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Towards the Paperless Office

Ecology of artifacts at work

MSc in Innovation and Entrepreneurship

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II

Abstract

Stepping one step closer to the paperless office by looking into existing technologies.

Looking at the whole ecology of digital artifacts of users. Only by understanding how people use paper, how they relate to their digital ecology of artifacts, and what makes them adopt new products can we hope to get one step closer to the paperless office.

There has been an extreme growth in mobile devices the last couple of year, and there have been a couple of new platforms emerging in the mobile ecology. This spark in multiple devices at the office leads to new ways of looking at how the existing ecology of digital artifacts can support some of the affordances of paper. The new emerging platforms transform the concept of compatibility in the mobile ecology. Because of this the earlier thought on what the limitation of the existing technologies are not that relevant any more. The problem seem to lie more in the way people deal with context and labeling and how this leads to consumers use of digital artifacts in a sequential manner.

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1   Introduction

I want to research how we with the help of existing technologies can come one step closer towards the paperless office, by taking advantage of all the digital artifacts around you at work, instead of focusing on only one device. I want to lead off with the changes in the mobile ecology and what makes paper better for certain human activities than their digital counterparts today? Before I come to my research questions and how I want to address them.

1.1   Growth in use of mobile devices

The sales of smartphones has dramatically increased in growth the last years, with a 24% growth from 2008 to 2009, and a year on year growth of 74% from 2009 to 2010. That makes for a total of 302 million smartphones sold in 2010 alone (IDC, 2011a). Research by Gartner tells us that ca. 23% (67,2m) sold with Android OS(Operating System), ca. 16% (46,6 m) sold with iOS, and ca. 16% (47,4m) sold with Blackberry OS (Gartner, 2011a). This means that these three OS have over half of the market share of smartphone sold in 2010. Tablet computers have been available to the consumer for quite some time, but they never gained much popularity until Apple announced the iPad in April 2010. Apple sold 3 million iPads in the first 80 days, making it the (to that date) fastest selling consumer electronics outside of the phone category (Melloy, 2010). In total 17.5 million tablets were sold in 2010. Apple's iOS had 83,9% market share and Android a 14,2% market share, giving these two OS 98,1 % of the market share in 2010 (Gartner, 2011b). Gartner goes on to predict that some 70 million tablets will reach consumers by the end of 2011, and in 2015 the yearly tablets sale is predicted to go as high as 294 million (Gartner, 2011b). Although it is still early to make predictions as competitors of Apple's iPad has only started to introduce their products. Interestingly, Gartner predicts that Apple and Google with their iOS and Android OS will continue to control over 80% of the tablet market. Although e-reader are a fairly recent addition to the range of mobile devices, the products have had a remarkable growth. There were sold 12,8 million e-readers in 2010 up from 3 million in 2009 that makes for a 325% growth year on year (IDC, 2011c). Further e-readers are predicted to rise to 14,7 millions sold in 2011 and 16,6 million in 2012 (IDC, 2011b). Last but not least, there is a fourth category that is not much mentioned; minicomputers with WIFI, like the iPod Touch and Galaxy Player 4 and 5. Apple reported on quarterly conference call to have sold over 14 millions iPod

Touch in Q1 and Q2 2011 (Slivka, 2011b, Slivka, 2011a). The interesting part here is that both of these minicomputers run on the same OS as their smartphone counterparts.

It is not just growth in mobile devices the last years that have changed the landscape of the mobile ecology. The rise of big OS like iOS and Android, that support developer communities. With the change in focus on app stores and developer communities that have change these OS to become something more, they have become developer platforms. If you are going to develop something for the mobile devices today, there is no chance of not doing it on these two platforms. The Android and iOS have the largest developer communities, and because of this they also have the largest number of apps in their respective app stores. Another reason that these OS are important to focus on is that they are present in every facet of the mobile ecology, with iOS and Android OS on smartphones, tablet, e-reader (just Android) and minicomputers. That fact that the same OS is used by all these devices makes compatibility between them much easier, and it is making cross platform compatibility more and more common as well.

1.2 Why would we want a paperless office

The book; "The myth of the paperless office", suggest five affordances of digital reading technologies:

- Storing and accessing large amounts of information
- Displaying multimedia documents
- Fast full-text searching
- Quick links to related material
- Dynamically modifying or updating content.

Storage is a problem, with vast amount of paper, and different versions, but the real problem comes when users are attempting to access information from storage. Sellen et al.(2002) suggest there are three kind of paper files hot, warm and cold. By hot paper we mean the paper that are in constant use in this moment in time, paper that are on top of your desk is a perfect example of this. Paper that are in the desk drawer can be a good example of warm paper, it is the paper that you have in close proximity to you, and can be easily transformed to hot paper by taking it out of your desk drawer. Cold paper on the other hand is paper that is ready for archiving, paper that you are finished with, and do not see any further need for in

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the nearest future. Paper is great for fast and frugal searching of hot paper, but not so much for warm and cold paper. Liao et al. did put it quit elegantly in the article PaperCraft

> "Interactions with paper documents create rich webs of annotation, cross reference, and spatial organization. Unfortunately, the resulting webs are confined to the physical world of paper and, as they accumulate, become increasingly difficult to store, search, and access." (Liao et al., 2008, 18:1)

Their point of access is also quite important. Paper is locked in to physical space, and cannot be accessed from afar or from multiple people at the same time. This fits with Sellen et al. (2002) limits of paper: paper must be used locally and cannot be remotely accessed, Paper occupies physical space, paper requires physical delivery, used by one person at a time, cannot be easily revised, reformatted and incorporated into other documents, cannot be easily replicated and only display static content. At last the most obvious affordance of digital content is the ease of modifying and updating documents.

There are many areas that would benefit economical by going paperless. Mostly within workplaces that operates with large paper archives, and where costs for paper material becomes insignificant when compared to the cost of dealing with documents after printing.

- United States 1 billion a year designing and printing forms
- 25-35 billion a year filling, storing and retrieving paper from and an extra 65 -85 billion dollars over the entire lifespan of the papers
- Storage cost 40,000 to 60,000 on filing cabinets alone for two million paper

(Sellen and Harper, 2002, ch. 1)

1.3 Affordances of paper

Today the paperless office is more of a myth than a reality. As stated in the book by Sellen and Harper (2002) "The myth of the paperless office". In the book they talk about how technology changes how paper is used, rather than replacing it. Computers and the Internet have instead of limited the amount of paper used done the opposite. People still want to read the information they find on the Internet on paper, so they print it out. You can see an increase in the use of general printing and personal printing paper from 1995 to 2000; up 15% in the

United States (Sellen and Harper, 2002). And a worldwide increase of 14% in use of paper for printing and writing from 2002 to 2008 (FAOSTAT, 2011).

What is it that makes paper better for certain human activates than their digital alternatives? To answer this Sellen and Harper suggest we look at what kind of affordances paper gives us (Sellen and Harper, 2002). The concept of ''affordances'' comes from the ecological psychologist J.J. Gibson in his book The Ecological Approach to Visual Perception (Gibson, 1979 cited in Sellen and Harper, 2002, ch. 1). An affordance refers to how people perceive a physical object, and the fact that the physical properties of an object affect how people can interact with it. Different physical properties give different function for the person perceiving or using it. So the properties of an object define the possibilities for action.

Designing new Technologies by looking at the way people use paper to move forward into the digital future more effectively. To understand paper we have to look at the four affordances of paper (Sellen and Harper, 2002):

- Tangibility
- Spatial flexibility of paper
- Tailorability
- Manipulability of paper.

