5
With some improvements on the digital capture forms the PDA could be useful on the field.	0	0	0	0	4
With more training, practice and use, the PDA would make my job easier.	0	0	0	0	4

I feel more secure to accomplish with my tasks, using the PDA than the manual paper forms.	2	0	0	1	1

Suggestions and comments:

1. The only thing is more practice with the script board.
2. I we get to know the system better, we would be able to run it easier.
3. The PDA is more secure because it detects erroneous data immediately.
4. It was really easy.

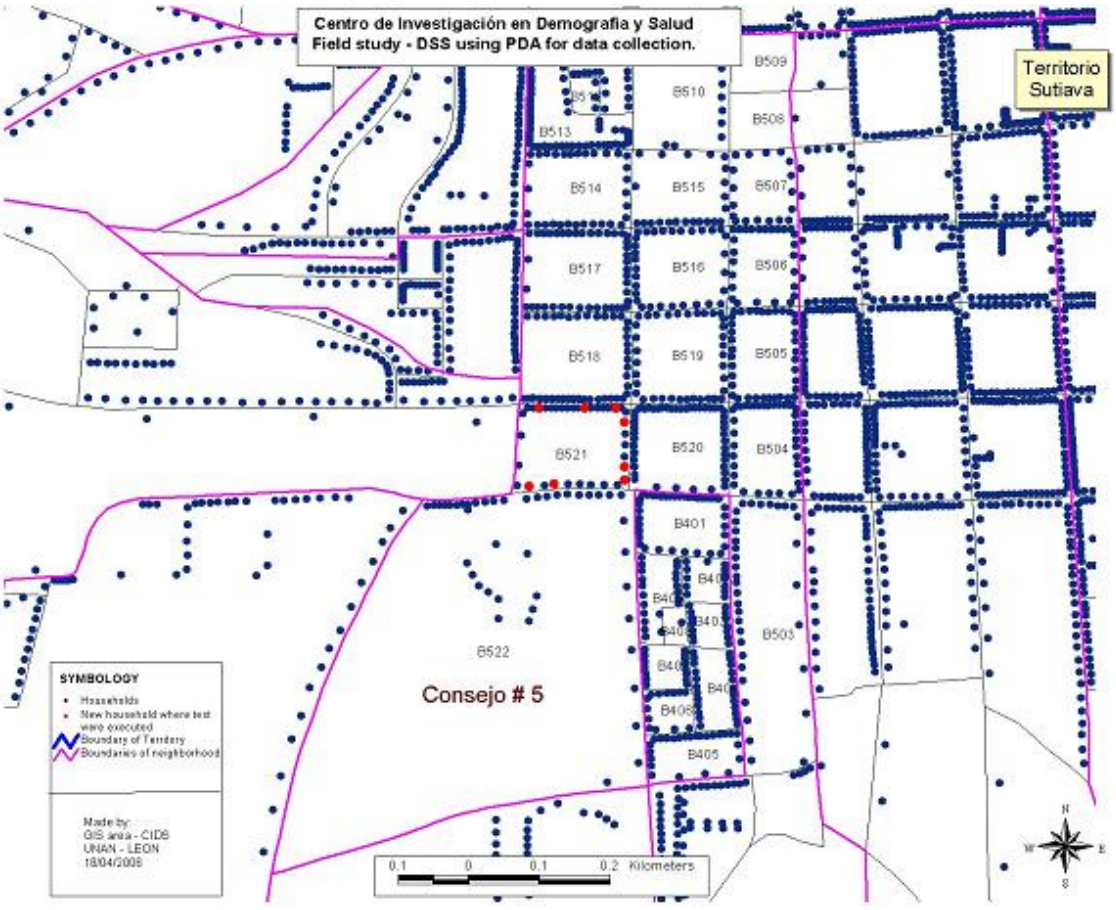
4.10.6 Test result

This section describes the test results from the usage study (see 3.4.8) for the four LCUs.

4.10.6.1 Field worker nr 6

Date of test: 2006-04-20

Place of test: León, Territory Sutiava, Consejo #5,.



Map 3. Study area in León, Barrio Sutiava, households subject to test in red.

SB521A2[20] – no events	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF[21], and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Checking house conditions.	Observes the house and checks parameters at the same time. Asks for parameters.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task.
SB521A6 - emigration event	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Register emigration	Have no problems finding the event and the emigration form. Difficult to write on the PDA key board, since everything in the PDA is really small. Register the event for erroneous person, due to name confusion.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. Lack of feedback while register event on erroneous person.
Checking house conditions.	Observes the house and checks parameters at the same time.	Relevance: Field worker

[20] Household code
[21] CF is Family head (Cabeza de familia).

	Asks for parameters.	can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task.
SB521A7 – immigration event	Observation	Usability measure
Checking house conditions.	Observes the house and checks parameters at the same time. Asks for parameters.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Register new person	Have no problems finding the new person form. Tries to register the event without filling in data about the new person, but gets feedback from the system. Difficult to write on the PDA key board, since everything in the PDA is really small.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. System gives balanced feedback.
Connecting child with mother	First trying to register a birth event instead of connecting child to mother. Gets into death form, but realizes her mistake.	Learnability: Seems to not correspond to field workers mental model of system.
Register pregnancy history	Have some problems in finding the pregnancy	Learnability: Seems to be one design decision that doesn't correspond

	information form. Makes no mistakes while working with the pregnancy information form.	to field workers mental model of system. Effectiveness: Better then paper form system.
Register new person	Have no problems finding the new person form. Less difficulties to write on the PDA key board.	Learnability: Seems to correspond to field workers mental model of system. Effectiveness: Less then paper form system.
Register immigration	Have no problems in finding the immigration form. Works nicely with the immigration form.	Learnability: Seems to correspond to field workers mental model of system. Effectiveness: A little bit less then paper form system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task.
Makes a comment over a missing function	Lacking parameters when the mother is not living in the same household as her child.	Attitude: Seems to have a positive attitude, while making suggestions of improvements of the software.
SB521B5 – no events	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Checking house conditions.	Observes the house and checks parameters at the same time. Don't ask the CF, since she notices that there has been no change since the last visit.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Locking for fertile women in the household.	Gets a little confused and starts jumping between the household form and the personal information form.	Learnability: Seems to not correspond to field workers mental model of system.

	There is no need for checking age of fertile women, since they all are in the pregnancy information list.	Attitude: Gets confused but not annoyed.
Checking out pregnancy history.	Gets a little bit confused, since the pregnancy history is not charged into the PDA.	Learnability: Seems to be one design decision that doesn't correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task.
SB521C9 - immigration	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Register new person	Have no problems finding the new person form. Less difficulties to write on the PDA key board.	Learnability: Seems to correspond to field workers mental model of system.
Register immigration	Have no problems in finding the immigration form. Works nicely with the immigration form.	Learnability: Seems to correspond to field workers mental model of system.
Checking pregnancy history, to see if there are any fertile (15-49) women.	Very quick learner, checks pregnancy history instead of every woman's age.	Learnability: Seems to correspond to field workers mental model of system.
Checking pregnancy history, for new immigrant.	Have no problems in finding the pregnancy information form	Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task. Effectiveness: In this case the total effectiveness is a little

		bit better then paper form system.
SB521D1 – death event, immigration	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Register two new persons	Have no problems finding the new person form. Less difficulties to write on the PDA key board.	Learnability: Seems to correspond to field workers mental model of system. Effectiveness: Less then paper form system.
Register immigration	Have no problems in finding the immigration form. Works nicely with the immigration form.	Learnability: Seems to correspond to field workers mental model of system. Effectiveness: A little bit less then paper form system.
Register death event	Have no problems in finding the death form. Works nicely with the death form. Not able to fulfil the task since the CF don't have the death certificate at hand.	Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task. Effectiveness: In this case the total effectiveness is a little bit worse then paper form system.

SB521D4 – no event	Observation	Usability measure
Start the interview for house D4, but making the interview in another house.	Don't mix the two houses up.	Relevance: Field worker can accomplish her task.
Checking house conditions.	Asks for the house parameters since she is actually not seeing house D4.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Checking pregnancy history, to see if there are any fertile (15-49) women.	Very quick learner, checks pregnancy history instead of every woman's age.	Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to CF and closes interview at the same time.	Relevance: Field worker can accomplish her task.

Table 6. Notes, observations and usability measurements from field worker nr 6.

Photo 10. Usage study in Sutiava

Photo 11. Usage study in Sutiava.

