The Telephone Repair Handbook

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"Mister Watson! Come here! I want you!"

ABSTRACT: The software design of the mobile telephone is poorly suited to its principle task, human social network management. The authors explore the evolving needs of the "swarm" of network users, then speculatively redesign the mobile telephone as an active device, employing multiple communication modalities to radically improve the device's ability to maintain and contribute to the user's social network. Three use cases explore the user experience in a fully-realized system.

Prologue: Dreading the Call

A few weeks ago, just before ABC turned on the cameras to tape the season's final episode of THE NEW INVENTORS, the show's host, James O'Laughlin, put me on the spot. Since I am described as a futurist when I am introduced as a panelist, James asked me (horror of horrors) for a prediction.

"Alright," I said, thinking furiously, and aiming a furrowed brow at the studio audience, "In five years' time you'll be using your mobile phones ten times as much as you do today."

The audience burst into a great, wearied groan. Not a gasp of disbelief, nor the laughter of dismissal, but the pained sigh of resignation. The audience instinctively recognized the inevitability of my prediction, and dreaded it. Why such dread? With telephony, human communication has grown from a phenomenon constrained by shouting distance to something which allows us to enjoy never-ending conversations with our friends around the world at nearly no cost. We enjoy talking on the phone; we collectively share a uniquely human pleasure in communication for its own sake. Yet the thought of spending more time doing more communicating struck that audience, at

that moment, as something to be avoided. That moment set us on course to this paper.

The disconnect between the joy of communication and the Procrustean Bed of our telecommunications technologies deserves our full attention. We spend a lot of time developing new telecommunications technologies without considering about how they might fit their users, or, as Marshal McLuhan would put it, shape the users to fit the technology[1]. Every communication technique limits the kinds of messages which can be sent across it, and additionally limits how both sender and receiver frame these messages cognitively, emotionally, and socially.

It is our assertion that the telephone as it exists at present is largely a set of vestigial organs, poorly suited to its actual task, and that the resentment engendered by the device is an inevitable by-product of a continuing series of unsatisfactory interactions with it. Such a conclusion immediately casts into doubt the entire recent history of the design of the telephone, which has been rife with invention, yet has never been quite successful, because none of these designs have *ever* been driven by the mass of individuals who use the phone.

We also assert that the essential design principles which must be embodied in the telephone can only be discerned, not invented. The telephone is not a style, nor a fashion, but, rather, is something closer to a human language, in that it requires immersion within that language to acquire mastery of it. We assert the necessity of observation before action. We must watch how people communicate before we can understand what their communication needs are; only from this observation can we draw any reasonable conclusions. Fifteen years ago, this would have been a very simple affair, as telephone calls were two-way conversations.

Today, all human communication is threaded, multi-participatory, multimodal, asynchronous, proximally indistinct, ubiquitous, continuous, and entirely

pervasive. Given this enormous change in the ground conditions, it seems perfectly sensible that we should rethink the basic instrument of electronic communication.

As the most concrete and pervasive manifestation of cyberspace, the mobile telephone establishes new cultural patterns of behavior. If, through observation, we can learn the form of these new patterns, we could design a device which plays into and amplifies them. Instead of "the street finds its own use for things,"[2] we could opt for a "comprehensive design science revolution,"[3] transforming the mobile telephone into a cultural probe, amplifier, and filter.

The question before us is whether we – as designers, engineers, academics and media theorists – secretly dread the call of the future, or whether we will approach this moment as an opportunity for play. In free play, results are unimportant; the performance is all. Therefore, we need have no goal beyond having a good time. Playing with mobile telephones is like playing with words, because the medium which transmits those words leaves its indelible mark on the message. Since words shape the world[4], transforming the mobile telephone is inherently a revolutionary act.

We therefore propose revolution. But "revolution without revelation is slavery."[5] Hence we must seek enlightenment in "the wisdom of crowds,"[6] for the mobile telephone is the medium of the crowd in its technologically-mediated incarnation, the "swarm"[7]. Studying the mobile telephone *in situ* is the only way toward any understanding of its actual role in human communication. We must draw our lessons from what we can observe in the behavior of swarms.

One: Emergent Social Networks

We take it as a given that nearly everyone living in the Western world has access to and enjoys the benefits of globally pervasive, continuous and ubiquitous data network. The main access points into this network are desktop computers and laptops – at least, that is the popular perception. However, there are at least half again as many mobile handsets in the world as internet-accessible computers. The vast majority of these handsets can easily make connections to the Internet. But these devices are not thought of as Internet attached; and this is the first of the "telephone repairs" which must be performed.

Upon connection to the Internet, each individual passes through a series of "evolutionary stages" as the technology of pervasive, instantaneous communication becomes ontologically incorporated, forming one component of the individual's relationship to the world of being. These stages appear to be replicated, in a scale-invariant way, both within the individual and across the swarm of internet users as a whole. For this reason, the history of the human use of the internet is reflected in patterns of individual use; the individual follows the patterns established by the swarm. To adopt a maxim from biology, phylogeny recapitulates ontogeny.[8]

Stage one is the age of discovery, where the user simply clicks into oblivion with an endless dromomania[9], never resting, never ceasing, but always moving on, and on and on. The behavior here is analogous to a kid in a candy store, or a yeast cell in a bath of nutrients; both will eat themselves sick. The user is excited and empowered, and thinks only of quantity, not quality. Yet this constant feeding, this restlessness, does not satisfy; once the user is convinced that this wealth will not simply vanish, a locus of reflective behavior emerges, and stage two, the age of discrimination, begins.

