Cultivating Interaction Ubiquity at Work

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Abstract: Ubiquitous computing represents the ideal of computational affordances disappearing for our very eyes and merging with our surroundings. Weiser's (1991) ground-breaking article created a conceptual clearing, which unfortunately has not been sufficiently cultivated over the years. Whilst computers are embedded in a growing proportion of the environment people interact with, this paper argues that focusing on the ubiquity of interaction forms a fruitful focus for bringing the discussion further. There may well be hundreds of millions computerised blenders, toasters and iPods, but with around 3.3 billion mobile phones in use and an increased diversity of mechanisms available for interacting with others, there is a need to consider the diversity technical affordances supporting users in cultivating ubiquity in their interaction. The article focus on interaction in the context of work and suggests distinguishing between embedded technical support for immediate encounters versus ongoing relationships as well as characterising technological assumptions of priority in terms of interaction- symmetry and asymmetry. The resulting four types of embedded support for interaction ubiquity of; connector, filter, mediator and coordinator, are illustrated in use through examples from four case studies of mobile work. It is argued that there is a an interesting duality between the propensity of available connections assuming symmetry in encounters and the organisational context of social asymmetry and ongoing conversations.

1.Introduction

The International Telecommunications Union estimates that there are 3.3 billion mobile phone users in the world in 2008 (Kluth, 2008). They engage each and every day engage in a variety of activities with their phones. The phones are used for a plethora of activities across all age groups and almost any conceivable activity across all continents. There are many ways of characterising this particular symbiosis of humans and technology, for example investigating of how cultural and socio-economic contexts influence patterns of use (Castells et al., 2007; Akiyoshi and Ono, 2008; Barendregt, 2008; Donner, 2008; Goggin, 2008; He, 2008; Ling, 2008; Ureta, 2008). Such studies will most often not be concerned with the specific processes of individual adaptation of the technology or the specific technological affordances evoked. The mobile phone will, however, not only take on specific meanings across cultural contexts, but also be imbued specific importance for the individual user. It represents significant development of computational power and of the variety and fluidity of how this power can by wielded across contexts. The resulting embodied interaction "creating, manipulating and sharing meaning through engaged interaction with artifacts" (Dourish, 2001, p.126) is no longer reserved boffins in research laboratories and fixed to specific locations. It is through the mobile phone alone available almost instantaneously, just about everywhere to around half of the World's population with around one billion of these in the developing world (Donner, 2008). Along with the mobile phone a range of other information

and communication technologies offer a variety of possibilities for technologically engaging in embodied interaction, such as notebook computers, embedded RFID (Radio Frequency ID) technology, and a variety of bespoke mobile technologies to name three types. Understanding the processes of adaptation between technological affordances in action and human activities is a complex arrangement of mediated and body-to-body interaction (Fortunati, 2005). In mediated interaction, the individual will engage in interaction and manage it using technology with close physical body proximity, but the technology will at the same time relate to distant others and possibly also to technological affordances embedded within the immediate physical environment.

The technological development of radically decreased computer- size and cost used for new types of purposes was in a 1991 Scientific American article by the late Mark Weiser (1991) famously characterised as ubiquitous computing. This concept has been the subject of much discussion, but is, however, still not well understood even if it signals the ultimate convergence of humans and computers (Sørensen and Gibson, 2008). Weiser outline the future of computing where miniaturisation of networked computing equipment and sensor technology imply not only computers everywhere, but also computers disappearing right in front of users' eyes and support them unnoticeably through "invisible", automated and seamlessly integrated services knowing users' every whim and being able to act upon them. Weiser drew his mainly technical arguments from the irrefutable prophecy of a move from one CPU per thousands of people, over one CPU per person in the PC age and foreseeing near future promising thousands of CPUs per individual. Although this prophesy is not quite realised yet, it is within reach for people in economically developed parts of the world. What is essential to understand is that the availability of thousands of CPUs for each person does not necessarily make up a digital utopia of easee. The human-computer relationship with ubiquitous computing reveals a range of new challenges and problems than needs addressing through new research.

From a technical perspective, ubiquitous computing can be characterised in terms of addressing the three concerns of; natural interfaces, context aware applications and automated capture and access (Abowd and Mynatt, 2000). However, while much attention in the HCI (Human-Computer Interaction) field has been devoted to understanding relationships between individual users and the technological interface, little attention has been devoted to the understanding of how specific technological affordances relate to the everyday processes of rendering information and communication technology ubiquitous. This relationship may on the surface be considered as a linear relationship of purposes being met by straightforward technological affordances. However, as argued by Arnold (2003), the relationship is much more comprehensively be characterised in terms of a non-linear relationship between a multi-faced set of affordances and a diversity of contrary performances. For example the argument that the mobile phone at the same time facilitates the user's mobility and provides an uniquely fixed point of contact. In such a non-linear relationship, the specific becomes important, but this paper will also ague that so does the technical situated within the specific context. Arnold (2003) describes heterogeneous performances of a fixed set of affordances.

He assumes the affordances of the technology and unfolds the complexity of life around this technology. Mathiassen & Sørensen (2008) conversely suggest that information services can be understood as individual configurations of heterogenous affordances assembled to support the user. Here, the diversity of performances is assumed, as is the diversity of choices in evoking and recombining a selection of affordances from a wider portfolio. Not only are there a range of possible ways of understanding the possible roles a technology can play. Each user will also have at their disposal a variety of technological opportunities. Understanding ubiquity involves addressing a broader range of both social and technical issues than the space in this paper will allow. This paper therefore narrows the inquiry in three distinct ways.