When people read in a work setting, they seldom read from beginning to end. People skip through bits as they see fit and they flick through the document to find sections and how long the document is. It is the tangible properties of paper that support this. So therefore the first affordance of paper is its tangibility. While reading in the work space we seldom or never read just one document. We seem to always have other documents on our desk spread out, so we can easily cross reference to another document. That fact that we can have many documents easily spread out on our desk talks to the spatial flexibility of paper. So the second affordance of paper is its spatial flexibility. While reading a document people may scribble on the document. Scribbling can be everything from marking the document, underline certain lines, writing question marks, jotting down arrows, and other sorts of annotations as part of the process of understanding. So the third affordance of paper is its tailorability in this regard. While people read they sometimes have another paper right next to them where they write their own notes. This opportunity to interweave reading and writing by having papers next to each other is the forth affordance of paper, this is done by the manipulability of paper.

The four affordances of paper are all aspects of active reading, so we need to understand why work related reading is so much more than just reading from beginning to end of a book. Sellen et al. (2002) found ten different ways people go about work related reading. People read to identify what kind of document or type of document they are facing. Sometimes people skim through the document in order to get a rough idea of what it is about and whether it its useful. People also read just to remind themselves what to do next, like a check list or a shopping list. People also read to search for answers to questions, or just to obtain information to make a decision. Reading is also done just to further general knowledge. We read to learn. This kind of reading is usually much more reflective in nature. Cross referencing documents is another way of reading, usually done for the purpose of writing. People read to edit or critically review text. The last two ways of reading is to support listing and discussion. Reading to support other activities as listing and discussion are done by looking at slides while listing to a presentation or by referring to a document while discussing, by using it as a frame of reference.

The problem is that by focusing on paper and looking at how paper is much more than just an old-fashioned medium, one comes off as being supporters of the status quo says Sellen et al. (2002), but they argue that studying how paper is used can be a resource for change, instead of an obstacle. This is possible by looking at paper as an analytic resource. Sellen and Harper talk about three different way of using paper as an analytic resource. First as a lens through which we can see the role paper has in the organizational life. Second as a way of illuminating why alternatives does not prove adequate for supporting how people currently work and want to work. Third, as a guidance for choosing, designing, or developing new products, systems, and services that my replace paper.

1.4 Research question

There has been an extreme growth in the mobile ecology within the short space of a couple of years, with over 340 million new mobile devices sold just in 2010. There have also been quite a lot of new entrances in the mobile space in the last five years including; tablets, e-reader and minicomputers. But people still use close to the same amount of paper for printing and writing as they did ten years ago, there even is a small increase in the use of paper for printing and writing. The rapid development within the area of mobile devices especially tablets and e-readers makes the question of the possibility of copying some of the affordances of paper to

this new medium. If not by other means than affording the user more surfaces to view at the same time. Giving you the chance to read and write simultaneously or to cross reference between two different screens/devices. So I ask the question of why this mobile revolution has not sparked the beginning of a "paperless" office? I want to examine this by looking into the ecology of digital artifacts, therefore I ask the following

In what way does focus on the whole instead of one single device change the way we approach digital alternatives to paper?

More specifically I will investigate:

- How does studying the use of paper change the approach to digital alternatives?

- Why is it important to focus on the existing ecology, of digital artifacts at work?

- Should we focus on one segment of digital alternatives?

1.5 How I am going to answer the research questions

I want to answer my research question by looking into the different approaches that exist to come one step closer towards the paperless office. I will be looking into Liao et al. (2008) categories of systems for digital alternatives for paper. From there I will focus on digital artifacts that exist, and are in regular use today. So to explore the existing use of the technologies I want to look at the ecology of artifacts at work. By going through some of the main findings from Jung et al. "Towards a framework for ecology of artifacts" (Jung et al., 2008). Then I want to explore the adoption rate of new products and the re-innovation of existing solution by looking into the diffusion research done by Rogers it the book "Diffusion of innovation" (Rogers, 2003). From the book "Crossing the chasm" by Moore I want to point out how important segmentation and the whole product approach is for crossing the chasm (Moore, 2002). Then I want to explore how the support is for flexibly adoption of persons own ecology. More specific I want to look at what kind of devices people have, how they use them, and what kind of cross device and cross platform tools they use through my case study. By focusing on the ecology when introducing new artifacts, and especially peoples own idea of the ecology of artifacts around them, we can better grasp the importance of communication

between artifacts and looking at the whole ecology instead of one on one device. The ecology I want to look more into is the ecology at work, more specific the ecology around paper at work.

2 Theory

Here I am going to talk about previous research done to finding digital alternatives to paper, then I am going to talk about ecology, diffusion of innovation and chasm theory to illuminate how looking at existing ecology can change our approach to digital alternatives.

2.1 Previous Research

Liao (2008) lays out 5 different categories for bridging the paper-computer gap. In my research I will merge category 4 and 5[1], since these categories concern pen and paper systems with and without restriction on input structure. I will use the four below categories of systems that tries to solve the gap between paper and digital alternatives:

1. Systems that attempt to remove the gay by eliminating paper and restricting interaction exclusively to digital media
2. Systems that bring digital functionality to paper by tightly coupling paper and computers. This coupling of paper and computer is done by projecting digital feedback directly onto paper.
3. Systems that further loosen the paper computer coupling by using paper and screens as separate displays.
4. Systems that allow pen and paper as input device for form filling and papers-based annotation of digital documents without any restriction on input structure.

The first system mainly employ tablet computers, that lets you annotate and copy information from one digital artifact to another. The problem as Liao (2008) sees it is that such systems do not give the user the affordances of paper like flexible display size and the limits of display size make navigation difficult. Especially multiple documents at the same time are clumsy. As for the second category of projecting digital information straight on paper, requires some sacrifices of mobility. To be able to project images and information one need equipment that are not that easily portable at the moment: computer, projector and camera. The limitation of the third category is that the interactions are preprogrammed into the content as link hotspots.

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[1] The fourth category use pen and paper as input devices for form filling, and the fifth category is paper-based annotation of digital documents without any restriction on input structure.

Liao (2008) argues for that the fourth category is what gives you the affordances of paper and digital. Since the user still works with pen and paper, but are able store the information digital and control the digital facilities.

Terrenghi et al. (2007) presents a comparative study of manipulation of physical versus digital media. Where the digital system fits in the first category of digital alternatives, by restrict interaction exclusively to a multi touch, interactive table top. They use a mix of qualitative and quantitative data gathering from observation of 12 participants. Were the 12 participants first used the interactive tabletop to do some task, and then did the same task with paper.

What they found from this study was that bimanual interaction was much less common on the digital media. Subjects used one handed interaction, that closely resembled how they used the mouse interface for computers on the interactive tabletop and they seldom used the non dominant hand as a frame of reference on digital media. So the subjects did not use bimanual interaction, even if this was what the interactive table top was designed for. So Terrenghi et al. (2007) states that to simply mimic spatial flexibility of paper in physical space through graphical interfaces on a multi touch tabletop may not be enough to encourage interaction as you see in the physical world. But this does not mean that we necessarily need to mimic physical properties, but have to recognize what those physical affordances achieve for people when working with tangible objects. Then they goes further to state that a better design decision may at times be to preserve these physical aspects, by designing hybrid or physical-digital user interface. One of the weaknesses with this study is that they used the same people at both of the tasks, instead of using a control group, and they designed the prototype that they used when testing themselves.

PaperWindows by Holman et al. (Holman et al., 2005) is an example of the second category of digital alternative systems. Where they are projecting windows on physical paper, and by this allows them to capture the physical affordances of paper in a digital work. The system uses a motion tracking systems to track movement of pens, finger hands and other objects related to the context provided by the paper artifact. They conclude with "By projecting windows on physical paper, PaperWindows allows us to capture the physical affordances of paper in a digital world" (Holman et al., 2005, p.598) The problem with this is that they just have some initial user experience test and some analysis to support this statement.

