Context-sensitive Communication in Hospitals: A User Interface Evaluation and Redesign of Ascom Wireless IP-DECT Phones

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***Abstract* - A variety of issues related to communication is a common phenomenon in current hospital settings. Sharing information by contacting colleagues, medical attendants, investigatory facilities and other resources, results in many communication events. This generates interruptions from mobile communication devices, which is a big concern for many physicians. In general, wireless phones are not currently widely in use at Norwegian hospitals, due to suspicions of increased interruption rates. Only a few staff members carry a wireless phone. Before introducing such devices as standard equipment, usability and user satisfaction are important factors, and have to be accounted for. The fact that such devices could introduce unnecessary interruptions is a motivation for developing a context sensitive solution. Observations and interviews from a study carried out by the first author, regarding the use of wireless phones at a hospital in Norway, showed that users were unsatisfied with the phones user interfaces. This kept them from using the full functionality of the system. This article presents an evaluation of the existing user interface of two wireless phones intended for hospital use, and suggests an improved user interface, which also intends to support context-sensitive communication. The new interfaces were considered an improvement compared to the old interfaces.**

Keywords – HCI; user interface design; context-sensitive communication; wireless communication; heuristic evaluation.

I. INTRODUCTION

Many activities within hospitals and healthcare processes require reliable communication systems. Sharing information by contacting colleagues, medical attendants, investigatory facilities and other resources, results in a lot of communication events. Clinical questions are often complex and not clearly defined, and will therefore require frequent conversations and discussions [1]. Devices currently used to communicate at hospitals, are mainly pagers, but wired/wireless phones and Personal Digital Assistants (PDA), are in use [2]. These devices can both be personal and role-based, since communication in many cases is not aimed to one person, but to a role such as; 'the nurse on call', or 'the physician on the next shift' [3]. Because of this, some staff members at today's hospitals are carrying multiple devices for different roles and purposes [2, 4].

However, communication in hospitals has shown to suffer from poor practice and inefficiency caused by an insufficient infrastructure, especially when the need of communication is urgent [1, 3, 5]. A more extensive use of mobile phones can offer a solution to this problem by improving accessibility and communication in hospitals [1, 5, 6]. Compared to the usage of pagers, important advantages can be achieved by offering two-way text and voice services. Providing smaller delays in communication may lead to improved patients care, and also reduce the risk of medical errors [5].

Despite the advantages of mobile phones, there are also well-known downsides to the usage of these devices. The increased availability and accessibility can cause an overload of numerous interruptions on key human resources, such as, senior physicians, or 'on call' staff [4, 7]. These interruptions can lead to a diversion of attention, errors, and may disturb in situations such as, in outpatient clinic, or in the operating theatre [4, 7]. A context-sensitive system can provide a solution to control availability and interruptions [4]. Based on the phones' location, a person's role and schedule, interruptions can be avoided, and calls can be redirected to other available resources. Combining the personal and role based devices into one single device, will also offer an improvement to the mobile communication [7].

In general, mobile phones are currently not widely in use at hospitals. Only a few staff members carry a wireless phone due to the suspicion of a phone interrupting more than a pager [2, 4]. Before introducing wireless phones as standard hospital equipment, usability and user satisfaction are important factors to account for. A study, carried out by the first author, regarding the usage of mobile phones at St. Olav's Hospital in Trondheim, mid Norway (an early adopter of implementing mobile phones), observations and interviews showed that the users were unsatisfied by the current user interface of the phones [8, 9]. It kept them from

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using the functionality of the system fully, especially the way messages were handled.

In this article, we investigate the role of user interface design on mobile communication devices used within health care, in order to improve the interface, and to include support for context-sensitive communication. We start out by presenting context sensitive communication systems for hospitals, in Section II. Section III describes the wireless phones subjected in this paper; the Ascom 9d24 and d62, and methods used. In Section IV we present the results from the evaluation, and our suggestions for an improved user interface. Further, in Section V, we discuss the evaluation and prototype, and then the limitations of the study, before we conclude and describe future work in Section VI.

II. CONTEXT SENSITIVE SYSTEMS FOR MOBILE COMMUNICAION IN HOSPITALS

We are involved in designing and developing a system for managing availability and interruptions from mobile devices, used by physicians in hospitals [7, 10-12]. The purpose of this work is to develop a new, low impact context sensitive communication system, based on existing infrastructure. Each physician will only need to be equipped with one mobile communication device for both personal and role based communication. The system will be connected to a reliable context aware communication system, which controls and reduces interruptions in a safe and reliable way [7]. Such devices or systems, based on existing infrastructure, are, by the authors' awareness, not currently available for hospitals. Due to space limit, we refer to [7, 10-12] for more details about our system.