Firstly, the paper is concerned with ubiquity relating specifically to individuals cultivating their interaction with others through evoking technological affordances. Ubiquitous computing is generally associated with the disappearing of computational affordances into everyday live. However, the death of the PDA (Personal Digital Assistant) and the explosive growth of mobile phones emphasise the importance of addressing social and organisational interaction mediated by technological affordances for understanding processes of ubiquitising technology.

Secondly, the paper is in particular concerned with understanding ubiquity in collaborative settings where technology supports distributed and mobile working. This focus emphasises mediated interaction with the purpose of negotiating division of labour, status of performance etc.

Thirdly, the paper in particular seeks to understand how the specific technical design characteristics of the technology can influence the activities of cultivating the ubiquitous relationship between users and the technology. The paper thereby seeks to more closely characterise ubiquity by anchoring the discussion both in a particular category of human activity and to reach insights through discussions of a number of example cases from an existing body of field studies of mobile working.

The paper is motivated by the increasing unease in the relationship between the simple technical notion of ubiquitous computing as offering a wealth of opportunities for computational technology to disappear from our attention and into iPods, toasters, blenders etc, at the same time as 3.3 billion mobile phones are subjected to more user- attention and discussion than any other contemporary technology. The paper assumes that users engage in processes of cultivation rendering technologies ubiquitous to the individual and that these processes are in particular shaped by the specific technological affordances for organising and managing interaction.

The concepts of interaction symmetry and asymmetry are established in order to characterise two essential aspects of ubiquity in mediated interaction, namely the technical assumptions about the support embedded within the technology as affordances and social assumptions governing the interaction. Ubiquity must be more than a generic term for an entirely

beneficial process and in order to explore the essence further, this paper looks at ubiquity in interaction at work, asking the question: How can technological affordances supporting processes of establishing interaction ubiquity be characterised in terms of interaction symmetry and asymmetry? A framework distinguishing technological embedded support for encounters or relationships and the technological assumptions about the symmetry or asymmetry of interaction is synthesised into four archetypes: 1) Connection offering non-prioritised encounters, e.g. standard SMS functionality; 2) Filtering supporting asymmetry through embedded prioritisation of encounters, for example ability to associate specific mobile phone ring tones to specific entries in address book; 3) Mediation through offering interaction symmetry and support for ongoing relationships — for example affordances allowing open publishing of Jaiku microblogging streams (www.jaiku.com); and 4) coordination through support for managing interaction asymmetry and ongoing relationships such as the support for negotiating membership and interaction status in Instant Messaging applications.

This diversity of technological affordances are explored through revisiting four case studies where mobile workers engage in cultivating interaction ubiquity through evoking a diversity of the four types as a means of obtaining the desired interaction ubiquity through social appropriation. The examples primarily illustrate the diversity of technical affordances for cultivating interaction ubiquity in the context of the mobile work cases. The analysis also highlight the necessity of understanding diversity in technological affordances beyond the simple standardised technical connection explicitly or implicitly assumed in the majority of research on the social aspects of mobile wireless technology. Whilst the simple connections in a social or organisational context can be appropriated into complex interactive process, a discussion disregarding diversity in affordances will over-emphasise the social and neglect the role of explicit technological support in the cultivation of interaction ubiquity. Furthermore, the paper highlights a need for more a comprehensive understanding of everyday processes where designed affordances most often will offer direct support for interaction through encounter symmetry in social contexts frequently characterised by the need to manage relationship asymmetry.

The following section discusses the concept of ubiquity. Section 3 characterises the technological affordances for individual appropriation in order to support the cultivation of interaction ubiquity. Section 4 uses this perspective in the analysis of cases of mobile interaction from a pool of empirical studies of mobile work. Section 5 discusses the results. Section 6 Concludes the paper.

2.Ubiquity

Already in the late 1960s and early 70s, at the time of the large monolithic mainframes, Alan Kay and others from Xerox Parc formulated the conceptual design of the Dynabook, which in essence was a notebook- or tablet computer. The Dynabook represented a conceptual leap in the understanding of how computers ought to support human activities. Another Xerox Parc

researcher, Mark Weiser (1991), was later on the first to properly formulate a vision of ubiquitous computing implying the social embedding of portable and pervasive technologies. Ubiquitous computing is most often used merely to signify omnipresence of technology, for example (Mccullough, 2004; Ahonen, 2008).

Weiser's proposition from 1991 of life with many computers for each person contrasts the Chairman of IBM Thomas Watson's statement in 1943 "I think there is a world market for maybe five computers"; the founder of DEC, Ken Olson's, prediction from 1977 that "there is no reason for any individual to have a computer in his home"; and even Bill Gates' statement that "Microsoft was founded with a vision of a computer on every desk, and in every home." However, when Harold S. Osborne in 1954 had just retired as chief engineer for IT&T he already forwarded a prediction for a device similar to the mobile phone with video connection and a phone number given to the owner at birth and following him or her to their death (Ling, 2004). This prediction was as many of such type purely technical and with less concern for the wider implications.

