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DESKTOP COMPUTING AS PARADIGM: HIDDEN ASSUMPTIONS THAT SUPPRESS MOBILE INFORMATION TECHNOLOGY

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Abstract

In this paper, it is argued that what we think of as information technology in support of mobility is related to and draws on traditional ideas of desktop computing in a multitude of ways. A key argument made is that these dependencies are not only beneficial and desirable-in terms of user familiarity, recognition, acceptance, and a supposedly steeper learning curve-but also carry with them restrictions and hidden assumptions that in different ways come to suppress mobility. Through an analysis inspired by phenomenological inquiry, this paper sets out to recognize some of the interactional assumptions and dependencies that mobile information technology holds in relation to the desktop computer, and which currently suppress mobility.

Keywords: Mobility, paradigm, desktop computer, phenomenology.

1. INTRODUCTION

This paper looks closely at mobile Human-Computer Interaction, i.e. human use of mobile devices such as mobile phones, personal digital assistants (PDAs), digital cameras, and the likes. What will be found is that what we in general think of as mobile information technology is related to and draws on traditional ideas of desktop computing in a multitude of ways. A key argument in this paper will be that these dependencies are not only beneficial and desirable-in terms of user familiarity, recognition, acceptance, and a supposedly steeper learning curve-but also carry with them restrictions and hidden assumptions that in fact come to suppress mobility in different ways. It is argued that the well-known desktop metaphor is not only a metaphor-a desktop, a number of icons, a few common applications-but rather a specific enframing of computing and computer use. It is neither the only enframing possible however, nor perhaps the most appropriate one for dealing with the issue of mobility and mobile use of information technology. Nevertheless, the desktop

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computer seems to saturate our current understanding of what computers and information technologies in general are and what they are supposed to 'do' for the user.

This paper sets out to recognize some of the interactional assumptions and dependencies that mobile information technology holds in relation to the desktop computer, and which come to suppress mobility.

In this way, the main question with which this paper deals is: how is human use of mobile technology related to human interaction with desktop computers? To do this, we will introduce desktop computing as a specific enframing of Human-Computer Interaction, captured through advancing the notion of the desktop computer paradigm. In our view, understanding desktop computing as a paradigm helps us also understand how and why our notion of mobile Human-Computer Interaction is suppressed.

The paper's analysis uses two approaches. First, it is founded in a phenomenological approach to studying human-computer interaction, as described in detail by Fallman (2003). Second, Kuhn's (1970) well-known notion of paradigms is used as a metaphor for framing the phenomenological analysis and to provide some structure to the discussion.

2. PARADIGMS ARE FRAMEWORKS THAT GUIDE ACTION

The use of the term paradigm draws on Kuhn's. The Structure of Scientific Revolutions (1970), where he develops it as a tool for describing the organization and process through which scientific revolutions take place. In this paper, the word paradigm similarly comes to refer to a set of basic beliefs-a world view-which is often implicit but which strongly guides both action and thought. While being aware that the use of the term is outside the scope of Kuhn's original work, the term paradigm is used here merely as a useful metaphorical concept in that it points to a set of basic beliefs that influence, often implicitly, how things are seen and done. The applicability of the term paradigm to other areas than that originally suggested by Kuhn has been discussed by for instance Masterman (1970) and Thompson (1989).

Kuhn (1970) argued that science advances through revolutions rather than by small, incremental steps, the latter of which is the common notion of progress in scientific communities. Revolutions on the contrary are larger leaps where a new paradigm is accepted and an old paradigm is rejected and abandoned. What constitutes a paradigm are the agreed upon set of facts, theories, methods, and textbooks that taken together form the implicit framework within which the research of a particular scientific community is carried out; the paradigm presents researchers with a set of problems together with the methods thought appropriate for solving these problems.

Doctrinal values contribute a vital part of every paradigm since they suggest to the normal scientist not to abandon the paradigm without qualms. The periods of scientific work that take place within a specific, trusted, and agreed-upon paradigm seek typically not to overthrow its own framework but are rather to be seen as work in support of the paradigm. Kuhn calls these periods for periods of normal science. According to Kuhn

(1970), a normal scientist must be largely uncritical of the paradigm in which she works, and failures in solving the puzzle provided by the paradigm must not be thought of as a structural issue of the paradigm itself but rather as a problem residing with the individual scientist.

While in the midst of solving the puzzle of normal science, some pieces that seem not to fit the whole are at times encountered-as well as there may be some expected pieces that refuse to be found. Kuhn (1970) identifies these odd and missing pieces of normal science as anomalies of the paradigm. These are what the current framework cannot handle well or simply does not understand; it is "the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science" (Kuhn, 1970, p. 52-53). The appearance or mere existence of anomaly is however not what constitutes or brings about a serious undermining of confidence in the current paradigm. A period best described as a crisis may however come about when an anomaly strikes at the very foundation of a paradigm and resists numerous attempts at removal (Chalmers, 1999). A period of great insecurity and uncertainty sets in during such a crisis. Attempts at solving the anomalies become more and more radical, which tends to loosen the rules of the paradigm and the paradigm hence begins to undermine itself.