However, several studies have been carried out within hospital settings with improved communication and interruption reduction in mind [1, 6, 13-16]. Other systems, like the AwareMedia and the AwarePhone systems to Badram et al. [17, 18], support context aware communication. These systems in combination form a complete communication system for clinicians in a surgical ward. They are based on GSM/3G, and not systems more widely used in hospital settings, like; Digital Enhanced Cordless Telecommunication (DECT) / Internet Protocol-(IP)-DECT, or wireless IP phones. We believe that systems connected to public phone networks could lead to further user resistance due to suspicions of more interruptions from outside the hospital, and will also be more expensive than the usage of existing infrastructure.

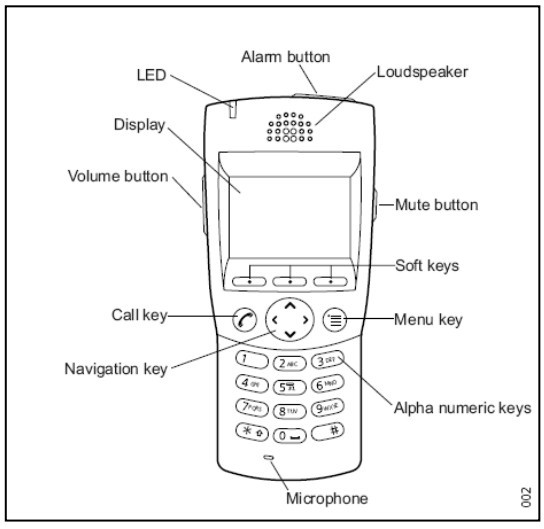

Figure 1. Ascom 9d24 handset.

III. MATERIALS AND METHODS

The phones subjected in this paper are already in use in hospital settings, and also in the context-sensitive system being developed at the Tromsø Telemedicine Laboratory (TTL) at Norwegian Centre for Integrated Care and Telemedicine (NST) [7, 10-12]. The phones are based on an IP-DECT system, used for wireless communication, offering voice and text services, and also role-based communication and alarms. In this Section we present the subjected phones, and the method used in the paper.

A. *Ascom 9d24*

The Ascom 9d24 is a wireless handset designed for usage in demanding conditions like in offices, security and hospitals. The handsets are resistant to water, dust and scratches, and can withstand falling on the floor [19]. There are three different versions of the 9d24: The 'Talker', which only supports voice communication, the 'Messenger', offering both voice and text functionalities, and the 'Protector' with additional alarm functions, including an alarm button on top of the handheld, a man-down alarm and a pull-cord alarm.

As can be seen in Figure 1, the 9d24 has 3 soft keys that

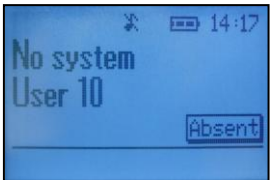

Figure 2. Main screen.

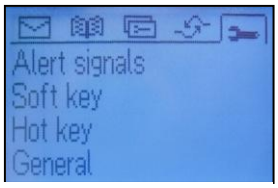

Figure 3. Main menu

Figure 4. Modes.

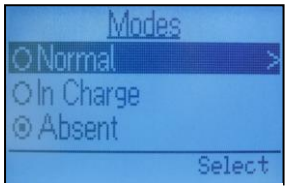

Figure 5. Edit screen

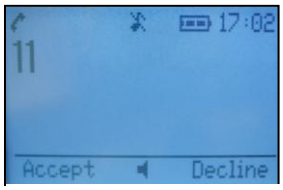

Figure 6. Incoming call

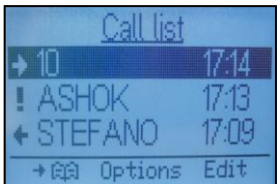

Figure 7. Call list

Figure 8. Ascom d62 handset.

correspond to the options on the display, a keypad, a call button, a menu button, navigation buttons and, on the side, buttons to regulate the volume. The one color display is illuminated in blue and has a resolution of 128x64 pixels. Due to space limits, we refer to [19] for further information about the phone.

1) Ascom 9d24 user interface

Figures 2-7 show screenshots of the graphical user interface. The main screen (Figure 2) displays the name of the user, and the current mode (Mode is the user profile of the phone, also called profile on other phones) in use. The top bar of the screen shows a clock and several icons, indicating new voice or text messages, audio settings, activated alarms, battery power and other events. The functions of the soft keys on the bottom of the main screen can be defined by the user, normally the most-used features.

By pressing the 'Menu key' (Figure 1), the main menu opens, consisting of 5 tabs with icons representing the function of the tab (Figure 3). The tabs can be opened to select an item in the list (Figure 4). The '>' sign indicates that another menu will open when pressing '>' on the 'Navigation key' (Figure 1). Options to edit the settings of the modes will open when pressing the 'modes menu' (Figure 5). These modes refer to profile settings, and will be applied when the mode is activated.

The 'Call key' (Figure 1) is both used to start and end a call. Figure 6 shows the screen of an incoming call. The number of the caller, or a name, when the number is listed in the local phonebook of the phone, is displayed. All incoming '⇨', outgoing '⇦' and missed '!' calls are stored in the call list (Figure 7). Due to space limits, we refer to [19] for further information about the phone.