4.10.6.2 Test results for field worker nr 6

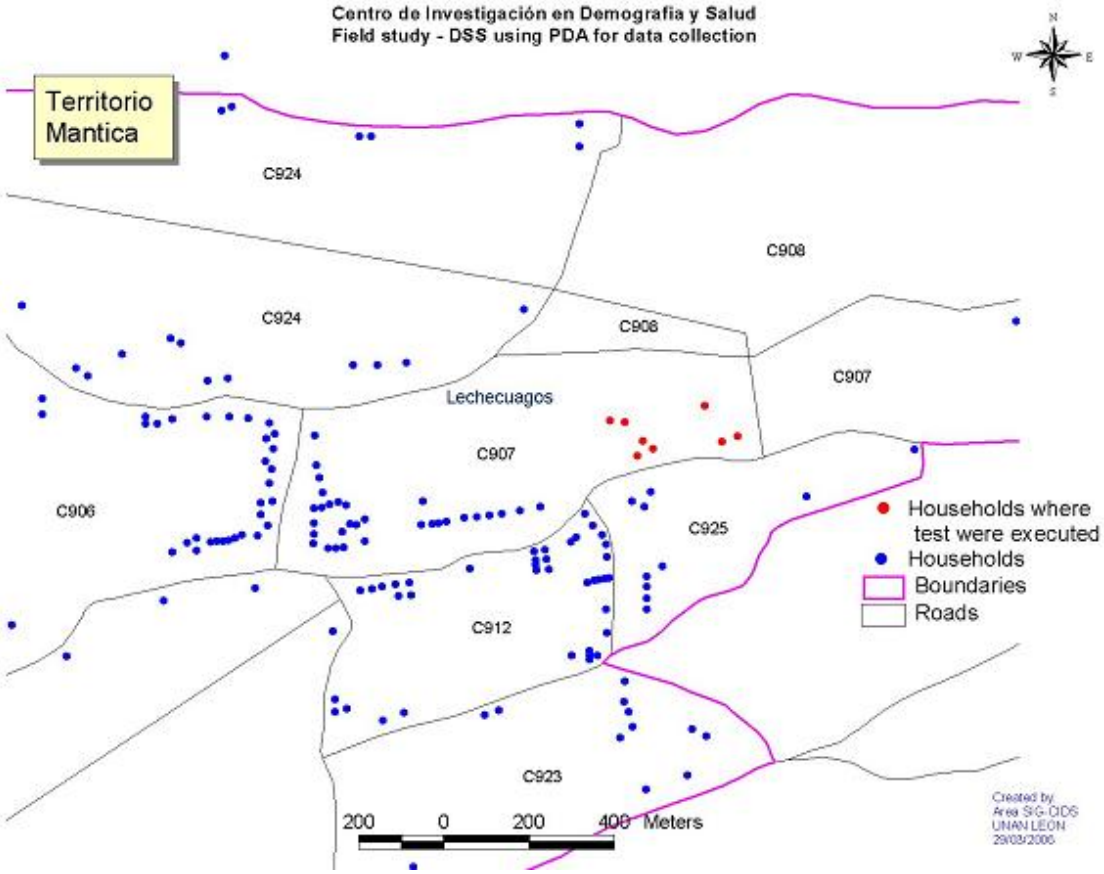
These are the results from the test with field worker nr 6.

- Works fast and smooth filling in all kinds of forms, however can't really keep up with the paper form system in all cases.
- In some cases, depending on the kind of events in certain households, the digital system is faster then the paper form system.
- Gets a little confused occasionally, due to the conceptual design, however she is a quick learner and don't make the same mistakes again.

4.10.6.3 Field worker nr 12

Date of test: 2006-03-29

Place of test: León, Territory Mantica, Lechecuagos, MC907A1-MC907A8



Map 4. Study area in Lechecuagos, household MC907A1-MC907A8 in red.

MC907A1 – no events	Observation	Usability measure
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time.	Effectiveness: Starts of with most important task. Attitude: Seems to have no problem in accepting the PDA.
Closes interview.	Talks to CF, tells her about another investigation, and closes interview at the same time.	Relevance: Field worker can accomplish her task.
MC907A2 – no events	Observation	Usability measure
Controlling list of persons living in the household.	Had already talked to CF in MC907A1, since they are family, and only elderly people	Effectiveness: Gets prepared and finish her interview in a few

	living in MC907A2.	minutes.
Checking house conditions	Observes the house and checks parameters at the same time.	Relevance: Field worker can accomplish her task.
Checking pregnancy history, to see if there are any fertile (15-49) women.	Very quick learner, checks pregnancy history instead of every woman's age.	Learnability: Seems to correspond to field workers mental model of system.
Closes interview.	Talks to test monitor, and closes interview at the same time.	Relevance: Field worker can accomplish her task.
MC907A3 – no events	Observation	Usability measure
Controlling list of persons living in the household.		Effectiveness: Starts of with most important task. Learnability: Seems to correspond to field workers mental model of system.
Talks to CF in MC907A3, and plays around with the PDA at the same time.	Seems like the field worker is starting to get confident and relaxed with the PDA.	Attitude: Seems to have no problem in accepting the PDA.
MC907A4 – no events	Observation	Usability measure
Some problem with starting the interview. Chooses the wrong house in the household list.	Easily covers the mistake, and stops the wrongly started interview, when she realizes her mistake.	Revisable actions.
Get mix up with the "new house" button.	Pushes buttons and follows instructions	Simple error handling.
Controlling list of persons living in the household.	Talks to the CF, and checks persons in the list at the same time. Realises that personal list is not corresponding to the actual situation.	Relevance: Field worker can accomplish her task.
Closes interview.	Have no problem in using the PDA and concentrating in other things at the same time.	Attitude: Seems to have no problem in accepting the PDA and don't get bugged.

MC907A6 – no events	Observation	Usability measure
Same problem as in MC907A4. Some problem with starting the interview. Chooses the wrong house in the household list.	Easily covers the mistake, and stops the wrongly started interview, when she realizes her mistake.	Reversal actions. Simple error handling.
Checking house conditions.	Observes the house and checks parameters at the same time.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Controlling list of persons living in the household.	Nice control of PDA. Talks and works at the same time.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.
Checking out pregnancy history.	Gets a little bit confused, since the pregnancy history is not charged into the PDA.	Learnability: Seems to be one design decision that doesn't correspond to field workers mental model of system.
MC907A7 – no events	Observation	Usability measure
Checking all necessary parameters.	Nice control, no mistakes observed.	Learnability: Seems to correspond to field workers mental model of system.
MC907A8 – birth event	Observation	Usability measure
Starts with the wrong household.	Realises her mistake	Reversal actions.
Registers a new person	Have some problems with the occupation list. Hard work with menu, since everything in the PDA is really small.	Learnabiltiy: Will take some time to physically manage the PDA.
Registers date of birth wrong, since CF gives the wrong date of birth	Changes the date of birth	Reversal actions.
Checks out pregnancy history	Very quick learner, checks	Learnability: Seems to

for fertile women	pregnancy history instead of every woman's age.	correspond to field workers mental model of system.

Table 7. Notes, observations and usability measurements from field worker nr 12

Photo 12. Usage study in Lechecuagos.