Where there is enough and more, strategies shift from simple acquisition to meeting the needs of the moment in the most effective way. Thus did the NCSA/CERN exhaustive list of web sites evolve into Yahoo!'s categories, only to be supplanted by Alta Vista's free-text search, which in turn was replaced

by Google's Page Rank. Each of these represent a refinement of the strategies which preceded them, and, in good evolutionary fashion, each replaced its predecessors through the natural selection pressure of the swarm[10]. This natural selection pressure is itself scale-invariant; the same pressures at work within the individual are also exhibited by the swarm. When an individual finds a better way to get what they want, when they want it, that technique is broadly adopted, and thus tends to drive its competitors into extinction. Although all of the search techniques developed since 1993 do still exist (except for the NSCA/CERN master list of web sites), natural selection pressure has favored Google's Page Rank with the highest level of "fitness" for the current ecology of the Internet. Google appears to understand this, subjecting its own methodologies to unceasing evolutionary variation, drawing its mutations from a study of the activities of the swarm, and adjusting its own algorithmic DNA to match[11].

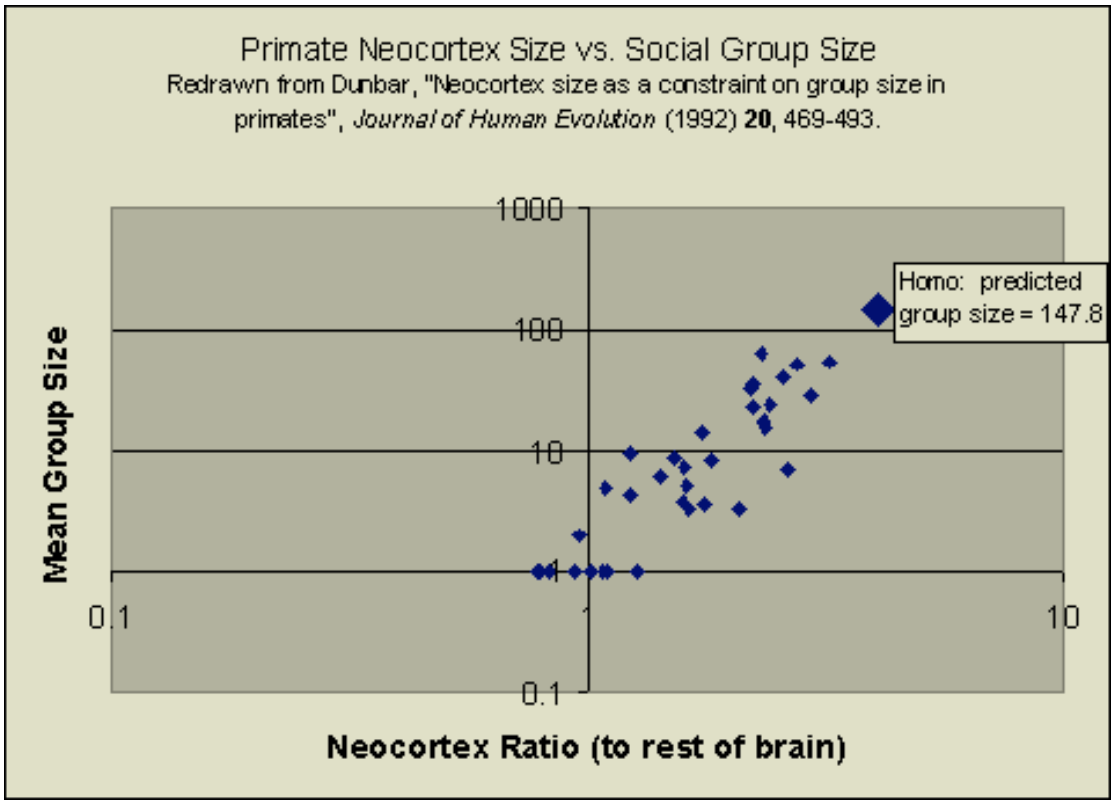
Once the user masters techniques of discrimination, stage three, the age of "virtual communities" begins. The user spontaneously forms networks of communication – "social networks," in the current parlance – which sit above the pervasive any-to-any Internet. In addition to the natural social relationships of proximity, kinship, and friendship, new social relationships bounded by common interest – communities – emerge. These virtual communities[12], which bear only accidental relations to proximity, kinship or culture, exist only because there is a medium which can support the constant reinforcement of these connections. Without cyberspace, there is no virtual community; within cyberspace, virtual communities are the rule. The unified swarm explores itself, and discovers patterns in its variation; where these patterns find resonance, sub-swarms form within the swarm, and communities emerge. Again, this same process takes place within the individual; once the torrent has been tamed, once the dial can be tuned, the individual becomes aware of others, who have tamed and tuned to the same channels, seeking communion with them.