B. Ascom d62

The Ascom d62 is a wireless IP-DECT phone, designed, like the 9d24, for usage in demanding conditions (industry, offices, security, hospitals, etc.). As the Ascom 9d24, the Ascom d62 exists in three different versions. There is only one version of the physical phone, but as you buy different licenses, you may improve the phone's characteristics: The "talker" only allows voice communication and 12 character display messages. The "messenger" offers both voice and messaging communication. The "protector" offers alarm functions, and base station location [19].

The Ascom d62 looks more like a regular GSM phone than the 9d24 (Figure 8). It has a color display, and a five-directional navigation button. It has a "hook on" and "hook off" button, 3 soft keys, a keypad, and side buttons on the left to regulate the volume and to mute the phone. A headphone jack is present on the right side, and the alarm button is located on the top of the handset. The display has a resolution of 128*160 pixels and supports 65 000 colors and 6 lines of 20 characters.

1) Ascom d62 user interface

Figures (9 to 14) are screenshots of the graphical user

Figure 9. Main Screen

Figure 10. Main menu

Figure 11. Profiles

Figure 12. Profile options

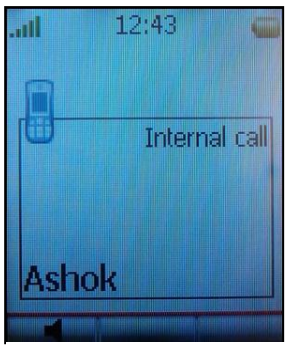

Figure 13. Incoming call

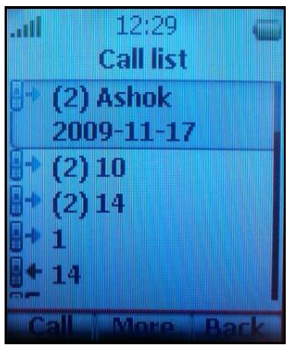

Figure 14. Call list

interface. The main screen (Figure 9) displays the name of the user (Owner ID) and the network the phone is connected to. On the top of the screen, time and date are displayed, and also several icons can be displayed, indicating new voice or text messages, audio settings, battery power, network reception, and other events.

The phone only displays a '?' icon beneath the battery icon, if the selected profile is not the default. The red icon on the bottom-right corner indicates the version of the phone (talker, messenger, and here protector). The functions of the soft keys, on the bottom of the main screen, can be defined by the user. The keypad can be locked and unlocked by pressing '*' and the left soft key.

By pressing the centre of the 'Navigation key' (Figure 8) in the main screen (Figure 9), the main menu opens. The main menu consists of 8 icons representing the sub-menus' functions (Figure 10). By opening a menu using the 'select' or the centre of the 'Navigation key', you end up in a sub-menu containing an item list. These items can be other sub-menus, or selectable items like; profiles (Figure 11). In some cases, by selecting an item, you can push a 'more' button with a soft key, which offers new options (Figure 12).

Figure 13 shows the screen of an incoming call. The number of the caller, or a name, when the number is listed in the local phonebook of the phone, is displayed. The left soft key enables the loudspeaker. All incoming, outgoing, and missed calls are stored in the call list (Figure 14). The left 'Call key' (Figure 8) is used to start and answer a call, while the right 'Call key' is used to end a call, or to cancel everything and go back to the main screen (Figure 9).

C. Methods

The method used to evaluate the user interfaces has similarities to heuristic evaluation where 3-7 usability experts identify challenges of an interface, using their experience and design heuristics [20, 21]. The challenges are then ordered according to their importance and expected impact on usability.

The test users involved here, all have a technical background within computer science and communication. The testing began by spending some time on using each phone, starting with the Ascom 9d24, and then the Ascom d62. Different tasks were performed, for example sending and receiving messages, calling, using the phonebook and changing settings. Initially the user manual was not used in order to test intuitive use, since the end users are not likely to pay close attention to the manual when start working with the handheld [22].

The various points raised in the Ascom 9d24 evaluation, were re-examined with the Ascom d62. In this way, we evaluated the differences between the two handsets, and revealed the resolved problems in the Ascom d62.

Based on guidelines for interface design [20, 23-25], we made a list of possible usability problems. Since the phones are intended to be used in hospitals, the context and requirements of usage in a health care environment was kept in mind when identifying the problems [26]. Also a set of guidelines for the design of context-aware mobile devices [27], was used to minimize usability risks.

To solve the revealed problems, and enhance the usability, we suggest adjustments to the user interfaces. This includes changes to support context sensitive communication. The new interface is visualized in a low-fidelity prototype, using Microsoft PowerPoint 2007, which should be advanced enough at this stage of the evaluation [21, 28, 29]. The prototype makes it possible to interact with the interface by simulating the button functions, and showing the design with enough detail to get feedback on the usability from test users.

To test the usability of the adjusted interface and compare it to the current version, a small scale user test is done. Four users with technical background, as the heuristic evaluation method recommends [20, 21], 3-7 usability experts, all familiar with the Ascom 9d24 and d62 phones, were asked to perform a number of tasks using the prototype. During, and afterwards performing the tasks, they gave feedback on the interface.

