

User-centered design of mobile solutions



A research note by **NAMAHN**

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Introduction

Mobile solutions are the next great wave in the digital revolution... and the wave is already breaking upon us:

- It's a well-known fact that in several Scandinavian countries there are now more mobile telephones than fixed phones.
- Possessing a Personal Digital Assistant (PDA) has now become de rigueur for the ambitious businessperson.
- Even the home personal computer user is becoming increasingly 'untethered' as wireless LAN technologies such as Wi-Fi (802.11a/b/g) and Bluetooth find their way into people's homes.

Moreover, the much heralded convergence between telephony, personal computers and consumer electronics is finally beginning to take shape. Convergence combined with the emergence of mobile solutions will lead to the development of entirely new classes of mobile device. Before a technology or new paradigm 'crosses the chasm' into mainstream use and acceptance it often is first applied in vertical markets and to specialised work. This is also likely to be the case with the new classes of mobile device. Hence, to see the future of mobile solutions, or to create it, we need to look at these specialised application areas.

Unfortunately, most research surrounding the design of mobile solutions has focused on new technologies – new possibilities for displays, non-keyboard input devices, portable battery use, etc. In this research note, we would like to step back from the details of specific implementation technologies and avoid becoming enamoured of a particular technological solution. Instead, we look at mobile solutions from a user-centered perspective. We investigate the actual environment and context in which mobile solutions are likely to be used and attempt to draw conclusions as to the optimal human interface design. We also avoid the well-trodden path of discussing the mobile phones or PDAs used by business people in detail. Instead we consider the needs of fieldworkers such as nurses, field engineers and others. It is these users who will drive early adoption of innovative mobile solutions. Furthermore, these are the most demanding and truly mobile users of information appliances.

At the end of this note, we will apply the Namahn methodology for user-centered human-computer interaction design to see what impact these truly mobile users will have on the future of user-centered design.

User-centered design of mobile solutions

A new paradigm

Today's digital, interactive world is dominated by two main interaction paradigms: the telephone paradigm and the personal computer paradigm. As Sacher & Loudon state in *Uncovering the New Wireless Interaction Paradigm*: 'In today's practice (telephone and PC) paradigms drive rules and conventions for designers and users. Designers embody the rules of an appropriate paradigm into products and users will know what to expect and do.'¹ According to Sacher & Loudon, in other words, users and designers are very familiar and comfortable with the twin interaction paradigms of telephone and PC.



From a purely technical perspective, mobile devices can be seen as a convergence of both paradigms. From a user perspective, however, mobile devices don't fall neatly into either category, and represent more than a mere convergence between telephone and PC. Though it may sometimes overlap with telephones and PCs, the mobile device should be viewed as a completely new type of device.

Designing a mobile device raises many questions: are interactions saved in files as with a PC or do they last until you hang up as with a phone? Can a user download other applications as with a PC or is the functionality fixed as with a phone? In fact many design approaches to advanced mobile products today use modes to switch between the rules of telecom and computer. So the two paradigms may co-exist uneasily on the same device. Personal Digital Assistants (PDAs) seem to be stuck in the 'no man's land' between PC and phone. Because they do not offer the whole spectrum of functionality of a PC or phone, their use is less appealing. Perhaps this is why many users still rely on analogue ways of working rather than using their 'gadgets'. Many mobile phones today offer the capability of taking notes during a phone call, for example, yet we still see users taking notes with pen and paper. And did you ever try to dictate over the phone a phone number from your contacts base? Talking into a device that simultaneously serves as a display is not convenient because the optimal reading distance and position is different from the optimal talking/listening distance and position. These examples show that in order to come up with applications that successfully communicate the value of mobile devices to customers, we need to treat mobile devices as unique rather than merely as extensions of the telephone or PC. In short, we need to start leveraging the unique rules of the wireless interaction paradigm.

¹ HEIKO SACHER & GARETH LOUDON, *Uncovering the New Wireless Interaction Paradigm*, *Interactions*, January-February 2002, p. 18.

Static or mobile use of mobile devices?