From the third category of systems for digital alternatives I have chosen Weibel et al. model for mapping between printed and digital documents instances (Weibel et al., 2007). Where the goal was to enable a seamless mapping between digital documents and their physical counterparts on paper. So the point is to transform the static paper sheet to an active and reactive object tightly bound to its digital source. Their conclusion is that " The paper outlines how our solution is a step forward towards bridging the paper-digital divide by supporting the publishing of interactive documents in an extended way."(Weibel et al., 2007, p.27). The problem here too is that there is not much evidence to support this in the way of empirical evidence.

As an example of the fourth category of digital alternatives systems, I want to use Liao et al. (2008) PaperCraft. PaperCraft explore the interaction model were you work with pen and paper, but still able to link to and control digital facilities. Liao et al. (2008) suggest that this approach will be especially effective with active reading. They conclude that by introducing digital function for paper they create interactive paper, and by this bridge the paper-digital gap while maintaining both digital and paper affordances.

There are of course many other concepts and design for the different categories mentioned, but my aim is to glance into the roads for digital alternatives for paper, and focus on just one. The commonality between the last three categories is that they are all hybrid products and none of these hybrid products have gone mainstream yet. Therefore I will focus on the first category of digital alternatives that can use existing technologies, by exploring the existing ecology of digital artifact and how they are used.

2.2 Ecology of Artifacts

People live with an increasing number of digital devices in their life: mp3 player, smartphone, tablets, e-reader, laptops, digital cameras and so forth. An increasing number of these artifacts (devices) have some kind of interconnectivity with each other and it is more common with overlapping function for several artifacts. When you have a smartphone it also has a camera and mp3player. This makes for a complicated picture of personal artifacts, so to explain Jung et al. suggest a concept of ecology of artifacts to better understand the implicit or explicit relationships between interactive artifacts (Jung et al., 2008). Definition set forth by Jung et al.

"We define a personal ecology of interactive artifacts as a set of all physical artifacts with some level of interactivity enabled by digital technology that a person owns, has access to, and uses." (Jung et al., 2008, ch 1)

Jung et al. stresses the point that the consumers are not users of one distinct artifact, but of a large set of interconnected artifacts. This resembles Rogers thought on diffusion research where he says that

"Past diffusion research generally investigated each innovation as if it were independent from other innovations. This oversimplification represents a dubious assumption, in that an adopter's experience with one innovation obviously influence that individuals perception of the next innovation to diffuse thorough the individual's system. In Reality, the innovations diffusing at about the same time in a system are interdependent. While it is much simpler for diffusion scholars to investigate the spread of each innovation as an independent event, this is a distortion of reality. More scholarly attention should be paid to technology clusters" (Rogers, 2003, p.15)

Rogers talk about interdependence between devices that are diffusing at the same time and technology clusters is of similar thought as Jung statement that interconnected artifact has not been given enough research attention(Jung et al., 2008). Jung et al. conducted two exploratory studies to investigate interconnected artifact and to make a foundational framework for designers and researchers to understand user's ecology of artifacts. The first study each subject maid a list of their digital artifacts, and the second study was a ecology map study where the subject were asked to map up their artifact ecology, by using post-it, magic markers on a whiteboard. When analyzing the result from their two studies they found that some properties and values from individual artifacts displayed ecology factors, and that these factors are manifested as diverse patterns of use. These diverse patterns they named layers of artifact ecology.

2.2.1 Ecological Factors

Based on the results and findings on the study in (Jung et al., 2008) Jung et al. introduced the notion of ecological factors. These factors makes an ecology based on the connection between artifacts, and the commonality through a group of artifacts. There are four ecological factors that they discuss:

- Connection through information sharing
- Connection through functional compatibility
- Contextual affordance and commonality
- Ecological values changing behavior

Connections through information sharing, is explained that the connection between artifacts made by sharing of information. Most users have several computers and they share information between their home computer, laptop and your work computer. So they are connected, but also the devices you share the information through. This devices range from external hardrive, music player and smart phones, but there were also web based services that connected digital devices, like email and schedulers. People also looked at their artifacts in the way of primary, secondary and complementary. This showed how the artifacts where thought of in the ecology of artifacts. Connection through functional compatibility is understood by the way artifacts are technical compatible with each other. Contextual affordances and commonality as stated by Jung et al. "The physical and interactional properties are related to the commonality of using digital artifacts or specialized affordance of individual artifacts in divers contexts of use." (Jung et al., 2008, p.206) Ecological values changing behavior is about how introduction of new artifacts in to users own ecology, can change the users daily behaviors and influence other artifacts in the ecology. One subject said after he got an iPhone he started checking email much more often. The subject also talked about how they sometimes used their artifacts to change their status in a social setting form public to private by putting earphones in, by doing this it detached them from others in public space. Other people said the same about working on their laptops in public spaces.

2.2.2 Layers of Artifact Ecology

Jung et al. talks about three different layers of artifact ecology (Jung et al., 2008): in purpose of use, context of use, and subjective meaning. People in Jung et al. studies catgorized some artifact by grops of "work," "computing," "gaming," "entertainment," "communication," "graduate studies," etc . This use of group categorising explains how the artifacts are used for similar types of tasks. This does not mean that they are always used a the same time, but that they are related through ecological factors such as connection throught information or functions. The artifacts are related throught ecological factors to support similar users goal,

with contex of use. This means grouping them by their physical contexts of use, such as where the artifacts are located, or where they are mostly used. Some examples of this could be at home, at work, portable or communincation. Jung et al. (2008) point out that people are very much affected by physical or temporal context when using an artifact. This is ecpecially intresting since more and more of digital artifacts are portable, and so make the context it is used in very dynamic. Subjective meaning is based on the value-oriented grouping of artifacts in an ecology. This grouping was done more implicit, the subjects did not have any clear labels for their grouping. One subject grouped by simalarity of design, another by who gave her the artifacts and a third by his own categories: "I don't care, ambivalence and I care about". This shows us that value criteria for individual artifacts, can be criteria for connection between artifacts, and it demonstartes the mutal influence of social norms and personal experiences. The figure below tries to describe the connection between the ecolcogical layer and ecological factors discussed above.
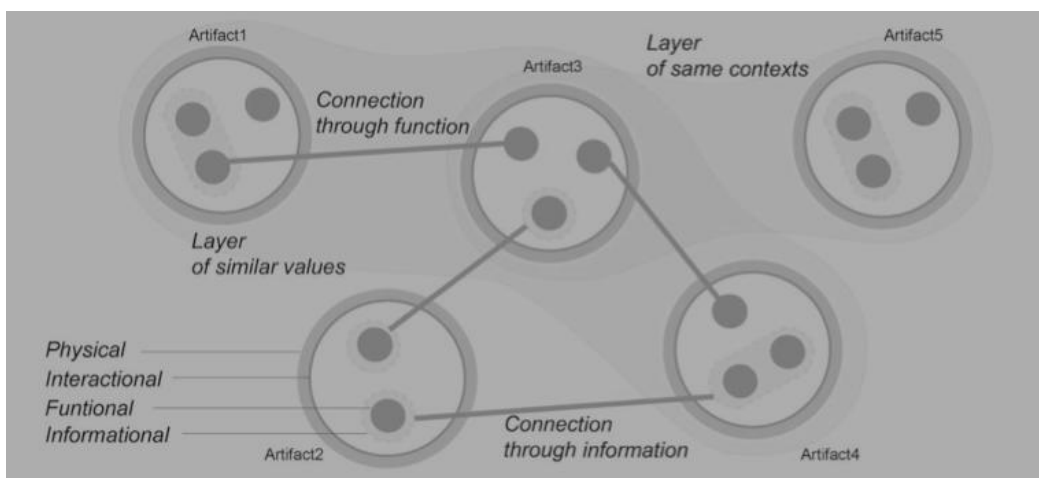
Figure 1 (Jung et al., 2008, fig 9)

Ecologies will be developed by individual users' personal preferences and inclination of usage. Therefore Jung et al. (2008) argues that designers should consider how to support this development of personal ecologies both flexibly and creatively over time.