IV. RESULTS

In this section, we present the results from the evaluation, redesign, and the prototype evaluation.

A. Evaluation

To identify the most important usability challenges of the Ascom 9d24 and d62 phones, the current interface was evaluated, and some issues were found:

1) Menu navigation – is confusing and not consistent in the way of selecting items in the different menus, and also differences in returning to the previous menus (d924). Most of these issues are improved on the d62 phone.

2) Messaging – Before writing the message, the user has to select a number or person from the phone book. The number is not editable later. The message is also erased if an incoming alarm, message, or phone call occurs while writing the message. This also happens if you leave the phone unused for 2 minutes while writing the message. When reading a received message, it is not possible to resturn a call to the sender directly from the message. If the phone is switched off, all messages will be deleted (9d24). Most of these issues are improved on de d62 phone, but on both phones, the list of received messages only shows the first words of the message, and the date/hour you received it, while the name of the sender would be more informative.

3) Calling – When a call is not answered on the 9d24, an exclamation mark appears at the top of the main screen to notify the user of a missed call, and you have to go each step through the menu to the call list to get more information. This is not the case on d62, which shows this as a large message on the screen, and enables you to go directly to the call list by just pressing one button.

4) Feedback – In general, the feedback given on the phones is good. Feedback on the current mode of the 9d24 is displayed in the main screen, the placing of the text may however not be appropriate, because it appears just above the soft keys, which may lead the user to think it is a soft

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key function. On the d62 it is impossible to know which mode is used.

5) Buttons – The phones have no on/off button. To switch on the phone the user has to press the call button for a few seconds. It is not clearly shown that the button has this function. On the d62, the same procedure is used for switching off the phone. While the 9d24 requires many steps; through the mode menu tab, the mode 'switch off' at the bottom of the list, has to be selected. However, this is because the phone is not intended to be switched off often. When the phone is not in use, it should be placed in the charger, which automatically changes its mode to 'in charger'. Users have indicated that it is not clear how to enter the menu on both phones, and wants different buttons for answering/ending calls on the 9d24 like the d62.

6) Other issues – A general remark from the users about the overall appearance, is that both phones are quite large compared to ordinary mobile phones. This is mainly due to the large screen size, which was perceived as a positive property of the phone. A smaller device is more comfortably carried, for instance in a coat pocket, as health care workers often do [4, 7].

B. Redesign

Evaluation of the current interfaces resulted in ideas of improvement. A prototype with the proposed changes was made, and tested in a small-scale usability test.

1) Prototype

To simulate the functionalities of buttons, we used hyperlinks in PowerPoint to switch to the menu screen related to the particular button. In the following sections, we are presenting our suggested new user interfaces.

a) Suggested changes to the Ascom 9d24

Main screen: The new main screen (Figure 15) is quite similar to the original. However, the bar at the top of the screen is changed. Icons indicating signal strength and battery power are shown to the user. In critical situations, which may occur in hospitals, the user has to rely on the performance of the system. Also the mode of the phone is now shown in the top bar. We believe that this placing is more logic than on the lower part of the screen. When the location detection is activated, a "dot within a circle" will appear in the top bar. This informs the user that location information is shared, and mode will change automatically.

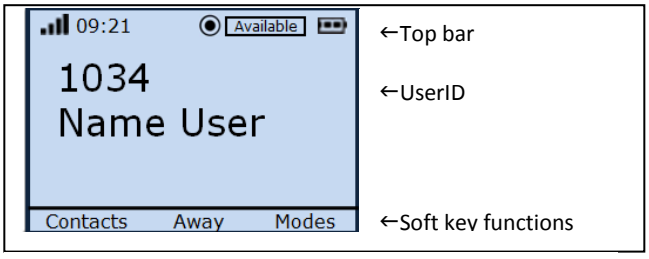

Figure 15. Ascom 9d24 prototype main screen

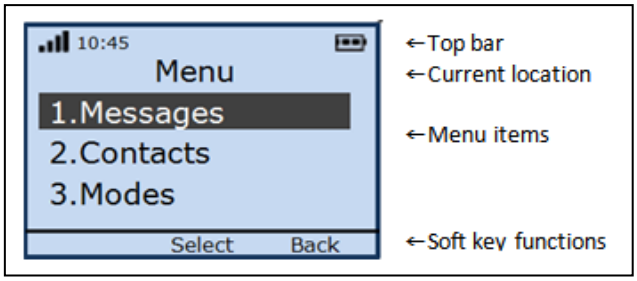

Figure 16. Ascom 9d24 prototype main menu

Functions accessible through the soft keys are; the phonebook, change mode to 'away', and the mode menu. From the phonebook users can start a call, or writing a message by selecting the receiver in the contact list.

Pressing the middle soft key will change the mode to 'away', e.g., when having an unexpected patient consult, or emergency situation where interruptions are not wanted. To select another mode, the right soft key will open the mode menu. This means that two soft keys are assigned to change the status of the phone. It is still possible to adjust the functions of the soft keys according to the user's preferences, and also the four directions of the navigation key are programmable to open assigned features.

