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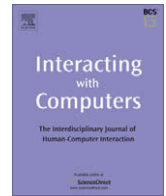


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Designing new technologies for illiterate populations: A study in mobile phone interface design

Zereh Lalji ^{a,*}, Judith Good ^b

^a Department of Informatics, University of Sussex, Brighton BN1 9QH, UK

^b IDEAS Lab, Department of Informatics, University of Sussex, Brighton BN1 9QH, UK

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ABSTRACT

Designing for illiterate populations involves particular challenges: for a start, the life experiences, needs and expectations of non-elite and illiterate populations in developing nations are likely to be markedly different from those of a designer. To avoid any bias, the creation of new technologies for such groups must develop in continuous partnership with primary users, and include a thorough investigation into their worlds, lives, relationships and concerns. Involving the user throughout the design process can also help in progressively testing and fine-tuning the prototypes by exposing the shortcomings and strengths in the design.

In this paper, we report on a study that investigated the design of a mobile phone for illiterate persons. While the study takes a user-centred, incremental design approach, the users' context of use forms the basis for the phone design. Through a discussion which compares key insights from our study with related HCI studies, we have endeavoured to illustrate how findings from our study could be useful in the area of design for non-traditional users.

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1. Introduction

The design of a new technology necessitates attention to a number of considerations: characteristics of the user population, context, purpose, and conditions under which the technology will be used, expectations of the product, and the nature of its influence on the user population and on human relations. For developing countries however, one cannot merely replicate models of highly networked societies. Non-elite and illiterate populations in developing nations have different life experiences, expectations, difficulties, needs and coping mechanisms from elites in the same region, or in other developed nations. A simple replication of western-centric concepts, interfaces, symbols and features, without a careful analysis of their requirements and worldviews, could result in products and applications that would seem useless and unusable to these populations. It could also cause discomfort, inhibit the adoption of technology (Brosnan, 1998), and further marginalize these groups from access to information and communication services (Sood, 2002).

In such a context, it would be presumptuous for a researcher to second-guess issues of significance for the user. It is therefore important that the creation of new technologies for such groups

develops in continuous partnership and dialogue with primary users, and includes a thorough investigation into their worlds, lives, relations and concerns.

This article describes a study that investigated the design of a mobile phone for illiterate persons, including their expectations for the device, comprehension of the interface, and types of support which would be most appropriate. The study, carried out between December 2004 and July 2005, adopted a user-centred, incremental design approach with context of use forming the basis for the phone design. The study included iterative phases of understanding requirements, testing and fine-tuning the design, and was divided into two main phases:

Phase 1: Investigates what phone features illiterate users would like through an iterative process of questioning and probing, participatory design and continuous testing of prototypes using hardboard models.

Phase 2: Looks more broadly at context of use, and tries to understand how phone interfaces can incorporate the features considered in phase 1 and (eventually) adapt to users.

In addition to refining and developing requirements for the design of the phone interface, these studies raised important issues, challenged some of our preconceived notions and provided us with insightful lessons.

The paper is structured as follows: Section 2 presents the rationale for the study, and considers related work in the field. Section 3

* Corresponding author. Present address: Y004 Regency Park 2, DLF Phase 4, Gurgaon, Haryana 122002, India; Permanent address: 304, Captain Villa, Mount Mary Road, Bandra, Mumbai 400050, India. Tel.: +91 9873420538.

E-mail addresses: zereh.lalji@gmail.com (Z. Lalji), J.Good@sussex.ac.uk (J. Good).

describes the two main phases of the study; the empirical work, evaluation of the designs, and key findings. Through a comparison with related HCI studies, Section 4 concludes the paper by discussing how lessons learned from our study may be of use in the area of design for non-traditional users.

2. Related work

Mobile phone growth in India has been quite remarkable; with about eight million new additions in January 2008 (Gupta, 2008), India is projected to have the world's second largest mobile subscriber base before the close of 2008 (Singh, 2007). However, the growth has been asymmetrical, with little effect on the non-elite, illiterate segments of the population (Malik, 2006).

Nonetheless, among the emerging, non-traditional users, the mobile phone appears to be the more widely accepted ICT option at an individual level, as compared to the PC (Parbat, 2005; Sood, 2006), and holds great promise as a vehicle for bridging the digital divide.

Mobile communications have been found to contribute significantly to enhancing income and improving quality of life (Sood, 2006; Waverman, 2005). Government policies and subsidies (Jhunjhunwala, 2004), low call rates, content and handsets adapted for the Indian market are initiatives to push mobile adoption among the masses. For example, one of the most popular cell phones in India was the sturdy Nokia 1100 (Dubey, 2004), advertised as dust-resistant and with a built-in torch, since power supply is unreliable. A variety of handsets are also now available in a few regional languages. However, these initiatives are mere translations of their English counterparts. They require users to be able to read, write and be familiar with western concepts, symbols and classification structures in order to use basic features or navigate through the phone menu, thereby neglecting the needs of approximately 355 million illiterate Indians.

Many efforts are underway to investigate how technology can be designed to support illiterate users. Research has shown that low literate users prefer fully iconic interfaces (Shakeel and Best, 2002), and that audio capabilities can improve usability (Deo et al., 2004).

Devices that enable illiterate users to use a computer by favouring voice and visual communication over reading and writing are being developed on platforms such as PCs, PDAs and other handheld devices. These include the PCTVt (Spice, 2004), a low-cost PC with multiple other functions, a Global Positioning System (GPS) field computer for animal trackers (Blake et al., 2001), and the Simputer (Simputer.org), an inexpensive PC alternative that permits sharing through a smart card.

Strategies such as the *training wheels* concept (Carroll and Carrithers, 1984), layered designs and scaffolding techniques (Shneiderman, 2000, 2003; Soloway et al., 1996), introduce new users to complex systems by initially limiting actions, functions or features, thus facilitating learning, and reducing user frustration and errors. Layered designs, similar to those used in games, separate out features according to their complexity and gradually introduce users to features and techniques as they acquire skills and expertise (Shneiderman, 2003). Scaffolding techniques assist users in engaging in activities that would otherwise be beyond their abilities (Soloway et al., 1996). Scaffolding may be adapted automatically, as in Intelligent Tutoring Systems (Beck et al., 1996), or it may be user controlled (Jackson et al., 1998).