Jung et al. (2008) wanted to explore the relation between users and their digital artifacts, and the relation between the artifacts themselves. They wanted to help designers and researchers by developing a framework within artifact ecology and to help them consider the dynamic

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relation between the artifacts rather than just one artifact on its own. All this research into people's own ecology tries to focus on how people see their ecology and not an objective look. Rogers states that the "…perceptions counts. The individuals' perceptions of the attributes of an innovation, not the attributes as classified objectively by experts or change agents, affect its rate of adoption" (Rogers, 2003, p.223).

2.3 Diffusion of innovations

Diffusion research is a big field and I am mainly going to focus on the main idea from the book Diffusion of Innovation by Rogers (2003). Especially want to focus on the rate of adoption and re-invention done by users.

2.3.1 Roger's five factors for rate of adaptation

In the book Diffusion of innovations Rogers talks about five factors that effect the rate of adaptation, and in accordance to Rogers these five factors explain 49% to 87% of the variance in the rate of adaptation (Rogers, 2003). Here you have the list of each factor with a correspondent generalization for each of the different factors.

- Relative advantage
    - o Generalization 6-1 "Relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption" (Rogers et al., in press cited in Rogers, 2003, p.233).
- Compatibility
    - o Generalization 6-2 " Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. The compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption" (Rogers, 2003, p.249).
- Complexity
    - o Generalization 6-3 "Complexity is the degree to which an innovation is perceived as relatively difficult to understand and to use. The complexity of an innovation, as perceived by members of social systems, is negatively related to its rate of adoption" (Rogers, 2003, p.257).

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- Trialability
    - Generalization 6-4 "Trialability is the degree to which an innovation may be experimented with on a limited basis. The trialability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption" (Rogers, 2003, p.258).
- Observability
    - Generalization 6-5 "Observability is the degree to which the results of an innovation are visible to others. The obeservability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption" (Rogers, 2003, p.258).

From the perspective of ecology theory the compatibility factor for rate of adoption is of most interest. The more compatible an innovation is, and the less of change in behavior it represents, the easier it is to adopt, but a completely compatible innovation would be seen as no innovation at all in the minds of the potential adopters. There could be situations were a completely compatible innovation would be good, if it comes as part of a cluster and pave the way for the next innovation in that cluster. Naming of innovation also affects perceived compatibility, and therefore it rate of adoption. It is interesting that the for artwork the complete opposite is true "Artwork must be somewhat radical if they are to diffuse rapidly" (Rogers, 2003, p254).

In according to Sellen et al. (2002) studying how people use paper can be resource, especially as a way of illuminating why digital alternatives does not support the way people work and want to work. This is supported by compatibility factor, diffusion researchers has found that change agents often commit an "empty vessels fallacy" when introducing new innovation. Change agent assume that the people who is going to adopt the new innovation are blank slates, and lack any experience or knowledge that they can associate the new idea with (Rogers, 2003). This often happens because technocrats often assume existing practice of the indigenous system are inferior and therefore can be completely dismissed. When change agent commits empty vessels fallacy, the results can be that the innovation is perceived as incompatible with the innovation it tries to replace. An thus making it harder to get it adopted by the users, because as Rogers states "Individuals cannot deal with an innovation except on the basis of the familiar." (Rogers, 2003, p.243)

Rogers (2003) talk about many forms of compatibility, I want to focus on the compatibility with previously introduced ideas and the ways of looking at previously introduced ideas within indigenous systems and technology clusters. Compatibility of an innovation with previously ideas can either speed up or reduce its rate of adoption. Since individuals cannot deal with innovation in any other way than on the basis of the familiar, previous practices provide a standard for how users interpret a new innovation. So previous practice decreases the uncertainty of introducing new innovation by being a link for interpretation of new innovation. Rogers mentioned an example of how indigenous systems can by compatibility cause miss adoption.

> "To Punjabi farmers, it made sense to keep their source of farm power warm during winter weather, but cleaning air filter and the oil filter on their tractor was not compatible with their previous experience with caring for their bullocks. In this case, past experience had negative consequences" (Rogers, 2003, p.244)

As mentioned earlier technology clusters, is of great interest in diffusion research. Innovation is not view by the adopters as single innovation, but rather interrelated clusters of new ideas. This technology cluster is defined as one or more distinguishable elements of technology that are seen as interconnected. The interconnected clusters have loose boundaries, and different adopters can sort different innovation in different clusters. This lose boundaries of technology clusters is just what Jung et al. and Ryan et al. wanted to investigate in (2008, 2009) by understanding users ecology of artifacts.

2.3.2 Re-invention

Jung et al. (2008) talked about the importance of supporting the user's personal preferences and inclination of usage. This is just other words for supporting users ability for re-invention.

"Artifacts are not only constructed by their designers, they are also re-constructed by their users." (Boezhowski, 1999 cited in Rogers, 2003, p.188)

Rogers talk about seven reason that contributes to re-inventions (Rogers, 2003) . The first reason is an invention is complex there are more chances for re-invention. Since the users tend to simplify the innovation, or change the innovation based on misunderstandings. The second reason is that the user of the innovation lacks detailed knowledge of it. This can

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happen when only awareness knowledge is shared and not introduced to the implementation stage. When the innovation is a general concept or a tool with a possible applications, the chances for re-invention increases. The forth reason is when innovation is implemented to solve a wide range of problems. This since each organization or individual will match their use to different set of problem, and thus increasing the chances for re-invention. The fifth reason is that people get ownership and local pride by re-inventing innovations. Sometimes re-invention occurs because the innovation must adapt to the structure of the organization implementing it. The last reason that Rogers talk about in (Rogers, 2003) is that it often occur later in the diffusion process of an innovation, since later adopters can profit from the experience the earlier adopters has done.

Rogers goes on to mention two generalizations for re-invention:

- "Generalization 5-9: A higher degree of re-invention leads to a faster rate of adoption of an innovation" (Rogers, 2003, p.183).
- "Generalization 5-10: A higher degree of re-invention leads to a higher degree of sustainability of an innovation" (Rogers, 2003, p.183).

Generalization 5-9 is supported by the facts that the easier it is to re-invent around the innovation the easier it will be to fit the innovation with different adopters, thus make the rate of adoption faster. Generalization 5-10 is supported by different studies as the one done in New Mexico with eight health innovations (Rogers et al., in press cidted in Rogers, 2003). There are several studies done in the judgment and decision field in psychology that supports this as well. Studies done by Ellen Langer (1975) cited in Hastie and Dawes (2001) where she had a bag with cards of American football players. She gave on part of the group of subjects the chance to choose which card they wanted, and the other part got handed a card. The premise of the game was that the one who had the card that she picked out of another bag of cards won, but before the drawing of the cards she wanted to know how much they wanted to sell their cards for. What she discovered was that only the act of picking the card themselves affected the subjects, and these subjects wanted four times the amount of money for their cards. Even if everybody agreed in a questionnaire later, that choosing their own card had no affect on the odds of winning.