Main menu: The main menu in the new interface is presented as a list, and not by using tabs (Figure 16). The advantage of the tabs (Figure 3) was to show all the 5 items at once. However, this was not considered as added value in navigation representation, and therefore the list is chosen to make the main menu look more like the sub menus. It is now possible to scroll from the last item to the first in the list, and a quick jump to menu items is offered by using the numbers corresponding to the menu item.

Three menu items are shown at once. Design guidelines regarding number of menu items presented, recommends three or more items, which leads to better usability than one or two, due to human memory [21]. The main menu consists of six items, and showing only three lines is therefore not expected to affect the usability.

The soft keys in the main menu are 'select' on the middle key and 'back' on the right key. This placing will be the same throughout the whole menu. The middle position to select a highlighted item is chosen because it is closest to the navigation button used for scrolling, and therefore, the easiest button to press when navigating with one hand. Pressing the 'back' key will bring the user one step back, to the previous screen. The menu button will always return to the main menu.

Another change in the interface is battery power, signal strength, and clock, not only visible in the main screen, but also above the menus. They can be considered during use: Time, for Instance, can influence the decision to call someone, or sending a message.

Messages: The inbox shows all received messages with the name of the sender, and date. New messages are

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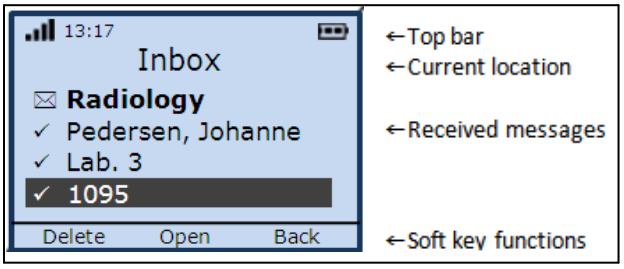

Figure 17. Ascom 9d24 prototype Inbox

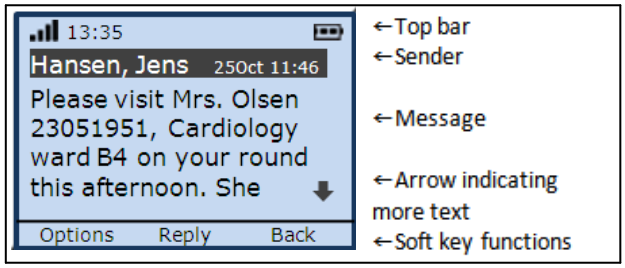

Figure 18. Ascom 9d24 prototype Messages

indicated with a closed envelope, and read messages with a check mark (Figure 17).

It is possible to call the sender directly from the message list, using the call button when the name is highlighted. When the message is opened (Figure 18), the name of the sender and time are displayed, followed by the message. An arrow appears when the message contains more text than is currently shown on the screen. The user can reply to the sender by using the middle soft key, or call back, using the call button. These actions, among others, are also accessible through the options menu on the left soft key.

Calls: When receiving a call, the name of the caller is shown, or the number, when the contact is not in the contact list (Figure 19). The call can be answered using the call button, or the middle soft key. During a call, a "hook off" icon is displayed in the top bar (Figure 20).

Modes: The mode, or profile of the phone, can be set using the mode menu, but can also change automatically based on for instance location, or calendar in a context sensitive system [7, 10-12]. The current mode is displayed in the main screen, but can also be shared with possible communication partners (Figure 21). In the new interface, the caller receives a message with predefined availability

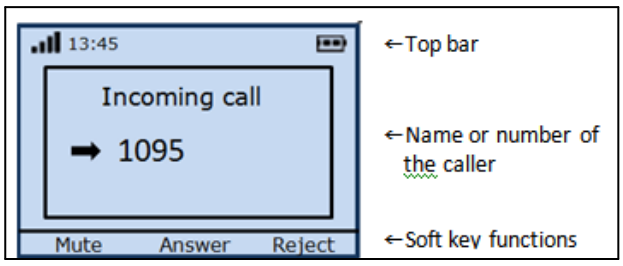

Figure 19. Ascom 9d24 prototype Incoming call (number)

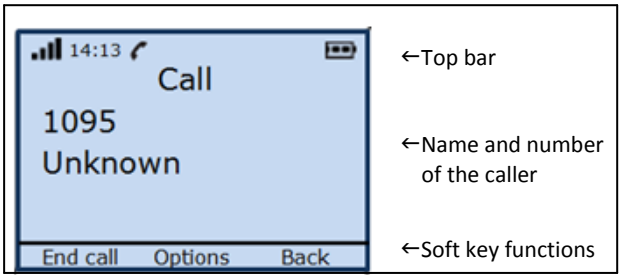

Figure 20. Ascom 9d24 prototype Incoming call (name & number)