Apart from being differentiated from telephones and PCs, mobile devices themselves come in many flavours. We have to be careful not to put all mobile devices in the same box. For one thing, not all mobile solutions are used in the same way. Handheld devices are now commonly used in business as work organisers. Not only do these devices contain contacts and calendar data, most PDAs today permit the businessperson to store a subset of business data and take it with him wherever he goes. The use of these mobile devices is, however, not always as 'mobile' as it may seem. 'The businessperson will normally be seated at a desk to use their PDA, or perhaps with the PDA rested on their lap. We could therefore describe this as portable computing rather than truly mobile computing because although the user can roam anywhere with their PDA, it is generally with the intention of bringing computing resources to use within a static workplace rather than to use them whilst on the move'.²

The usage pattern of a fieldworker with a mobile device is 'mobile' in the true sense of the word. Fieldworkers typically operate over a large geographic area, using the mobile device whenever and wherever they need it. Their work is completely dependent on the environment where they are working in. The mobile device is situated in and acts on the surrounding environment. Besides that, fieldworkers often will use their mobile device in a dangerous environment: a car, a chemical factory site, a gas cabine, etc. The environment of use is so different from the traditional office environment that this mobile computing has different requirements.

Financial investment

The development of a mobile device requires very considerable financial efforts. Any delay in the successful deployment of the product will reduce the potential return of this investment. One important point of failure is the quality of the user interface. A bad user interface can:

- Bring down productivity
- Cause resentment and refusal by users
- Cause low utilisation of the product's feature
- Impact quality of service

Given the high personnel turnover, training time must be reduced to a minimum. This can be achieved by making the user interface intuitive and easy to learn.

² JASON PASCOE, NICK RYAN & DAVID MORSE, *Human-Computer-Giraffe Interaction: HCI in the Field*, University of Kent at Canterbury, Canterbury, Kent CT2 7NF, United Kingdom.
<http://www.dcs.gla.ac.uk/~johnson/papers/mobile/HCIMDI.html>

Mobile computing in fieldwork environments

A limited amount of research has been done on the nature of mobile computing in fieldwork environments. Some important issues for the interaction design of these devices emanate from these rather dispersed studies.

General characteristics

Use anywhere at anytime

The fieldworker wants to use his mobile device whenever and wherever he likes, mostly in places where no chairs or desks are nearby on which to set up his computing device.

The flip-open pocket computers equipped with miniature keyboards are not suitable for fieldwork environments. 'In-hand use of these devices requires both the user's hands and often involves a clumsy method of typing with the thumbs. Pen-based interfaces on a pad-like device provide a more ergonomic solution that can be held in one hand if simply viewing data, and generally use some form of handwriting recognition for entering data. They provide a natural substitute for the fieldworker's paper notebook, similar in size and operation, and suitable for use by the user in many different dynamic situations (e.g. whilst walking).'³

Most of the time, a fieldworker will use tools, such as screwdrivers or a camera, to accomplish his task. While using these tools, he might want to consult a list on his mobile device or register data. Therefore, mobile devices have to offer the possibility of hands-free interaction, so that their user can use his hands to do his work. Integration of speech technology could be considered, taking into account the strengths and weaknesses of this technology.

Speech interaction could also be applied for use in the car. When moving from one place to another, a fieldworker will pass many hours in his car. He might want to use the device while driving, e.g. to follow a route description, make a phone call or search for

information about his next client visit. Interaction design has to take into account these needs, and offer a safe solution according to the applicative rules and regulations for use of devices while driving. This is both a productivity issue and a worker-safety issue.

Use appearance

Users are always concerned about how they look when using a device. Mobile devices are not only used in the relative privacy of offices and living rooms. Mobile computing often happens in the presence of other people. Use appearance is, therefore, an important consideration in the interaction design of mobile devices.

Sacher and Loudon have noted: 'Every interaction design leads to physical gestures – which can look cool, tense or silly. If such gestures lead to an awkward appearance, the application is very likely to be rejected'.⁴

Limited attention span

A fieldworker will have a limited attention span for the use of his mobile device. When making observations, observing birds, for example, the user must keep constant vigil on the subject to note any changes in state. A maintenance engineer engaged in repairing appliances is focused on this activity and has to manipulate other tools. Use during driving would make reducing the amount of time devoted to interacting with the mobile device of utmost importance.

³ JASON PASCOE, NICK RYAN & DAVID MORSE, *Human-Computer-Giraffe Interaction: HCI in the Field*, University of Kent at Canterbury, Canterbury, Kent CT2 7NF, United Kingdom.
<http://www.dcs.gla.ac.uk/~johnson/papers/mobile/HCIIMI.html>

⁴ HEIKO SACHER & GARETH LOUDON, *Uncovering the New Wireless Interaction Paradigm*, *Interactions*, January-February 2002, p. 21.

As the attention of the user is not at all constantly focused on the device itself, the device should be able to attract the user's attention in many ways.