Mobile and wireless technologies such as laptops, notebooks, mobile phones, PDAs and smart-phones provide users access people and information sources whilst on the move. Lyytinen & Yoo (2002a) characterise this aspect of the technology in terms of the level of mobility with a shift from traditional business computing to mobile computing. They also characterise pervasive computing as a departure from traditional business computing by an increased level of embeddedness. Pervasive computing rely on technologies embedded within and interacting with the user and their surrounding environment utilizing environmental and contextual information in the services offered. Whilst it is possible to carry around portable computers, they do not necessarily constitute ubiquitous technology unless they contain pervasive capabilities by relating to and using information about their surroundings. Similarly, some pervasive technologies may not be mobile, for example, stationary sensors feeding data to a central computer (Lyytinen and Yoo, 2002a; Kietzmann and Sørensen, Forthcoming).

From the mid-90s, both Europe and South East Asia saw a growing installed bases of mobile phones connecting people through global telecommunications infrastructures and the beginning of the 21st Century signalled the era of expanding network connectivity. In 2001 the 358 million European mobile phone subscribers superseded the 330 million fixed line subscribers, and 2008 is destined to see around 3.3 billion mobile phone users globally against 1.5 billion Internet users (Castells et al., 2007; Kluth, 2008). Personal Area Network (PAN) technology such as Bluetooth offers device interconnectivity in close proximity. Local area network standards such as WiFi (IEEE 822.11.a/b/g/) provide medium-range wireless connectivity, and standards such as GSM, 3G, and WiMAX, provide wide area wireless connectivity. Broadband Internet access is brought to the mobile phone in addition to the existing services of voice, SMS, and email. Such rapid development of network technology has expanded the reach of computers around the globe, while at the same time bringing it ever more intimately into everyday computing. Weiser's prediction of several computers for

each person has definitely been accomplished in large parts of the World.

A variety of research efforts have been concerned with ubiquitous computing. Research programmes such as The Disappearing Computer (http://www.disappearing-computer.net/); research conferences; and journals, for example, Journal of Personal and Ubiquitous Computing, have been established to focus on this subject,. Much of this research has been quite technical, for example, Baresi et al (2004) and Hansmann (2003). However, there has also been some effort invested in understanding ubiquitous computer use from a broader social and organisational perspective. Dourish (2001), for example offers a very comprehensive phenomenological analysis of what he coins embodied interaction.

A significant part of research in ubiquitous computing relates to the design and usability of such technologies, for example, Greenfield's (2006) excellent presentation of 77 principles for understanding what he calls everyware; most of Ishii's work on remote collaboration and on tangible bits (Ishii and Ullmar, 1997); and Norman's (1999) work on invisible computers and information appliances. Mitchell (1995; 2003) and Mccollough (2004) consider broader relationships between people, ubiquitous computing, and the built environment in terms of the changing role of the city and the individual inhabiting this world of merging architectural and informational elements. Mann & Niedzviecki (2002) explore the social implications of ubiquitous computing based on Steve Mann's more than 20 years of experience with wearable computing. Warwick (2002) takes the concept of embodied interaction literally and experiments with RFID (Radio Frequency ID) chips operated into his body and sensors enabling him with his hand to remote control a mechanical hand via an Internet connection. Within the Information Systems field, very little effort has been invested in understanding ubiquitous ICT. Notable exceptions addressing the research agenda for ubiquitous computing in organisations are: Lyytinen & Yoo (2002a; 2002b); Lyytinen et al. (2004); Sørensen et al. (2005); and Kourouthanassis & Giaglis (2008). Albrecht & McIntyre (2006) offers a techno-political exposition on the relationships between individuals as consumers, commercial organisations and RFID technology.

Whereas the term ubiquitous computing traditionally has implied ever-present and embedded computation, this paper consider aspects relating to individuals' cultivation of ubiquity in the interaction with others for the purpose of engaging in distributed collaborative work arrangements. Ubiquity is traditionally discussed as an inherent property of a particular type of technology, for example, in terms of being compact, mobile and provide capabilities of embedded computation.

3.Interaction

Whilst ubiquitous computing relates to a range of socio-technical phenomena from individual technologies to ambient information spaces and shared public displays, this article focuses on the diversity of technological support for mediating interaction within the context of people working together. This section outlines the core concepts suggested for understanding the diversity of technical affordances supporting ubiquity in interaction.

Ubiquity and Interaction

The characteristics most commonly associated with ubiquitous computing is the disappearing of the chunky computer and computation instead being integrated into appliances, clothes, walls etc (Norman, 1999). Weiser's vision has been powerful in shaping the understanding of the technical possibilities but it also engenders the notion of ease of use and technology simply disappearing into the fabric of life. Whilst the size of a computational artifact obviously can make it disappear much easier into pockets, handbags, tables, toasters, and walls, its presence may indeed be so much the greater through this disappearance act especially when we expect it to be readily available and out of sight according to immediate needs. The traditional PC is one we turn on, turn to, sit by and work with for stretches of time. Ubiquitous technology inhabits our physical environment and the rhythms of coupling and uncoupling technology from social action can vary greatly from person to person, from task to task, and from day to day (Dourish, 2001, p. 138ff; Sørensen and Pica, 2005).