This is of course much simpler than actually doing some re-invention, but when something as simple as just choosing a single card, can affect how one feel about it, it is reasonable to think

that the process of re-invention gives you a much bigger feeling of ownership and gives you a even harder time of letting go. To process re-invention leads to a bigger chance of sticking to the innovation, and therefore higher degree of sustainability.

2.3.3 Adopters Categories

There are five adopters categories in (Rogers, 2003):

- Innovators (2.5%)
- Early Adopters (13.5%)
- Early Majority (34%)
- Late Majority (34%)
- Laggards (16%)

Innovators are a venturesome group and usually have the funds necessary, to be able to take chances with new ideas. They also typical have an understanding of complex technical knowledge, and able to cope with high degree of uncertainty about the adopted innovation. An innovator is not usually respected by other members of their local group, but they act in a gate keeping role by adopting new innovation from outside the systems boundaries. Early adopters on the other hand are respected by his or her peers. They are the go to guy or girl for information and advice about new innovation. Peers look to early adopters to see if new innovation is safe to adopt. The early adopters are what helps trigger the critical mass when they adopt an innovation in accordance to Rogers (2003). Early majority carefully consider their adoption of new innovation. Early majority frequently interacts with their peers, but seldom hold position as opinion leaders. They are on the other hand a very big group, with one third of the whole system of adopters group. Because of this and their unique position between the very early and the very late to adopt, they are a very important link in the diffusion process. The late majority is much more skeptical to new innovation, and only adopts new innovation when most other in their environment has done so. The late majority usually are not motivated to adopt, before they experience pressure from their peers, and when they can see that the uncertainty of the new innovation is removed. The late majority as the early majority constitute one third of the system. The last group is the laggards and they encompass 16% of the whole system.

2.4 Crossing the chasm

Whole product becomes interesting when one want to cross the chasm between early adopters and early majority described above. Whole products not just the physical product in itself, but everything around it like support, compatibility and so on. Looking at Microsoft one can see that it not only the generic product, but also all the books, courses, and other kinds of support you get when buying Microsoft products. And when you look at this as part of the product as well, you see why Microsoft Word for example is better product in the consumers eyes, than other text editors that are objectively better generic product.

There is a difference between the early markets and the main stream markets. In an early market consumers are more willing to piece together the whole product themselves, whereas in the main stream market that is not the case. This is where many high tech companies fail, they do not see the change in customers behavior form early markets to main stream markets. A great generic product is not enough, one need to have the best whole product. (Moore, 2002)

The phrase whole product includes training and support, cables, installation and debugging, system integration, additional hardware, additional software and standards and procedures. As capture in the figure of the simplified whole product model (Moore, 2002)
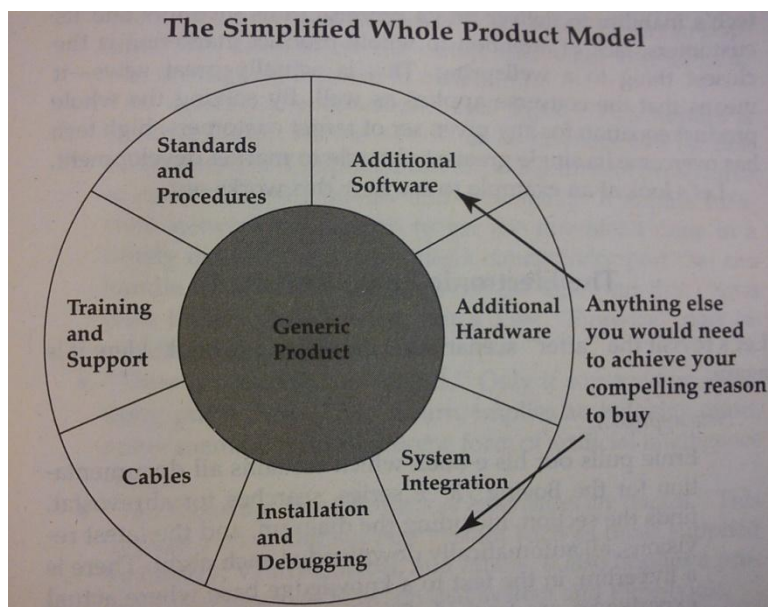

Figure 2 (Moore, 2002, p.113)

By looking at the Simplified whole product model in figure 2, on can see form the factors of System Integration, additional software and hardware, and standards that compatibility is important in the whole product. Compatibility with existing standards, but also compatibility with additional software and hardware are important for the whole product model..

"Trying to cross the chasm without taking a niche market approach is like trying to light a fire without kindling." (Moore, 2002, p.67) Moore states in (Moore, 2002) that there are three reasons to be niche focused when crossing the chasm. Firstly to be able to use a customer as a reference, we must commit or guarantee the provision of the whole product. Since whole product commitments are extremely expensive, one has to do whole product commitments statically, by levering them over multiple sales. This can only be done by focusing sales on one or two niche markets. The second reason to be niche focused is to achieve the word of mouth benefits. Since customers mostly talk to other people in the same industry as themselves, winning one or two customers in each industry would not give a product critical mass for word of mouth to be established. On the other hand if an entire product is focused on one market niche, getting four or five customers talking about the product can create the desired effect of word of mouth. The third reason is simply to achieve market leadership. This is clearly much easier to do by using the "big fish, small pond" approach. It is much simpler to become market leader in a niche market. The reason becoming market leader is so important is that pragmatist customer want to buy from market leaders, since it is only around the market leader that whole products is made.

3 Method

In this chapter I am going to discuss my choices for research strategy of exploratory design, and my research design of case study of the IT-department at the department of Informatics. I will also discuss the research methods of observation and workshops that I choose for the case study.

3.1 Choice of research strategy, research design and method, sampling and case selection

I will study and examine the ecology of artifacts and the use of paper at work. As there is little research on the field, I have chosen to do some exploratory studies. So therefore I have chosen to use a qualitative research strategy. An exploratory study will provide more insight into how the ecology of mobile devices in the work place intercedes with our personal ecology of mobile devices. It will also provide an opportunity to observe the use of paper in the real-life context during the subjects working day. To investigate the ecology of mobile artifacts within the work place I have decided to use a case study, where the single case study is the IT–support at department of Informatics.

> "A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p.18).

I chose to do a case study because I wanted to better understand a real-life phenomenon of personal ecology and paper use in the work place. Since my thesis is that both these phenomena rely heavily on context. A common concern about case studies is that they provide little basis for scientific generalization (Yin, 2009). Yin argues that case studies as experiments need to be replicated across multiple set in different condition. So I have to chosen to see the findings from my own case studies with those done by Sellen et al. (2002) and the ecology exploratory studies done by Jung et al. and Ryan et al. (2008, 2009).

Unit of analysis:

- Ecology of paper and digital alternative at work, and more specifically the IT-support at department of Informatics.

When selecting a case Yin (2009) points out that you need to have sufficient access to the potential data, be it access to interview, observe or other forms four data collection. If you have access to more than one case, you should chose the one than most likely illuminates you research questions. My choices where the IT-department at department of Informatics or a consultancy company. Both cases would have given me access to people in a work space. In my opinion my best alternative was the IT-support at department of Informatics.

I examine how people use their mobile technology at work as digital alternatives to paper. Especially interesting is what kind of work around or reinvention they have made on existing technology and software. To best look for reinvention I have decided to make use of observation. I followed my subjects in everyday life and decided to pick out two meetings to observe as well. Because I judge it interesting to see what kind of digital artifacts people would bring to a meeting, and because this way I was sure to get a glimpse of a regular week at the office. For discovering the subjects personal ecology at work I used a workshop based on the "Ecology Mapper" (Ryan et al., 2009). I also interviewed the subjects after observing, workshop, and some other times.