Mobile user interfaces must, therefore, provide mechanisms that minimise the amount of user attention that is required to perform a particular task.⁵

Some examples are:

- All eyes-free forms of interaction, e.g. hardware buttons or a touch-sensitive screen divided into fixed areas, that can be manipulated without looking, and a speech interface
- Methods that reduce the amount of focus required by the user, e.g. one-handed operation, a pen use interface instead of miniature keyboard
- Enhanced possibilities for attracting the user's attention, e.g. multiple beeps and sounds, different vibrating call alerts, visual clues to new items or changes

In order to meet the needs of the mobile fieldworker, the multi-modality of interaction should be developed.

High-speed interaction

Mobile users have higher expectations with regard to the speed and responsiveness of user interfaces than do users in a desktop context.

Fieldworkers can have intense periods of activity, during which they need to be able to enter high volumes of data very quickly and accurately. Downloading and uploading data must also be quick and efficient operations to avoid slowing down the main work activity.

⁵ ASON PASCOE, NICK RYAN & DAVID MORSE, *Human-Computer-Giraffe Interaction: HCI in the Field*, University of Kent at Canterbury, Canterbury, Kent CT2 7NF, United Kingdom.
<http://www.dcs.gla.ac.uk/~johnson/papers/mobile/HCIMDI.html>

⁶ HEIKO SACHER & GARETH LOUDON, *Uncovering the New Wireless Interaction Paradigm*, *Interactions*, January-February 2002, p. 21.

Connectivity

Connectivity of mobile devices has two faces:

- Connecting to people: being mobile often means being remote from a group, family or office colleagues. Real-time interaction with colleagues can enhance work efficiency and coordination.
- Connecting to other devices: mobile devices normally are not stand-alone. All sorts of data can be stored remotely and downloaded when needed, and newly collected data will need to be uploaded to a remote database or to a desktop computer.

Nomadic trade-offs

Humans have a special sense for the right combination of tools to take on the road – assessment of the nomadic benefits vs. the nomadic demand.⁶ In the case of a mobile device the nomadic trade-off has to be evaluated in terms of hardware and software.

- Battery-life: a device that can be used for at least a whole day without requiring replacement batteries is desirable.
- Small form-factor: both in terms of space to stow the device and the amount of equipment to carry, a small form-factor is essential. Ideally, the device should fit in a trouser pocket.
- Robustness: a very durable device is required. Mobile devices for fieldworkers have to be able to withstand knocks, drops, and the general conditions of outdoor life, including heat, dust, rain, etc.
- Complexity of use: inefficient or superfluous features should be eliminated or turned off. On a desktop computer an underused feature can be ignored. In contrast, mobile users only want the essential features.
- Portability: the device and its accessories (headphones, power supply, etc.) have to be carried from place to place and used everywhere. Special handles, covers and cases can improve the device's portability.

Context dependency and location-awareness



In an office environment, the computer screen is the context. The office environment itself exercises no or a minimal influence on the work itself. In most cases, assuming access to documents and servers is provided; it doesn't matter if the office worker works in the office or at home. With his mobile device, he carries his context with him.

A fieldworker, on the contrary, is situated in context and depends on his context. He moves from one place to another, performing work that can only be done on location. A maintenance engineer has to go to the machine in order to repair it; a nurse has to be with the patient. These activities cannot take place at a distance.

Furthermore, the particular context will influence the activity. An appliance on a certain location can be very different from one on another location; there can be other (weather) conditions or a different historical background. Each individual context can require other information and a different treatment.

Moreover, mobile users are typically involved in other activities, and not focused on the device itself. A tool that can keep up with what is going on with the user and his environment can allow the user to maintain his attention on his work, and can provide timely support for the user's activities.

‘There are a number of different technologies that can detect the user's current location: GPS, DGPS, mobile phones, PARCTabs, active badges, tags, and, for cases where the user actively records their location, barcodes placed at defined locations’.⁷ Mobile devices combined with such context-aware technology are called location-aware devices. ‘Simple applications [of location-aware applications] are in tourism, where information is given about sights that the user is passing, and in maintenance, where the user is automatically given information about nearby equipment. In some applications, e.g. those concerned with the logging of events, the act of triggering causes a program to be run’.⁸

Lots of work situations require the user to fill in information related to a physical location. In observing a bird, the location of the birds and the observer has to be registered. Nurses maintaining a patient's records first have to identify the patient in the system. A maintenance engineer has to register device number, date and location before being able to note other information. If this information can be filled in automatically by the context-aware device, users have to register less and can focus on their core activity. A fieldworker's information retrieval needs are also context-dependent.