3. PARADIGMATIC QUALITIES OF DESKTOP COMPUTING

Below, a basic description and analysis of the desktop computer is presented, influenced by a phenomenological approach to information technology (Fallman, 2003), in which Kuhn's framework is applied as a conceptual tool for capturing some of its pervasive elements, which — much like the rules of scientific paradigms — are often implicit, pre-assumed and which accordingly are easily overlooked:

3.1 The Anatomy of a Desktop Computer

In The Invisible Computer, Donald Norman (1999) describes the desktop computer (referred to as the personal computer) in the following way: "The personal computer isn't very personal. It's big and clumsy, sitting there on the desk, occupying space, requiring more and more time to maintain, requiring lots of help from one's family, friends, and neighbors. Rather than being personal, friendly, and supportive, it is massive, impersonal, abrupt, and rude" (Norman, 1999, p. 69). Thus, according to Norman, the desktop computer is anything but invisible. In fact, it seems to some extent quite explicitly present to and for the user. Its large screen is typically placed clearly visibly on the desk, along with various kinds of related items; a keyboard, a mouse, one or two joysticks, a steering-wheel, a tablet, a scanner, a printer, and a number of speakers. All these things have different shapes and sizes, while all being connected with a grey, square box known as the computer.

Despite its obvious shortcomings, there are several interesting observations to be made from this Fig. 1. As mentioned in passing above, it becomes obvious that what is addressed as the desktop computer is in fact not one thing, but rather a network of a number of devices with individual shapes and functionality. Some of these devices are quite small and light, such as the mouse, while others-like the screen-are large and heavy. The different devices are typically not connected to each other, but rather to the grey box — a central device. It is obvious from these basic physical characteristics that the desktop computer rarely gets moved around. Rather, when it is put in one place, it has a tendency to remain there; because for every additional device that is added to it, the harder and more demanding it is to move it as a whole around.

Fig. 1: A Picture of a Typical Desktop Computing Setup

Various additional artifacts further suggest that the desktop computer and the environment created around it is something *to which one brings things*. Coffee cups and books, among other things, seem to have been brought to this environment. From the Post-It notes attached to the screen, there is also evidence to suggest that this environment represents some kind of consistency and dependability for the user. The desktop computer seems to be an artifact situated in an environment molded for it.

Its physical character does not only seem to suggest that the desktop computer stays in one place, it also puts demands on the place in which it stays. It needs a reasonable sized and fixed horizontal surface on which to put its screen, keyboard, and mouse-a need to which a typical desk generally answers. Naturally, the desktop computer's physical topology and basic assumptions like these that guide its further design-that it is tied to one place and rarely moved, and that the location itself consists of a reasonable sized and elevated horizontal plane-has never been unanimously decided and carved into stone, but has rather co-evolved through an interplay between hardware and software designers, users of desktop computers, and perhaps especially from the use context in which the desktop computer was originally most successful; the office.

It is also clear from the picture that the desktop computer is designed in such a way that its user must be positioned in front of it, typically sitting in a chair. With roots in office work, this is of course not an unexpected characteristic. Office workers and their likes-whether they were writing with quill pens or typewriters-were sitting in front of desks long before computers were introduced. The physical configuration of chair and desk allows the users to have a bird's-eye view of what is taking place on the desk; to monitor the device's 'output'.

If we for a moment disregard the possibilities of contextual disturbances-such as someone knocking on the door-it seems that, on some abstract level, the interactions that take place between the artifact and the user may be sketched out physically as well as conceptually as taking place on three vertical levels (see Fig. 2). The first level, which could be said to be limited to the user's head, seems to be exclusively for one-way communication between the computer and the user. This is thought to be a one-directional, audiovisual channel where images appearing on the screen as well as any sounds generated by the system are fed from the computer to the user. Few interaction devices appearing outside of research labs break this assumption. Voice control and voice recognition are perhaps the closest ones, besides eye-tracking, retinal scans, and various other technologies beyond reach for the average desktop computer user.

The second level is on the contrary characterized by one-way communication between the user and the system. Users act within the virtual imagery provided by the computer through manipulating available interaction devices in the physical world-such as keyboards, mice, and joysticks-and do so almost exclusively by use of their hands. Unlike writing on a piece of paper with a quill pen, the effects of the manipulation appear not where the manipulation itself appears, in the physical world, but are rather mirrored by the virtual world provided by the computer. Similarly to the first level, very few devices which are not research prototypes break this assumption. The most commonly available devices that in fact do this are some computer gaming devices, such as joysticks and steering-wheels, which may provide force feedback. A small number of other innovations, such as vibrating mice and specific devices tailored for certain user groups, such as the physically challenged, also tend to bend this assumption.

Thirdly, the desktop computer user seems literally dead from the waist down. Users neither use their legs for interacting with the desktop computer, nor are other parts of their bodies involved in interaction. Hence, the third level seems to be an uninteresting, inactive space when it comes to designing and thinking about desktop computers. This view, that the computer user is seen as a legless information processor, is also obvious in the legless model of Card et. al. (1983; 1986), the Model Human Processor, which has been very influential traditionally in the field of HCI.