4.10.6.4 Test results for field worker nr 12

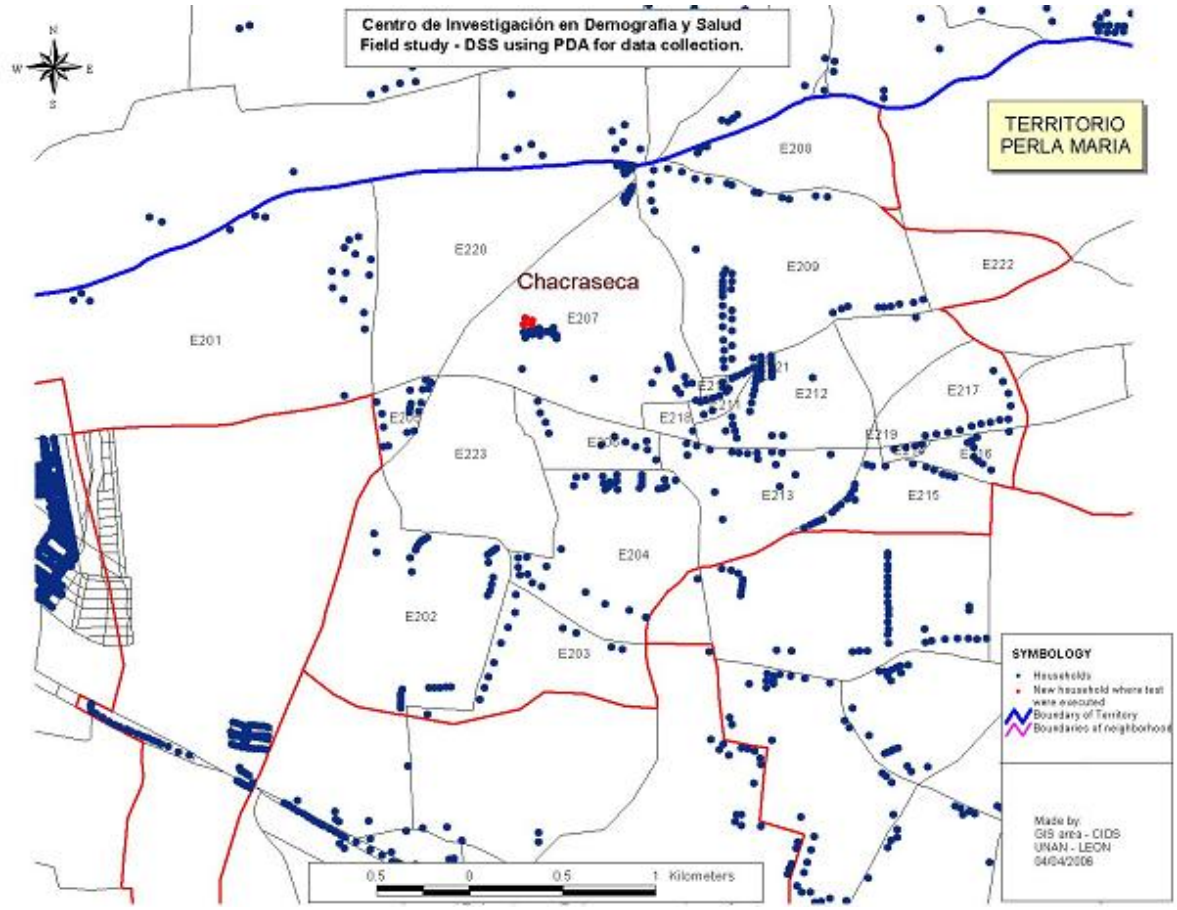
These are the results from the test with field worker nr 12.

- Everything works all right when the PDA is charged with the proper values from the database.
- Pregnancy history is not charged into the DSS software on the PDA, which confuses in the beginning; however that's a policy decision concerning the integrity of the people in the study. If the PDA is lost or stolen, no really important information is revealed for public.
- Some problems in changing between two households, field worker chooses the "new household" button instead of the "start interview" button.

4.10.6.5 Field worker nr 13

Date of test: 2006-04-04

Place of test: León, Territory Perla Maria, Chacraseca, new households in Semilla de Esperanza, PE207.



Map 5. Study area in Chacraseca, new households.

PE207.. (P000040)	Observation	Usability measure
Filling in “new house” form.	Some problems with the keyboard. Problems with changing between, small and big letters and international keyboard.	Effectiveness: Starts of with most important task. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA.
Finishing filling in “new household” form.	Works very well. Nice response from the interface, giving clear alerts.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of

		system. Internal locus of control. Informative feedback. Dialog yield closure. Reversal actions.
Filling in “house condition” form.	Works very well. Nice response from the interface.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task.
Finishing filling in “house condition” form.	Works very well. Nice response from the interface, guiding the user to the “new person” form.	Learnability: Seems to correspond to field workers mental model of system.
Filling in “new person” form.	Some problems with the keyboard. Problems with changing between, small and big letters and international keyboard.	Effectiveness: A little less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. Internal locus of control. Informative feedback. Dialog yield closure. Reversal actions. Reduce short-term memory load.
Finishing filling in “new person” form.	Works very well. Nice response from the interface, guiding the user to the “pregnancy history” form.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load.
Filling in “pregnancy history”	Have some problems in	Consistency in “mother

form.	selecting a “mother” in the list. Solves the problem through error message. Start filling in pregnancy information, which is not necessary for “new households”.	list” not 100%. Simple error handling. Informative feedback. Not reducing short-term memory load. Learnability: Seems not to correspond to field workers mental model of system. Effectiveness: Better then paper form system.
Finishing filling in “pregnancy history” form.	Works very well. Nice response from the interface, guiding the user to the end the interview.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load. Consistency in navigation between different GUIs.
PE207.. (P000051)	Observation	Usability measure
Filling in “new house” form.	Still some problems with the keyboard. However less then in the first test.	Effectiveness: Starts of with most important task. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA.
Finishing filling in “new household” form.	Works very well. Nice response from the interface, giving clear alerts.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control

		Informative feedback Dialog yield closure Reversal actions.
Filling in “new person” form.	Fewer problems with the keyboard then in the first test. Seems like its only practice that is lacking.	Effectiveness: A little less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. Internal locus of control Informative feedback Dialog yield closure Reversal actions. Reduce short-term memory load.
Finishing filling in “new person” form.	Works very well. Nice response from the interface, guiding the user to the “pregnancy history” form.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load.
Filling in “pregnancy history” form.	A fatal error occurs when field worker chooses a mother.	Functional deficiency in the software, nothing to do with usability.

Table 8. Notes, observations and usability measurements from field worker nr 13.

4.10.6.6 Test results for field worker nr 13

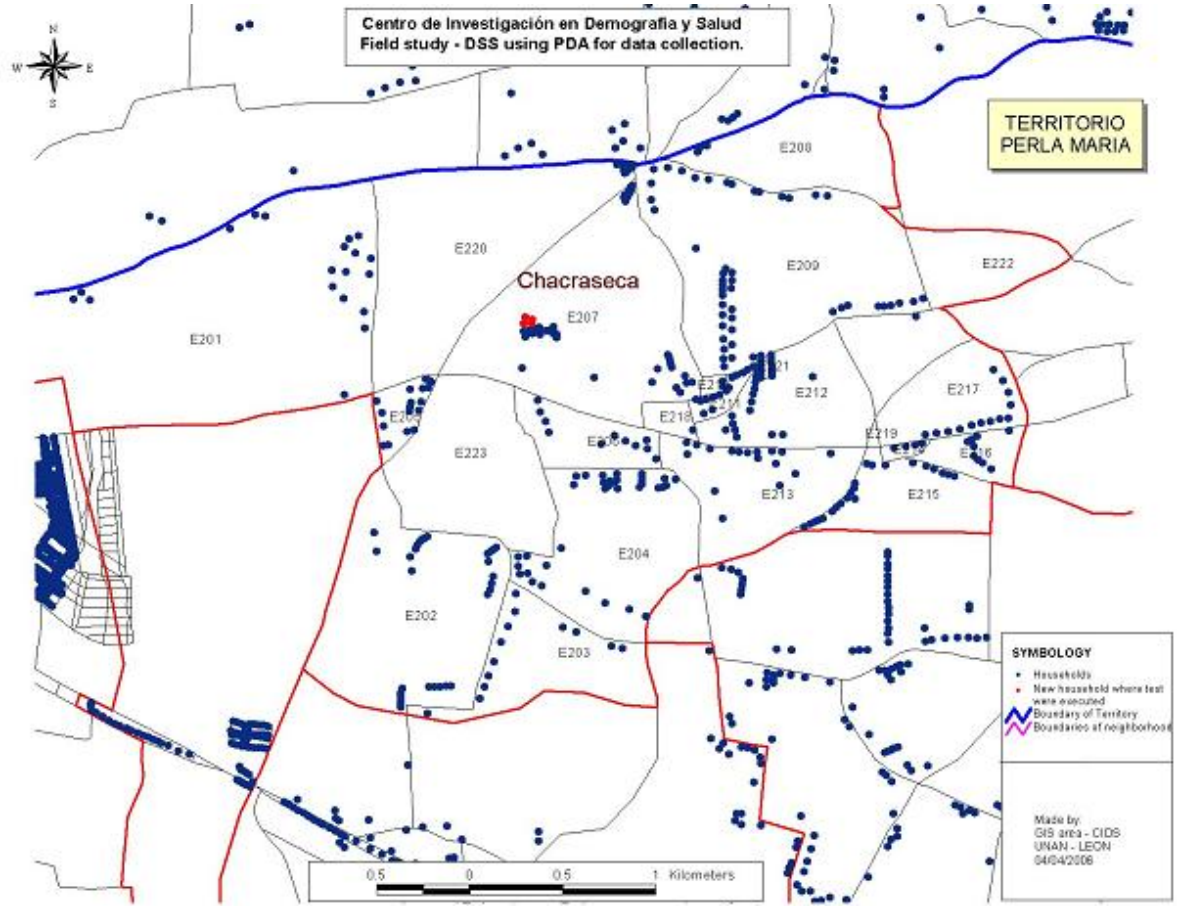
These are the results from the test with field worker nr 13.