As described earlier, illiterate users are likely to have markedly different life experiences from designers. This has obvious implications for design approaches. User-centred design (UCD) approaches seem ideal, given their focus on the user throughout the design and development lifecycle (Preece et al., 2002). User involvement throughout the design also helps in progressively testing and fine-tuning the prototypes.

UCD approaches such as contextual inquiry and participatory design have been used to design new technologies for underserved users in emerging economies (Blake et al., 2001; Parikh, 2003; Sood, 2003). However some consider that gaining access to such participants can be time-consuming and expensive. For such cases, Huenerfauth (2002) has proposed Hypothetical User Design Scenarios (HUDS), a scenario-writing approach through which designers can distil their ideas, and think through potential interface problems. While this approach may be time and cost effective, the design process is not guided by empirical data and may therefore run the risk of making incorrect assumptions about users. A user's latent needs or reservations may never surface. In contrast, although the approach described in this paper used scenarios and personas, they were developed only after ample interaction with potential users, and an initial requirements gathering phase.

The literature reviewed here forms the foundation for our study. While projects that deal with illiteracy provide cues for the interface design, universal usability strategies of layering and scaffolding form the basis for exploring the concept of an adaptive interface.

3. Study description

3.1. Methodology

The study was a single long term study that adopted an incremental design strategy and was divided into two broad phases: the first focused on the phone features and their relative usability, while the second focused on the context of use and explored the possibility of an adaptive interface incorporating features considered in the first phase. In both phases, a needs analysis stage was followed by prototype development and testing.

Needs were identified through semi-structured interviews and exploration exercises. A participatory design session was also conducted in phase 1 to understand how participants perceived certain concepts.

Low and mid-fidelity prototypes were developed and tested in phase 1, and a high-fidelity prototype that mimicked a phone interface was developed and tested in phase 2 using a Nokia 6681 phone.

Sessions had an informal feel, and were conducted in Hindi at the participant's place of work.

3.2. Participant sample

Our study concentrated on illiterate blue collar workers from Mumbai, a large metropolis in India, who were aware of mobile phones, and had direct or indirect access and exposure to technologies. While different sets of participants were recruited in both phases, they had a similar profile. Most participants did not know their actual ages and gave approximations ranging from late teens to late fifties. They had come to Mumbai looking for work and kept in touch with family back in their villages. Most lived in a rented room with family members or friends from their village.

Some participants had been to elementary school. They could not read or write, a few stated that they did not recognise numbers, but most could calculate using their fingers. Most married women said that their husbands and children were educated.

3.3. Phase 1

The first phase of the study, carried out with 5 participants (3 females and 2 males) served as an initial inquiry to better understand the mobile phone features an illiterate person would desire.

3.3.1. Identifying needs

Needs were identified through interviews, an exploration exercise, and a participatory design session, described below.

3.3.1.1. Interview findings

3.3.1.1.1. Awareness and perception of mobile phones. Participants were aware of, and desired mobile phones. However, they did not feel clever enough to use them, and would like to be 'taught'.

"...You need to be educated to use these phones..."

"...My employer gifted me his old phone. I it sold for Rs. 500 as I found it difficult to use".

3.3.1.1.2. Reasons for wanting a mobile. Participants wanted a phone to improve their businesses, and for contact with their families, as it was not possible to get telephones in shanties where they lived, or for their families back in the villages.

"...My neighbour, a door to door vendor got an inexpensive mobile phone and gave his number to customers. Now he has a cart in the market and additional help for home deliveries..."

3.3.1.1.3. Calling habits. Participants used public pay-phones, or a neighbour's telephone to make calls.

"...I call my family at a fixed time from a public phone every Sunday. There is no phone in our village and we have to walk to the next village." She adds, "...I look forward to speaking with my family all week and it's frustrating if either of us cannot make it at the scheduled time. It's a waste of money and time..."

3.3.1.1.4. Coping with words and numbers. Participants' faculty of association and recall was highly developed. While some important phone numbers were memorised, others were written down for them in their 'telephone diaries'. Numbers were identified by the handwriting, page number, a distinguishing mark beside the number, or the ink colour (Fig. 1).

Participants stated that they could not tell time, but knew when it was time to go by looking at the hands on a clock/watch. They could not write a 2 or a 7 and were hesitant when asked spontaneously to identify the numbers, but could match numbers from a piece of paper or knew the number 27 bus (Fig. 2).

They could use basic features of a TV remote.

3.3.1.2. Exploration exercise. Participants were asked to make a dummy phone call using a landline, a cordless phone and a Nokia 6610i in order to better understand comprehension and comfort levels with each (Fig. 3).

- They made phone calls by matching numbers on the dial pad to numbers that were printed for them.
- They hesitated when asked to use the cordless phone, but had no difficulty using its keypad or that of the landline. They found the numbers on the mobile phone's alphanumeric keypad difficult to read.
- When using the mobile phone, all participants waited for the dial tone. They did not know that they had to press the green button to confirm an action, and the red button to disconnect.
- Most participants identified the camera and radio options in the Nokia 6610i menu, but other menu options made no sense (Fig. 4).

3.3.1.3. Participatory design sessions. Participants were asked to draw common menu concepts such as a telephone diary, radio, torch, voice mail and camera.

Participants' interpretation of concepts and objects that were tangible, and with which they were familiar, was fairly unproblematic: see Fig. 5.

However we received some interesting compositions for novel concepts such as voice mail: see Fig. 6.

3.3.2. Low-fidelity prototype development and evaluation

Based on the findings from these sessions, an interface with simple graphics, animations and voice instructions in the users' local language was proposed. Three designs were developed iteratively. For each design, hardboard models were tested and refined based on participants' frustrations, reactions and requirements. While each interface had simple audio-visual instructions, the number of features, presentation and type of graphics, and even the physical model of the phones were altered depending on participant feedback. Sometimes sketches were drawn spontaneously while testing a particular model in order to ascertain whether slight alterations to the same design would work better.

Post-it notes were used to simulate screen changes while corresponding voice instructions were read out in the participant's language. Participants were asked to think aloud during the tasks, and asked about the meaning of certain icons.

