

Evolving Wireless User Interfaces

By David Crowe

What is visible when bad but invisible when good?

Not that naughty 2-year-old (they usually behave in quite the opposite fashion). The answer is a user interface – something that evokes sighs, groans and even curses when badly designed, but is completely taken for granted when perfected. User interfaces were “happenings,” not designs, with early cellular phones, but over the last decade they have become a critical differentiating factor.

A Touch of History

The first commercial cellular phones in the 1980s were cumbersome, with the radio in the trunk of a car and the handset several times larger than any cellular phone available today, and the user interfaces were primitive. They provided a touch-tone telephone keypad supplemented only by SND (no room for the “E” on most phones), END and perhaps CLR to round out a three-by-five keypad matrix. The display gave the user a line of LCD digits and a couple of indicators such as home versus roam and an in-call indication.

The basic architecture of cellular phones dramatically increased capacity from previous systems. This huge benefit meant it was some time before anybody complained

the only thing you could do with the phone was make and receive calls (what more could you possibly ask for?) – no text messaging, no camera, no MP3 player, no e-mail, no colour screen, no sounds beyond an all-purpose beep and no personalization. These early phones epitomized stark functionality and the masses loved the one function that they provided – making calls anytime and anywhere there was coverage.

Keypads

Even today the keypad is the dominant user input device. This was perfect when all people were able to do was to dial calls, but the need to enter letters arose even before text messaging. Electronic phone books were originally indexed by number – 01 for Vladimir, 02 for Maria, 03 for Omar, etc. The problem was that few people could remember which number went with which person. An obvious solution was to store the name of the contact. But how to enter letters on a numeric keypad?

The first approach, one that is still available, was to simply press digits multiple times: pressing the “2” key once would give “A”, twice would give “B” and three times would give “C”. Even this simple system had many variations. Some would allow the digit on the key to be selected in

alpha mode (perhaps the fourth press of the key) and some would allow both upper and lower case to be entered. An interesting conundrum occurred with the “7” and “9” keys, which standards said should be imprinted with “PRS” and “WXY,” leading to confusion when pressing the “7” key twice and getting “Q” not “R.” Eventually, in an early victory for sanity, engineers conceded rigid adherence to ancient standards was not necessary and found room for a fourth letter.

The multi-keypress solution allows the generation of any number of letters, digits and punctuation, but it is hardly user-friendly. Few can retrieve a phone book entry or type a text message without looking at each character as it appears on the display while typing and without often overshooting, meaning that you have to go around the circle of keys one more time. Can you spell “Frustrating”? Let me see, 3-3-3-7-7-8-8-7-7-7-8-7-7-2-8-4-4-4-6-6-4!

A major innovation now incorporated in almost all phones was T9, an abbreviation for “Text on 9 keys.” Based on a dictionary, T9 allows predictive typing, where the phone continually looks for the best match with the keys already dialed, guessing at what the most



likely next key is, and often even suggesting an entire word based only on a few letters. For example, to type the word "Found," you would first press the "3" key and probably see the letter "e," then press the "6" key and you might see "do." Perhaps by the fourth keypress the phone will be displaying "foun" (and perhaps suggesting the entire word "found"), now that words starting with "d" or "e" have been eliminated.

For the entry of digit strings, punctuation or words that aren't in a dictionary, most phones allow you to change into different modes, including the old multi-keypress mode. When entering complex strings, mode changes mean that your eyes still have to be glued to the screen, but for simple strings, typing without reviewing every letter is certainly possible with a little practice.

A more recent solution to the problem of text input is the Fastap system that puts the letters of the alphabet in between the digit keys. While conceptually easy to understand, it is very different from the QWERTY arrangement of letters that most people are familiar with.

Those who want the ultimate in text entry, buy a phone with a miniature, but full QWERTY keyboard, an arrangement that most people are familiar with, whether their style is touch-typing or hunt-and-peck. QWERTY is the system that is most likely to allow typing without looking at the screen, but unfortunately it takes a lot of real-estate on the surface of the phone.

Displays

The phone display is now as important as the data input device. It evolved from a single-line character-based LCD in the 1980s, to multi-line character displays in the early 1990s, to black and white graphic displays in the late 1990s, and in the last few years, to full-colour displays.

Larger displays with colour allowed new user interface functionality. Camera phones need one, location-based applications use them to display maps, and even the rare phones without one of these applications need a display to allow intuitive navigation through a wide variety of functions and data. Even

the lowly address book becomes more effective with a scrolling list of names and a detailed entry that not only includes a person's name and phone number, but often multiple phone numbers, other contact details and a photograph taken with the phone's camera and a custom ringtone.

Improvements in display technology are avidly adopted by cell phone manufacturers, as the display is not only functionally important, but a brilliant display also pulls in customers. Improvements that manufacturers look for include more brightness, denser (smaller) pixels and something that customers rarely think about – lower energy consumption.

One area where much work remains is better adaptation of displayed data to devices with small screens. A classic challenge is to display a Web page effectively. Originally this was tackled by developing new markup languages, such as WML (for WAP). However, this required every Web page to be rewritten in a new language. Current trends are to include more intelligence in the mobile device to allow good display of any Web page, and to provide methods for developers to optimize their Web pages for the small screen through markup code or through special server optimizations based on knowledge of the device accessing the Web site that do not involve separate files or markup languages to serve up pages to mobile devices. More sophisticated software, compared to bigger screens (at least when counting pixels), will lead to interfaces that are increasingly similar to those on a personal computer.

Navigation

As user interfaces became more complex, buttons became reserved for navigation. It is now routine to see four buttons, a single multi-way button or ring that can indicate up/down/left/right. This can help build a model in the user's mind of the menu structure and can be quite intuitive. Unfortunately, due to a shortage of buttons to indicate every function, they are often overloaded with quite different meanings in different parts of the phone's menu

structure, with some navigational and some not.