A fieldworker will search for information about the activity that he is performing at that moment in that location. Information retrieval, therefore, is situational and highly specific, in contrast with information searches on the Internet which are likely to be more general in nature. Location-aware technology offers other possibilities for information retrieval and download. The information needed for work on one particular location could, for example, be downloaded automatically when the user arrives at that location. For more information, see text box on next page: 'context-aware information retrieval'.

Context-aware systems can also adapt their interface to the user's current environment. A simple example is that of the mobile device that "knows" whether his user is driving a car, or working outside or inside, and chooses the right profile of interface settings (feedback sounds, screen resolution, battery-saving mode, voice commands...).

It is although always important to maintain a balance between effective support and intrusion. A mobile user should always have the possibility to change the context-related suggestions.

Another point of discussion related to location-awareness is the privacy issues it brings along. Most of the location-aware technologies permit tracking from outside. For fieldworkers, whose freedom during working time is often an important advantage, this means they give away part of their privacy: their employer is always in the possibility to track where they are and how long they stay on that place.

To avoid irritation and privacy issues, providing the mobile fieldworker with a locator-off switch could be considered.

7 PETER J. BROWN, *Some Lessons for Location-Aware Applications*, Computing Lab., The University, Canterbury, Kent CT2 7NF, UK. <http://www.dcs.gla.ac.uk/~johnson/papers/mobile/HCIMD1.html>

8 *ibid.*



Context-aware information retrieval

The data storage capacity on a mobile device tends to be much lower than on a desktop computer. Different patterns for the distributed storage of data and triggering of information on various levels are conceivable.

- All information can be stored in a central repository. Each day, a subset of the information can be filtered out based on contextual information contained in the database. The user will carry on his mobile device only what he needs during a particular task. Example: the data carried around on the user's PDA could be everything needed for use during one day's work.
- Not all data has to be stored on the same database, information can be collected from different sources and integrated on the mobile device. Example: local weather forecasts can be extracted from a web page; traffic information can originate from another source. Both can be integrated and rendered as one entity of information on the mobile device.

- Another possibility is that during the day, context-aware information is sent to the user over a communications link. The user or the device has to communicate its location to the central repository, which then sends the appropriate information. Example: a user can ask by mobile phone (SMS) the way to the nearest patrol station.

- Mobile devices equipped with location-aware technology can automatically download information that is relevant to the user's current location. From the moment the user arrives at a certain location, all relevant information will be available on the device. Example: personal reminders can be programmed to remind the user of certain tasks at the appropriate time and place.

Context-aware information triggering, however, should not be the only way to retrieve information. Users need normal search functionalities such as alphabetical research or research by theme. Another possibility lies in information retrieval based on a virtual context: the user can go virtually to a location (in a model of the environment or a simulated world) and retrieve the information related to this context.

Example: this technique is used for oil rigs. Before being built or changed, oil rigs are simulated using computer models. The user can then explore the computer model and find all information relevant to each location in the model. The same information can be used on the real rig, where the location of the user is determined by GPS.

Use and adoption

How and why should individuals accept mobile devices? Which motivations and circumstances surround use and adoption of mobile devices from the perspective of the users? Because introduction of a mobile device for fieldworkers is mostly a case of non-discretionary use, these questions are very important. S. Sarker and J.D. Wells⁹ tended to find an answer through social analysis.

The first important group of influencing characteristics are associated to the individuals themselves: their age, their technology experience and self-efficacy, their cultural origin. These individual characteristics help to predict whether and how an individual is likely to use mobile technology. Inexperienced computer users can encounter difficulties to get acquainted with a device; but either experienced users can have problems when switching from familiar technological frames. Cultural factors on the other hand can affect use patterns, e.g. the exchange of short text messages with superiors will not be possible in every culture.

Two broad factors affect the adoption of mobile devices from the technological point of view: the interface characteristics and the capabilities of the network. As already mentioned, users of mobile devices have high expectations toward interaction speed, connectivity and portability. Sarker & Wells emphasise that “flaws in the logical interface of the devices” can bother seriously. Poor network characteristics act as severe inhibitors of use and adoption. Lack of coverage in certain areas, limited reach and reduced responsiveness damage the sense of freedom and safety and reduce the enthusiasm for using mobile devices. If not all network deficiencies can be avoided, it is important to inform the user in a complete and appropriate way about the network status and its failures, and tell him what to do in case of malfunctions.