Stage four, representing the present day, is the age of the swarming hyperdistribution[13] of media. Every individual harnesses their own social network to create their own media distribution network. We have, over the past twenty-four months, rapidly moved into an time when every single individual has become his or her own network. We hyperdistribute much which comes our way, forwarding email, links to websites, podcasts, video clips, Flash animations, even 3D games. We spend an ever-greater portion of our attention forwarding (i.e., publishing) relevant media into the relevant links in our social network. This, right now, is where we really are, both as individuals and as a swarm. Each of us is building and becoming our own media distribution network. Occasionally we create the content in these networks, but far more often – **even** if we are full-time, professional media producers – we pass content *through* our networks.

This is the reason that eighty million people have forwarded links to JibJab's "This Land"[14], the video of the Chinese university students singing a Backstreet Boys song, or footage of an exploding whale[15]. Although these examples are exceptional because of their breadth of distribution, the same processes are taking place, in a scale-invariant fashion, throughout the entirety of the swarm, sub-swarms, and in individual members.

To understand what is going on, we must ask ourselves "why?"[16] Why do we forward media through our social networks? Why has this become the consuming task of the present era of the Internet? One possible explanation can be drawn from the study of human social networks. These networks are thoroughly dynamic, and subject to selection pressures of their own because of the concept, from anthropology, of the Dunbar Number. The Dunbar Number states that the number of first-degree connections within a social network (i.e., the number of individuals who are directly connected to every other member within a social network), can never be greater than 150. The reason for this is not known, but the Dunbar Number seems to be strongly correlated to the size of the forebrain. Figure 1 shows the correlation between

forebrain mass and the number of nodes in the social network of humans and apes[17]:



Great apes, such as chimpanzees and gorillas, who are very close to human beings in their neural structure, can maintain social networks – "troops" – with between 30-60 members, while the lesser primates form smaller groups. Thus, it can be inferred that the management of social networks is a very high-order cognitive task.

It is already well-known that humans or apes who are ostracized from their social networks spontaneously age and die; their endocrine systems rebel, and begin destroying the body[18]. Individuals who fail to establish strong social networks will fail to thrive, and thus fail to pass their genes and memes along to their offspring. The inverse is also believed to be true; human beings with strong social networks tend to live longer, healthier lives than those weakly connected to the community of man. The development of dense social networks may be our evolutionary response to this essential feature of

neuroendocrinology, a response with both biological and memetic components.

We establish and maintain our social networks through strategies of interaction. In the Great Apes, this interaction principally consists of grooming and food-sharing. One analogous behavior, in network-connected humans, is information-sharing. The careful balance which weights the relative value of the nodes in our social networks is determined by the interactions between ourselves and our first-degree nodes. Obviously, proximity is a strong component of the weighting; individuals we see every day naturally have a heavier weighting in our social networks. But for those nodes which are not proximal – individuals who exist, ontologically, in virtual space – weighting is determined by the quality of informational interactions.

We thrive within social networks which have become more fluid, no longer bounded by physical proximity, where informational exchange is the sole arbiter of rank; this means that the selection pressure to remain within in a social network is stronger than at any time before. We are all working harder than ever to maintain our position within our partially virtualized social networks. Since information transactions are one way we can establish and maintain our position within these networks, we are placing an increasing emphasis on "the three F's": finding, filtering and forwarding the key pieces of information which will reinforce relationships within our networks. Each informational transaction produces, as its result, some "social currency." While social currency is not necessarily transferable between social networks, within a social network it is the determinant of one's rank.

Thus we see the emergence "taste makers" within a given community, who "lead" that community through their steady accumulation of social currency. Now that this has been recognized as a successful strategy (not only by individuals but also by commercial organizations), we are rapidly adopting the technique; self-similarly, the swarm and sub-swarms are also adopting it. This explains the recent emergence of technologies like del.icio.us[19], which

accelerate and hyperdistribute the accumulation of social currency. We have become a species of "cool-hunters"[20]; the hunters who can bag the biggest, most impressive game are given precedence within the community. This is the why behind the what.

We are just at the beginning of the era of digital social networks. The efforts thus far have been interesting experiments, but they have universally failed to realize their enormous potential to accelerate the accumulation of social currency within social networks. The earliest digital social networks, such as Friendster, Orkut, LinkedIn, MySpace, and TheFaceBook.com, managed to embody the principle of the "six degrees of separation"[21], producing a digital representation of a social network composed of both proximal and virtual members, but had neither the capacity nor the design intent to embody the dynamic nature of human social networks, which vary from moment to moment, and task to task. **Existing digital social networks treat the human being as a static entity, a category error of the first order.** A human social network is a living thing, and must be treated as such. This mistake is so fundamental that it needs to be highlighted against another example: would Google's Page Rank remain relevant if Google ceased its constant devouring of web pages? Page Rank would quickly grow stale and become useless. In this sense, digital social networks are like sharks: they must constantly move, and eat, if they are to survive.

Digital social networks, in order to be at all useful, must be active, and extraordinarily well-fed. Existing digital social networks are designed to be passive; they require constant human intervention to reflect the dynamically evolving relationship between the nodes within the network. This is neither feasible nor reasonable; we would need to spend more time maintaining the digital representation of our social network than maintaining the network itself. This is a basic failure in design. A digital social network needs to draw from our data shadows constantly, like a digital vampire, building its soul out of our actions in virtual space.