- Have problems in filling in all the members of the household, cant keep up with the paper form. Problem due to lack of practice and that the PDA keyboard is difficult to manage.
- Filling in the pregnancy history is faster then the paper form.
- Navigation structure seems to work very well with the field workers mental model of the system, which provides input for relevance, attitude and learnability.

4.10.6.7 Field worker nr 14

Date of test: 2006-04-04

Place of test: Chacraseca, new households PE207.



Map 6. Study area in Chacraseca, new households.

PE207.. (P000036)	Observation	Usability measure
Filling in “new house” form.	Some problems with the keyboard. Little problems with changing between, small and big letters and international keyboard.	Effectiveness: Starts of with most important task. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA.
Finishing filling in “new household” form.	Works very well. Nice response from the interface, giving clear alerts.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system.

		Internal locus of control Informative feedback Dialog yield closure Reversal actions.
Filling in “house condition” form.	Works very well. Nice response from the interface.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task.
Finishing filling in “house condition” form.	Works very well. Nice response from the interface, guiding the user to the “new person” form.	Learnability: Seems to correspond to field workers mental model of system.
Filling in “new person” form.	Some problems with the keyboard. Problems with changing between, small and big letters and international keyboard.	Effectiveness: A little less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. Internal locus of control Informative feedback Dialog yield closure Reversal actions. Reduce short-term memory load.
Finishing filling in “new person” form.	Works very well. Nice response from the interface, guiding the user to the “pregnancy history” form.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load.
Filling in “pregnancy history” form.	Start with “other pregnancy form”, which is correct. Filling in pregnancy	Informative feedback. Not reducing short-term

	information, which is not necessary for "new households".	memory load. Relevance: Field worker can accomplish her task. Effectiveness: Better then paper form system.
Filling in "other pregnancy" form.	Gets a little confused with the "Emigrado" option for a child not living with her mother in the "Estado actual" list. Also unclear which is the date of event? Other pregnancy is not shown in the "pregnancy history list"	Learnability: Seems not to correspond to field workers mental model of system. Relevance: Field worker can accomplish her task. Effectiveness: Better then paper form system. Not informative feedback.
Finishing filling in "pregnancy history" form.	Works very well. Nice response from the interface, guiding the user to the end the interview.	Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load. Consistency in navigation between different GUIs.
PE207.. (P000049)	Observation	Usability measure
Filling in "new house" form.	Fewer problems with the keyboard than in the first interview. Seem like it's all a matter of practice and learning.	Effectiveness: Starts of with most important task. Effectiveness: Less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA.
Finishing filling in "new household" form.	Works very well. Nice response from the interface, giving clear alerts.	Relevance: Field worker can accomplish her task. Learnability: Seems to

		correspond to field workers mental model of system. Internal locus of control Informative feedback Dialog yield closure Reversal actions.
Filling in “house condition” form.	Works very well. Nice response from the interface.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task.
Finishing filling in “house condition” form.	Works very well. Nice response from the interface, guiding the user to the “new person” form.	Learnability: Seems to correspond to field workers mental model of system.
Filling in “new person” form.	Some problems with the keyboard. Problems with changing between, small and big letters and international keyboard. Gets a little bit confused when the interviewed person doesn’t know the educational level of one person in the household. Field workers are used to mark this kind of unfinished paper forms in some way, which is not possible in the digital form.	Relevance: Field worker can’t accomplish her task. Learnability: Not corresponding to field workers mental model of system. Effectiveness: A little less then paper form system. Learnabiltiy: Will take some time to physically manage the PDA. Internal locus of control Informative feedback Dialog yield closure Reversal actions. Reduce short-term memory load.
Finishing filling in “new person” form.	Works very well. Nice response from the interface, guiding the user to the end the interview.	Effectiveness: Better then paper form system. Relevance: Field worker can accomplish her task. Learnability: Seems to correspond to field

		workers mental model of system. Internal locus of control. Dialog yield closure. Reduce short-term memory load.

Table 9. Notes, observations and usability measurements from field worker nr 14.

4.10.6.8 Test results for field worker nr 14

These are the results from the test with field worker nr 14.

- Works faster and smother filling in all the new values, however can't keep up with the paper form system.
- Works very fast filling in the pregnancy history form, and is faster then the paper form system.
- Fills wrongly in the pregnancy information, which is not necessary for "new households"

4.10.7 Results from post test questionnaire

After the Usage study – DSS using PDA for data collection, the four LCUs were asked to fill in a small post test questionnaire. The post test questionnaire has been used to estimate REAL after the final test and the following results where achieved:

- **Relevance** - The common opinion is that use of a PDA for data collection in the field is relevant; the DSS software has capacity to collect almost all the necessary information, but the field workers feels that they need more experience in using the PDA. The DSS software needs improvements. Not all fieldworkers feel that the present software implementation is all right. Some important functions are missing and some things have to be changed in the present software implementation.
- **Effectiveness** - The PDA method is considered as effective as the manual forms but the field worker needs more practice and training. Some parts of the PDA use are more effective than the manual forms however other parts are less effective. The software needs some improvements to make it more effective.
- **Attitude** - All field workers are very positive to the PDA usage and think it is going to be an improvement of their working situation.
- **Learnability** - The software is well mapped to the field workers mental model of the data collecting system. The field worker feel that it is quiet easy to learn and understand the PDA software, however some important functions are missing and some functions has to be changed.

Table 10. The result table shows how many of the field workers that gave a specific answer, a suggestion and/or a comment.

Instructions to complete this form:	Likert scale				
This questionnaire is anonymous. This questionnaire is for evaluating the design of the graphical user interface used on the PDA.	1 = I don't agree at all . . . 5 = I fully agree				
Relevance	1	2	3	4	5
The digital forms capture enough information.	0	0	0	1	3
During the usage study I was able to accomplish with a part of my tasks.	0	0	0	2	2
With more training and practice the PDA would make my job easier.	0	0	0	0	4
The digital capture forms have several disadvantages compared to the manual paper forms.	1	1	1	1	0
Suggestions and comments:	1. I feel more calm using the PDA 2. I am very satisfied with the PDA and would like more training.				
Efficiency:	1	2	3	4	5

Caused by deficiency in the PDA system, I made several errors.	3	0	0	1	0
It takes more time to make an interview using the PDA than using the manual paper forms.	1	0	1	1	1
The first time I used the PDA it was more difficult then now.	0	0	0	0	4
It is possible to erase data that I register in the PDA.	1	0	0	1	2
Several times I needed orientation to use the PDA.	0	2	0	1	1

Suggestions and comments:

1. With more practice it would be easier to use the PDA than the manual paper forms.
2. I still need more orientation.

Attitude:	1	2	3	4	5
I felt that I had to concentrate a lot in the use of the PDA, during the usage study.	0	0	0	2	2
I like using digital equipment and I feel that my working situation improves.	0	0	0	0	4
I have hopes that the use of the PDA will improve my working situation in the future.	0	0	0	0	4

I would like to participate in future tests of the PDA.	0	0	0	0	4

Suggestions and comments: 1. I like to participate other times.

Learnability:	1	2	3	4	5
I feel secure about the information that I register.	0	0	0	1	3
It has been pretty easy to learn how to use the PDA	0	0	0	0	4
I feel that the capture forms guides me to register the data that I capture.	0	0	1	2	1
I get the impression that it is easy to commit errors, using the digital forms.	1	0	1	1	1
I feel that some important functions are missing in the system.	0	0	1	2	1
The use of the digital capture forms is similar to the use of the paper forms.	0	0	0	0	4

Suggestions and comments: 1. When I can’t complete an interview, the system should give me some kind of signal.

4.11 Usability audit – Expert users in Nicaragua

This usability audit (see 3.4.9) evaluates the compliance with Ben Shneiderman's "Eight Golden Rules of interface design" (see 2.1.2) to establish the quality of the PDA GUIs using benchmark standards.

4.11.1 Summary

The audit shows compliance with some rules and lack of compliance with other rules. Best is rule {4} Design dialog to yield closure complied and the worst compliance is with rule {2} Enable frequent users to use shortcuts.