Certain task characteristics can also play an important role in the judgement of a mobile device user. The risk is real that the fieldworker may not fully or properly use the mobile device, unless its interface is particularly adapted to the user’s requirements, both in terms of

intuitiveness and appropriateness to the task at hand. If a user’s activity implies requesting information for completing a task, and immediate response of the system or person on the other end of the line is required. Multi-lateral and synchronous use of data can be desired, or large amounts of data have to be transferred. If the mobile device or the network does not support these requirements, they will impede the user’s task completion immediately and lead to serious adoption reticence.

The first moments of use can also be decisive in the adoption process of a device. An elaborated and well-considered working method with a clearly defined extent of use can help the user to understand the new way of working and to adopt it easily together with the device. A comprehensive training instruction is very important to adapt the user’s cognitive and technological frame. The circumstances of the introduction of a new device have to be chosen carefully and prepared with caution.

The immediate feeling of positive impact on effectiveness and efficiency can help a fast adoption of a new device. A good example: users get a feeling of greater efficiency when they are able to read and respond to e-mails, or call someone in the time slots between other scheduled activities, instead of batching up all communication to the end of the day.

Another rule to take into account in user acceptance handling, is the “Give me something and I’ll give you something”-principle. Users will be more inclined to accept a new tool for work, when they can take themselves advantage of the tool. E.g. a tool that contains an internet browser for working purposes could also be used for personal web searches. What can be used as incentives depends on the nature of the work and the tool, and can be revealed through contextual inquiry.

9 S. Sarker and J.D. Wells, *Understanding Mobile Handheld Device Use and Adoption*, *Communications of the ACM*, December 2003, Vol. 46 No. 12, pp. 35-40.

Challenges in interface design for mobile devices

The limitations of mobile devices such as small screen size, limited screen resolution, cumbersome input mechanisms, limited processing power and low bandwidth... make that the interface of these devices has to be designed carefully.

Another challenge is the user of the mobile device himself, who will not automatically be an experienced computer user. They are then not only novices in the content of the application, but also in the technology of the equipment. The design must thus, more than ever, provide 'self-evident cues and clues to the meaning of icons, hard-buttons, and other user-interface design for navigation and interaction details'.¹⁰

But an even greater challenge is to design these devices so that they can be used everywhere at anytime. We have to realise an interaction that requires minimal user attention, hands-free interaction or interaction in the most unthinkable situations and positions (while walking, climbing, driving, outdoors, in inclement weather, etc...).

When interface design is applied to mobile devices, particular characteristics and challenges arise.

Metaphors

Metaphors are fundamental concepts communicated via words, images, sounds and tactile experiences. "It is often not possible to reuse ideas directly from the desktop UI world. Small user interfaces do not scale."¹¹ New, fundamental concepts that differ from traditional desktop metaphors like files and folders on the desk, or shopping carts, have to be found.

Mental models

It is proven that users who have a good mental model of a menu structure, perform better in using the application. Inventing intuitive and logic mental models is one of the base challenges in user interface design.

Moreover, on a small screen, parallel representation of options turns into sequential representation. Users must browse the menu in the order it is presented and have no overview anymore. Therefore:

- Access has to be simple, with primary routes of travel.
- The content must be categorised and ordered in some efficient manner.

To realise this, relevant features have to be selected and prioritised. Feature prioritisation on its turn, requires a very good user understanding.

¹⁰ A. Marcus, *Babyface design for mobile devices and the Web, Telematics & The Mobile Interface*, January 2004.
<http://technologyreports.net/nextinnovator/?articleID=977>

¹¹ C.Lindholm, T.Keinonen & H Kijlander, *Mobile Usability: How Nokia Changed the face of the Mobile Phone*, Mc Graw Hill, New York, 2003, p. 139.

Navigation

Navigation can be facilitated through:

- Transparent navigation. The user has to know: where am I, where do I come from, how to continue.
- Easy bookmarking and possibilities for personalisation of the interface.
- Consistency in naming and navigational patterns.
- Names of categories, options and links that fit as closely as possible to the skills and expectations of the user and put the to be expected content in a nutshell.¹²
- Localisation. Automatic navigation based on physical location of the user – although he has to be able to deactivate the localisation function.

Interaction

When defining interaction for mobile computing, the following ideas have to be taken into account:

- The KISS (Keep It Simple, Stupid) – principle: avoid complexity or hide it from the user.
- Text input has to be minimised: although a big number of text input systems and alternative keyboards are available on the market, none of them are really satisfying.¹³ Search for innovative techniques for selection and language input.
- ‘Increased demands on users’ attention in dynamic environments can be addressed through interfaces that require less attention’,¹⁴
- Including hardware design in the interaction design phase can help to develop easy-to-use devices: hardware buttons have some serious advantages on software (touch screen) buttons when it comes to eyes-free interaction.
- Users should get enough feedback from the device, and via a feedback channel adapted to the user’s circumstances, e.g. no visual messages when a user is driving a car, immediate warning and fallback when Wifi-connection or GPS is down, etc.