The focal point of this paper is the diversity of technical affordances supporting a technology user in cultivating their experienced ubiquity of the interaction they engage in with others. Interaction ubiquity relates to Arnold et al's (2008, p.49) argument that "things do not speak" as the telephone, for example, easily disappear from our attention when we recall having spoken with a friend on the telephone and recall this as having spoken to the friend and not spoken through the telephone with a friend. However, this ideal scenario is at most the case when the telephone is indeed not in the way. Whereas things may not speak, they can still call and disturb. It is the mobile phone ringing until the identity of the caller is established, thus shifting the issue of the phone disturbing towards the discretionary decision of engaging or abandoning the request for interaction. Furthermore, the technological complexity not only involves interaction mediated by standardised connections, such as the telephone system simply providing point-to-point connections. Technological affordances can indeed directly support the management of interaction, for example by explicitly embedding rules into the technology supporting collaborators in managing the complexity of their joint endeavours (Carstensen and Sørensen, 1996; Schmidt and Simone, 1996; Mathiassen and Sørensen, 2008).

Focusing specifically on ubiquitous technology supporting and mediating interaction between people working together or providing interactive access to enterprise systems, then we must place greater importance in interactivity as defining the experience of ubiquitous technology. The mobile phone is of course a good example of this as a small portable device continuously connected to a global wireless infrastructure. The relationship we have with the mobile phone is mostly that of mediating interaction with others and as such the smooth imagery of ubiquitous technology is easily pushed into the background and replaced by a more multifaceted story of users being both at the instigating and receiving end of technological affordances. Revealing ones mobile phone number to others is an act, which at some later point may result in calls, and if the coupling and uncoupling of technology is the ongoing relationship between intention and action (Dourish, 2001, p. 138ff), then mobile phone

callers are remotely seeking to influence the intentions of those they call, if nothing else, then to pick up their phones.

The extent to which ubiquitous technology is situated in a context of norms, policies, social interaction and mutual interdependencies, they may occasionally recede into the background of attention, but will always be evoked in this context. As illustrated by Ngwenyama & Lee (1997), the richness of an email is not an inherent property of the email but a relationships between the email and the organisational context in which it is situated. The decision of whether or not to pick up a specific mobile phone call will be informed by a whole range of possible factors. Who is calling? What physical and emotional situation does the recipient find him or herself in? What image does the recipient wish to display to the caller. This can be understood both in terms of practical aspects of the interaction context (Ljungberg and Sørensen, 2000) as well as more substantial questions of emotional states (Ciborra, 2006).

Affording Encounters and Relationships

Arnold (2003) characterises technology as a diversity of contrary performances of a fixed set of affordances. Mathiassen & Sørensen (2008) suggest that information services can be understood as individual configurations of heterogenous affordances assembled to support the user. Here, the diversity of performances is assumed, as is the diversity of choices in evoking and recombining a selection of affordances from a wider portfolio. This paper draws critically on the distinction between technological affordances implementing encounters where memory of the interaction is not supported by the technology, and those mediating ongoing relationships through recording aspects of the interaction (Mathiassen and Sørensen, 2008). Encounters imply the technologically embedded assumption of algorithmic codification, whereas the mediation of relationships places importance in the cultivation of data (Wegner, 1997). The Apple iPhone implementation of SMS messages offers an example of this distinction. A traditional implementation of SMS messages will of course enable sent and received messages to be stored on the the phone for the user subsequent retrieval. However, messages are typically organised according to the time they were either sent or retrieved. The Apple iPhone implementation of SMS messages, however, is based on the embedded assumption that SMS messages are not individual messages to be placed according to their chronological order. Instead, it is assumed that each message is part of an ongoing conversation between the sender and the receiver and this is afforded by the messages being arranged according to person, similar to instant messaging logs.

Interaction Symmetry and Asymmetry

Rather than disappearing seamlessly into the fabric of life, ubiquitous computing technology can indeed amplify relations for better and for worse by providing easy access to others irrespective of what situation the parties may find themselves in. Whereas much of the discussion of ubiquitous computing assumes harmony and symmetry in the relationship

between technology and users, this paper will explore this assumption further and apply the concepts of symmetry and asymmetry to characterise specific technological characteristics governing the interaction. Symmetry tends to imply balance, equality and perfection, whereas asymmetry signals that something is not right and needs correction. Symmetry is a property associated with a vast array of phenomena, both theoretical and very real ones, from a variety of academic traditions. As argued by Stewart (2007) from a mathematical perspective, symmetry is inherently associated with beauty and invariability. Symmetry is geometrically understood as well-proportioned, and symmetry in a poem makes it pleasing to the ear. Symmetry is an ideal striven for. However, as argued by Close (2001), asymmetry is not only the creator of the universe as the tiny residual difference at the dawn of time between matter and anti-matter, it is also hidden in all of us, for example our faces, which look eerie if we force symmetry with a mirror. Whilst symmetry is nice, tidy and orderly, asymmetry provides energy, edge, and life.