The sample I have picked is three different people who I will be observing, throughout their ordinary work days. I have chosen a sample size of three subjects out of a total of ten possible subjects at the IT-support department. Since I am going to do an exploratory study, and need research the subjects habits in depth, a bigger sample size would be impractical because of time and size constrains. The unit I chose for the case, IT-support has people with a broad technology background. So the chances of finding a bigger range of digital devices used are greater than the average user groups. In this qualitative study the there is greater need for diverse use of mobile devices than to get a random sample of the population. This is similar to what Jung et al. (2008) did in their two studies where he picked graduate students from the department of Human Computer Interaction Design at their University.

So to sum it all up I have chosen to observe three people at IT-support department as they to their daily work and after the observation do an ecology mapper workshop. My focus for the observation and the workshop will be to see if and how they use digital alternatives to paper at the work place. Since my case study has a small sample, there is not much hope for external validity. Therefore this is an exploratory study that tries to discover and explore new ways one should go forth from here towards the paperless office.

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3.2 Observation

The observation will be an undisguised and non-participant manner. This to forgo any ethical problems that comes with the use of disguised observation, but also because it will be hard to do a disguised observation of people in single offices (Wilson, 2010). The observation was done in a non-participant observation, since the IT-support department I am studying mostly work by themselves. But also to get more time to observe, and take notes of specific action done by the subjects. By choosing undisguised observation there is a concern that my subjects will act differently because they know they are being observed (Wilson, 2010).

It is important to consider the amount of time used on each observation, it is vital to pick a time frame that gives the opportunity to observe the subjects as they would react in their natural setting (Wilson, 2010). Therefore I chose to observe my participant one by one and for the first six hours of the day. Through this approach I got an insight into the different tasks and activities they performed throughout a work day. I made use of a diary system for note taking for logging information about location, time, observed activates and comments. I also took photos of work desk setup and special uses of mobile technology. While interviewing the subjects I used an iPod Touch as a recording device, my mobile phone as the camera and a paper note book for note taking.

3.2.1 Observing

The actual observing took place in the subject's work location, I monitored how the subject used digital artifacts in their work situation. My main focus is both out of office assignments, and how they used mobile system at their desks. I want to explore in what way the subject interacts between office equipment and mobile devises.

Questions for the subjects in some cases are better left for later, and some are better answered in the setting where they occur. Deciding where to ask question and where not to ask question was at times challenging. The reason one should not ask too many questions is that by doing that one constantly reminds the subjects they are being observed. So therefore I tried to collect

most of my questions for the end of the observation, and at times show the photos I had taken on an iPad as discussion pieces while asking question.

3.2.2 Analysis of gathered data

Here I have gone systematically thorough the time log of the observation, by tagging different findings with different colors, and then analyzed the data with the help of picture and the voice recordings.

3.2.3 Limitation in Observation

Using observation as a tool is always challenging because it is impossible to tell how much the subjects changes his/her behavior because they are being observed. This could affect some of my findings, so one should try to make the setting as natural as possible, and not interrupted the subjects to much with questions as mentioned earlier.

Ideally I would follow each and every subject each day for week, so I could be sure to get all the different kinds of activities they do with their mobile ecology. Since this is not feasible in a master assignment I have to try to elevate the problem by doing some more probing and questioning to be sure to get all the different kind of situation they usually are in.

3.3 Workshop

The point of interest in this study is the subjects' personal ecology of digital artifacts at work. This encompass the digital artifacts they use at work that are common for all the people in the work environment, their personal work equipment and their personal equipment that they use in their work setting. So quite close to definition found in the Ecology Mapper study:

"We identify artifacts in this study specifically as devices that a person owns, uses, or has access that are both digital and interactive. Also, for this study, we isolate the contexts of use as being part of one's personal ecology of artifacts" (Ryan et al., 2009, p 4239).

Except that I will not use the last constraint that's specify just the personal ecology of artifacts, since I am also interested how they intricate with ecology at the work place.

3.3.1 Device Ecology Mapper

Ecology mapping begins with spatial arranging artifacts on a flat surface. Connection is the made between artifacts depending on which perceived relationships the subjects see between the artifacts, this connection can be both physical and not physical, but they will represent the subjects perception. Both the artifact and the connections are value laden, so there can be many different types of connection between artifacts. The connection included in the ecology mapper for the artifact property was: functional (red), informational (blue), interactive (green) and physical (red) (Ryan et al., 2009). So both the spatial placement of artifacts and connection lines between artifacts was tools the subjects could use to try to explain their personal ecology of artifacts.

The device Ecology Mapper was a high fidelity prototype made with Adobe Flash. Since I was not able to get hold of this prototype I chose to implement a low fidelity alternative similar to what they used in earlier versions of the prototype and what Jung et al. (2008) used in their exploratory ecology map study. Where I used post-it notes, white board and different colored pencils. Here I also change the color of the physical connection from red to black, just for practical reasons.

3.3.2 Doing the workshop

For practical reason I chose to met my subjects in their offices. Both because they all had a whiteboard in their office, and that by being in their offices I hoped their surroundings would help them with listing all their digital artifacts. I gave them post-it notes and made them write down each digital artifact they own and use in the work setting. When they were finished, I asked them to place the post-it notes on a white board and group them as they see fit. After that I gave them some different color pencils, were each color represented the different connection. I worked with each participant in a form of workshop experience with continual encouragement, asking them to evolve their understanding of their own ecology of digital artifacts.

3.3.3 Analysis of gathered data

After the workshop was finished I transcribed the voice recording of the workshops. Then went on to tagging the different findings with the categories taken from observation, then analyzed the result while comparing it with the end result of the ecology map.

3.3.4 Limitation of Workshop (Ecology Mapper)

It was important to encourage the subjects, but at the same time I did not want to influence them too much. Because it was their view of their ecology I wanted and not a view influenced by me. Especially when they are trying to group their post-it notes together it important not to lead, this is the essential part of the study and should proceed with the least amount of interference. A place where it is safe to influence the subjects is in the listing of their ecology, here on can safely encourage them to find all of their digital devices.

There are quite a number of limitations when applying an ecology mapper, and especially a striped down version like the one used in my research. One of the biggest challenges is that by just using pencils to connect and comment, the users will not be given a framework to work in and the result will be affected by each users ease of working in a very loosely fitted environment. There is some positive side with giving them no framework to work with, since there is little to constrain and lead the subjects. But this is positive only if the subjects actually manage to capture some of his or her thoughts of her connection between artifacts by using pen and pencils.

All my subjects had a hard time understanding the connection type between artifacts. When looking at further use of an ecology mapper study I think it will be wise to better explain this connection by use of examples and so forth. It helped to link functions like email, web server and so forth to the function by introducing separate post-it notes. By introducing function as post-it notes it helped the subject to see functional connection between devices. Maybe some of these problems were not discovered when designing the ecology mapper, since they used design students. Design student are maybe more trained to consider abstract connection than other people.

4 Case

To investigate how mobile devices are used in the work place, I need to study a group that is more likely to have found ways of using mobile devices in their daily work routine. Therefore I decided to use the IT-support at the Department of Informatics. The department of Informatics is organized in twelve research groups and on "study lab", a technical unit and an administrative unit. Where IT-support is the technical unit at the department of Informatics. IT-support the local support for master students and employees at the department of Informatics. The IT service they supply to the department of Informatics is a collaboration with Usit (The University's central IT –department). The IT-support department has 10 permanent employees, one apprentice, and four employees with connection to the different research groups at the department of Informatics. The department has a leader, but each employee has his own area of responsibility. This means that all their work is mostly done without cooperating with their coworkers.