This audit is not suitable for comparing this software with other similar software, but it gives designer a good idea of what is good and bad in the GUI, what is most urgent to redesign and where the impact of redesign will be the highest.

Working with the rules; {1} Strive for consistency, {2} Enable frequent users to use shortcuts, {3} Offer informative feedback and {5} Offer simple error handling would probably improve this software.

Working with the forms; add new household, pregnancy information and pregnancy history which got the lowest scores could also be feasible way to improve the usability of the software.

4.11.2 Test participants

In this usability audit participated: supervisor nr 1 and 2 and urban area fieldworker nr 10. Characteristics for test participants are shown at 3.7.3.

4.11.3 Result

Following table show the outcomes from analysing the DSS software on the PDA. The table below shows the average outcome for each design rules after analysing the different forms in the GUI. Comments are made below, to clarify some usability measurement.

Number of forms:	15
Usability rating (min/max)	480 - 620
Average:	585
Standard deviation:	41

Design rule	Usability rating
{1}Strive for consistency	65
{2}Enable frequent users to use shortcuts	39
{3}Offer informative feedback	60
{4}Design dialog to yield closure	97
{5}Offer simple error handling	56

Design rule	Usability rating
{6}Permit easy reversal of actions	89
{7}Support internal locus of control	90
{8}Reduce short-term memory load	89
Total:	585

Comments:

{1}The forms are consistent in terminology and colour. Buttons are of the same size and design in the other forms. Responses from buttons, list items and so on are not consistent throughout the system.

{2}The DSS software basically doesn't offer any shortcuts more than the once offered by the operating system. There are no help screens or pop-up windows. Information is filled in with drop-down menus in most forms.

{3}Some forms offer informative feedback and others don't.

{4}The DSS software is designed in a way that everything is done in a logical way corresponding to the field workers metal model of the system, which supports closure.

{5}There are some possibilities to make serious errors which are not handled by the system.

{6}Most actions in the system are easily reversible other are not.

{7}The interviewer easily takes control over the system and always has different choices corresponding to the field workers mental model of the system.

{8}The system is kept very simple and is almost self guiding.

4.11.4 Discussion

It is always possible that some subjective thinking affects this kind of audit, when it is done by the same people that have been working with the software for some time. However the whole idea of making this audit using well known benchmark standards was to avoid subjective thinking, which we hope we have done.

In the future these results could be useful to establish new usability requirements. For instance requirement could express the minimum level on different rules, the average level for the whole GUI or the least acceptable total for each form.

Example: Usability requirement states: "All design rules should have a usability rating of at least 75". "The average usability rating for the GUI should be 600" or "All forms should have a "usability rating" of at least 600".

4.11.4.1 Initial form

Following table show the outcomes from analysing the “Initial” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	10
{3}Offer informative feedback	80
{4}Design dialog to yield closure	75
{5}Offer simple error handling	80
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	80
Total:	580

Comments:

{1}The form is consistent in the lay-out, terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. Jumping to the “add a new household” is not consistent with starting a new interview.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form doesn’t have any menus, help screens or pop-up windows.

{3}When the user start an interview the system gives a reasonable feedback. Jumping to the “add a new household form” uses no help screen or feedback. Browsing between households gives a reasonable feedback.

{4}The initial form is the starting point for the DSS application to which the user always will return. It is not possible to mark an unfinished interview which does not support closure.

{5}The form is designed in a way that it is very difficult to make a serious error. It is not possible to change an erroneous address.

{6}The form only offers two options, to start en interview or to add a new household, if the user makes an erroneous decision the action is reversible.

{7}The form only gives the user two options and it is easy for the user to take control over the system; jump to screens to start an interview or add a new household. Browsing between different households works very well.

{8}The form is kept very simple. When the user returns to the initial form from an interview, the marker is always on the first household which might confuse the user.

4.11.5 Add new household form

Following table show the outcomes from analysing the “Add new household” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	20
{3}Offer informative feedback	90
{4}Design dialog to yield closure	80
{5}Offer simple error handling	25
{6}Permit easy reversal of actions	75
{7}Support internal locus of control	90
{8}Reduce short-term memory load	50
Total:	480

Comments:

{1}The form is consistent in terminology and colour with all the other forms. The lay-out is a little bit different; this form is smaller than all the other forms. Buttons are of the same size and design as in the other forms.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form doesn’t have any menus or help screens. It is possible to use the copy paste function that comes with the operating system.

{3}When the user wants to go back to the initial form or wants to add the new household to the database, the system gives reasonable feedback. The system helps the user to fill in the household code. The system tells the user when the user tries to add an existing household code.

{4}The form is designed in a way that everything is done in a logical way which supports closure. The focus of the marker is not set to the territory code when the form is started.

{5}The form is designed in a way that it is easy to make a errors. It is possible to enter lower case letters and numbers in fields for letter and vice verse. It is possible to enter wrong directions. It is not possible to enter existing household codes.

{6}Once a new household is added it is not reversible, however, the user gets an alert before making the error. Other actions are reversible.

{7}The form only gives the user few options and it is easy for the user to take control over the system; add the household code and the address and discard changes or accept them.

{8}The form is kept very simple. The user have to think about not using lower case letters or writing numbers in text fields and vice verse. The system doesn’t provide any help for adding the direction to a household.

4.11.6 Household form

Following table show the outcomes from analysing the “Household” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	50
{4}Design dialog to yield closure	100
{5}Offer simple error handling	75
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	595

Comments:

{1}The form, Figure 83, is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The end interview button can be used as a cancel button, which is not consistent with other forms. The different responses in the buttons are not consistent.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions. There are no help screens or pop-up windows.

{3}When the user wants to go back to the initial form the system gives reasonable feedback, Figure 84 . When the user wants to go back to the new person form or pregnancy form the system doesn’t give good feedback. When the user changes house parameters the change is immediately reflected in the form.

{4}The household form is the starting point for the interview to which the interviewer always will return. The form is designed in a way that everything is done in a logical way which supports closure. If the interviewer closes the household form the interview is considered as finished.

{5}The form is designed in a way that it is very difficult to make a serious error. Everything in the form is entered through drop-down menus and so on. The system doesn’t give a warning if house parameters are changed to a lower standard (possible but not common).

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; change house conditions, Figure 85, check the persons who live in the household, Figure 86, or jump the “add new person” form or the “pregnancy history” form.

{8}The form is kept very simple. Once the household form is started the user never has to think about in which household the data is entered. It is impossible to enter data in another household, without first closing the interview.

Figure 83. Household form

Figure 84. Household form with reasonable feedback

Figure 85. Household form - changing house conditions

Figure 86. Household form - checking the persons living in household

4.11.7 Person form

Following table show the outcomes from analysing the “Person” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	25
{4}Design dialog to yield closure	100
{5}Offer simple error handling	50
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	570

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The add changes button can be used as a cancel button, which is not consistent with other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions. There are no help screens or pop-up windows.

{3}When the user wants to go back to the household form the system doesn’t give any feedback. When the user changes person parameters the change is immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is possible to make a serious error. Everything in the form is entered through drop-down menus and so on, but it is possible to set several persons as head of family. It is not possible to change an erroneous surname, last name or birthday. The system doesn’t give a warning if education parameter is changed to a lower standard.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; to can change the status of the person or jump to the event screen.

{8}The form is kept very simple. Once a person form is started the user never has to think about to which person new data is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.8 Add new person form

Following table show the outcomes from analysing the “Add new person” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	75
{4}Design dialog to yield closure	100
{5}Offer simple error handling	50
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	620

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The add changes button can be used as a cancel button, which is not consistent with other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions and a calendar control. There are no help screens or pop-up windows.

{3}When the user wants to go back to the person form add changes or cancel the action the system gives reasonable feedback. When the user changes person parameters the change is immediately reflected in the form. Use of the calendar control gives good feedback.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is possible to make a serious error. Everything in the form is entered through drop-down menus and so on, but it is possible to set a person to an erroneous age (for instance, son older then father). It is possible to change an erroneous surname, last name or birthday.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; set the status of the person, jump to the event screen, add changes or cancel.

{8}The form is kept very simple. Once a person form is started the user never has to think about to which person new data is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.9 Personal event form

Following table show the outcomes from analysing the “Personal event” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	50
{4}Design dialog to yield closure	100
{5}Offer simple error handling	75
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	620

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The add changes button can be used as a cancel button, which is not consistent with other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions. There are no help screens or pop-up windows.