Appearance

The small dimensions of the interface elements affect appearance seriously. In addition there is the ubiquitous computing demand of a readable screen in all circumstances. Some conclusions from recent research:

- Quality is much more important than quantity: the application has to be limited to the most necessary options and functionalities.
- Creative solutions for small displays, such as pop-up screens, zoom or even tilted graphics¹⁵ can help to create an increased overview.
- Text readability can be slightly limited by a small screen, but comprehension stays the same as on a big screen.¹⁶
- Size plays an important role in the recognition of images,¹⁷ much more than in readability of text.
- Screen contrast should adapt or be adjustable to the user’s environment: most users will need a sunlight-readable mode now and then.

¹² S. Duda, M. Schiebl, J.M. Hess, *Mobile Usability*, <http://www.eyesquare.de/dokumente/Mobile-Usability-eyesquare-english.pdf>

¹³ Little Springs Design Inc., *Text input on mobile devices*, <http://www.littlespringsdesign.com/design/textinput.html>

¹⁴ P. Tarasewich, *Designing Mobile Commerce Applications*, *Communications of the ACM*, December 2003, Vol. 46 No. 12, pp. 57-60.

¹⁵ E. Carling, *Creative Solutions for Small Displays*, http://www.creativemedialab.se/utvecklingsarena/tilt_display/

¹⁶ M. Jones, G. Marsden, et al., *Improving Web Interaction on Small Displays*, http://www8.org/w8-papers/1b_multimedia/improving/improving.html

¹⁷ Kolars, P. A., R. L. Duchnick, R. L. & Sundstroem, G. (1985). Size in the visual processing of faces and words. *Journal of Experimental Psychology: Human Perception and Performance*, 11(6), 726-751.

Methodology

It is clear that the user-centered design of mobile solutions for knowledge technologists poses some issues:

- The mobile interaction paradigm is different from the well-known paradigms that reign in today's digital interaction world.
- Use of mobile solutions by fieldworkers seems to display other characteristics than the better known usage patterns in business.
- A different usage pattern makes other demands on hardware and software. We summarised a number of general findings about specific requirements for use of mobile devices during fieldwork.
- The emerging technologies for context-aware applications raise opportunities for the functionalities of mobile devices, but complicate the interaction design. 'The case remains that functionality does not exist for the user if that functionality is not usable'.¹⁸
- Interaction design has to take into account the total diversity of mobile devices, and re-question each principle of user interaction.

In order to come up with a mobile solution that is accurate, functional and widely accepted, it is important to follow an appropriate design methodology.

For 15 years Namahn has used and refined its methodology for user-centered design. The numerous client projects that we've done throughout the years have enabled us to build the rich toolbox that we use today. From this set of design tools, our interaction designers choose those that best address a client's design issues.

A user-centered product design process at Namahn includes the following activities:

- Field studies: learn how the product fits in context through observation and interviews with end-users.
- Personas: describe archetypes of users, models which represent the behaviour and the goals of a real class of users.
- Scenarios of use: write detailed stories which describe how an application might be used on a daily basis by a variety of users.
- Conceptual design: produce the interface architecture and create mock-ups, to give an idea of the proposed look and feel.
- Usability testing: set real users real tasks. Observe their performance, analyse the results and make a report with recommendations
- Detailed specification: draw up detailed design specifications for the developers.

When applying this methodology to the design of a mobile device for use by fieldworkers, we see some important challenges due to the particular nature of the fieldwork environment. In what follows you will find an overview of these challenges for the three methodology steps that are affected: field studies, conceptual design and usability testing.

18 PETER JOHNSON, *Usability and Mobility; Interactions on the move*. Department of Computer Science, Queen Mary and Westfield College, University of London. London E1 4NS.
<http://www.dcs.qla.ac.uk/~johnson/papers/mobile/HCIIMD1.html>

Field studies

A well-known, efficient method to discover the users, their needs, their tasks, their business and social environment, are field studies. The techniques adopted in field studies are the observation of users in their working environment and interviews or focus groups with users and stakeholders. It is also important to get to know the business and the social context, to discover the broad user needs and desires and define functions for the device.