This paper suggests that technological affordances for ubiquity also are characterised in terms of symmetrical properties of the interaction embedded within the technology. Affording interaction symmetry implies that the technology embed assumptions of standardised two- or multi-way symmetrical connections where each party carry equal weight in the interaction. Asymmetry in the interaction can, however, be supported through mechanisms defining technologically embedded rules influencing the unfolding interaction or the principles for interaction to take place at all. Again using the standard SMS message, then it will under normal circumstances take place as interaction symmetry. The mobile phones of users sending messages to each other will not normally embed specific rules governing who can send messages to whom. The use of Instant Messaging is, however, critically relying on embedded assumptions of interaction asymmetry. Obtaining a person's instant messaging identifier does not automatically mean that messages will flow instantly. First, the instigator must obtain the permission of the person receiving the request. Once this request has been accepted, both people are now on each others' buddy lists. However, this may still not be enough as most instant messaging systems will allow users to set levels of availability in the form of filters managing the interaction. Whereas traditional SMS functionality does not embed assumptions about the unfolding interaction, instant messaging systems most often embed a whole range of assumptions of interaction asymmetry. These mostly relate to the initiation of interaction as interaction once established between two people can be characterised as interaction symmetry similar to the SMS interaction. In this sense, instant messaging directly affords the explicit management by the user of who has access and when. For the mobile phone user, it is entirely left to the individual to keep track of who has their mobile phone number and therefore can call and send messages.

Explicit support for prioritising incoming interaction can be implemented in two different manners, either as an awareness mechanism providing the receiver with information about attempts to interact and thereby warning of impeding interaction, or as an accessibility mechanism explicitly prioritising interaction (Ljungberg, 1999; Ljungberg and Sørensen, 2000).

Diversity of Interaction Ubiquity Support

Synthesising the distinctions between support for encounters as opposed to the embedded support for ongoing relationships with the distinction between built-in assumptions of interaction symmetry and support for prioritisation, we yield four archetypical technological affordances as illustrated in Figure 1 with support for: 1) Connection offering non-prioritised encounters; 2) Filtering supporting asymmetry through embedded prioritisation of encounters; 3) Mediation through offering interaction symmetry and support for ongoing relationships; and 4) Coordination through support for managing interaction asymmetry and ongoing relationships. The four types represents a diversity of affordances, which will be perceived and instantiated depending on the particular user's preferences, need and particular situation and the four types of technical affordances can each influence the extent to which the individual can cultivate interaction ubiquity to best suit their perceived needs. The extensive use of connections as a means of interacting can for the instigator represent an appropriate means of interaction, whereas for the recipients, this may be considered highly inappropriate (Kakihara et al., 2004). However, it may also be convenient to engage some form of filtering to cultivate interaction asymmetry. It can be argued that one of the current problems with technologies such as email and SMS messages is the burden excessive use places on recipients resulting in reports of excessive use (Mazmanian et al., 2005).

Ubiquitous computing affordances can embed predetermined assumptions about the interaction. These embedded assumptions will then be met with the everyday practices of using the technology and here engage in a process of appropriation, which can result in a variety of behaviour.

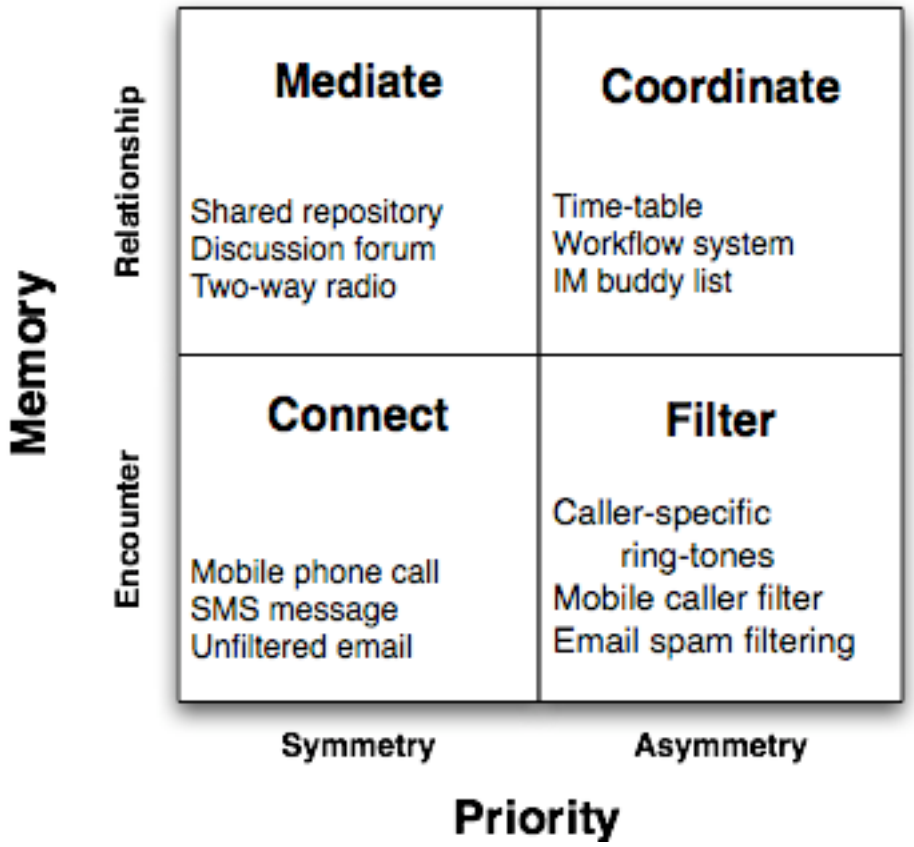

Figure 1: Characterisation of embedded assumptions in ubiquitous computing services of memory and filtering.