{3}When the user wants to go back to the person form, add changes or cancel the action the system doesn’t give reasonable feedback. When the user selects an event the change is immediately reflected in the form. Registered events are reflected in the event list.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make any serious error. Events are selected through a drop-down menu.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select a new event, edit an existing event or delete an existing event.

{8}The form is kept very simple. Once the “add new event” form is started the user never has to think about to which person a new event is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.10 Immigration form

Following table show the outcomes from analysing the “Immigration” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	75
{4}Design dialog to yield closure	100
{5}Offer simple error handling	25
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	595

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions and a calendar control. There are no help screens or pop-up windows.

{3}When the user wants to go back to the select event form, add changes or cancel the action the system gives reasonable feedback. Changes in drop-down menus and calendar are immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make any serious error. Type and cause of events are selected through a drop-down menu. Dates are selected with a calendar control. However some of the causes to immigrate don’t correlate to the reality. For instance it is not logical to immigrate to a household because of fights in the family (possible but not logical).

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select from drop-down menus or calendar control.

{8}The form is kept very simple. Once the “immigration” form is started the user never has to think about to which person the event is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.11 Emigration form

Following table show the outcomes from analysing the “Emigration” forms. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	75
{4}Design dialog to yield closure	100
{5}Offer simple error handling	25
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	595

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions and a calendar control. There are no help screens or pop-up windows.

{3}When the user wants to go back to the select event form, add changes or cancel the action the system gives reasonable feedback. Changes in drop-down menus and calendar are immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make any serious error. Type and cause of events are selected through a drop-down menu. Dates are selected with a calendar control. However some of the causes to emigrate don’t correlate to the reality.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select from drop-down menus or calendar control.

{8}The form is kept very simple. Once the “emigration” form is started the user never has to think about to which person the event is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.12 Death form

Following table show the outcomes from analysing the “Death” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	75
{4}Design dialog to yield closure	100
{5}Offer simple error handling	50
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	620

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions and a calendar control. There are no help screens or pop-up windows.

{3}When the user wants to go back to the select event form, add changes or cancel the action the system gives reasonable feedback. Changes in drop-down menus and calendar are immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make a serious error. Death certificate and cause of death are selected through a drop-down menu. Dates are selected with a calendar control.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select from drop-down menus or calendar control.

{8}The form is kept very simple. Once the “death” form is started the user never has to think about to which person data is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.13 Death certificate form

Following table show the outcomes from analysing the “Death certificate” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	25
{3}Offer informative feedback	90
{4}Design dialog to yield closure	100
{5}Offer simple error handling	10
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	570

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions. There are no help screens or pop-up windows. Since this form uses text field the lack of an automatic fill in function is obvious.

{3}When the user wants to go back to the death form, add changes or cancel the action the system gives very good feedback. Changes in drop-down menus are immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is possible to make serious errors. It is possible to put anything in the text field. Direct cause, intermediate cause or basic cause of death should be loaded from the database to avoid errors. Who certified the death is selected through a drop-down menu.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; fill in the form or select form a drop down menu.

{8}The form is kept very simple. Once the “certificate” form is started the user never has to think about to which person data is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.14 No death certificate form

Following table show the outcomes from analysing the “No death certificate” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	75
{2}Enable frequent users to use shortcuts	25
{3}Offer informative feedback	90
{4}Design dialog to yield closure	100
{5}Offer simple error handling	50
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	90
Total:	610

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. The form has drop-down menus to speed up fill in functions. There are no help screens or pop-up windows. Since this form uses text field the lack of an automatic fill in function is obvious.

{3}When the user wants to go back to the death form, add changes or cancel the action the system gives very good feedback. Changes in drop-down menus are immediately reflected in the form.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make serious errors. It is possible to put anything in the text field, which might be confusing.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; fill in the form or cancel.

{8}The form is kept very simple. Once the “no death certificate” form is started the user never has to think about to which person data is entered. It is impossible to enter data to another person, without first closing the person form.

4.11.15 Pregnancy information

Following table show the outcomes from analysing the “Pregnancy information” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	25
{3}Offer informative feedback	10
{4}Design dialog to yield closure	100
{5}Offer simple error handling	75
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	100
Total:	540

Comments:

{1}The form is consistent terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons and list items are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. There are no help screens or pop-up windows.

{3}When the user wants to go back to the household form or to a selected female the system don’t give any feedback.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make serious errors.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select a female or return to the household form.

{8}The form is kept very simple. Once the “Pregnancy information” form is started the user never has to think about to which household data is entered or if women in the list are in fertile age (15-49). It is impossible to enter data to a fertile woman in another household without first closing the household form.

4.11.16 Pregnancy history

Following table show the outcomes from analysing the “Pregnancy history” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	25
{3}Offer informative feedback	10
{4}Design dialog to yield closure	100
{5}Offer simple error handling	75
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	100
Total:	540

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons and list items are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. There are no help screens or pop-up windows.

{3}When the user wants to go back to the pregnancy information form, edit a birth or delete a birth the system don’t give any feedback.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make serious errors.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; connect a child to his/her mother, delete or edit a birth, add other pregnancy or update information.

{8}The form is kept very simple. Once the “Pregnancy history” form is started the user never has to think about to which female data is entered or if the children in the list are already connected to a mother or not. It is impossible to enter data to another female without first closing the pregnancy information form.

4.11.17 Birth information

Following table show the outcomes from analysing the “Birth information” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	25
{4}Design dialog to yield closure	100
{5}Offer simple error handling	90
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	100
Total:	595

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. There are no help screens or pop-up windows. All information is filled in with drop-down menus.

{3}When the user wants to go back to the pregnancy history form or cancels the system gives little feedback.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make serious errors.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; selecting from drop down menus, cancel or update information.

{8}The form is kept very simple. Once the “Birth information” form is started the user never has to think about to child data is entered. It is impossible to enter data to another child without first closing the birth information form.

4.11.18 Other pregnancy information

Following table show the outcomes from analysing the “Other pregnancy information” form. Comments are made below, to clarify some usability measurement decisions.

Design rule	Usability rating
{1}Strive for consistency	50
{2}Enable frequent users to use shortcuts	50
{3}Offer informative feedback	75
{4}Design dialog to yield closure	100
{5}Offer simple error handling	90
{6}Permit easy reversal of actions	90
{7}Support internal locus of control	90
{8}Reduce short-term memory load	100
Total:	645

Comments:

{1}The form is consistent in terminology and colour with all the other forms. Buttons are of the same size and design as in the other forms. The different responses in the buttons are not consistent with other buttons in the system.

{2}The form does not offer any shortcuts more than the once offered by the operating system. There are no help screens or pop-up windows. All information is filled in with drop-down menus.

{3}When the user wants to go back to the pregnancy history form or cancels the system gives little feedback. When the user selects a pregnancy result the system gives very good feedback.

{4}The form is designed in a way that everything is done in a logical way which supports closure.

{5}The form is designed in a way that it is not possible to make serious errors.

{6}All the actions in the form are easily reversible.

{7}The interviewer easily takes control over the system and has different choices; select pregnancy result, cancel or update information.

{8}The form is kept very simple and is almost self guiding. Once the “Other pregnancy information” form is started the user never has to think about to child data is entered. It is impossible to enter data to another child without first closing the other pregnancy information form.

5 Conclusions

This report shows how an iterative design approach has been used to develop a graphical user interface in close relation with the actual end users (see 3.4.3). The result shows a GUI with usability possible to present in terms of REAL. The final results are based on several iterations of user centered design; including usage study on the field, different pres- and post-test questionnaires and a usability audit. During 11 iterations of user-centered design (see 3.3) the GUI has been subject to test at about 60 different occasions which has lead to more than 40 significant changes to the design.

Detailed test summaries, results and measurements can be studied in the test compilation (see 4.1 - 4.11).

5.1 User-centered design

The user centered design process started with a paper prototype of the GUI including 4 different forms (see 4.2). The DSS were analysed and an early prototype was developed during the spring of 2005 by multimedia engineers at Campus Helsingborg. At the end of the design process in the spring of 2006 the GUI included 15 digital forms with most of its necessary functions implemented. The following section shows the navigation structure in the paper prototype at the start of the design process and the navigation structure used in the final usage study.

5.1.1 Paper prototype navigation structure

The original paper prototype had a linear structure, Figure 87, but several important functions where missing. These functions where encountered during the different test, test debriefings or focus groups discussions with the end users. After discussing the changes to the navigation structure with the software developer the changes where implemented and retested in an iterative approach.