Fig. 2: Levels of Involvement

In addition to this supposed leglessness of the desktop computer user, it also becomes clear from the model human processor that the context of use, physical as well as social, is largely absent. What is emphasized is the communication between a human information processing system and a computational equivalent. Hence, HCI becomes modeled as a disembodied enterprise; with legless as well as worldless users. Worldlessness is an especially important assumption in the desktop computing paradigm in the sense that it tells designers that they can count on the user's full attention at all times.

According to the picture of the desktop computing paradigm sketched in this section, it has become possible to conceptually model its assumption of how interaction proceeds between a desktop computer and its human user as a kind of three-way, cyclic relationship.

The legless and worldless human user is provided with a virtual, imagery world by the computer, on which she acts through interaction devices appearing in the physical world, which affect only what goes on in the virtual world.

3.2 The Virtual Desktop

What is it then that goes on in the virtual world? According to Laurel (1991), one way is to think of the desktop computer as a provider of a virtual world: "The notion of employing metaphors as a basis for interface design has partially replaced the notion of the computer as a tool with the idea of the computer as a representer of a virtual world or system, in which a person may interact more or less directly with the representation. Action occurs in the mimetic context and only secondarily in the context of computer operation. The 'desktop metaphor' is the leading example of this interface metaphor" (Laurel, 1991, p. 127).

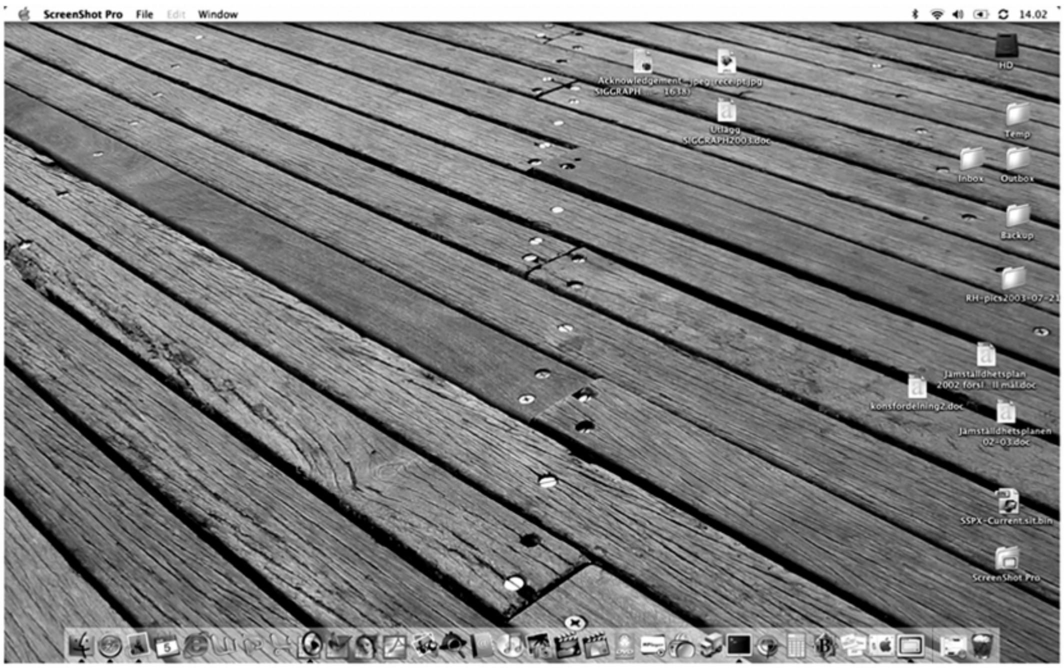

Fig. 3: An Idle Desktop Computer's Desktop

The common elements of most computer desktops are the desktop itself, folders, documents, windows, applications, and a trashcan. The desktop is a two-dimensional background area on which folders and documents are spatially organized, and on which all windows appear. In this way it becomes the background against which all other activities take place. Documents, on the other hand, represent work carried out by the user or by someone else, and are in some ways the most meaningful elements of the desktop to the user — they hold content. Documents may also represent the work of others, by being downloaded off the World Wide Web, or copied from a colleague's computer. Folders may also convey meaning, but here rather in the way they partition and structure the user's documents, so that all documents do not have to be kept on the desktop – similar to how physical folders allow office workers to keep their desks neat and tidy. The notion of a document, hence, has a primary position in the desktop metaphor.