My subjects are two males and one female, they are all in the age of 35-50. They have all worked at IT-support for over 5 years. They have each different area of reasonability, subject 1 is responsible for all the printers, and the printer system, subject 2 is responsible for the web and databases, and subject 3 is responsible for all the apple systems for Department of Informatics.

People that need help form IT-support are asked to contact them through mainly two channels: email or phone. Each of the 10 permanent employees shares the responsibility of one week guard duty. On the week guard duty they are in charge of taking the phone, distributing task sent via email, and assist the people who show up at the office for help. The email address is linked up to a ticket system, and the employees at the department take care of the tickets that have been assigned to them.

5 Findings

Here I am going to present my findings from the observation's and the workshop's. The observation and the workshop have together given me a deeper understanding of my subjects ecology of artifacts, and how they use and see their digital artifacts at work. The Workshops have mainly given me the subjects point of view of how they use their ecology around them, and in that way supplement the observation where the ecology have been looked at from a objective point of view. The workshop has also been a great help in finding out what function they use in different device, and what kind of device that are most centrals in their work day.

I will first write about the findings for each subject, and then I want to deliberate on my main findings from all the subjects.

5.1.1 Subject 1

This subject seems to be much more inclined to use paper. There are several good examples of this, he used a paper book for calendar, and he had an A4 scratch pad on the center most place at his desk, that he constantly scribbled something on. He even had a pen in hand most of the time when he used his computer. There are also post-it notes in different formats found on his desk, as well as a paper calendar between his computer screens. Another interesting example is that he used his whiteboard to store information about in which floor all the printers he was in charge for was located. This he had done in a natural map kind of way, buy having the ground floor farthest down on the whiteboard and increasing numbers as upwards on the board. This observation is demonstrated through figure 3.
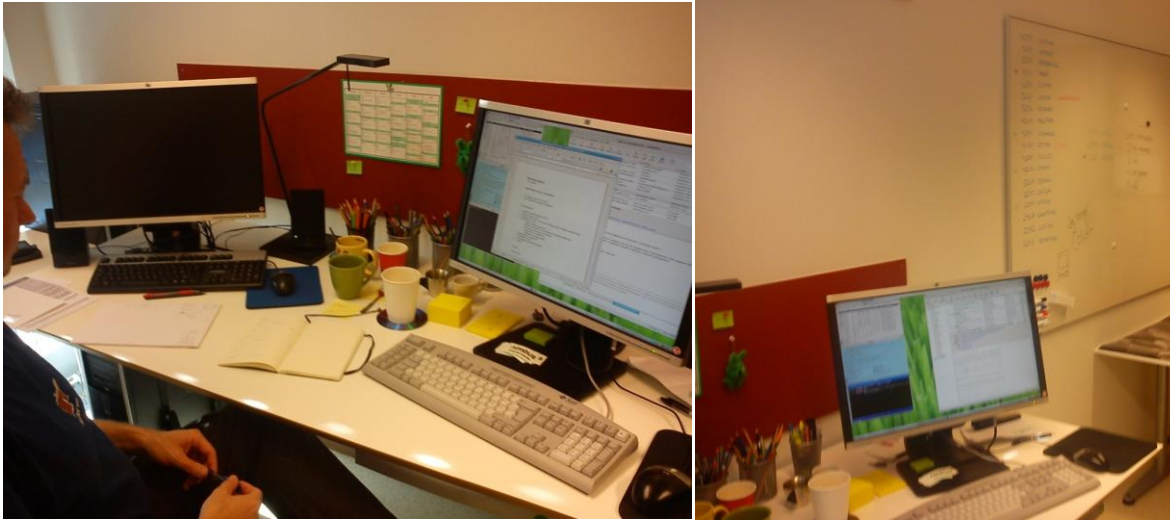
Figure 3

Subject 1 had two screens hooked up two different computers, and an smartphone (iPhone) with a 3,5" screen size. He has Windows on one computer and Linux operative systems on the other. The reason he has two different computers he says is because he works with equipment that should run on both platforms. He uses the term "main computer" for his Linux computer, the windows one he have mainly for testing, but also for different systems he uses that comes from the administrative side of UiO like the HR portal, and the purchasing system at UiO. The interesting fact is that he actually changes position with his chair between the two computers, as you can clearly see from the position of the screen on figure 3.

As a side note during the observation subject 2 showed subject 3 a new iPhone calendar app, that was a kind of reinvention of the standard calendar since it main function was just adding a week view. In figure 4 you can see subject 1 ecology of artifacts that he uses with work.
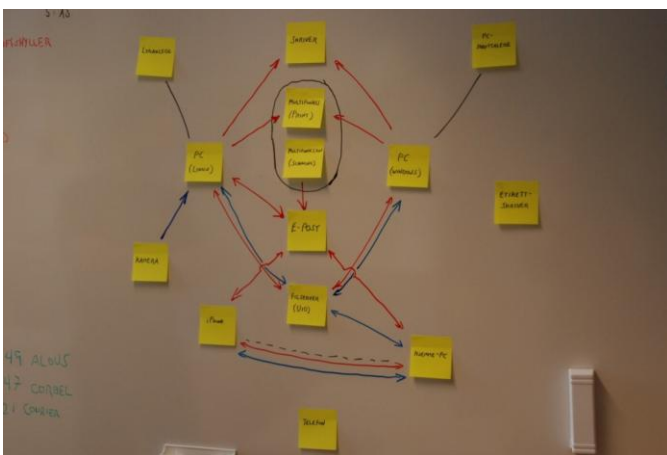

Figure 4

5.1.2 Subject 2

The subject has three computers that she uses with her work. Stationary Linux that is located at her work place, stationary at home that she uses mainly to read email before going into work, and thirdly a laptop with Windows that she brings forth and back between work every day. At work her laptop is placed close to her stationary computer, because she uses this computer as a test machine. She also has a smartphone (Android) with 3,5" screen.
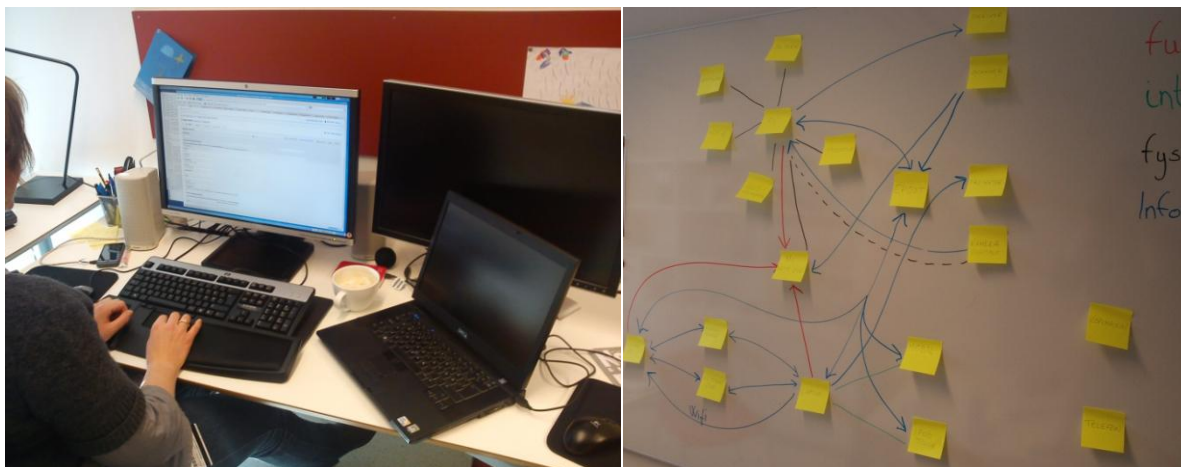

Figure 5 and 6

She used her mobile phone in her lunch hour to check her mail and add something to her calendar. This she did with an app that is called notes that she uses on here mobile android device, which syncs the information with the desktop version, but apparently not with the local mobile calendar. She had memory sticks and portable hard drives in her office, but all here transportation of files that has to do with work she accesses through the server at her work place. Another aspect that was interesting is that she did not seem to print the materials or documents from cases or problems they discuss, but rather used the 24" work screens as discussion objects when working with web related content.