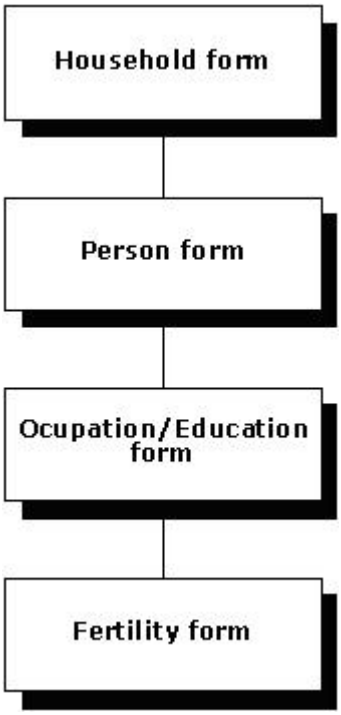


Figure 87. Paper prototype navigation structure at the start of design process

5.1.2 PDA navigation structure

The user centered design process resulted in the following navigations structure, Figure 88. The hierarchy in the PDA interface has a linear structure that will help the fieldworker registering data during an interview on the field. By following the forms from top to bottom the fieldworker will have the opportunity to fill out all important data that the DSS requires (see 4.8).

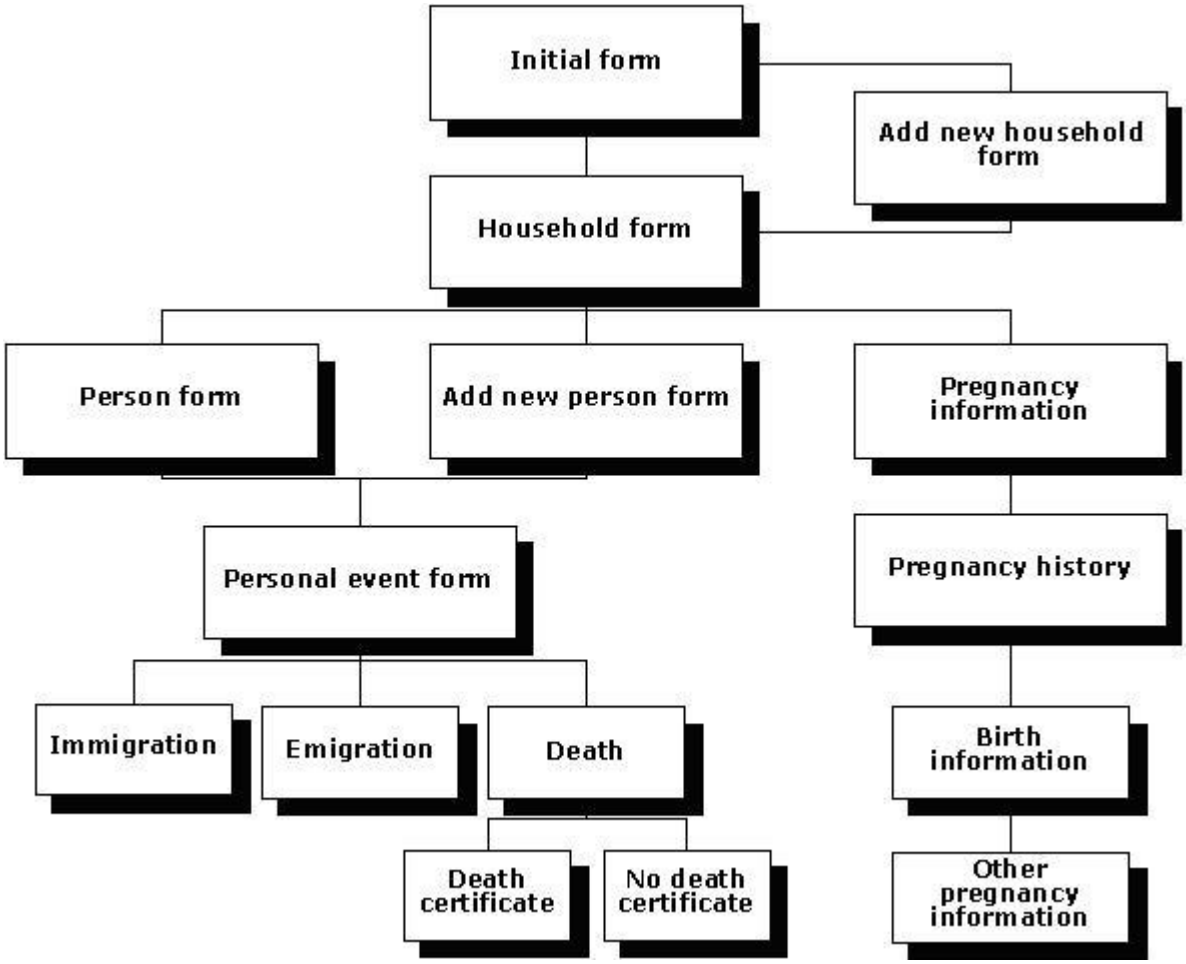


Figure 88. PDA interface navigation structure (final result)

The GUI is supposed to react and inform the user if important information is missing, if data is not correct according to the database used by the DSS or if the fieldworker violates rules for data collection or if the system is malfunctioning. According to the final usage study and the usability audit, these functions are only partly available. In the usage study (see 4.10) in the test compilation it is possible to see where the fieldworker encountered problems that had influence on the final test result regarding the relevance, effectiveness, attitude or the learnability (see 2.1.1). In the results from the usability audit (see 4.11) it is also possible to see where the GUI has problems according to the Ben Shneiderman's "Eight Golden Rules of interface design" (see 2.1.2).

5.1.3 GUI development

Figure 89 - Figure 95 shows the four original LoFi paper prototypes and its HiFi digital versions.

Figure 89. Paper prototype household form

Figure 90. Digital household form

The design process took us from the original form to a small sub sequence of initial, household and a register new household form. The household form, Figure 90, maintained lots of the original design, Figure 89.

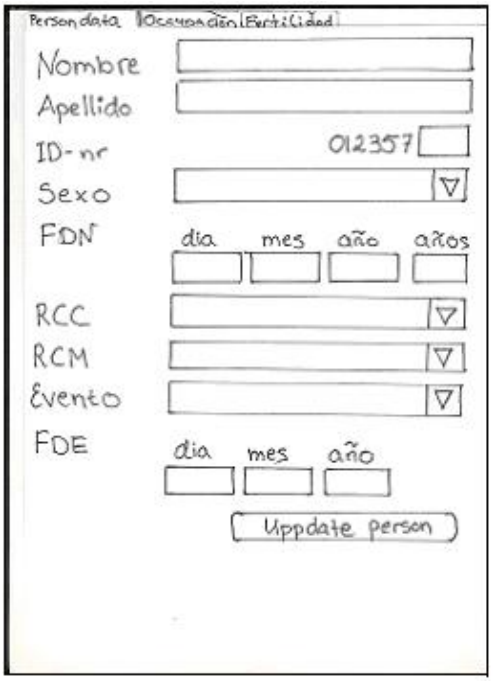


Figure 91. Paper prototype person form

Figure 92. Digital person form

These two forms, Figure 91 and Figure 92, are quite similar, however things like the

system calendar control and dropdown menus severely improved the design. The events where moved to a separate event sub-structure that resulted in six different forms, not including the pregnancy information. This separation where necessary to not confuse the user, since some events only concerns woman. A form for adding new person to a household where also added.

Figure 93. Paper prototype Occupation/Education form

This form, Figure 93, could be eliminated. Data about occupation and education in the digital GUI is registered in the person form, Figure 92.

Figure 94. Paper prototype Fertility form

Figure 95. Digital Pregnancy history

The fertility form in the paper prototype ended up in a separate sub structure with four different forms for registering all data that concerns pregnancy information.

5.2 REAL analyse

The PDA GUI has been developed on fundamentals of relevance, effectiveness, attitude and learnability (see 2.1.1). During debriefing after each test the REAL issue always have been discussed with the test person. This knowledge about REAL has, throughout the development process (see 2.5), been brought into the coming iteration.

The final result for the REAL estimation where achieved after analyzing the usage study (see 4.10.1) and the post test questionnaire (see 4.10.7). For detailed description on REAL issues, see the test compilation.