We have arrived at the forward frontier of the evolution of networked humanity, both as swarm and individual. This paper has outlined the problem in precise terms; what remains now is to describe a solution. Collectively, we have created a whole host of ad-hoc techniques which we use to manage our social networks: we have mailing lists and address books, and these help, but we haven't put any computational intelligence behind these techniques. Furthermore, these informal techniques, developed from need, but poorly fit to their tasks, are losing their utility, bending beneath an increasing selection pressure[22]. Fortunately, selection pressure drives evolution; it drives both the need and the capability to experiment with a multitude of forms – mutations, if you will – in search of solutions which will relieve some of the selection pressure, producing a higher level of selection fitness.

Now that we have an *in situ* understanding of the swarm, it is time to turn our attentions to the telephone.

Part Two: The Telephone and its Disconnects

Before we can begin any discussion of a "repair" of the telephone (in truth, it is not the telephone that needs repair, but rather that we, who design them, must repair our thinking), it is necessary to prick consciousness with a few probes, interventions in the form of three questions, which will help to illuminate the enormous weight of subconscious and unrecognized prejudices which accompany the modern mobile telephone. These questions outline the telephone's "disconnects," where logic and reason fail, and prejudice, embodied, is revealed.

Question One: Why does a mobile telephone have a keypad?

Automatic dialing technology is about eighty years old[23]; before that, calls were switched by an operator at a switchboard, who physically connected trunk lines to make the circuit. Mechanical automation obsolesced the

operator, and the rapid advance of computerized switching systems in the 1960s gave birth to DTMF "touch tone" dialing.[24] It is this "touch tone" keypad which we have come to consider as the "natural" interface to the telephone, even though it is not quite as old as this author. In the years before the microprocessor revolution, when AT&T stamped out hundreds of millions of absolutely identical, identically dumb, touch-tone telephone handsets, users had to peck the number into the keyboard every single time they placed a call.

How often do you hand tap a number into your mobile phone? I've been doing some informal polling, and the answer seems to be, "About once a week." Although we might be using our mobile phone tens of hours a week, we only tap a number into it once a week. If that's the case, ***why is half the interface of the mobile telephone composed of a keypad?***

We all know what the keypad is used for, tens of times a day: SMS. Text messaging is the killer app for the mobile telephone, and the keypad is the interface to that service. Yet text messaging via keypad is so slow, so fraught, even with predictive text, that it's amazing we bother to do it at all. It's a clear indication that the need to send text messages outweighs our frustrations with the text message interface. Nevertheless, that resentment persists, and grows with every text message sent. It's part of the reason why THE NEW INVENTORS audience gave up that groan.

Why do we use the keypad for SMS? Because that's the interface we've got. And why is that the interface we've got? Because this is a telephone, and the one, absolutely uniform feature of the telephone interface is the dialing keypad. People need to dial numbers. But no one actually does dial numbers anymore. They're all in our address books. We don't even remember numbers anymore. I can remember my mobile and my office and my voice mail numbers. Everything else is managed by my mobile phone – which is as it should be. As we transition to a VOIP world, the concept of the phone number will be entirely meaningless, replaced by a SIP URL. At that point, we'll never type numbers into our telephones.

The interface to text messaging, the keypad, shapes all communication through the device. Consider these contrasting examples: A few weeks ago I learned how to compose text messages on my Macintosh, shipping them over to my phone for delivery. It was immediately liberating; I had the full benefit of punctuation and a dictionary larger than the predictive text library. As an immigrant to the world of text messaging, I found relief. On the other hand, the younger generation has gone in the opposite direction, adapting their communication forms to the interface, creating a rich linguistic pidgin, which reads like shorthand.

The information pressure behind text messaging has been so intense that we have seen the emergence of new SMS-based languages[25]. This pressure is pushing the mobile telephone through a series of mutations; some look like the Blackberry, which features a full, if miniature QWERTY keyboard. Others favor other interface modalities, such as speech recognition. The keypad itself is a vestigial organ. It will wither away then disappear entirely, resurrected as a ghost, in a virtualized, on-screen interface, for those rare occasions when we type a number into the telephone.

Question Two: To how many networks is the mobile telephone connected?

The telephone is essentially a network terminal; it provides services to the user by making, managing, and destroying connections to the network. In Australia, we readily acknowledge that our mobile telephones sit on two networks: GSM, which handles lightly-digitized analog traffic[26]; and GPRS (Global Packet Radio Service), which is a packet-switched data-only network with full TCP/IP capabilities[27]. As third-generation "3G" cellular networks become pervasive, the analog-only network is being dropped in favor of a all-digital, high-speed, packet-switched, TCP/IP network connection. These are the networks we connect to with our mobile telephones. But these are not all.

The average model mobile telephone for sale today – anything that sells for more than AUD $100 – actually presents at least **four** network interfaces. In addition to the standard GSM/GPRS network interfaces, the mobile telephone is also equipped with an IrDA (Infrared Data Association) network interface. The IrDA interface is a very short range, line-of-sight, point-to-point networking protocol, which generally fades away after about 50cm of distance. Historically, IrDA has been used to allow devices to share small chunks of data, such as address cards, URLs, and the like. It features a relatively slow transmission speed – reaching an upper limit of 57Kbps – and hence is not suitable for large file transfers. While IrDA is an inexpensive interface to implement in a small-profile device such as a mobile telephone, its shortcomings have kept it from widespread use.