3.3.2.1. Design 1. The first prototype was a touch-screen phone with a telephone diary, camera, radio, voicemail, and torchlight (Fig. 7, Prototype 1a). Prompts and instructions were given through animations supported with voiceovers.

The concept of a 'touch-screen' seemed to make participants uncomfortable as they said their hands were not always clean, therefore participants were asked to access features via the numeric keypad. Some participants found identifying numbers difficult; colours therefore replaced numbers, with the colours on the keypad matching those of the pictures on the screen (Fig. 7, Prototype 1b) to facilitate easier connections between the two.

Some icons made little sense to participants; the radio button, a headphone with musical notes, a western concept, was not something they could identify with. One person thought the musical notes were birds (Fig. 8, left). The speaker icon was mistaken for the torch and the 'Up' and 'Down' buttons had to be pointed out to most participants (Fig. 8, right).

Although participants were initially excited by all of the features, they became confused with the numerous instructions, and gave up while going through the tasks, saying that they were not clever enough to use mobile phones.

3.3.2.2. Design 2. The number of features, and steps required to access the features, were reduced in the second design, which included a telephone diary, radio, torchlight, and a camera for



Fig. 1. An example of a telephone diary.



Fig. 2. Numbers and letters turn into symbols: local bus in Mumbai (left) (Mahajan, 2006). Indicator at the train station (right) (Kumar, 2007).



Landline and cordless phone (left). Nokia 6610i (right)

Fig. 3. Phones used in exploration exercise: landline and cordless phone (left). Nokia 6610i (right).



Fig. 4. Some icons used in the 6610i menu.

attaching a photograph to a number in the telephone diary. All features were accessed through the keypad. The use of voice supported by animations was maintained.

We experimented with the placement of the 'Up' and 'Down' arrow keys to access and scroll through the telephone diary. These were initially placed above and below the screen (Fig. 9, Prototype 2a), however when participants did not understand the concept of highlighting a particular entry in the telephone diary, we tested a second option, where users were presented with a single choice in the telephone diary (Fig. 9, Prototype 2b).

This design seemed to work better, but the telephone diary still posed a memory overload for the participants, who quickly forgot how to access and use the feature.

3.3.2.3. *Design 3.* The final design did not include the telephone diary, but simply enabled people to make and receive calls. The radio and torch were included, as their perceived value was much greater than expected, and access via a single button press made them easy to recall and use (Fig. 10). Participants were however disappointed by the absence of the camera.

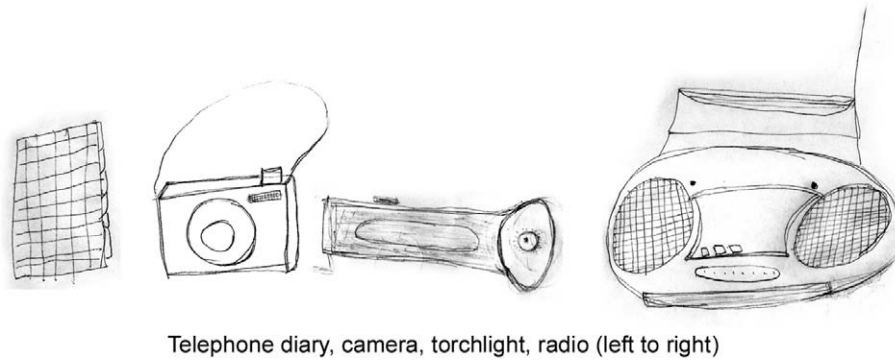
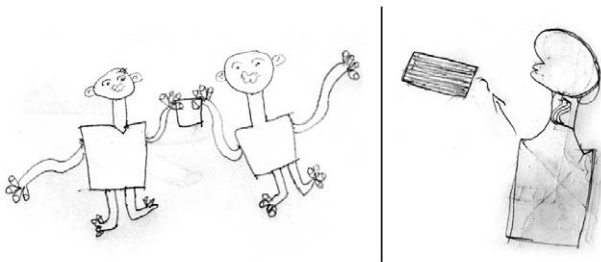


Fig. 5. Some drawings of objects familiar to participants: (left to right) Telephone diary, camera, torchlight, radio.



Participants' interpretation of voice mail that was explained as something similar to a talking telegram (left). In another rendition (right); the curvy lines in what looks like a person's neck is the voice which is being sent. The arrow points to the letter that is on its way.

Fig. 6. Drawings of unfamiliar concepts: a participant's interpretation of voice mail that was explained as something similar to a talking telegram (left). Another rendition of voice mail. Here the curvy lines that appear in what looks like a person's neck is the voice which is being sent. The arrow points to the letter that is on its way (right).



Fig. 8. Some icons used made little sense to participants: headphone icon (left) and speaker icon (right).



Fig. 7. Prototype 1a (left) and 1b (right).



Fig. 9. Prototype 2a (left) and 2b (right).

3.4. Phase 2

Although multiple options, and 'feature rich' phones excited the participants, using the phones frustrated and confused them. We therefore felt that when introducing a technology to such users, it must be simple, with features restricted to core necessities. However, we could not disregard the desire to learn, and therefore

wanted to explore the idea of an adaptive interface that would support illiterate users in learning to use the phone.

The second phase started with an investigation aimed at understanding the broader context of use, in particular:

- users' everyday living and working conditions;
- their need for a phone – who, how often, and from where do they call, and reasons for using a phone;
- their use of other technological products like TVs, radio, etc., and how they learnt to use them;
- their level of self-confidence – who makes the decisions, whose advice do they seek, and how do they cope with new products or situations, e.g. a TV, radio, travelling by bus, a public phone, etc.;



Fig. 10. Prototype 3.

- their perception of mobile phones;
- reasons, if any, to own a mobile phone;
- amount they are able to spend on one.

In order to better understand the issues relating to the use and ownership of mobile phones, we focussed on two different populations: mobile phone owners, and non-owners. It was also decided to include a larger male sample in this study.¹

Group 1 comprised 22 participants (14 males, 8 females) who did not own mobile phones.

Group 2 comprised eight mobile phone owners. Not surprisingly, all participants were male. Some were vendors operating in a residential area, others in a wholesale flower and vegetable market.