However, navigation is not just a problem of distinguishing up, down, left and right. There are multiple levels of meaning, such as distinguishing between navigation within a page and navigation within the menus. This leads to situations where the "up" key will mean the previous menu item when in the menu tree, but might mean "go up a line" when editing a text message. Or perhaps the "Clear" key will delete characters in a text message, but when the text message is empty it will cancel the operation, leading to accidental cancellation when someone presses the button one too many times.

Button-oriented interfaces require a great deal of design effort to be maximally intuitive, and unfortunately, most manufacturers have not taken this seriously enough (I would be happy to identify to any manufacturer places where inconsistencies and inefficiencies exist in their navigation button design, and I will gladly eat my hat or perform community service if I am presented with a phone model in which I cannot find several problems in a short time). Often, this is because the notion of a geographical model has not been fully thought through.

Quite often there are two or more "soft" buttons that have their changing meaning displayed at the bottom of the phone screen depending on your location in the phone's menu tree. Although common, they are generally a poor idea because the human mind finds it difficult to intuit their changing meaning, forcing the user to read the tag associated with the button before each press.

Buttons are also limited because the information that the user can provide to the phone through them is limited – at most "click and release," "click and hold" or more rarely, "double click." As phones gain capabilities, more buttons need to be added or more menu levels navigated, neither of which is desirable.



Over the last few years, navigation tools that are more innovative and powerful than buttons have crept into cell phones: first scroll wheels and now track balls. A trackball is a nice addition as it can indicate up/down in some applications, up/down/left/right in others, and provide arbitrary movement in more graphically oriented applications (such as editing a photograph). Humans intuitively know what makes sense for each application and see the movement of the ball

as a natural flow, rather than as a sequence of discrete events (which it actually is). Other powerful navigation devices are a stylus and, starting with the iPhone, the finger.

Audio

The purpose of audio feedback is not to entertain, but to allow a user to operate a phone without having to watch the screen closely to ensure that everything has been entered correctly. The first audio feedback was merely a beep when any key

was pressed. Providing a suite of sounds that intuitively indicate which operation was performed and whether the outcome was successful helps users know when things are going well and when they need to pay close attention to the screen. Humans are well attuned to their aural environment. Everyone who has been calmly walking through the woods only to hear a stick crack unexpectedly has experienced the phenomenon of our unconscious monitoring systems sending a jolt of adrenalin into our consciousness.

Designing sounds with an intuitive meaning is not easy, although people do have the capacity to learn to associate sounds with particular events. This association can be left to the user, but most people have neither the training nor inclination to design their own audio feedback system, so assignments of ringtones to people, or to certain functions, tend to be random and inconsistent, meaning that the goal of the user recognizing the event from a sound is usually not met.

The use of audio feedback (along with visual feedback) is far more important with touch screen phones because of the lack of tactile feedback that keyboards and other physical input devices provide.

Another important audio trend is the separation of the speaker and microphone from the device itself. No matter how beautiful the user interface is, it becomes useless during a call if the wireless device has to be held at the side of the head. Millions of users have recognized this, as shown by the huge popularity of Bluetooth earphones specifically designed for cellular phones. Many of the functions of a wireless device are useful, sometimes more useful, during a call, so it is important to be able to keep the device in front of you where it can be used to record a phone number, take notes, pick a photograph to send to a person or compose a text message or e-mail.

Killing the Keypad

The latest trend in cell phones is the touch screen, now available in many phones, not just the iconic iPhone. Its big advantage is the input device, navigation device and screen

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all share the same real estate. The screen is limited only by the size of the device, allowing it to easily double in size once the keyboard and navigation buttons are removed.

Some of these phones are based on a relatively new science of interpreting gestures. For example, moving two fingers towards each other indicates "make smaller" (for making a photograph smaller, for example), whereas moving two fingers apart indicates the opposite.

But touch is more than just direction and speed of the finger (or fingers). Gestures can also harness motion or force. Motion detection can change the orientation of the screen when the phone is changed from a vertical position to horizontal. More finely, the orientation of the screen can be used to tilt objects into place. The power of this kind of technique is that humans are superbly adapted to actions like tilting a container so the last cookie slides out slowly, with the crumbs left in for Mom to clean up. Initial applications may be more eye candy than function, but if properly harnessed, they add another dimension to the user interface without stealing any of the precious surface real estate. The force of a finger press could also be harnessed, perhaps to indicate how fast an operation such as scrolling should occur or to set the priority indicator on an e-mail.

Despite the benefits of gestures, many applications are still text-based, and some will always remain this way. Entering a text message or e-mail still requires typing, although some functions can be simplified by working with entire words or even phrases pulled into place by touch.

One of the challenges to this new design paradigm will be to provide a suite of gestures to applications in a way that does not overly complicate the development of software, to encourage all add-on software (which is another trend of its own) to follow the user interface design guidelines and to create a consistent feel to the overall user interface of the phone.

Crystal Balling

There will be no single dominant user interface in the future. The low cost of a keypad with small display, and its suitability for voice users,

will keep that user interface style around. Text-intensive uses, such as e-mail, will ensure continued growth in popularity of phones with a compact keyboard and medium-sized screen. And the ability to maximize both the size of the display and the input device will drive the growth of touch screen devices. User interfaces will continue to be an area of significant innovation in wireless because all devices available today incorporate some tradeoffs – massive improvements over only a few years

ago – but still are not perfect. User interface nirvana will only have been reached when interfaces are so intuitive and so similar to each other that people cease to talk about them anymore. I can safely predict that this will never happen! With each improvement comes a vision of the next step. ■

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