4.Praxis

This section presents an analysis of how the diversity of technical affordances presented in the previous section supporting interaction ubiquity are appropriated in four empirical cases. The outcome is an understanding of how the cultivation of interaction ubiquity is constituted by appropriation of technological opportunities. The four empirical examples are related to the four types of affordances discussed in the previous section. They are drawn from an extensive body of in-depth qualitative studies of mobile working across a range of countries and sectors collected from 2001 to 2008 (Sørensen et al., 2008). The aim is to illustrate how the designed properties discussed as; connection, filter, mediator, and coordinator. These types can each be evoked and combined in a variety of ways in a working situations. The emphasis of the illustrations will be to explore how the four archetypes presented in the previous section can be applied in order to understand the challenges involved in cultivating interaction ubiquity.

Interaction Ubiquity at High Speed

In the study of operational policing, the technology subjected to most intense cultivation of ubiquity and most highly rated by the police officers was the personal radio mounted on the officer's shoulder (Pica, 2006). The radio was generally the only remaining technology in use

during critical incidents demanding the officer's full attention and thereby in this situation offering the optimal sense of interaction ubiquity. Officers would remain in constant contact with the control room during incidents both to report progress, to rapidly gather information, to coordinate efforts with other officers and to request further assistance in case it was needed. In terms of technical affordances, the two-way radio system offered a an non-prioritised constant two-way connection between the police officer and the control room. In order for this to work, however, the police engage in intense cultivation of how this connection is shaped into a means of supporting ongoing collaboration by applying strict discipline as to how the shared radio-waves are used. Officers themselves would also apply highly selective audio filtering to the stream of radio messages broadcast and through this maintain peripheral awareness of ongoing and upcoming incidents similar to that documented from studies of traders and underground train control room operators (Schmidt, 1993; Heath and Luff, 2000).

In the police vehicle, the radio had traditionally been the main means for individual officers to obtain information about new incidents to attend. This had been supplemented with a new means of obtaining the same information, namely vehicle-based mobile data terminals providing a range of data services to the officers. These terminals provided officers with a more effective means of gaining information about an incident immediately before attending it as detailed case information. It could also provide information about related incidents involving the same address or the same citizens could be sent to the particular terminal. This allowed much more comprehensive briefing as the information would be filtered and only sent to the particular vehicle engaging the incident and not on a set of shared frequencies with implicit demands of keeping interaction brief and to the point. For the officers attending an incident, this filter engaging in an encounter uploading data to one car had significant advantages in terms of being prepared. Streaming data to the car also suited the officers as the officer in the passenger seat would the data information and continue to negotiate over the radio at the same time. This system was, indeed so effective that over time there was a gradual shift away from using the two-way radio system for pre-incident briefing and instead rely on the more effective dedicated streaming to the relevant car. As a side-effect of this shift from connections with interaction symmetry, where information was freely pulled by all officers listening to the main frequency, towards dedicated and filtered push of information, only to those obtaining the information would have an overview whereas everyone else would be more in the dark.

The data terminal also embedded a updated list of current incidents registered, which much like the queue of customer requests in a taxi system presented for the dispatch office a semi-automated way of coordinating the allocation of incidents to police vehicles simply by allowing officers to pick incidents themselves on the touch screen in the vehicle. From the point of view of the individual officer in a vehicle, the active queue of incidents represented mediation of ongoing available- and completed jobs. The officers evoked connectors when sending messages similar to SMS messages between the mobile data terminals installed in their patrol cars as well as using mobile phones to contact witnesses and colleagues to gather

critical information or for instant micro co-ordination (Ling, 2004).

Trading Foreign Exchange Out and About

At a large Middle Eastern Bank mobile foreign exchange traders would spend their days in the trading pit and then continue to trade foreign currencies after normal working hours (Al-Taitoon, 2005). This arrangement was made in order for the bank to continuously engage with the market 24 hours each day of the week. In the past, the bank had experimented with 3-shift pit-based trading both in headquarters; with distributing trading across time-zones in branches, and with selected traders trading out of hours from a stationary PC at home. These three previous attempts to extend trading hours beyond normal working hours all proved unsuccessful primary because they did not yield satisfying results when traders engaged in individual process of cultivating interaction ubiquity. This was crucially required for traders to get on with their private life while continuing to engage in trading (Sørensen and Al-Taitoon, 2008).

The fourth, and successful, solution supported traders in out-of-hours working through a combination of Reuter's SmartWatch, a small trading information device showing rate changes, a mobile phone for co-ordinating trading limits with colleagues, and for calling into an answer machine at the office to leave auditable details of the trades made out of hours. A highly select and trusted subset of traders engaged voluntarily in working around the clock. This imposed very high demands on the technology being able to support the individual's need to cultivate an acceptable level of interaction ubiquity.

As the traders throughout their working day were subjected to various co-ordination mechanisms and control systems, they were allowed significant discretion when engaging in mobile trading and they engaged in extensive cultivation of ubiquity with their Reuters SmartWatch, setting up limits triggering alarms and views through filtering. They generally kept the interaction with colleagues through connections such as the mobile phone to an absolute minimum and generally were left to trade on their own. An organisational coordination mechanism imposed some minimal interaction asymmetry from the trader to the organisation as each was required to record details for each trade on an automatic answering machine for subsequent processing the following day. Their individual cultivation of filters for tracking rate changes and for providing a constant stream of information on the SmartWatch was entirely unregulated and allowed the individual trader to accommodate his own rhythm of work.