3.4.1. Identifying needs

3.4.1.1. Interviews. Different questionnaires were devised for each participant set. The questionnaire given to people who did not own mobile phones focused on family background, telephone use, technological know-how, and knowledge about telephones and mobile phones (Lalji, 2005).

The questionnaire for those who owned mobile phones primarily focused on their family background, and their knowledge about mobile phones (Lalji, 2005).

3.4.1.1.1. People who do not own mobile phones.

Decision makers

- While all respondents contributed to their household income, male family members were the predominant decision makers.
- Self confidence was not very high even among male respondents; only 9% of the male respondents considered themselves to be key decision makers in their homes. Fathers and brothers,

even those in villages, were mentioned as the central figures. Female respondents cited sons, husbands, or fathers as the main decision makers.

- A small percentage of male respondents, 9%, referred to their wives as important decision makers. Interestingly, these respondents stated that their wives could read and write.

Telephone usage

- Eighty-six percent of respondents claimed to have a need for a telephone. Sixty-four percent said that they use a telephone 1–2 times per week, 5% have a daily need, 18% need it once or twice a month, while 14% do not make phone calls.
- Most participants used a phone to call family in their villages, or when required to give an urgent message to family members. Calls are usually made from public telephones or a neighbour's house, with some also using a family member's or friend's mobile phone. However, these same people also said that they had never *used* a mobile phone: the phones were borrowed if there was an incoming call for them, or the number was dialled for them by their friends.
- While 71% of male respondents said they can dial on their own, only a quarter of the female respondents claimed to do the same, stating that they were afraid of dialling the wrong number. However, none made a mistake when dialling using the mobile phone.
- They said that they usually dial only 3 or 4 numbers, which they have memorised. Some mentioned having numbers written down for them, or depending on husbands, children or even the man in charge of their local public phone to give them the numbers.
- Participants who called their families in the village stated that they made calls to a public phone or a neighbour's house as their families did not have telephones. Some arrange a specific time with their families for phone calls, or ask neighbours to send for a family member and then call back in 5–10 min. This sometimes led to missed calls or delays.

Technological know-how

- Seventy-three percent of participants owned a TV and could operate it themselves. While the male participants said they learnt how to use it on their own, or by observing someone, women stated that they had been shown by their husbands or children.
- Less than half of the participants owned a radio, with some not wanting one because of the additional cost for batteries.
- Most had had their pictures taken and were aware of cameras, but very few had ever used one.

Knowledge about mobile phones

- A majority of the participants stated that they had seen advertisements for them and were aware of the features available. Features mentioned included:
 - Enabling people to stay in touch (73%)
 - Radio (23%)
 - Camera (23%)
 - Games (9%)
- Female participants, who used their husbands' phones, said that they were shown to press the green button to answer the phone and red to end a call *only if* the phone rang and nobody was around to answer it.
- Fifty-nine percent of the participants said that they thought mobile phones were easy to use (by which they meant pressing the green and red buttons) despite not having really used one.

¹ According to Ruchika Gupta (ruchika.gupta@nokiaIndia.com), Manager–Consumer Insights, at Nokia India, men are the primary adopters of mobile phones in India. She therefore recommended that the study have a larger male sample size.

Need for a mobile phone

- The primary reason for wanting a phone was to keep in touch with family. In addition, male respondents, primarily vendors and hawkers, mentioned mobile phones as a means of growing their businesses by enabling them to check market rates, offer free home delivery, or make them contactable by clients thus saving on time and travel cost.

Amount willing to spend

- Seventy-seven percent of participants felt that mobile phones were still expensive and were waiting for them to become cheaper. The amount participants were willing to spend ranged from Rs. 100–200 (£1.25–2.50) to about Rs. 3000 (£37.50).
- The maximum response, 25%, was for up to Rs. 2000 (£25). Twenty percent said up to Rs 1000 (£12.50), and another 20%, up to Rs. 1200 (£15). Fifteen percent said that they could spend up to Rs. 3000 (£37.50).

3.4.1.1.2. People who own mobile phones.

Decision makers

- Sixty-three percent considered themselves to be the chief decision makers in their homes. The rest mentioned a brother, who had either given the phone to them as a present, or advised them to purchase one, to be the major influence in their lives.

Calling habits

- Those who own mobile phones use it primarily to keep in touch with family, to facilitate business and for incoming calls. Public phones are used when calling someone in the village as the rates are cheaper.

Knowledge about mobile phones

- All participants stated that they were taught to use a mobile phone by someone. Phones were primarily used to make and receive calls. Few used the telephone diary, and one stated that he played games taught to him by his son.
- Participants stated that they mainly called only 3 or 4 numbers which were saved for them by someone else. They recognised the numbers and could therefore use the telephone diary with relative ease.
- Some mentioned that their phone automatically stores the number they dial – referring to the last dialled number feature on the phone, used as a de facto telephone diary.
- The majority (63%) stated that the phone was easy to use as all they had to do was press the green and red buttons.

Reasons for owning a mobile phone

- All participants stated that the primary reason for owning a mobile phone was for business. In addition 75% stated that it was useful to keep in touch with family and friends.

Investment cost

- Those who bought phones stated that they spent between Rs. 2500 (£31.25) and 3500 (£43.75); others said that their phones were given as gifts.

3.4.1.2. Task performance. At the end of the interview, participants not owning mobile phones were asked to identify the various buttons and make a dummy phone call using first a Nokia 6610i, and then a hardboard model with a simple numeric keypad and well defined buttons (Fig. 11).

- Although all participants dialled the number given to them successfully, either on their own, or by matching numbers to those on the paper, they found the numbers on mobile phone's alpha-numeric keypad difficult to read. Some participants confused the '6' and the '9' keys.
- The use of a single button for two actions posed a problem, as in Fig. 12, where the 'Options' and 'Confirm' functions are accessed through the upper and lower halves of a single button.
- Participants said that they found the keys on the hardboard model easier to read. The green, red, blue, radio and torch buttons were also identified easily.
- Participants seemed happy with the easy access to the radio and torch, and were excited that they would not have to spend money on batteries, as they would for a standard radio or torch.