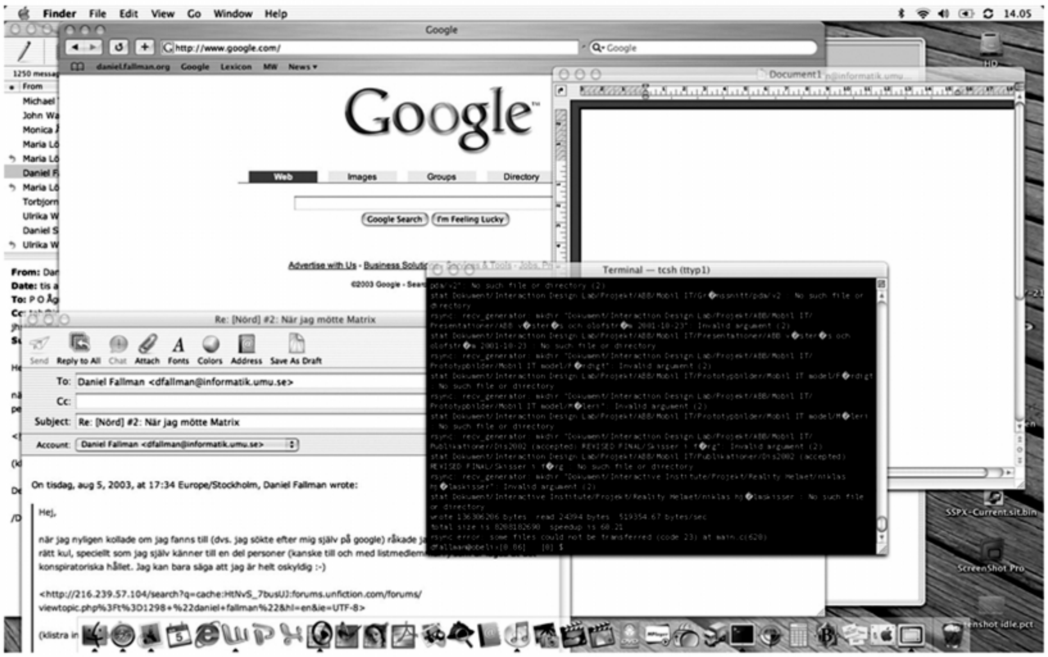

Fig. 4: The Same Desktop when the Desktop Computer is Being Actively used

Management of digital documents-like word processing documents, e-mails, web bookmarks, pictures, etc. — is generally restricted to putting files (documents) into folders (hierarchical separators). Some kind of hierarchical tree-like system is promoted and implemented in basically all modern operating systems.

3.3 Is there a Body in the Desktop?

It was previously shown that the desktop computer paradigm presumes a legless and worldless user. However, this does not mean that the desktop computer is unbiased or flexible towards the position of the user in the world. From the depiction of the desktop computer interface, it becomes clear that the virtual world provided to the user is presented in such a way that it confines the computer's as well as the user's position.

The computer desktop is seen from a bird's-eye perspective, which is a common way of visualizing information to create a sense of overview. This perspective, which allows lots of information and details be present in the same picture, however also means that one is not and cannot be present in the first person. Quite the contrary, the bird's-eye view implies a distance between the perceiver and the perceived. The distance between where one would have to stand to have the bird's-eye perspective of the city presented in the map is important, because one cannot simultaneously be involved in the city from this perspective-go in and out of its shops, stroll down its streets, and so on. In a similar way, one takes on a bird's-eye view of one's virtual desktop; a view where one perceives and controls things from a distance. In some sense, this perspective is an implementation of the view from nowhere discussed by Nagel (1986)-a disembodied view.

Apart from introducing a certain distance, it is also suggested by the map that the perceiver is located in a physical sense above the perceived. The perceiver of the map is positioned above, possibly on top of some imaginary hill or simply hanging in the air. Likewise, the perceiver of the desktop computer is in a position above the virtual world; looking slightly down onto it. The user's body is thus not only detached and distanced from the virtual world it controls, it is also physically located above this world-of which she at all times has a monitoring and controlling bird's-eye view. And what is more, this relation between the user and the world is stable; it does not change over time. Even if the user lies down on the floor with her monitor hanging from the ceiling, she will still conceptually remain in a position slightly above the virtual world it presents.

3.4 A World of Objects

The virtual world provided to the user by the desktop computer appears to the user primarily as a world of objects which is largely self-contained in its physical and social context. While not completely closed, it however seems-in terms introduced by Urry (2000)-to favor the mobility of symbols, not that of objects or bodies. Much like amateur radio, the networked desktop computer has traditionally been seen as something which simply sends and receives. Be it downloaded files, recorded video, received e-mail, or the reading of information from a floppy disc; they are things that all conceptually as well as semantically seem to come to the desktop computer. In this, the latter tends to become seen as something to which other things move in relation, while it in itself is regarded as stable, stationary, and immobile. It seems reasonable to suggest that this idea comes from understanding the desktop computer as a more or less a self-contained world of objects, a closed environment promising us a set of techniques and a praxis for dealing with the various kinds of issues that arise within it. But this conceptualization is becoming more and more inadequate and impotent as a framework for grasping and dealing which what goes on in the desktop computer.

Some currently popular applications of desktop computing shed light on this argument, and also show that the basis for this pre-assumption is becoming increasingly splintered. As Urry (2000) notes, the kind of symbolic travel networked desktop computers are currently concerned with has also come to suggest a kind of mobility of space itself. Seeing the desktop computer as a self-contained world of objects used by a single user is becoming an obsolete view, unable to deal with the creation of social and mental spaces promoted by for instance online communities, the web, and multiplayer computer games played online. These are all examples of where the pre-assumption of the desktop computer as a self-contained world of objects is possibly not the most appropriate way to enframe the activities that take place. This is partly because the shift to mobility of space rather than of symbols threatens the pre-assumption that holds that things come to the desktop computer. If things stop coming to the desktop computer, its stationarity becomes questioned.