Except for observation, field studies about the use of mobile devices by fieldworkers will not differ from any other field study. It is as important as in other inquiries to cover the whole target user group, to collect work products and information artefacts, and to focus on information use in the broadest possible context (electronic and paper resources, such as reference lists, sticky notes, road maps – everything has to be taken into account).

The observation of users in fieldwork environments, however, raises some issues.

All activities must be covered

The observation period should be “suitably” filled with events interesting or relevant to the objectives of the research. When observing a fieldworker, observation time can become long (and expensive) because of the necessary travel between work activities and possible ‘dead time.’ A good average is a user shadowing of one day, assuming most of the work activities are done in one day.

Communication should be observed too

If possible, observers must be present at both ends of a communication activity. This is particularly important for observation of fieldworkers: when they interact with someone or with a device, the other party should be observed too in order to be able to report on the whole of the activity. Other solutions are to ask the user retrospectively “what the other one said”, or record or log the communication. A privacy policy is required in many cases!

‘Shadowing’ of mobile users

The mobile nature of the fieldwork compels the observer to move with the user, trying to be as invisible as possible, in order to keep the interaction and the communication as authentic as possible. He will have to “shadow” the mobile user. The observer could be seen as an intruder, and in certain professions even issues of confidentiality could emerge. In some public places, it may even not be allowed to take pictures or capture video.

Conceptual design

When the functional requirements of the product are well understood, the interface (both hardware and software) can be designed. Some of the requirements can raise important challenges for the conceptual design: small size, screen contrast, location awareness, communication, connection, touch screens, variable screen orientation (portrait-landscape), different user positions ... The challenges in interface design for mobile devices have been summarised on pages 9 to 10.

The general scope in the design of every mobile device is to avoid the need for a user manual. The interface has to be self-explanatory, so that mobile users don't have to carry a manual around with the device. A good interface, combined with good user training and, if necessary, online help should be sufficient.

Usability testing

Logically, in a user-centered design process, the final validation should come from the end user. So, the conceptual design work comes full circle by taking mock-ups to the end user in formal usability tests, often performed in a lab environment. These tests will determine whether the design has drifted away from the initial scope and parameters set out in the first phase of the design process.

Lab vs. field environment

The standard method of tests in lab environments loses the very idea of mobility. Laboratory tests are good enough to test tasks that are not related to specific mobile context, but mobile applications are designed to be used in a mobile context, so at least once they should be evaluated in a mobile context. Doing tests in real life contexts, however, sets high requirements for the data collection methods used.

What is the best way to collect useful fieldwork data for evaluation of location-based outdoor mobile applications? Questionnaires and interviews do not easily reveal enough detail, and collecting data by shadowing users with a video camera risks to disturb the actual situation so much that the gathered data is not authentic. If these techniques are applied, prudence is called for the authenticity of the situation, and a combination of techniques imposes itself.

A pilot study combined with an experience diary can be used to reveal some (less detailed usability) issues. The technique tested by M. Isomursu,¹⁹ where pairs of users walk around in the relevant environment, one testing out the new mobile (location-aware) application, the other one armed with a mobile camera phone, capturing video and audio seems to achieve good results.

When hardware is involved

When compared to traditional software, realistic prototyping is even more important for understanding the detailed requirements of mobile software.

With most mobile devices, the software functionalities are integrated with customised physical controls, such as hardware buttons. It becomes less evident to create a prototype that integrates all interaction that is needed to perform a usability test.

Paper prototyping is certainly not sufficient to solve the usability issues of the detailed interaction, but can already be used to verify the product requirements without any investment in technology. Screen prototyping, where the user's navigation path through the screens is simulated by a series of screens in a Powerpoint-like simulation, are only suitable to catch a user's real-time reaction to navigation, focus and logic. To test the real ergonomics of the task-based flow with the real timing of the working product, a more realistic prototype is necessary. Studies show that a setup composed of a working application on a laptop computer, combined with the keyboard of a mobile device, already permits to test more complex issues with real users. The highest in the hierarchy of prototypes is the beta version of the product, which of course will be necessary to test the last usability issues.

The better the prototype, the more complex the functionalities which can be tested. Designers, however, don't have to wait to test the application until the beta version is launched: each step in the prototyping hierarchy permits an increasing level of functionality to be tested. To ensure maximum efficiency, it is important to choose the medium that can answer your design questions in the least amount of time, and upgrade to a more advanced prototype when all questions that can be answered are solved.

19 M. Isomursu, K. Kuutti, et al. *Experience Clip: Method for User Participation and Evaluation of Mobile Concepts*, Proceedings of Participatory Design 2004, July 2004.