Loosely or Tightly Coupled Relationships

An organisational system with RFID-enabled mobile phones used for recording RFID tags and automatically sending SMS messages with the readings to a central server comprised coordination used by the work force in two different organisations (Kietzmann, 2007). In a security firm the security guards would swipe the phone over passive RFID tags embedded in the walls along their route. After each swipe the phone would automatically send an SMS

message to a central server updating it with the security guard's position and the status of the situation selected by the guard on a menu in the phone. For the individual guard, this was an example of explicitly imposed coordination of the work. The security guards generally found it easy to cultivate their interaction ubiquity with the new system as the main difference from the existing system, where a torch-like tag reader was used, only was the immediate update of position instead of infrequent batch-updates. As the work already before was highly regulated with little scope for individual discretion, the guards did not find it difficult to cultivate ubiquity with the new system.

A similar system was, however, also implemented in another organisation to help track industrial waste barrels with RFID tags. In this domain, however, the workers, found this particular interactive type of mediated coordination problematic as they traditionally did have considerable discretion and now would have to engage in discussions with central management who felt they had a good overview remotely through the updated information fed by the RFID-based coordination (Kietzmann and Sørensen, Forthcoming). The embedded coordinator mechanism automated aspects of the work previously conducted by the user and also provided the possibility of real-time interactivity as opposed to data being recorded in the centralised system with some delay.

Finding Fares in London

A study of London taxicab drivers found a high degree of reliance on mobile phones for flexible connctions exchanging information on available customers, roadwork and for engaging in general social conversation with fellow taxicab drivers, friends and family when on a job or when waiting for one to emerge (Elaluf-Calderwood, 2008). Most London taxicab drivers traditionally work entirely on their own with no overall support for coordination of their efforts. They have appropriated the mobile phones as a means of obtaining work, and for staying in constant touch through evoking mobile phone connections. However, competitive pressures from minicabs, who can hire less qualified drivers has meant that London taxicab drivers increasingly seek membership of computer-cab organisations, which dispatch jobs to taxis through a computer-system based on drivers continuously updating their position to the central dispatch office. This system acts for the cab driver as a coordinator of jobs. The embedded rules for allocating jobs is a subject for much discussion among drivers as these rules greatly influence the overall performance and perceived fairness of the dispatch system (Elaluf-Calderwood, 2008). The study also revealed the further innovation of a co-ordinator where the driver's mobile phone location automatically is updated in a central system. The matching of customers and drivers is then almost automatically resolved when the customer calls the company from their mobile phone and here reveals their location to the system, which in turn automatically seeks out the nearest available black cab. The driver of this cab will be called on their mobile phone and can then accept or reject the fare. This coordination is an example where the customer and the cab driver are matched automatically through coordination as opposed to the traditional system where the customer would either call one cab directly or a human operator who would

located a cab.

5.Choices

Arnold (2003) argues that technological affordances are evoked in a non-linear and paradoxical manner. The previous section illustrated how individuals studied in four case studies appropriated a range of technological affordances as a means of cultivating interaction ubiquity. It was illustrated how affordances flexibly supporting instant encounters were implemented as connections and filters. Conversely, ongoing relationships over time were supported successfully through mediators and coordinators directly supporting part of the management of the ongoing interaction instead of relying exclusively on the individual participant to do this.

Human interaction is always conducted within a complex context of assumptions about others and about the interaction. This has been described best by Goffman (1963) in his study of the ongoing social processes of seeking to shape others' opinions of oneself, whilst these seek to gain the truth behind the masquerade. Goffman argues that in this ongoing process, we will always be a bit better at revealing the true intentions of others than they are at developing further strategies for obscuring these. Ling (2008) offers an extensive analysis of how the ideas of co-located interaction as studied by Durkheim, Goffman, and Collins can be understood in the context of new forms of technology-mediated interaction.

An interesting duality can be identified in the tension between the overwhelming success of connections assuming encounter symmetry, and the assumptions governing social interaction of relationship asymmetry. Emails, SMS, and mobile phone conversations are popular means of engaging flexible encounters in social situations of ongoing interaction relationships characterised by asymmetry.

Whilst relying on connection and mediation embed assumptions of symmetry in the interaction, filtering and coordination directly stipulate assumptions of interaction asymmetry and through this supporting the user in prioritising the interaction. These dimensions offer a span of possibilities for designing interaction support. Applying connectors and thus leaving most to the discretion of the individual makes a compelling case for easily cultivated ubiquity.

However, issues of information and interaction overload as well as interaction addiction and other side-effects speaks volumes of the possible consequences of not making design-choices regarding effectiveness of performance. As interaction and requests for interaction intensify this ubiquity becomes increasingly problematic and there will be a need to establish principles, rules and mechanisms stipulating asymmetry to manage interaction. If the amount of mobile phone calls suddenly explodes then the user will be forced to either turn off the phone or redirect calls to a bank of people answering. In the longer term, this would lead to carefully crafted heuristics for who has access to the number. Immediately, the problem with interaction symmetry seems worse when engaging in obtrusive interaction, such as phone

calls as opposed to asynchronous text messages or emails, which seem more inconspicuous as they need not disturb directly. However, any initiation of interaction can be viewed as a request for someone else's' time and whilst missed calls only leave behind information that they are missed, emails and SMS messages leave themselves behind entirely as long-lasting requests for attention. One of the useful features of buddy-lists in instant messaging clients, or the invite system in social networking sites, is the ability to include and exclude — applying filters and coordinators stipulating asymmetry in instant encounters or ongoing relationships.