Further evidence in favor of this argument includes the semantic shift that the web has brought into the desktop computing paradigm. Rather than being talked about as dealing with documents and files, the web is something which users feel they navigate. Through their browsers, users go to a particular web page, go back from one page to where one previously was, they go 'home', and so on. In this, it is the user with the desktop as a vehicle that seems to do most of the conceptual traveling, not the symbols that appear on it.

4. CONCLUSIONS: MOBILITY AND THE DESKTOP COMPUTING PARADIGM

The term paradigm has neither been chosen incidentally nor just used in search of a better word. On the contrary, the term is a useful in that it suggests that desktop computing is so much more than simply a metaphor which could be replaced by another one. Thinking about desktop computing in terms of a paradigm instead points us to the characters and qualities that make it a pervasive framework, which has come to lie beneath and found our understanding of what it is like to use a computer. The term in this usage points neither just to the desktop computer itself, pieces of technology appearing on desks; nor solely to all instances of technology which it has come to influence. Rather, the desktop computing paradigm is meant to include all these but also acknowledge the role of semantics, rhetoric, conceptions, ideals, pre-assumptions, and shared notions which the paradigm has formed around itself. In this sense, the desktop computing paradigm provides a world view and a set of basic beliefs which seems as demanding to break out of as a scientific paradigm appears to a normal scientist.

With a tad of phenomenological wordiness, one might say that the desktop computer paradigm has come to sediment our horizon of being-with computers, when it comes to what it is and perhaps even more importantly also what it could be. History shows us many similar examples. When a potentially new technological paradigm occurs, it is generally first interpreted-and typically misunderstood-in terms of some already existing piece of technology. The telephone, for instance, was originally though useful for broadcasting musical concerts directly into people's homes; the first motion pictures were generally shot as live performances on theatrical stages (Svanæs, 2000). But the telephone as well as the motion picture soon became their own media, with individual genres, languages and forms. As we have seen, desktop computing holds a certain pervasiveness that makes a similar separation between stationary desktop computing and new paradigms of computing-such as mobile computing-quite demanding. But let us now compare some of the characteristics of desktop computing and mobile computing.

4.1 Body and Bodies

A thematic character of mobile information technology is its embodiment into small, demarcated physical bodies. Mobile phones, personal digital assistants (PDAs), digital cameras, MP3-players, Tablet PCs, and even traditional notebook computers are all examples of mobile devices that come in single and easily identifiable bodies. This can be contrasted with desktop computers that most often appear as a network of interconnected physical devices. While this conclusion is clearly trivial in some respects, it is nevertheless important to emphasize as it constitutes one of the most important design axiom which influences mobile information technology in several ways — far beyond those which may be thought of as commonsensical. In terms of interaction, this means for instance that everything that caters for interaction with the human user must typically appear either hidden inside of or, which is most often the case, materialize on the surface of the single device. These interaction devices — i.e. screens, knobs, buttons, speakers, microphones, and so on-are in effect often clustered on one side of the device. One mobile phones, for instance, most screens and buttons typically appear close together on what we then consider to be the phone's 'front'. This configuration, as well as the placement of the screen and the buttons, suggests in several ways how the device ought to be held and operated by a human user.

While a desktop computer has several interaction devices — a screen, a keyboard, a mouse, and so on — each with their individual bodies, it indeed appears reasonable to also design mobile information technology in such a way that these interaction devices are still there, but now appear somewhere on this single body. Interaction with mobile information technology is by design envisioned to be similar in its character to interaction with a desktop computer-all interactional devices have just been shrunk to fit the new form factor. According to these examples, the only thing that would make interaction with a PDA different from interacting with a desktop computer is that the interaction devices themselves are put on the body of the device and that they are smaller.

But is this what interaction with mobile devices must be like? It is useful for our analysis at this stage to precede that discussion with an example of one such candidate, namely tilting as an input device, as it will provide some clues to understanding the pervasiveness of the desktop computer paradigm. While tilting a PDA could be a useful way for the user to input certain kinds of data to the computer system, it has remained largely unused except for a small number of HCI research prototypes. Why is this? One possible reason could be that this is because tilting is not part of the scope of the desktop computing paradigm. As for the desktop computer itself, lifting it up to tilt would indeed be a quite impractical way of providing user input. This is because of the stationary nature of desktop computer use, where the user typically sits in front of a desk. Sitting does not provide the physical incentives in which lifting things up and controlling them in multiple dimensions in the air is very practical; it would rather be a physically obtrusive, complicated, and tiring experience. In addition, as the virtual desktop world is largely two-dimensional, despite its overlapping windows which merely gives the impression of depth, for which the computer mouse provides a reasonable amount of freedom, the possible benefit of multidimensional control is not obvious for the user. Hence, within the desktop computing paradigm, tilting does not come into view as adding anything of substantial value to interaction.