3.4.2. High-fidelity prototype development

The overriding need was for a phone that would enable a person to make and receive calls. However, as the phone represented a substantial financial investment, it also needed features that were deemed to be of value, such as a telephone diary, radio, torch and camera. Finally, with low levels of self-confidence, it was imperative that using the phone did not discourage or de-motivate users.

We thus explored the concept of an adaptive mobile phone interface for illiterate users that would offer features according to the user's level of competence while assisting them in learning to use those features. This exploration led to the development of a series of high-fidelity prototypes, described below.

3.4.2.1. Design philosophy. A learner-centred design (LCD) philosophy was applied to the design of the prototype, using the TILT model (Tools, Interface, Learner's needs, Tasks) (Soloway et al.,



Fig. 11. Mobile phone (Nokia 6610i) and Hardboard model used for the task.

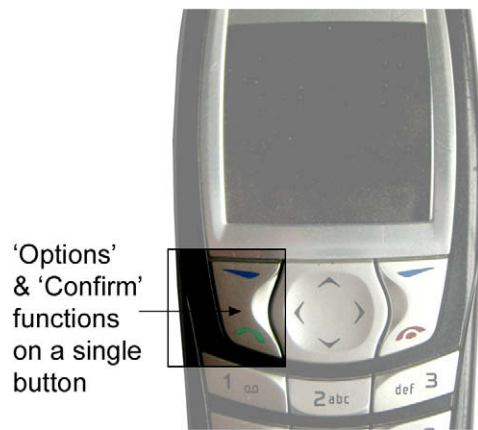


Fig. 12. A single button used for 'Options' and 'Confirm'.

1994). According to the LCD philosophy, users as learners have a unique set of needs, which are growth, diversity and motivation (Soloway et al., 1994, 1996). In the TILT model, the learner's needs are central, and can be addressed by incorporating appropriate scaffolding into the interface, tasks, and tools (Fig. 13).

This approach would enable users to achieve task goals, for example, add a number to the telephone diary (user-centred), while helping them learn to perform those tasks (learner-centred) (Soloway et al., 1994). In the design of the prototype, scaffolding such as step-by-step instructions, contextual help (*coaching*); increasingly complex layers (*adaptability*); and the use of colourful graphics, voice instructions in the user's language, animations, and photographs (*different media*) were incorporated into the tasks, tools, and interface to address growth, diversity and motivation.

3.4.2.2. Prototype description. At this stage, our prototype was not 'intelligent', in that there was no user model determining when adaptations should take place. Instead, three separate versions of the interface, increasing in complexity and the number of features offered, were developed (in an adaptable/adaptive model, these versions would act as increasingly complex layers, revealed to users as they became more proficient). Each version worked independently and simulated the various actions associated with it such as dialling a number, adding a number to the telephone diary, playing the radio or taking a photograph. The versions made use of simple graphics, had voice instructions in the users' local language,² and were implemented in Macromedia Flash. As target users seek advice from male relatives and friends, we decided to use male voiceovers recorded in both Hindi and Marathi.

3.4.2.2.1. Version 1. Functions as the first layer enabling users to make and receive calls. On pressing a number key, a voiceover of the corresponding number is heard. A radio can be accessed directly via the 'Radio' button.

If the user presses the 'Blue' help button while performing a particular action, contextual help is offered. Otherwise, they are given default help demonstrating how to make a phone call (Lalji, 2005).

3.4.2.2.2. Version 2. In addition to the above, this version has a telephone diary. In an intelligent interface, the telephone diary would be offered when users no longer need help to make calls, or if they call a particular number frequently. At the end of a phone call, users are asked if they would like to save the number in the telephone diary. On confirming, they are prompted to take a picture

of something that will remind them of who the number belongs to. Users are taken through the process of adding a number to the telephone diary with step-by-step instructions (Lalji, 2005).

Given the fact that most participants call very few numbers, and that phone cost is a concern, we explored an alternative to camera use whereby, instead of a photograph, a graphic image can be selected from a list and assigned to a number (Lalji, 2005) (Fig. 14).

Numbers saved in the telephone diary can be accessed via the 'Up' and 'Down' buttons. Contextual help is present, and the default help informs users that they can make a phone call by dialling a number or selecting one from the telephone diary (Lalji, 2005).

3.4.2.2.3. Version 3. With a hierarchical menu-based interface, the third version is closest to current mobile phones. On pressing the 'Up' and 'Down' buttons, the user is presented with a menu with two options – a telephone diary and a photo album (Fig. 15). The photo album option enables users to view or delete photographs. Selecting the telephone diary provides another two options – adding or accessing a number. The decision to carry out actions such as adding a number to the telephone diary, or viewing photographs, now lies with the user.

Similarly, if users take a picture by pressing the 'Camera' button, they are asked if they would like to assign a number to the picture, or add it to the photo album.

While contextual help still exists, the default help only provides an overview of the various buttons (Lalji, 2005).

3.4.3. High-fidelity prototype evaluation

The aim was to understand:

- How participants use the phone and its features.
- Their comprehension of graphics, language for instructions, and buttons.
- Whether the order in which the versions were presented influenced participants' comprehension and use of features.
- Their reaction to the product and the effect of the interface on their level of confidence.

The prototype was tested with 18 participants, 12 males and 6 females. Both the Hindi and Marathi versions of the interface were loaded on to a Nokia 6681 phone for testing. Interview respondents had expressed difficulty with an alphanumeric keypad; therefore images of single bold numbers were stuck on the phone (Fig. 16).

As evaluations were conducted at the participants' places of work, which was sometimes a noisy marketplace, a headset was used.