The fourth network interface, and by far the most interesting one, is Bluetooth. Bluetooth is a low-power wireless networking technology which provides a sphere of coverage of about 10 meters in radius around the Bluetooth device. Bluetooth has been around since the late 1990s, launched with great fanfare, followed immediately by a very public failure as many Bluetooth devices proved to be incompatible. The market took care of these problems quickly, and with the introduction of version 1.1 of Bluetooth in early 2001, the market for Bluetooth devices began to take off. Nearly all mobile phones which cost more than $AUD 100 have Bluetooth network interfaces, and, at present, five million Bluetooth are manufactured each week[28]. This includes mobile phones, laptops, PDAs, wireless headsets, etc.

At present Bluetooth isn't used for very much; it has become a more-reliable replacement for IrDA, because it does not rely on line of sight, but rather, physical proximity, something that's much easier to manage. Bluetooth is used to keep devices synchronized, or as a file transfer protocol – a way to get photographs off the phone, and appointments onto it. Yet Bluetooth is capable of far more than this. Its link layer (layer 3), L2CAP, is capable of managing "piconets" of eight devices – one master and seven slaves. These piconets can overlap in physical and logical space, so the same device can be

a slave in one piconet and master of another. This means that when Bluetooth devices are brought together, they can easily form a complex network topology. Furthermore, this network topology need not be entirely local, with all traffic restricted to the piconet; any Bluetooth device could act as a gateway, routing traffic directed through it to the Internet, or to other piconets, as required.

We haven't seen anything like this show up on our mobile telephones. Although these devices have the advantage of some very sophisticated networking technology, we're simply using Bluetooth to push discrete blocks of data around. We are not treating these Bluetooth devices as nodes within a packet-switched network. Why? Because we have not recognized the power of this highly versatile network interface. We see the mobile telephone purely as a terminal on the GSM/GPRS networks, when it is actually a terminal on at least four different networks. As mobile telephones acquire 802.11 "WiFi" capabilities – they already are, to satisfy the demands of VOIP users – these handheld network terminals will present **five** network interfaces. Yet we continue to act as though these other interfaces simply do not exist.

Question Three: What is the mobile telephone doing?

The modern mobile telephone – such as my SonyEricsson K750i – is an impressively powerful device. It has a gigabyte of non-volatile memory, a fairly large RAM scratchpad for program execution, an operating system (SymbianOS), a Java Virtual Machine (J2ME), and a host of custom ICs dedicated to digitizing audio signals, converting digitized signals to audio, managing the UHF connection to the cellular network, driving the Bluetooth radio, and so forth. The K750i also has a chip which performs the vector mathematics needed in three-dimensional transformation matrices, so that I can play any number of 3D games.

Why would we play games on our mobile telephones? By this we don't mean to question the validity of mobile entertainment, be it music or video or games

of strategy and skill. This is a big industry, earning billions of dollars a year as people find new ways to use their mobile phones to fill the otherwise empty moments in their lives. We are not questioning the human desire to be entertained *every single moment of the day* (although perhaps we should)[29], but rather, we are asking if this is an appropriate use of the mobile telephone. The mobile telephone, like our desktop and laptop computers, suffers from consistent underutilization; we rarely keep it busy. Even when we are engaged in voice communication, newer mobile telephones use only a small portion of their capabilities in call management. The mobile telephone represents a tremendous computational resource which is almost entirely unutilized. Hence, the phone is free for games and other entertainments.

Why is the mobile telephone so underutilized? Once again, we see the vestigial behavior of analog fixed-line telephony. Fixed-line telephones did nothing until the network sent a call to the handset, or until the user picked up the handset to make a call. The duty cycle for the fixed-line telephone was entirely driven by users, as the only actors within the network. This basic assumption drives the design of mobile telephones: the devices are essentially passive, waiting to be activated by the network or the user. But why should this be? There's no essential purpose served by such passivity – far from it. But the mobile telephone has been cursed by its ancestry, and this curse has kept it from reaching its full potential. This is the most important thing we must unlearn, if we are to repair the telephone. The mobile telephone is only a passive device because we have designed it so.

We believe it a necessary precondition for telephone repair that we treat the mobile telephone as an entirely active device, a network terminal which has been designed from its outset to facilitate management of and communication with the social network of its owner-user. The mobile telephone is already the de facto device for digital social network management; voice calls and text messaging are arguably the most significant components of the electronic communication within our social networks. The ephemeral nature of synchronous voice communication and

asynchronous text messages means that these informational transactions are not captured by existing digital social networks, which, in turn, means that we unconsciously underestimate their importance, because they are not counted (except on our monthly bills), and are not tracked, except within the mobile handset. If we transform the mobile telephone into an active device, and design it to be conscious of the electronic communication which takes place through it and around it, we have a device which can gather a wealth of data – a "data shadow" – from which we can build emergent models of a dynamic digital social network. The mobile telephone is the only device which is well-suited to the task of feeding our ever-hungry digital social networks; it is the only device capable of recording our lives as they are lived. **The mobile telephone should be fully realized as an active device which takes note of our digital social interactions, using this information to assist us in improving the quality of these interactions.**

This is the core design principle that we recommend be put into practice; without this step forward, nothing else is possible, and the mobile telephone will remain an overpowered, underutilized twin of its mechanical-analog ancestors. Because of the growing importance of ad-hoc digital social networks, there is a growing pressure to consistently improve and reinforce the connections within our social networks. Should we succeed in transforming the mobile telephone into the instrumentality of our social networks, that transformation will release this pressure, driving the mobile telephone forward into a fantastic array of mutations and forms. It will be a Cambrian Explosion of communication, brought into being we connect our need to our capability.