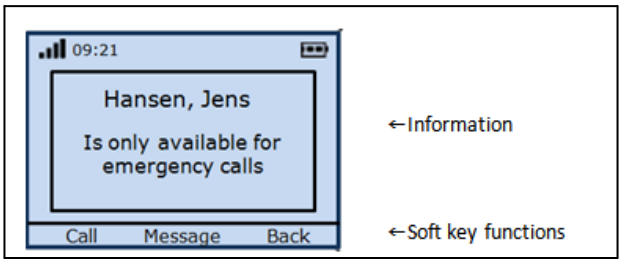

Figure 21. Ascom 9d24 prototype Availability check

information of the one he/she is trying to contact; for instance, 'only available for text messages'. The soft keys offer the possible options for the caller to choose, based on the shared information. A similar principle is used by Schmidt et al. in an application for context aware telephony [30].

b) Evaluation of 9d24 prototype

A small usability test was done to evaluate the adjusted interface. A few tasks were performed by the test users, like placing a call, receiving a message, and changing modes. During and after the tests, they gave feedback and comments on the usability of the interface.

Main screen: The placing of the current mode in the right upper corner was perceived as good. Also the icon indicating the location detection switched on, was perceived as an improvement. One test user mentioned that it would also be useful to show the current detected location in the main screen. In this way the user can check whether this location is correct. However, we considered this as unimportant information to the intended user of the phone. Interaction with the interface will mainly happen when the user has a specific goal, like; writing a message, or answering a call. We believe that it is not beneficial for the usability, and may be distracting, if a lot of information is shown on the main screen.

Menu navigation: The possibility to use the numeric keys to select menu items seems useful; in this way users are able to remember their own sequence of numbers to frequently used items. There is, however, no indication whether the selected menu item is a branch item, opening another menu list or a leaf item, or starting an action. In the old interface, branch items were indicated with a > sign (see

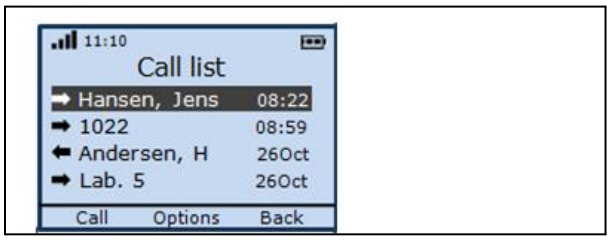

Figure 22. Ascom 9d24 prototype Call list

Figures 6 and 7). Since the text usually clearly explained the function of the item, the test users did not perceive this as a usability problem. However, this will be considered in the next version of the interface.

Another remark regarding the menu navigation, was that the left and right buttons of the navigation key (Figure 1) are not used when browsing through the menu. In our prototype these buttons are not used at all, and seemed unnecessary. However, in the real interface they will be used when writing messages, or entering text or numbers. This was not a possibility in the prototype. The left and right button of the navigation key can also be set as shortcuts to preferred functions, accessible from the main screen.

Soft keys: The three soft keys in the main screen: contacts, away and modes (Figure 15), where evaluated as convenient. A soft key to write a new message were recommended, instead of the 'modes' key. On the other hand, it is easy to access the 'new message' function from the contact list, by selecting the recipient. There is a soft key, shortcut to 'contacts', therefore this is not seen as an important problem. It is also possible to change the functions of the soft keys to the user's personal preferences.

Visibility: A general remark was that the text size is smaller in the prototype than in the original interface. More text on the screen is pleasant, especially when using the phonebook, contact list, and message list. However, making the text size too small might influence the visibility. For example, the time and date details in the call list (Figure 22).

c) Suggested changes to the Ascom d62

Main screen: The main screen is substantially identical to the original (Figure 23). The reception indicator, battery icon, and the clock is not moved, but the date is moved left to leave some space for the mode in use, here; 'Available'. The '?' icon is displayed if the automatic change of mode is activated. Network information, user, and license used, here; 'protector', are always located in the same position. The soft keys are default set for hospital use, but remain customizable.

The 'SMS' button is a shortcut to write a text message, the 'Call key' allows you to make a call from the call list, the phonebook, or by typing a number. The 'Modes' button, allows you to quickly change from 'Available' to 'Away', and enables or disables the automatic change of mode/profile. The 'Menu' key provides access to the main menu of the phone.

It is possible to create custom shortcuts with the navigation keys and the 9 numeric keypad keys, but the customization of these phones will hardly ever happen as shown by studies conducted in hospitals. Thereby, the most frequently used functions are set by default.

Modes: The modes can be set via the dedicated menu in the main menu, but can also, as explained above, automatically change by the position of the phone, the user's schedule, his role, etc., as explained in [7, 10-12]. The mode in use is displayed on the main screen, but can also be shared with other users. This information is important, due to whether it is appropriate to contact this person (Figure 24). In the new interface, the caller receives a message with availability information of the person he/she tries to contact. The soft keys permit to choose whether you still want to call, to send a message, or if you want to cancel the call. It is, of course, always possible to define personal modes, and use them manually.