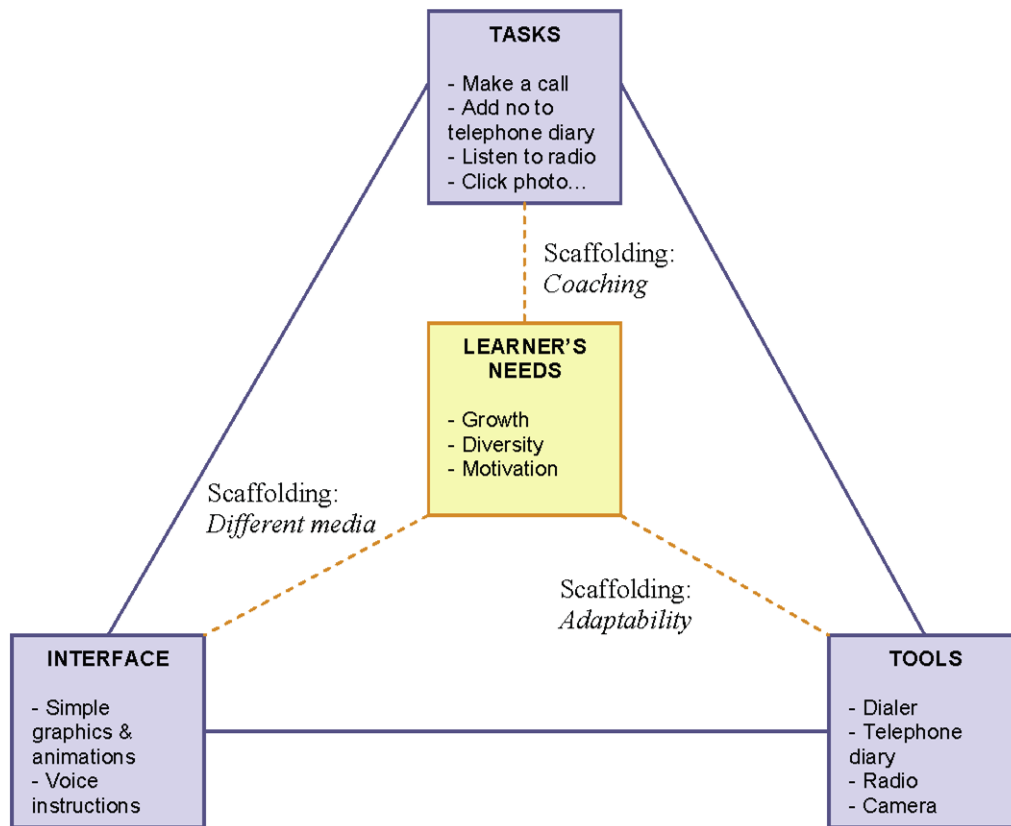
One version of the interface was tested per participant per day in either sequential or random order to establish if the order of presentation influenced participants' understanding in any way. Participants were asked to perform certain pre-determined tasks associated with each version (Table 1). Session length varied from 15 to 30 minutes, and the entire study took place over a period of 9 days.

3.4.3.1. Key findings.

3.4.3.1.1. Use of the phone, its features, and participants' comprehension of graphics, language, and buttons.

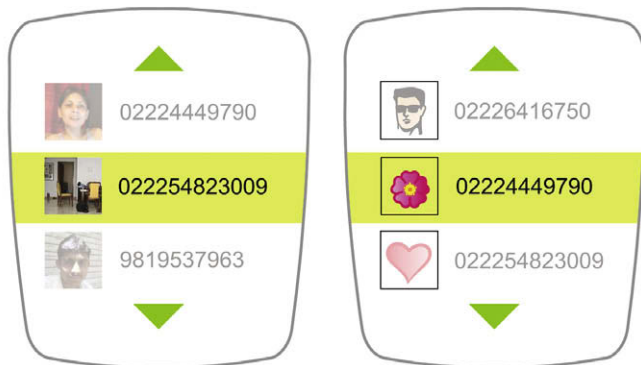
- Participants followed step-by-step instructions successfully. However, if a set of instructions had multiple steps or more than one action, some participants followed the first prompt without waiting until the instructions were complete.
- Although voice instructions made it easy for participants to perform actions, when asked why they were doing something, they often said it was because the phone told them to do so.
- Participants could not remember recorded instructions even after hearing them a few times, but did so when told what to do in person.

² The prototype was developed and tested in Hindi, the most widely spoken language in India, and Marathi, spoken in the state of Maharashtra.



Design of the interface using the TILT model. As adapted from Soloway et al. (1994)

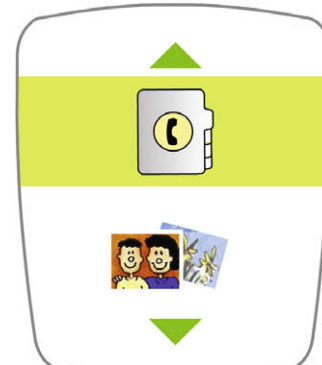
Fig. 13. Design of the interface using the TILT model. As adapted from Soloway et al. (1994).



Telephone diary with photographs. Users can take a picture of anything that will serve as a reminder of the number

Telephone diary with a choice of graphic images

Fig. 14. Telephone diary with photographs (left) and with graphic images (right).



Main menu displaying the telephone diary and photo album option

Fig. 15. Main menu in version 3.

- Placement and colours of buttons confused some of the participants. Although they identified all the buttons correctly, participants often pressed the green button when 'instructed' to press the blue and vice versa.
- All participants were very excited by the radio.

- One participant thought he had to press the 'up' and 'down' arrows to change radio stations.

3.4.3.2.2. Version 2.

- While accessing the telephone diary, the instructions said to press the 'up' and 'down' buttons to find a number, so participants were literally only pressing the 'up' and 'down' buttons, thereby toggling between 2 numbers.
- One participant thought the telephone diary was like a reference and on finding the number she was asked to call in the telephone diary, started typing in the number instead of simply pressing the green button to confirm.

3.4.3.2. Issues specific to each version.

3.4.3.2.1. Version 1.

- After dialling, some participants did not press the green button; on asking them why, they said they were waiting to be instructed by the phone.



Fig. 16. Nokia 6681 used for testing of the prototype.

Table 1

Tasks associated with each version.