Conclusion

Alan Kay once said that ‘the best way to predict the future is to invent it’. The knowledge economy may spawn completely new categories of work. Moreover, new technologies and new applications of technology may spawn hitherto unseen categories of mobile device. The challenge for interaction designers is to both anticipate and drive these changes. The information age has by now become a well-accepted fact, and most users are comfortable using telephones and PCs. And, indeed, the PC and telephone interaction paradigms are a rich and useful past upon which we can draw. However, to develop truly appropriate human interfaces for mobile devices a new paradigm is called for: the *wireless interaction paradigm*.

As we have seen, the wireless interaction paradigm is finely attuned to the particular context of mobile users. Fieldworkers represent a major class of users. They are in many ways more demanding than either telephone or PC users. They need to use their mobile device in a variety of sometimes harsh environments. Hands-free interaction with the system may be required. Moreover, in contrast with business users, interaction with the mobile device will often not be the main focus of their activities – they may interact with the mobile device for only brief periods of time. Given the nature of fieldwork, product designers face a difficult task. They must design highly reliable, high performance products with just the right combination of features: connectivity, battery-life, size, robustness, ease of use, and portability. On top of all this, since mobile devices are frequently used in public environments (e.g. in front of the customer), it’s important that the user looks good.

The fieldworkers among knowledge technologists who will represent a major group of users are highly demanding. They tend to be well-educated and are often technology savvy. Moreover, they come from a diverse array of vertical industries and vocational fields. Designers of mobile devices will need to take into account the unique context of each type of user.

Ultimately, the wireless interaction paradigm will take the world by storm. Wireless LANs are already sprouting up not only in businesses but also in people’s homes. Man wants to be free – untethered and unfettered. The wireless interaction paradigm fits well with the quasi nomadic lifestyle of modern man.

Against this backdrop, interaction designers will need to manage more complexity and more diversity. It is a challenge but also an opportunity. The advent of mobile devices means that intelligent interaction design will come to the forefront of product design. As interaction designers we must follow Guy Kawasaki’s imperative. Writing in *Rules for Revolution: the Capitalist Manifesto for Creating and Marketing New Products and Services* he exhorts us to: ‘Create Like a God, Command Like a King, and Work Like a Slave.’



Knowledge technologists and fieldworkers

Peter F. Drucker, well-known management guru, came up with the term 'knowledge technologists', which he considers the most important group of workers in the society of the future.

Most large, knowledge-based organisations have lots of different types of specialised workers. Until the 1950s, 90 percent of the workforce was subordinates who did as they were told, mostly blue-collar workers. The other ten percent, the supervisors, did the telling. Today, less than 20 percent of the workforce remains truly blue collar. Some 40 percent are 'knowledge workers'. Within their area of knowledge they are supposed to do the telling. They have supervisors, but they are not 'subordinates'. The fastest-growing group of knowledge workers are the knowledge technologists.

Drucker compares knowledge workers (a term he invented as well) with knowledge technologists as follows: 'Knowledge workers refers to those people with considerable knowledge and learning; doctors, lawyers, teachers, accountants, engineers. In contrast, knowledge technologists basically are a combination of manual and knowledge workers as they usually spend more time working with their hands than with their brains. Knowledge technologists are people who do much of their work with their hands (and to that extent are the successors to skilled workers), but whose pay is determined by the knowledge between their ears, acquired in formal education rather than through apprenticeship. They include X-ray technicians, physical therapists, ultrasound specialists, psychiatric case workers, dental technicians and scores of others.'²⁰

Knowledge technologists are the fastest growing group of workers. 'Within two or three decades, knowledge technologists will become the dominant group in the workforce in all developed countries, occupying the same position that unionised factory workers held at the peak of their power in the 1950s and 60s.'

Many knowledge technologists are fieldworkers. Not only do they work mostly with their hands and bear with them a huge amount of knowledge to perform their work, they go from one place to another during work. They can be helped with a mobile solution. Nurses in hospitals not only straighten out patients' beds and administer medicines, they also have to keep and complete dossiers of patients. Their work could be made much easier with a mobile device. They could, for example, register data to complete patient records, verify and confirm the amounts and types of medications administered, insert data such as vital signs and other physical conditions, consult doctors' schedules, etc.

By putting a mobile solution at their disposal, we can enhance the productivity of knowledge technologists and make it easier for them to perform their work. Before doing so, however, it is worth considering the particularities of their working situation in a constantly changing environment.

²⁰ PETER F. DRUCKER, *Managing in the next society*, Truman Talley Books, New York, 2002.