Where mobile information technology is concerned, such as a PDA, the incentives for tilting as a potential means of providing interactional input however appear more promising. First, users are not stationary but often standing up, moving around, or finding themselves located in an unknown and at times interactionally hostile environment (such as subway trains). While this typically makes use of a computer mouse impracticable, tilting would on the contrary be quite achievable. Second, tilting would neither have requirements on the precious surface real-estate of the mobile device itself, as it is embodied in the device itself, nor would it require designers to add interface widgets to the screen. Hence more space left for bigger screens less cluttered with user interface widgets. Taken together, use of tilting as an interaction means would imply more space to provide information to the user.

The argument is however that tilting as a way of interacting with mobile devices nonetheless remains commercially unexplored because of the tendency to interpret the latter in terms of the desktop computing paradigm. What would not be considered to add value to desktop interaction is either not seen, or perhaps rather not even considered in the first place, as potentially useful for mobile information technology. The problem with this, however, is that this design approach seems to contain some inherent paradoxes, which are becoming more and more pertinent the more potent mobile information technology gets. It seems that while miniaturization is an agreed-upon design goal for mobile devices — the lighter and smaller a device is, the easier it is to carry around — it also severely confines the design, size, placement, and ergonomics of interaction devices. While the tendency in desktop computing is towards larger screens and ergonomic keyboards and mice, the goal of miniaturization of mobile devices necessarily posits an interactional paradox in that these must then too be made smaller and smaller. In this sense, two competing paradigms seem to clash, and so far, the latter has not made its case.

4.2 Relations Among Bodies

As discussed above, desktop computers tend to remain at a fixed location, metaphorically setting roots through their many cables and heaps of adjoining stuff that tend to get stacked and organized around them; manuals, books, coffee cups, notebooks, phones, Post-It notes, and so on. The desktop computer is hence something to which one brings things, not something one brings to other things. As discussed above, the user comes to take on certain bodily relations to the desktop computer. First, as the desktop computer screen is generally located on a desk, users tend to sit on a chair in front of it, looking down with their heads slightly above the screen. Second, the way in which the virtual desktop is designed positions its users in a bird's-eye perspective, an overview, from which they cannot escape and which in a phenomenological sense confirms their bodily position. When looking down onto the desktop computer's screen, the relation between the computer and the user was also found to be fairly stable. Regardless of whether the user is writing an e-mail, playing Tetris, or doing her taxes, she sits in front of the screen and perceives a virtual world over which she has a bird's-eye perspective.

Mobile information technology, on the other hand, is necessarily concerned with and relates to the human body in quite different ways than the desktop computer. The relationship between a human user and a digital camera, for instance, has been found to be multistable to its character (Fallman, 2003). But in the relation between a human user and a mobile device, one must not forget the various contexts in which HCI takes place. Thus it becomes clear that to such an analysis one must add the social, and not only physical, context in which both the human user and the artifact appear. A human user's relation to mobile information technology should hence be thought of as one in which users neither can nor want to shield off the world from the interaction between themselves and the computer device. Acknowledging the role of the body puts the human user in a more active position, and it becomes easier to accept and regard the relation between an active and situated user, and a likewise situated computational device, i.e. the foundations of *human–computer–world interaction* (Fallman, 2003).

Mobile information technology hence introduces and makes explicit a set of bodily concerns that have been largely absent in the discussion in and around the desktop computer paradigm.

4.3 Worlds of Objects Versus Objects in the World

This paper has seen the way in which a desktop computer appears to the user as a self-contained world of objects. Perhaps by convention rather than necessity, and relying on the desktop computer paradigm for guidance, PDAs and mobile phones are increasingly beginning to resemble desktop computers in many ways. Not only are they physically similar, but also in terms of interaction (text input and pointing in two dimensions); applications (e.g. miniaturized versions of Microsoft Office, web browsers, and notebooks); and interface (overlapping windows and menus appearing on a two-dimensional background). In its original state, the PDA, much like the desktop computer, is also unaware-uninterested-in the physical and social environment; it does not know its location, its near context, whether it is indoors or outside, whether its user is talking to someone else or is busy eating an ice cream.

Thus, in the case of the PDA, the currently dominating conceptualization seems to be to understand it as a self-contained world of objects. Given such a conceptualization, interaction design focuses largely on how to create, manipulate, present, and otherwise manage objects within the limited confines of the physical device itself.

The contending conceptualization is to understand mobile information technology devices as first and foremost objects in the world, which only in a secondary sense should be understood as in themselves constituting worlds of objects. This conceptualization stresses that the design space for mobile devices is not ultimately constrained by the properties of the specific artifact-which is to say that mobile interaction must not be seen as limited only to issues regarding the user and the computer. Here, the design space gets opened up to the possibilities that both meaning and interaction-between human and computer, computer and world, and human and world-can occur as a result of the properties that emerge when the threefold relations of human user, computational device, and world are allowed to afford each other.