The impact of such a transformation would be immediate and profound. When users stop fighting the interface, and find, instead, that the interface enables social network management, these users will enter into a new ontological accommodation with the device. It will, in short order, become entirely indispensable. It will not be thought of as a device for voice communication, or even as a terminal for text messaging; it will be the portal

into the user's social network: the physical, proximal and ubiquitous connection into the sphere of human connection. There is precedent for such a rapid transformation: in twenty-four months the web browser grew from its origins as a hacker curiosity to become the indispensable information age tool.

Our analysis of the requirements for this transformation of mobile telephony from passive to active modes indicates that the technological infrastructure for such a revolution is already in place; this is a revolution in software, not hardware; a revolution in usability, not deployment. The handsets and networks are fully ubiquitous. We need only learn how to design software to fit the needs of the network's users. To do that, we must experiment, play, and listen to the users.

Part Three: Me and My Data Shadow

Theory is good; observation is better. One of us (Pesce) has been observing the growth of the Internet, user communities, and swarms for nearly 20 years, while the other (Fraser) has deep experience concerning the issues of mobility and usability. The concrescence[30] of observation and experience has lead us from theory into practice. We are presently designing technological probes, testing the theses we have laid out in this paper, in order to concretize our understanding.

One of us (Fraser), as the former Director of User Experience for Hutchinson Telecoms Australia, has a strong understanding both of the desires and the frustrations of mobile telephone users. These real-world insights have guided us into designs that require a minimum of user intervention. In other words, we have done our best to design things that "just work," without a lot of care and feeding. An example of this philosophy, created by one of us (Fraser), is ImageShow, a Java J2ME application which fetches images from the photo

sharing site Flickr, allowing the mobile to dip into “Flickrstream” for an endless supply of imagery, filtered by user name and meta tags.

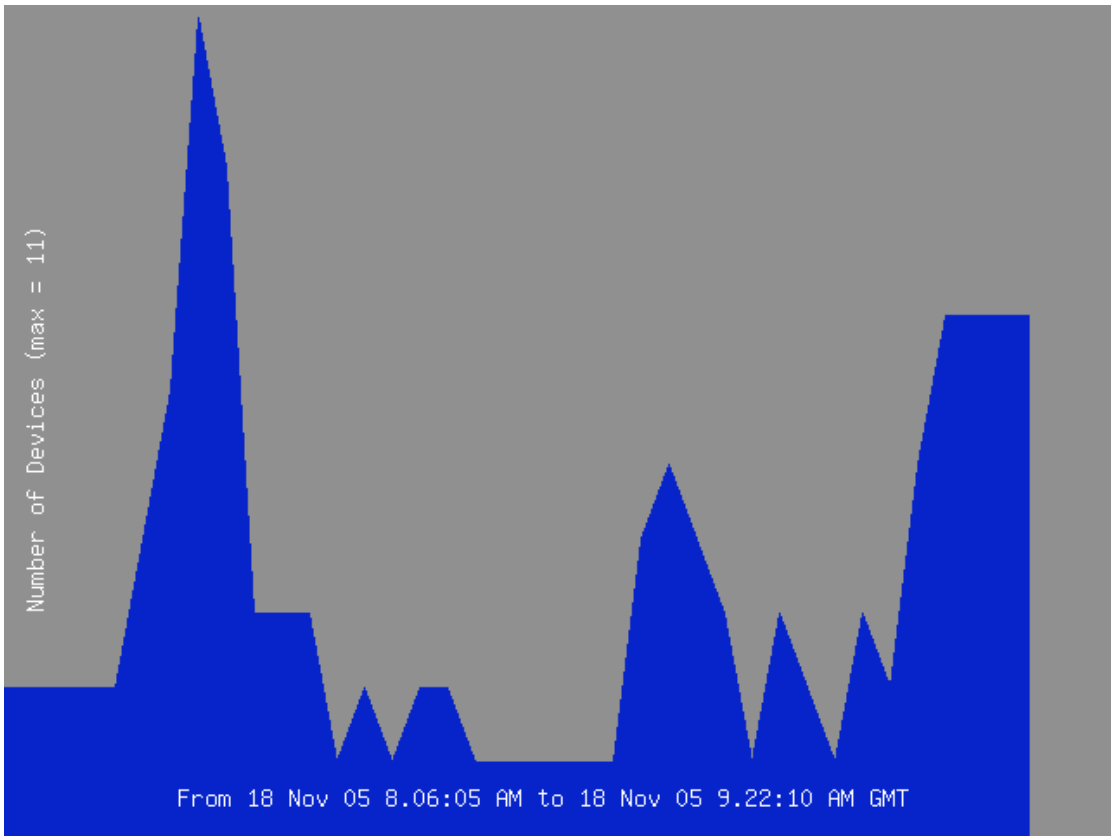
What follows are three speculative use cases, shown principally from the user’s point of view, and drawn from the themes outlined in this paper.