Version	Tasks
Version 1	<ol style="list-style-type: none"> 1. Identify the various buttons 2. Make a call and disconnect after hearing "hello" 3. Dial an incorrect number, clear it with the red button, and then dial the correct one 4. Listen to the radio and change stations
Version 2	<ol style="list-style-type: none"> 1. Make a call and save the number to the telephone diary 2. Phone a number from the telephone diary 3. Listen to the radio and change stations
Version 3	<ol style="list-style-type: none"> 1. Phone a number in the telephone diary 2. Save a number to the telephone diary 3. Click a picture and add it to the album 4. Go to the album, look at the pictures, find the picture of the dog and delete

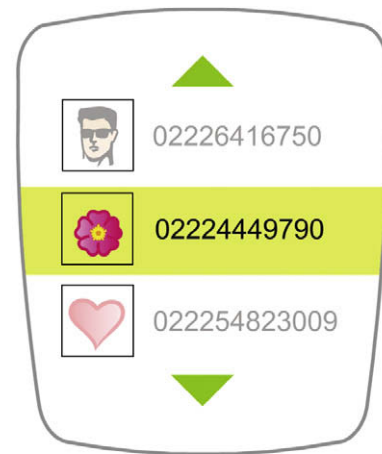
- The green highlight made little sense, and participants pressed the green button once they saw the picture they were supposed to call on the screen. (Fig. 17).

3.4.3.2.3. Version 3.

- Participants understood concepts like adding a number to a telephone diary or accessing a number from the phone diary in principle, but seemed bewildered by choosing features from a menu-based hierarchical structure.
- After taking a picture and adding it to the photo album, two participants thought they had to press the camera button to access the photo album.

3.4.3.3. Influence of presentation order on the participants' comprehension and use of features.

- Participants needed to be presented with either version 1 or 2 before version 3 as the last version did not have help explaining how to make a phone call.
- After testing all three versions, participants were asked if they thought version 3 was too complicated for them and whether they would like a phone that allowed them to only make calls (version 1) or one with only a telephone diary (version 2). All of them said that they found it complicated because they had never used a mobile and that they just needed a little time to get the hang of it; otherwise it was not that difficult.



When asked to call the number associated with the heart, participants would press the green 'Confirm' button as soon as they saw the heart on the screen

Fig. 17. Highlight made little sense.

3.4.3.4. Reaction to the product and the effect of the interface on their level of confidence.

- Confidence levels appeared to be higher after using each interface, and tasks were performed without too much effort. Initially some participants were reluctant to hold the phone and asked for confirmation before pressing a button. By the second day however, they followed instructions on their own. Participants said that they found the phone easy to use, and were surprised they could use it as they had never used a mobile phone before.
- After performing a certain task 2–3 times, participants stopped waiting to hear the instructions and pressed buttons, remembering the order on their own, all the while 'thinking aloud' while performing the action. They were also randomly asked if they could perform certain actions such as adding a number to the telephone diary without the aid of the headset, and most succeeded.

4. Lessons learned

The collaborative, user-centred design process adopted for our study enabled us to obtain information directly from users on their needs and experiences of the product in question. It also challenged some of our preconceived notions and issues that we took for granted. Below, we discuss some of the key insights which arose from our study, and contextualise these findings by comparing them to other HCI studies which focus on the design of technology for non-traditional users.

4.1. Nature of adaptation

We found that although the interface was successful in facilitating and encouraging participants to use the phone and its features, an interface that regulates the introduction of features may not be necessary. The order in which the versions were introduced did not affect the comprehension of features; participants did not have problems using the telephone diary in version 2 or the photo album in version 3, albeit with instructions.

We now feel that the adaptive nature of the phone should focus on the instructions given, rather than the features. At the outset, users need to be carefully scaffolded, with no more than one

instruction at a time. As confidence increases, the scaffolding can cover more than one instruction and/or the instructions can be couched at a higher level of abstraction.

When instructions are no longer needed, a voiceover which simply states what the user is doing (e.g. reads out the number that is pressed) will reassure users that they are not making mistakes.

4.2. Instructions

Step-by-step instructions not only proved to be more effective than the help button, but were preferred by participants: none used the help button when step-by-step instructions were available. Participants easily forgot what to do when instructions involved more than two actions. After pressing the help button, participants would often not wait to hear it completely, but would start carrying out the first action. They then waited for the phone to prompt them, or pressed the help button once again for the next set of instructions³ using it like step-by-step instructions.

In such situations, it might be helpful to resume contextual help from the last action performed by the user, rather than from the beginning. Alternatively, the next set of instructions can be given automatically in case of prolonged inactivity.

We also found that not only was it important that the participant received instructions in a language with which they were comfortable, but also the words used were important. When instructed to scroll, many participants would merely toggle using the 'up' and 'down' arrow buttons, or press one of the buttons and then stop. In the instructions, we had used the word '*Athva*', meaning '*either*' or '*or*' in Hindi, rather than the more colloquial '*ya phir*'. When asked if they understood the term '*Athva*' none of the participants said they did. Thus, if support is language based, choice of words and phrasing must be given as much thought as the development of the visual interface.

4.3. Access and control

Certain methods for accessing and controlling features worked better than others. Direct access to features such as the radio, camera, or telephone diary through single-click actions was most effective and had the highest recall. In contrast, the use of a single button for a number of actions, or access to a particular feature in multiple ways proved confusing.

The use of lists seems far more effective than a hierarchical classification. Participants remembered that they could use the 'up' and 'down' buttons to scroll through lists, but easily forgot how to access features when presented with a menu-based interface.

In another study with functionally illiterate animal trackers, researchers similarly found that trackers preferred to locate animals in a mixed list rather than from a hierarchical classification, using the exact positions of each animal to assist them in subsequent searches (Blake et al., 2001).

Moreover, while scrolling using the 'up' and 'down' buttons seemed to make sense to the participants, the highlight was ignored. In addition, pressing the 'down' arrow button caused the list to scroll up, and vice versa (as in the telephone diary list), confused users. Thus while lists may prove to be more useful than a hierarchical structure, effective ways of drawing attention to a selected object need to be explored.

Finally, over-cluttered buttons, such as alphanumeric keypads, seemed to pose problems and should be avoided for such users.

4.4. Icons and symbols

Different cultures use similar symbols in different ways, or different symbols entirely. In our study, musical notes, a western concept, were mistaken for birds. Secondly, there is an assumption that icons somehow replace text, making them ideal for the illiterate user. However, icons are best understood when accompanied by textual descriptions (Weidenbeck, 1999), otherwise, they are far from comprehensible (see Fig. 18).

While non-traditional literate users may still be able to cope with such unfamiliar metaphors through accompanying text, illiterate users would be at a loss.