4.4 Worldlessness Versus In-the-world

The previous theme also relates to an assumption that the desktop computing paradigm seems to hold about the user. If users are seen as legless and worldless, it makes sense to provide them with a world of objects and the tools with which they have both overview and control. This design ideal nevertheless has its side effects. Seeing computing as stationary has led us to believe that the context of computing, i.e. in stationary, contemporary terms the physical desk, the office room, or the office corridor-is of diminutive importance to the virtual world established by the computer through its desktop, icons, windows, applications, networks, and recycling bins. Each of these components cover up for a part of reality which previously remained physical, making us aware of the context of computing. Yet, a consistent trend within the desktop computing paradigm seems to be that if the virtual finds a foothold, it conquers and then expands from within, adding convenient virtual features and commodities which its physical correspondence cannot live up to. Hence, what has previously been a physical practice becomes virtualized, where soon its physical origin is forgotten. The desktop computing paradigm does not side with and complement alternative ways of doing and being; it rather seeks to include, virtualize, and eventually supercede. This abstraction is precisely that about which Heidegger (1982) expresses concern-that the world "no longer passes through the hand as it writes and acts authentically [...] this means the hand is removed from the essential realm of the world" (Heidegger, 1982, p. 118-119). Heidegger's fears are echoed by a number of dystopian philosophers of technology, such as Ellul (1964; 1985) and Marcuse (1964).

As argued, because of its lack of a specific domain the desktop computer appears in the guise of neutrality. It seems to be used for everything by everyone, independent of domain, gender, ethnicity, social class, and so on, so surely it must be a quite neutral thing? What one may not think of at first, but to which some of these dystopian philosophies of technology are pointing, is that pervasiveness and domination of technologies like these in effect becomes a form of dominating, political power; a way of controlling society. Without repression, possibly, but also without an explicit choice being made.

It is clear that the virtualization of physical practices does not come without consequence. While the desktop computer has made several things previously unimaginable possible, it has unfortunately also made many possible things now seem unimaginable. It is for instance possible to browse the Web to find old classmates; to instantaneously send e-mails to thousands of unknown people encouraging them to buy cheap inkjet cartridges; to take part in virtual communities and spend hour after hour chatting with people you would never otherwise have wanted to meet. In this, the desktop computer indeed constitutes an enchanting, lively, and pulsating milieu; even a kind of life-world. But when an electronic document such as a digital picture is printed anywhere else than on the screen, the desktop computer tends to lose interest in it and disregard it completely. Why does not the desktop computer recognize that this print-out is an instantiation of one of the documents stored on its hard drive?

The answer to this question is, quite simply, because it is not at all concerned with context — and it does not need to be, as its model is that of a self-contained world of objects. The desktop computer's way of expanding is not an expansion in which it generates tentacles into the world, connecting the physical and the virtual by being attentive or even interested in what goes on outside of it. Rather, its paradigmatic tactic seems to be to incorporate and transform the physical world from analogue to digital, from physical to virtual — and perhaps from real to emulative. Whatever is still left on the outside is considered of no importance and disregarded more or less completely.

In light of mobile information technology, this character of the desktop computing paradigm — in which it expands its own realms to form a larger and larger, but self-contained, virtual world — seems hardly beneficial. Or rather, it may even provide one of the key incentives to break up the marriage between mobile information technology and the desktop computer. This is because mobile information technology is dependent on context, in that it necessarily gets involved in whatever its user is up to. The fact that a user shows an interest in mobile information technology seems in itself an incentive for an interest in some aspect of the physical and social world that one cannot get at behind a desktop screen. If the user did not have an interest in the world, why would she then bother with mobile technology in the first place? That people are struggling with the cumbersome interaction, small displays, silly miniature keyboards, and poor network connections-all of which today's mobile information technologies feature-suggests that for these users, a stationary computing alternative for the activities they are involved in is just not possible, even though it would provide a far more developed and mature use environment.

4.5 Overview Versus Involvement

The desktop computer gives its user a bird's-eye view of the desktop, an overview of the world of objects under her control. While this perspective provides the basis for many kinds of tasks, it is important to realize that having overview is also pre-assumed in the styles of interaction that have evolved. The now all-pervasive style of interaction called direct manipulation takes user overview and control for granted. It is only if the user has an overview of the situation at hand that the benefits of virtual direct manipulation-pointing and clicking on virtual objects, dragging virtual objects onto other objects, and so on-become obvious. The success of direct manipulation in the context of desktop computing is also partly the reason why computer monitors are becoming larger and larger. When interfaces were sequential and text-based, direct use of the interface took place at the position of the prompt, and screens had just to convey some of the previous dialogue between the user and the system to provide a reasonable context. With the introduction of direct manipulation on the other hand, the more overview the user gets, the better.