Example One: Active Listening

Starting from the basic proposition that the mobile telephone ought to do everything within its power to be intensely aware of its environment, the first use case involves the emergent user experience of a mobile telephone programmed for “active listening.” In this case, the mobile telephone maintains simultaneous connections across all available network connections, using these as probes into both proximal and virtual environments. GSM/GPRS provides connectivity to the global network, while Bluetooth, and, to a lesser extent, IrDA, provides a probe into the proximal environment.

One of us (Pesce) has already constructed a Java J2ME application which turns the mobile telephone into an active listening device. The application constantly scans the “bluesphere” (the 10 meter radius around the mobile telephone), keeping a record of all the devices it sees, and reports these results, via GPRS, to a server on the Internet. The server then puts these results into a database, so they can be retrieved and analyzed as needed.

Our supposition was that it should be possible to construct a heuristic model of the user’s task modality – home, work, traveling, shopping, etc. – based on the information gathered through active listening to the bluesphere. Figure 2 shows a basic plot of the data gathered by the application, over a period of seventy-five minutes, covering a trip from Surry Hills to the AFTRS campus in North Ryde, via public transport:



As can be seen in the diagram, the first moments are stable, as there are, in general, a fixed number of Bluetooth devices within range of the mobile telephone when it is in the user's home. The number drops during the walk to the train station, and rises dramatically while waiting on a crowded platform. The number of bluesphere devices drops again while the train is in transit to its destination station, rising slightly at the arrival platform, finally settling at a consistent number once the user arrives in the office. This pattern is regular and repeatable, day after day; this means that minimal machine intelligence is required to translate a scan of the bluesphere into an assessment of task modality.

It needs to be noted that active listening to the bluesphere returns more than just the raw number of Bluetooth devices; the mobile telephone also learns the unique addresses (the Bluetooth equivalent of Ethernet MAC addresses) and the "friendly names" of those devices. This means that it is possible to pinpoint the location of the mobile to within 10 meters when it is within range of some known, fixed-point Bluetooth device, such as the five Bluetooth

devices which crowd the offices of the Emerging Media and Interactive Design Program at AFTRS, or the one which is always visible within my home. Again, it is a trivial operation for a server to translate a given Bluetooth address to a task modality; the mobile simply sends this data to the server, and the server tells the mobile that it is at home, in the office, and so forth.

Once the server is able to generate information about task modality, it can treat the mobile telephone as a network terminal, and reconfigure its display to present information which is relevant to the task. For example, in the office my mobile telephone could inform me of upcoming meetings; in transit it could warn me of rail delays and changing weather conditions; at home it could prompt me to turn on the television and watch a program recommended to me by a friend. None of this is difficult, but it is all quite useful, and this utility can be delivered to the user with a minimum of user interaction.

The more interesting phenomenon comes from a detailed analysis of a long-term recording of the bluesphere – over a period days to weeks. That analysis will show that certain devices come into the user's bluesphere regularly. These occasions of proximity are the foundation for a model of an emergent social network. Rather than laboriously building the elements of the social network by hand, via a web site, the mobile telephone can simply listen to the bluesphere, SMS traffic and voice traffic, learn who the user is communicating with, when, and for how long. While this model will not necessarily be complete, it will be substantial, and will build itself without user intervention. That, in and of itself, is a powerful capability.

Active listening must extend beyond the network interfaces available to the mobile telephone into the real-world interfaces offered by the device. Most modern mobile telephones can make audio recordings. If this recording capability were kept on all the time, when combined with the analysis of the user's emergent social network, it should be possible – and easy – to offer the user the opportunity to keep a full audio record of their day-to-day life. The mobile telephone would simply record audio constantly, storing it locally until it

came in contact with a device it could use to synchronize this data with the user's server. (The amount of data is small; just about 80MB covers an entire day's recording.) The server could then present this data to the user, visualized across the time domain, with annotations showing who was around, participating in conversations, throughout the day. The user would simply click at the appropriate place on a web page, and hear their own conversation repeated back to them.

Such features are as invaluable as they are dangerous. There are a host of privacy issues strewn throughout these examples, and these must be regarded as elements to be incorporated into the design of the system. Our basic belief is that users control the rights to their own data shadow, and that they share this data with others at their peril.

Example Two: Feeding the Hungry Social Network with Active Interventions

Once the system has grown a model of the user's social network, it can then begin to feed that model as much information as can be gathered through active listening, augmented with "active interventions". In an active intervention, the mobile telephone will interrupt the user in meaningful ways, designed to improve the quality of the user's social network.

In this use case we'll consider the Thanksgiving dinner I'm planning with friends; one of those friends, James, pops into a pub down the street; James and I have agreed to share data about our relative proximity, so I'm informed, via my mobile telephone, that James is in my neighborhood. I give him a call (which is noted by the active listener on both our mobile telephones), and drop down to the pub (also noted by the active listeners). When our mobile telephones come into proximity, I get an alert on my mobile – the first instance of an active intervention. I've made a note to remind myself about Thanksgiving dinner, which is being held at James' home. The note comes up, and I ask James about some details. No need to write any of this down,

it's all being recorded by my mobile telephone, and I'll be able to play it back later.