Likewise, the button placement and colour needs to be considered carefully, particularly if instructions direct users to identify different coloured buttons. We found that although participants identified all the buttons correctly, they often pressed the green button when 'instructed' to press the blue, and the other way round. It may have been the proximity of two similar colours or the prominent central placement of the blue button.

4.5. Context of use

People do not interact with technology products in a vacuum. In order to develop products and systems of desire and value, it is extremely important to understand their use in a holistic context.

Working with users changed our way of thinking about a design concept, and forced us to look at alternative interaction modes when we found participants unfamiliar with the concept of a touch-screen. Participants had never used a touch-screen product before and said they would be uncomfortable using a touch-screen as their hands were not always clean. Further, Indians often use plastic cases to protect products from damage. The second hand market is well established in India, and products in good condition have a higher resale value. In such a scenario it would be hard to imagine how successful a touch-screen phone would be without taking into account dirty hands, or sturdy plastic cases.

Similarly while most people found value in associating a photograph with a phone number, they asked why they would need a photo album if they could not print the pictures. A radio and torch appeared to be of more value to them.

Thus any design that does not look beyond the obvious and take into consideration the broader context of use is likely to fail.

4.6. User inspired design solutions

Rather than challenge the user with abstract concepts and features, the users' mobile experience could be improved by drawing inspiration from their abilities, everyday practices, and work-arounds (Chipchase, 2005).

Interviews with participants found that telephone numbers are identified by the handwriting, colour of ink, or user created symbols next to phone numbers. The motivation for the use of graphic images and photographs to attach to phone numbers in the telephone diary came from this everyday practice. Another option could be allowing users to create their own symbols by having a tiny handwriting recognition area on the phone. In this case everyday objects such as a hairpin, or a painstakingly painted pinky nail⁴ could be used as a stylus.

By maximising the user's ability to speak rather than read or write, the phone could have a telephone diary with voice tags at-

³ This trend was observed when using the help button, but not step-by-step instructions.

⁴ Something we observed among Indian men from the lower income bracket – some men had grown their little fingernail for no apparent reason and often had a bright colour nail varnish on it. They always seemed to be sticking it out gingerly as if to protect it from damage.

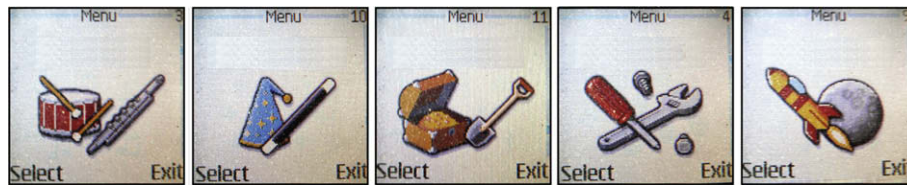


Fig. 18. Nokia menu without supporting text.

tached to each number. The user could say who the number belongs to while adding it to the telephone diary which would get recorded and played back to the user while accessing or receiving a call from that number.

We also found that the last dialled number log was used as a de facto telephone diary. Thus rather than forcing the user to use a telephone diary through a complicated menu, such work-arounds could be capitalised on to inspire design.

4.7. Motivation and self-confidence

We found that the problems people experienced were less about cognitive issues than confidence levels. According to Brosnan (1998), psychological factors such as apprehension, intimidation, fear of doing something wrong, looking stupid or even damaging the equipment could result in the avoidance of computer technology (Brosnan, 1998). None of the participants had ever used a mobile phone before and their perceived self-efficacy was extremely low. While recruiting participants for the study, many said that they were not the right candidates; “I’m not educated, test it on him, he can read and write...”. However, they agreed to participate when told that the phone was especially for people like them, and given an assurance that they could drop out at any point if they did not feel comfortable.

At first, participants’ reactions varied from reluctance, or refusal to hold the phone or press the buttons (they asked the researcher to hold it and press the buttons they pointed to), to asking for approval before pressing a button. However, by the second day, they seemed more confident, following instructions on their own. An interface with voice instructions and simple graphics did boost confidence levels. We also found that starting the experiment with a task that was entertaining as well as easy like using the radio played an important role in encouraging participants.

4.8. Prototype

While developing or validating a novel technology product or concept with a group of uninitiated or illiterate people, there are issues around trying to explain the notion of a prototype, what the design process consists of, and what their role in the process can be.

At the time of our study, the phone that we used to test the prototype, the Nokia 6681, was a few days away from an official launch in the Indian market. Participants were explained that the phone was only a “model” and that the final product would look different. They said they understood, but were extremely curious about what the cost of the phone would be. They were told that if the phone were to be developed, it would be modestly priced. Two days later, when we went back for another round of testing, a man approached us with a half page advertisement in the newspaper saying that the phone that we were developing had been launched by Nokia and that we should be ashamed of ourselves for making such an expensive phone for the poor.

Other participants, even after being told that all actions were simulated, believed they were making a real phone or taking a pho-

tograph. They responded to the “hello” voiceover used in the interface, and thought that the person on the other end had hung up when they did not get any further response.

Not only is it hard for such users to understand the idea of a prototype, but also difficult for them to imagine how the product may work in cases where they have not used a similar technology or form of interaction.

5. Conclusion

A user-centred design process provides a valuable framework for developing products that people will enjoy and want to use, as it ensures that the product or technology being developed will meet the needs, demands, and desires of real users. This process is all the more important in the case of designing for non-traditional users in developing countries as their life experiences are likely to be markedly different from those of the designers. Involving the user throughout the design process also helps in progressively testing and fine-tuning the prototypes by exposing the shortcomings and strengths in the design.

One thing which becomes clear when carrying out participatory, iterative design of this type is the crucial role of context of use. In addition to investigating the relative usability of the phone’s features, many other, more subtle issues arose which were unrelated to pure usability factors, e.g. the reluctance to use touchscreens. Design approaches which involve the user provide rich data, and a nuanced view of the broad context of the user’s daily experience. By their very nature, findings gleaned from such investigations cannot, and should not, transfer to different contexts. Nonetheless, we hope to have flagged up some important issues and challenges in designing for non-traditional users which can provide a stimulus to individuals looking to design technology for use in a wide variety of contexts.

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