The underlying assumption of interaction asymmetry also relates directly to the ongoing and relational nature of interaction at work mediating, negotiating and resolving mutual interdependencies (Schmidt and Simone, 1996; Karsten, 2003). Much of the literature on meetings assume these to be relatively long-lasting atomic encounters, few in numbers, several in participants, and based on a pre-determined agenda. Empirical studies of interaction at the workplace has, however, found that if all inter-personal meetings are recorded then brief un-planned interaction about ongoing issues between typical two people lasting around 90 seconds counts for most organisational meetings (Whittaker et al., 1994; Wiberg, 2001; Wiberg and Whittaker, 2005). Assuming this to be the case, it is highly unsurprising that technologies such as mobile voice calls, SMS messages and mobile email has turned out successful as they directly support such micro-coordination activities (Ling, 2004). However, this leads to users' spending considerable time managing multiple contacts as well as many ongoing conversations (Whittaker et al., 2001). Whittaker et al (2001) illustrate how a desktop-based co-ordinator can support both remembering the content of conversation, tracking status of conversations and outstanding actions, as well as maintain contact information. Wiberg (2001) identifies how ongoing interaction consisting of multiple concurrent conversations can be supported and here identifies the ability of the technology to mediate the relationship through what this paper will characterise as mediators and coordinators as essential.

The successful cultivation of ubiquity relies critically on the specific context. Whereas some work contexts, for example as in the case of security guards, require the explicit mediation of ongoing relationships through mediator or coordinator mechanisms ensuring sufficient technological support, other contexts, such as for example the mobile traders, only require relatively simple connector mechanisms to ensure the appropriate levels of individual discretion for the user. Extensive changes in the ways the ubiquitous services relate to the individual, for example in terms of shifting from symmetry to asymmetry, can make it problematic for users to cultivate ubiquity and the mechanism may be seen as foreign and inappropriate. For security guards, the added interactivity and transparency of their movements did not impose a critical barrier for ubiquity as they already were used to being closely managed, whereas the industrial waste management workers found the added visibility problematic as it led to more intervention from management and less discretion for the workers. For the mobile traders, there was an absolute premium on individual discretion even if they worked in the highly regulated banking business. They would, however, on their

own cultivate ubiquity through asymmetry embedded in profiles and alarms on their Reuters SmartWatch. This cultivation was, however, entirely determined and controlled by the individual trader (Al-Taitoon, 2005; Sørensen and Al-Taitoon, 2008).

Working life represents a myriad of emerging relationships continuously connecting and disconnecting social activities through technological capabilities and face-to-face engagements. Some of these connections are relatively easily established and broken, for example in close-knit networks of mobile phone connections. Others take hard work and significant organisational commitment to establish and to get accepted, such as establishing more significant direct support for collaboration through mediators and coordinators where the technology directly supports work processes. In general, symmetry, such as that offered by email systems and telephones, have easily found a place in organisations as flexible means for instant negotiation and micro-coordination. These connections offer flexible complements to interaction conducted by a variety of technologies embedding assumptions of interactional asymmetry, such as coordination mechanisms, schedules, organisational procedures and forms (Yates, 1989; Carstensen and Sørensen, 1996; Schmidt and Simone, 1996).

6.Conclusion

To briefly conclude this paper, then it has sought to unpack some of the central issues related to the ongoing integration of human and technological action and suggests that the relationship can be characterised in terms of ongoing cultivation of ubiquity through users evoking a variety of technical affordances. The paper studied this in the context of work. Within this scope, the paper suggested that the cultivation of ubiquity could be understood as the individual appropriation of ubiquity mechanisms characterised in terms of technologically mediated encounters versus relationships embedding memory of the process and its decisions. Ubiquity affordances were also characterised in terms of their designed and embedded assumptions of interaction symmetry or asymmetry. Four resulting archetypes of ubiquity affordances were suggested as: 1) Connectors providing support for symmetric encounters with no assumptions about the process or the relative importance of elements; 2) Filters embedding assumptions of interaction asymmetry supported through encounters with no memory of the process; 3) Mediators providing support for ongoing symmetric interaction; and 4) Coordinators embedding assumptions of asymmetry in the unfolding of events as well as mediating support for the process. Examples from a range of field studies of mobile working were discussed in terms of these four archetypes being subjected to the cultivation of ubiquity in the support for interaction at work.

With rapid innovation in the diversity of technologies and services available for the support of inter-personal and organisational interaction, there is a great need to reflect further on what the consequences of these technological choices may be once the technology engages in a process of social appropriation. The emerging debate of information growth, overload, and other unforeseen consequences of the broader digitisation project can greatly inform such discussions. However, this paper argues that there is a need for an additional vocabulary

when discussing the intimate relationships forged between individuals, organisations and technologies. This vocabulary must support us in understanding the consequences of socio-technical choices as well as guide our decisions of how to design further support. The argumentation provided in this paper marks one small step in this direction.

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