Messages: Previously, it was only possible to send a message to a single contact. This has been changed, and it is now possible to send messages to multiple contacts (Figure 25), both by typing a number manually, or by adding a number from the phonebook. It is also possible to send a message directly from the phonebook. The left soft key brings you directly to the phonebook, and if a number is entered manually, it will display an "ok" button to validate the given number. Once one or more numbers of contacts has been selected, the left soft key opens a menu to send the message, to remove a recipient, or to access the phonebook to add more recipients.

It is also possible to save a new contact directly from a message, either the senders' number, or a number in the message. That is, when a number from a message (or call) is selected, a screen offers to save it as a new or existing contact (Figure 26). It is also possible to overwrite an existing number, or set a second number to the same contact. Originally, when one or more numbers were present in a message, it was only possible to save one of those numbers. It is now possible to record a number in a message, in addition to all the options already present (Figure 27).

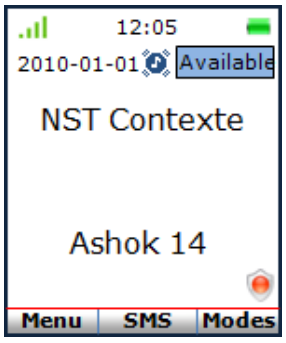

Figure 23. Ascom d62 prototype Main screen

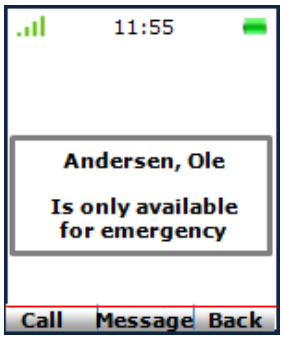

Figure 24. Ascom d62 prototype Availability

Figure 25. Ascom d62 prototype sending message

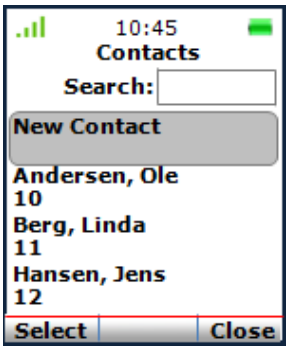

Figure 26. Ascom d62 prototype saving a number

Visibility improvements were also made on the inbox. Unread messages are displayed in bold, which divides them form the read messages. This allows you to quickly see if a message has been read or not (Figure 28). Previously, the only difference was the envelope icon. Also the sender's number and the time of the message are displayed on the selected message.

d) Evaluation of d62 prototype

Main screen: Placing the used mode in the upper right corner was perceived as a good improvement, and fits with the other information provided by the phone in this area of the screen (sound, battery, etc.). The icon indicating that the mode is changing automatically was also perceived as a major improvement. One of the test users indicated it is useful to show the current location detected by the device, so that the user can check the correctness. However, it is not expected that the end users will pay close attention to the main screen. The interaction with the interface is mainly about sending and receiving messages, or transmitting and receiving calls. We believe that showing extensive information on the main screen is not an improvement, but rather a possible distraction.

Soft keys: The choice of 'menu', 'SMS' and 'Profiles' for the soft keys, were perceived as a good choice. It is also possible to personalize these buttons, if a problem of effectiveness is found.

Contacts: The new principle of the contact list, allowing to register a new contact, or to save a number on an existing contact, was received as an improvement, but not necessarily useful in everyday use. The new interface for sending an SMS to several persons was considered intuitive and efficient.

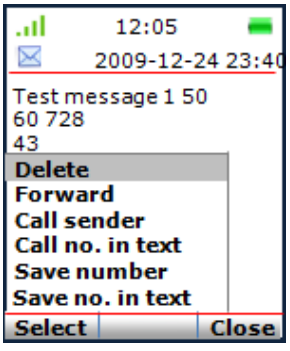

Figure 27. Ascom d62 prototype Message options

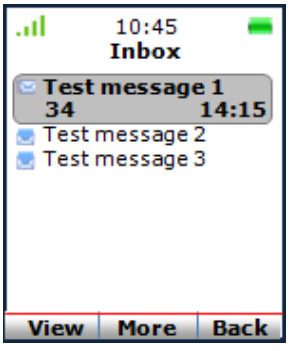

Figure 28. Ascom d62 prototype Inbox

Calls: No major changes have been made on the calls, but having a confirmation when a call is rejected, were perceived as a significant improvement. Providing information on the screen about the status of the person you want to call, were also perceived as very positive feedback. This means that you can use context information to avoid interrupting someone, without blocking communication.

Visibility: In general, the visibility was already good in the original interface. However, some improvements have been greeted positively, like; using bold fonts on unread messages, and normal text for the read messages, the display of the sender's number, the date and time of reception, and the start of the message contents when selecting a message. Another improvement was proposed by one of the test users: Instead of putting many options for the recipient's number, or a number in a message, an option covering all the possible actions could be implemented under the name "use number", and thereby improve the visibility of the screen, and at the same time, avoiding having too many options, which uses almost the entire display.