But to have overview also suggests a certain distance to what is perceived; to have an overview is to not be involved, in a phenomenological sense-it means standing aside. There is a tension between overview and involvement. When one is in a position of overview of several things, one cannot simultaneously be really involved with any one of those things. While overview is one of the accepted key design dimensions for the desktop computing paradigm, there are some pertinent arguments to be made for why this interest need not be shared by designers of mobile information technology. First, while overview implies a distance to what is perceived, this is an expected characteristic of desktop computing. But as argued, mobile interaction on the other hand is rather concerned with involvement. Metaphorically, if desktop computer use is like perceiving a city from a distance, mobile interaction is about walking its streets, feeling its pace, and smelling its smells. While mobility is about involvement, overview is a distancing. Use of mobile information technology is thus better characterized as a kind of first-personness, a kind of engagement in the world. Obviously, this difference does not come with a choice. If we accept that mobile interaction is about human-computer-world interaction, the complete overview and control needed to bring forth the goods of direct manipulation would hence also imply a complete overview of world, which of course is impossible.

Second, there is also the more down-to-earth issue of screen real estate. Systems attempting to provide visual overview tend to perform poorly on small-screen displays. Again, this points to a suggested paradox of current mobile information technology design. While the latter strives towards miniaturization, there is at the same time an opposing design ideal-coming from the reliance on the desktop computing paradigm-which suggests that screens as well as other interactional devices should on the contrary continue to increase in size.

Third, the reliance on overview as a key design dimension is also to depend on vision as the primary modality for system output. While using a desktop computer, the environment of use-i.e. sitting in front of a desk-in a natural way allows for the user to lean back in her chair, to visually take in the whole of the interface. As mobile information technology has been described as involved and engaged in the world, a kind of first-person paradigm of use, it seems questionable to depend on a paradigm which requires one to lean back and have a kind of reflective, visual overview. In the realities of mobile information technology use, one's visual attention must often be shared between the device and many other things, e.g. the bus that is coming down the street one wishes to cross, the speaker at a conference or meeting, the broken pump a service technician is standing in front of, and so on. It hence seems plausible to complement visual output with other means of communication between the computer and the user that makes use of other modalities, such as sound and force feedback for instance. While using other modalities than vision clearly constitutes an option which will be further explored in this work, doing so within the realms of the desktop computer paradigm would pose the designer with a new and quite difficult problem. How should the necessary overview needed for direct manipulation be communicated with the user through sound, which in some way is more one-dimensional than vision?

5. ANOMALIES OF MOBILE INTERACTION

Kuhn (1970) identifies the odd and missing pieces of normal science as anomalies of the paradigm. These are what the current framework cannot handle well or simply does not understand; it is "the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science" (Kuhn, 1970, p. 52-53). From the above discussion, it is possible to distinguish some potential anomalies in the current design of interaction with mobile information technology. These seem to provide clues to the idea that not only is mobile information technology dependent on the desktop computing paradigm, but that it is also suppressed by it. First of all, what appears to be a paradox was suggested and exemplified above. It holds that, first, mobile information technology should be designed to be as small and light weight as possible, thus catering for ease of mobility. Second, particularly screens but also other kinds of interaction devices should on the contrary be as large as possible, to provide the user with the interfaces and interaction styles of the desktop computer. If one considers and then extrapolates recent design trends in mobile phones, what will happen? What should designers of mobile phones do to be able to continue the two seemingly conflicting and paradoxical directions of miniaturization and increased screen space and interactional means in the future?

Traces of a second anomaly can be found in mobile interaction's reliance on text input from the user. Composing text has always been a stationary activity, whether it is carried out using quill pens, typewriters, or desktop computers. One of the major concerns in mobile interaction today is the quest for a feasible way of providing text input for users which are on the move or who cannot use both their hands. While the design space of possible solutions provide us with a broad range of potential solutions-such as the T9 system popular on mobile phones, the host of virtual keyboards and character recognition systems available on smartphones and PDAs, as well as various semi-prototypical add-on Qwerty and one-handed keyboards-there is comparably very little discussion on the issue of the amount of text input required by mobile applications, and almost no discussion whatsoever on the issue of whether or not mobile information technology should demand text input at all. In light of the desktop computing paradigm, this should come as no surprise as the pre-assumption of literally all previous paradigms in computing has taken the computer keyboard as a basic interaction device for granted. It here becomes clear that mobile use of information technology is different in its character from use of a desktop computer from this perspective: the keyboard cannot be taken for granted. What seems missing from the discussion in mobile HCI, which is currently mostly occupied with trying to design the optimal mobile text input device, is however the chance that there might not be a way to allow mobile input of text that is as unobtrusive as typing on the keyboard of a stationary desktop computer, simply because doing so is still and has traditionally always been a stationary activity. If so, this limitation would not be because the devices designed for this purpose have design flaws, but rather because the activity of text input is in itself a stationary, immobile activity which has been forgetfully postulated for mobile interaction because of a reliance on the desktop computer paradigm. Thus, while the horizon for possible solutions for providing text input is confined by the paradigm, the problem remains set at how it is best achieved-not whether or not text input is an appropriate mobile activity in the first place. The point here is that the problem of text input cannot be treated as a problem that will or can be solved solely by improved designs within the paradigm; neither can it be treated as a hardware issue that will be solved through advances in technology. It is rather a structural issue, which may provide the necessary incentives for making mobile information technology's reliance on the desktop computing paradigm visible.

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