After a few beers, James and I decide to go to see a film; but what film should we see? Since my mobile is in a task modality which indicates a social situation, it is already presenting information about social diversions. I see that "Wolf Creek" has gotten a rave review from my friend Nicola, so James and I decide to go to the film. The Dendy theatre uses a few Macs, with Bluetooth installed, so my mobile telephone notes this, tells the server, and my server guesses that I'm going to see a film. A few hours later, I receive a request – an active intervention – to rate the film I've seen. When I do so, that information is then shared within my social network, and contributes to the growing list of shared ratings[31]. I can also add my own review of the film, just by speaking into my phone; the server will later share that voice recording with anyone in my social network who wants to hear it.

Many of my social interactions are observed by my mobile telephone; all of these are recorded, mapped and analyzed. That said, not all of my social interactions can be observed by the mobile telephone; many of them take place through my laptop computer. My mobile telephone may be with me everywhere I go, but it can't actively listen to my computer. My computer therefore needs to shoulder some of the burden. I will need to have an email client which notes who I receive email from, and who I send email to, adding that information to my data shadow. My web browser's history also needs to be fed into that data shadow.

There is a pattern here: we generate enormous data shadows – not just the ones related to our financial progress through the world, but others which relate to our social and informational presence. This information may be stored locally, but it is not collected, collated, or analyzed. In other words, we are depriving our data shadow of the constant stream of information we generate as we communicate. For this reason, it is our recommendation that software designers implement "audit trails" of user activity which can then be

fed into dynamic digital social networks, enhancing their capability to model the user's social network. It is relatively easy to do this within a system such as Gmail, which never forgets any transaction through it: you can simply scrape the data off Gmail. An extension for Firefox would do the same for web browsing. These are simple changes, which require no user intervention beyond setup, but they would provide the data shadow with a more complete recording of the user's activities. This information should never be discarded; it is far too valuable.

Example Three: Sharing the Shadow

The value of the individual's data shadow has not been overlooked by commercial interests. Wal-Mart, the largest retailer in the world, builds extensive data shadows on each of its customers, studying their buying patterns, constantly adjusting their store inventories to meet the needs of their customers. This is the basic premise that has driven the adoption of customer "loyalty" programs, such as the ColesMyer "FlyBuys" card. ColesMyer offers incentives to regular customers; in return they build a data shadow of that customer's purchase habits. This information is essential for ColeMyer's purchasing plans; it also allows ColesMyer to target individual consumers with offerings that they are very likely to accept. In short, ColesMyer has a database, drawn from user interactions, which is of great benefit to them. They guard this data tightly; they don't share it, even with the customers who created it. But there are good reasons to share that data with customers.

In our final use case, I am popping into the Coles at Surry Hills Marketplace, shopping for my Thanksgiving dinner. My mobile telephone knows I've entered Coles because they've setup a small Bluetooth transmitter which identifies the store. Immediately the task modality of my mobile telephone changes, and it displays my shopping list. Behind the scenes, the server managing my own social network is having a detailed discussion with ColesMyer's own substantial computing facility. My server knows what I'm shopping for, and negotiates with Coles to get the lowest prices for each of

the items on my shopping list. All of these sale prices will be tied to my FlyBuys card, so when I pass through checkout, the sale prices are applied. These prices are for my eyes only, and really, I don't even see them. What I do see is a offer for $5 off on a fine Thanksgiving turkey; that's important enough to be bounced up to my attention. It's the only thing that I'm aware of, even though a lot of communication has taken place, out of view, between my own server and ColesMyer.

Furthermore, when I pass through the check-out, ColesMyer will do me the favor of informing my server of what I've bought, what it all cost, and so forth. This means some items will be removed from my shopping list, without my intervention, while others will remain. It also means that I can track my purchases and my expenses without having to laboriously enter any data.

All of this is easy enough to implement: if there's one thing we understand, post dot-com collapse, it's how to make databases talk to each other. We have XML and other standards which provide roll-your-own protocols. There is some programming involved here, but nothing extraordinary. User setup and user intervention are both minimal. As long as all parties can agree on how to communicate, such a system just works.

Why would Coles offer this service to its customers? The answer is obvious: loyalty. Any store which could make my shopping experience as personalized and seamless as this use case is more likely to hold their customers. They get a better sense of their clientele, as well, because ColesMyer gets a peek at what their customers are looking for, not just what they're buying today. ColesMyer can build models of my user behavior as a consumer, which will help them to offer me just what they want, just when I want it. That will help them tailor their stores' inventories. A commercial enterprise is just as much a node within a social network as any individual; strong and constantly reinforced informational relationships between these nodes will tend to improve and strengthen the real-world relationship.

Conclusion: Playing the Future

It is no longer sufficient to consider electronic communication as a two-way affair; electronic communication in the twenty-first century involves swarms of individuals, engaged in common or closely-aligned or loosely-coupled tasks. The translation of human social networks into dynamic digital entities, fed continuously by devices which actively listen and actively intervene, creates the necessary precondition for the fifth stage in the evolution of Internet use, an era where our data shadows stand alongside our physical selves, working to maintain and improve our effectiveness across the breadth of our social networks.

Many of the ideas explored in this paper are not ours, but have been drawn from longstanding research in ubiquitous computing[32], and recent work in the visualization and management of social networks[33]. The present work contributes to this discourse an awareness that **the infrastructure for this transformation is already in place**. This is a software problem, which means that in all likelihood it will be solved quickly. We invite you to do your own research, play with these devices, learn from the users, and invent the platforms for our human future.

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