V. DISCUSSION

It is well known that the usage of mobile phones enables higher availability and accessibility, but can also introduce a numerous of interruptions [4, 7]. This often leads to user resistance against wireless phones in clinical settings. A context-sensitive system for mobile communication can provide a solution to control the availability, and thereby the interruptions [4]. The easiest way to do this, is to introduce an already developed solution, like the AwareMedia and the AwarePhone systems to Badram et al. [17, 18]. But, we believe it is less expensive, and that the user resistance will be lower by utilizing an existing infrastructure, and well known devices used in clinical settings, but with user interfaces more equal to conventional 3G/GSM mobile phones.

The Ascom phones exploited in this article are used in existing infrastructures at several hospitals, and are thereby well known devices for health care workers. A new user interface is designed with the aim to improve the usability of two wireless Ascom phones. We have made an attempt to solve the usability challenges, which were identified in the current interfaces. Another goal was to suggest a user interface more suitable to context sensitive functions. It was not possible to deal with all the problems, since some of them concerned the physical design of the phone. Only the design of the graphical user interface is changed.

The design is implemented in a low-fidelity prototype, which at this stage should be advanced enough [21, 28, 29]. A low-fidelity prototype can be helpful in testing usability focused on the use and design of the interface, while not

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being distracted by the design of the phone itself [28], which was not subject to this redesign. This prototype did not resemble the actual physical design of the device, but consisted of an image of the phone with different screens, which changed interacting with mouse clicks on buttons within the image. The ideas for the graphical user interface are displayed in detail. Although the prototype could be used to perform a few tasks, the functionality of the interface was limited. Selecting items and browsing through the menu, did not always work, but making a fully functional interface, was not the goal of the prototype. The intention was to give test users an impression of the design, choice of soft key functions, and the menu structure. During the user test it was sometimes difficult for the test users to focus on the design of the screen, and not on problems caused by incorrect links, or the fact that not all functionalities were implemented. This may have influenced the results of the usability evaluation, but it was helpful to see how the users performed the tasks, and the expected, or unexpected actions they performed to complete the task. Asking specific questions about the users' opinion on the design, or the location of items on the screen, also led to useful feedback.

Another problem with the prototype was that the users initially tended not to click on the simulated buttons of the real phone, but directly on the screen. This is a common problem when testing with low fidelity prototypes [21]. This was solved after a few minutes of training. A shortcoming of the prototype was that the size of the display in the prototype was slightly bigger than on the real phone. Feedback on visibility and size of items could therefore have been influenced.

Only four test users have evaluated the new interface, and critically reviewed the design, to see what could still be a challenge, or points of improvement. This is a low number of evaluators, but according to the method used, heuristic evaluation, where 3-7 usability experts identifies challenges of an interface, using their experience and design heuristics [20, 21], it turned out to be sufficient at this first stage of the redesign. Before more test users, and also the intended end users, like hospital staff, are involved, it has been useful to develop this prototype, which allowed us to see if the adjusted interface fitted the expectations of the usability experts, and whether they perceived it as an improvement compared to the old interface.

Our approach is limited to one manufacturer, but we believe that the ideas can be used in general, when designing user interfaces for mobile phones intended for use in context sensitive systems at hospitals.

VI. CONCLUTION AND FUTURE WORK

In this article, the user interface of two Ascom IP-DECT phones is evaluated, and improvements are suggested. These improvements include support for context-sensitive communication in hospital environments.

The most important usability challenges found were:

- No consistent way of selecting options or to return to a previous screen (9d24)
- Large text size (9d24)
- When writing a text message, it will be deleted if interrupted by a call or another message (9d24)
- No reply options of received text messages (9d24)
- Missed call list is not easily accessible (9d24)
- Not clear how to enter the main menu (9d24)
- No way to know which mode is used (d62)
- Undefined functions for the soft keys on the main screen (d62)
- Only one recipient possible when sending a text message (d62)
- Impossible to save a number on an existing contact (d62)
- Not enough visual difference between read and unread messages (d62)
- Dismissal of a call by the cancel button (d62)

An adjusted interface was made, with attention to the identified usability problems of the current phones. The new interfaces include aspects for using the phones within a context-sensitive communication system:

- Current status or mode displayed on the main screen
- An icon indicating that the location detection is activated and on the d62 an icon showing if the automatically change of mode is available
- A soft key on the main screen to quickly switch to the 'away' mode
- Easy access to the mode menu, to change availability status manually
- Automatic messages to show availability status to callers (d62)
- Automatic message to know the status of the recipient (d62)

The prototypes of the interfaces were evaluated by test users, and were considered to be an improvement compared to the old interfaces. However, some points of doubt where mentioned. Particularly about the many options available in some of the menus on the d62. In addition, questions were asked related to the preferences of hospital workers, the intended end users. To test the usability of the user interface, it is important to involve the actual end users. This will be done in the next phase of the project, were we also have to include and work closer with Ascom AB (during the project, we have discussed several solutions with some of their engineers), to plan and implement a more advanced prototype, running on the actual phones.

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