- **Relevance** - All field workers agree on that the user interface and the PDA system are relevant for data collection and with further development it might be a great help for the field worker in the future. The DSS software has capacity to collect all the necessary information that is collected today, but the field workers feels that they need more training, practice and experience in using the PDA. The DSS software needs improvements. Not all fieldworkers feel that the present software implementation is all right. Some important functions are missing and some details have to be changed in the present software implementation.
- **Effectiveness** - The different test and analyses shows that the user interface is not yet as efficient as the paper form system in all aspects. Field workers have some problems with the “new household” sequence and “adding new persons” in a household which requires more time then the paper form system. The pregnancy history is more efficient than the paper form system due to that no redundant information has to be registered. The main problem with the efficiency seems to be the key board on the PDA, which is very small and requires training and experience. The DSS software doesn’t have any usable copy paste function. The PDA operating system has a copy paste function, but it is troublesome and requires some experience and training.
- **Attitude** - All the field workers have shown a great attitude for the user interface and the PDA system since the start of the development. Field workers are very positive to the PDA usage and think it is going to be an improvement of their working situation and no one seems to have any problems in accepting the new system. Most test participants have shown great interest for the digital system and have throughout the development process done several suggestions of improvements.
- **Learnability** - The different test and analyses shows that the design and the navigation structure correspond to the field workers mental model of the data collecting system. The main problem is the key board, which probably will be the hardest part to learn for the field worker. The field workers feel that it is quiet easy to learn and understand the PDA software, however some important functions are missing and some functions has to be changed.

5.3 Usability audit

The audit shows compliance with some rules and lack of compliance with other rules. Best is rule {4} Design dialog to yield closure complied, with an average usability score of 97. Worst compliance is with rule {2} Enable frequent users to use shortcuts with an average usability score of 39 (see 4.11).

A positive side effect of the usability audit is that the usability score could be useful in future development. For instance the usability score of the GUI, each form or a separate design rule could be used to improve usability requirements, in an easy, cheap and effective way.

5.4 Usability problems and recommendations

Based on feedback from the tests participants during debriefing, outcomes from the different test alongside with analyses of recordings both on camcorder and hyper cam, analyses from questionnaires and the usability audit, we found the following high priority usability problems with the GUIs on the PDA.

Working with the rules; {1} Strive for consistency, {2} Enable frequent users to use shortcuts, {3} Offer informative feedback and {5} Offer simple error handling would probably improve this software (see 4.11).

Working with the forms; add new household, pregnancy information and pregnancy history which got the lowest scores could also be feasible way to improve the usability of the software (see 4.11).

The final usage study shows that the PDA software still needs some improvements. Detailed description of usability problems during the final usage study can be found in the test compilation (see 4.10).

6 Discussion

Obviously user centered design (see 3.3) has its advantages and disadvantages. One troublesome thing is that you might have to go to the place were the actual user is; which can cause you several practical problems. To start there is have a time and cost factor. Another reason is that it might be difficult to communicate with the actual user if you don't speak their language. It is especially important to be able to communicate with participants during tests and debriefings to come up with something constructive.

One other risky part with user centered design is if you make a bad design decision at the beginning of your development (see 2.5); Suppose that there would have been a more suitable hardware then the PDA, another operating system then the Palm Os or maybe a GUI implementation was not the best choice in this case study? Then the most optimal solution was discarded before even starting the user centered design process.

Before this case study we discussed the advantage and disadvantage with the PDA and compared it with other possible systems; Tablet Pc, Anoto-pen, C-pen and we also did a review of available software on the market. At the end we thought that the PDA had lots of advantages; price, memory, battery time, flexibility in operating system and so on in front of other alternatives. The disadvantage was actually the screen size, which at the same time became a challenge with this case study.

The Tablet Pc has a much bigger screen and it would probably be easier to develop the GUIs if we had chosen that hardware. On the other hand carrying around a Tablet Pc in the study area, is not only a physically heavy burden, it is also something that attracts criminals. We figured that the PDA is more discrete and most people will confuse it for an ordinary calculator. Anoto-pen and C-pen really did not provide anything to the solution we wanted from the start, since they don't have any built in logic; quality control or error handling. The available software was all much too expensive and didn't provide the flexibility required by CIDS.

Finally after deciding to work with a data collection system built on PDAs, we had to discuss which operating system was the most suitable. Microsoft Pocket Pc was an alternative since it is easier to develop GUIs and to establish the connection to the server database then with Palm OS. In spite of this the software developer considered Palm OS a better alternative, since it is more flexible. The Pocket Pc requires more memory then the Palm OS, which in the end means that you have to buy a more expensive PDA. The DSS software developed for the Palm OS requires less the 100 kb, and it is possible to run it on a really cheap PDA[22]. That is something that we considered very important, since there is always a risk to lose the PDA.

I consider user centered design with close contact with the actual user (see 3.4.3) one of the best alternatives to develop the DSS software. I think I would have been almost impossible to develop a user interface with the same level of usability without going to Nicaragua and without working together with the field workers. Still there are some things that I could have done in a different way to end up with a better result. When I first analyzed recordings from test I was mainly focusing on quantitative data. When I analyzed the same tests several month later I also found lost of qualitative data. My approach in Nicaragua was lots of iterations, less analyzes and focusing on the serious design issues, since the development was in a considerable early stage. Maybe in the future more attention should be paid to analyzes and fine tuning of the DSS software. At the start of the usability testing my debriefing technique wasn't that good, since I lacked experience and training in that field.

[22] Price on a Palm Pilot is about 100 us$ and the cheapest PDA with Pocket Pc cost about 400 us$.

Still after some training and talking to people with lost of experience, I think my debriefing technique improved.

The selection of the least competent user (see 3.7) is one of the things that could have been done in a different way and is of course a subject for discussion. I selected the LCUs based on six different criteria; computer usage, PDA usage, experience from data collection, educational level, living situation and age. These criteria were basically invented by me, one supervisors and one statistics working at the centre. For sure it is possible to select other criteria and evaluate the field workers in a different way. In spite of this I consider my selection of the four least competent users as good enough; because these four field workers have the lowest education level and the least experience from actual data collection on the field.

In the method section following usability requirements (see 2.3) were presented and have then served as guidelines throughout the whole procedure of developing the graphical user interface for the PDA:

- 7 out of 10 users shall think that the prototype works as a better aid to gather information than the present system.
- Use of the digital system shall not be more time consuming than the present system using paper forms.
- There shall be a clear resemblance between former used forms and the PDA interface.

This report doesn't show any quantitative measurements on the compliance with these three requirements. In the case of the first requirement; the user group is very small, and in the final usage study only four field workers participated. The usage study results in high relevance and very good attitude which shows compliance with this specific requirement, but it is not relevant to estimate the degree of compliance since the test group is so small. In the case of the second requirement; the case study results in effectiveness which is sometimes better and sometimes worse than the paper form system. But in this case study the total effectiveness of the whole digital system is never measured, so it is impossibly to say anything about the compliance with this specific requirement. In case of the third requirement; the study shows that there is a clear resemblance with the former paper form system, but it is not specified to what degree.

Finally I will end this case study with some thoughts about improvements of the PDA software that might affect the relevance, effectiveness, attitude and learnability positively:

- **Relevance** - The PDA usage could probably be even more relevant with at least two more, fairly easy improvements: photos of all household would be a usable function which not requires much work, equipment or advanced development. Another improvement would be a GPS[23] in the PDA. A GPS could be used to take coordinates for new household and to find already registered households, in case of a change of field worker or study area.
- **Efficiency** - Registering data in the MS-Access database is not included in this study. The PDA system eliminates a whole sequence of troublesome work, quality control, redundancy and so on which probably would improve the effectiveness. However this troublesome work was never investigated in this these. The PDA

[23] Today all households are positioned with GPS and registered in a Geographical Information System at CIDS.

software is lacking some effective automatic copy past function. Something like cell phones automatic text fill in functions (T9) would be very effective.

- **Attitude -** One reason for great attitude is probably that the field workers have been participating since the start of the development and that their ideas and suggestions have been reflected in the software. Right now it is difficult to point out something concrete that would actually improve the field workers attitude. If the development of the PDA software continues and still done with participation (see 3.4.3) from the field worker it would be possible to maintain and possibly improve the field workers attitude.
- **Learnability** - Field workers have had very limited time to actually learn the system. The four least competent users only receive four hours of training before the usage study, but they did not have many problems with the use of the software. As a matter of facts the software worked better than we expected, considering all limitations. One reason might be that most field workers can afford a cell phone. It is not proven in this thesis, but I think that the navigation structure in cell phone software is quite similar to the navigation structure in the DSS software. This experience probably helps the field worker to learn the PDA system quite easily.

7 Reference materials

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