5.1.3 Subject 3

This subject has two iMac computers, one 15" laptop, iPad, Kindle and iPhone 4. Where one of the iMac is a test machine, one is used as his main computer and the laptop is used as his portable computer, and work as a music player at work. He also owned a hybrid product

"Livescribe". The Livescribe is a hybrid product between paper and digital. It works like a regular pen, but whatever you write is automatically stored both on the special paper you write on with physical ink and electronically on the pen itself. It also has one more function, it can record sound around you when you write with it. You can then easily go back to a one place in the recording by just pointing at word you have written, and it automatically play what was said around you at the time you wrote that word.

Figure 7 and 8

When he went to meetings he equipped himself with his Livescribe, Kindle, iPad, iPhone and a note book for the Livescribe pen. There were five people in the meeting, person 1 brought a MacBook Air and person 5 brought a MacBook Pro 15" and mobile Sony Ericson Elm, person 2 brought an iPhone and person 2 simply brought a newspaper. Apparently the reason why he brought the kindle was to show it around. In the meeting subject 3 only used his iPad as a reference and note tool. The Livescribe just lay there next to him. On the iPad he used a range of different apps: OmniFocus, mail, safari, calendar. The one he used the most was his task manger app OmniFocus. Where he created new task in the meeting, but what he used it the most for was some sort of reference tool, since he browsed, read and edited tasks quite often during the meeting. He also browsed Omnifoucse while talking, so it is clear that he used it for some kind of reference. The subject seemed to be doing the same while reading email, this probably have in common that the ticket system for user question are based on an email system. So the email works like a kind of task manager as well.
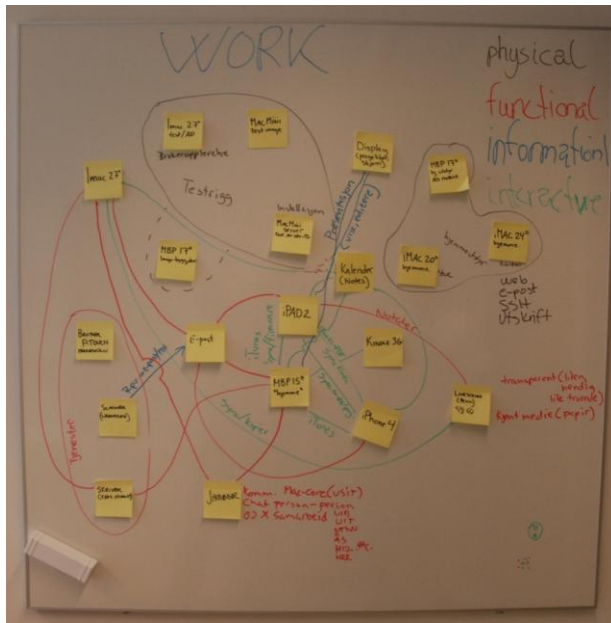
Figure 9

5.2 Main findings from observation and workshop

Both the first and the last subject used some paper or paper like artifacts. Subject 1 used an A4 book that he used as some sort of temporary scratch pad, he used a calendar book, post-it notes and he used a whiteboard. Subject 3 used a whiteboard, and the paper that came with his Livescribe pen. Both subject 1 and 2 used to print out documents to read them.

Every one of the different subjects had at least three different screens as they moved about their working day, one even had as many as six. This is counting the screens that are theirs alone, but they also have access projectors that where in the different meeting room, and computers screen at the different test labs. From my studies I found that there were two main teams that constrained the use of these potential screens: use in sequential order and defined use. All the subjects had at least two computers at their office. They tagged one computer as the main computer and the other one for test computer. The positioning of these computers in their office was interesting, since it mainly called for change in seating to switch between them. Subject 1 just slid his chair about half a meter to change between computers, while the subject 3 actually changed chair. This actual small change in location for changing between computers, make it impossible to use both screens at the same time as is the case so often with multiple papers, when you interchange between reading or writing, or cross referencing and so on. Subject 2 had both of her screens and laptop in a position so she could more easily change between them. But still she mainly used here desktop computer. She only seemed to

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change to her laptop when it was convenient that it was another computer, because that computer was not logged in to the various systems she was making. Therefore that computer was ideal for testing the web pages she was making. So her use of the other computer screen was used in order of defined use as of testing. Smartphone also seemed to be used in a defined use context, mainly on the move. The subjects seemed to mainly use their smartphone when they moved about outside of their office. They always had their smartphone with them, but mostly used them in meetings and during the lunch hour. At these times they used their smartphone for checking mail, inputting calendar events, and subject 3 used it for inputting a task in his task manager. They seemed to use mail both for checking for news, and for checking up on their tasks as the e-mail system also contained their department's tasks. When at their desk they to seemed to change their preferred artifact from smartphone to their computers for the same functions. Except subject 3 that seem to prefer to use either his iPad or main computer depending on the function in question.

There were mainly four functions that crossed both device and platform. This cross platform function was: mail, calendar, task manager and pdf viewing. Every one of the subjects used mail on each of their devices. Two of the subjects used the calendar function of Lotus Notes, to sync their calendar appointments across their smartphones and their computers. Subject 3 also used one cross device application called OmniFocus and the cross platform application Kindle to view pdf across his devices. The OmniFocus app he used on his iPad, iPhone, MacBook Pro laptop 15" and his iMac (main computer). The Kindle app he used on his iPad, Kindle and iPhone. What all this cross platform application had in common was that they all have made it easy to use their application over multiple devices, by making the synching and interaction between the devices automatically. Mail synchronize in a none intrusive manner for the user by using either IMAP technology or Microsoft Exchange technology. Lotus Notes syncs automatically over Exchange as well. Subject two need to manually sync her notes application on here Android smartphone, since android is not fully supported yet. OmniFocus also have a little more complicated way of doing this, you have to have a webdav, iDisk or DropBox server to easily sync all your devices.

6 Discussion

There are many ways of going towards the paperless office, when one look at it in the perspective of the affordances of paper. As mentioned in section 2.4 there are mainly four categories of digital alternatives to replace the use of paper.

1. Restricting interaction exclusively to digital media
2. Tightly coupling of paper and computers.
3. Using paper and screens as separate displays.
4. Pen and paper as input for digital documents

The last three categories represents a group of hybrid products combining paper and digital functions, that in some way mimic the function of paper or the way people write on paper. So I will look at these three categories as one hybrid categories in my further discussions. The downside with approaching the paperless office from a hybrid perspective is that this ads new artifacts to an already complex digital ecology. Complexity is one of Rogers (2003) five factors affecting the rate of adoption. The complexity of an innovation is negatively related to the rate of adoption, and by complexity we mean the perceived difficulty of using and understanding an innovation. So one of the main goals when introducing innovations for a paperless office should be to reduce complexity, not add to it. Introducing new innovations through familiar artifacts should diminish this complexity. Compatibility is another of Rogers's five factors that affect the rate of adoption and is another good argument for why developers should focus on the existing ecology within their given field while developing digital alternatives for use in the paperless office. For the consumer the compatibility of any new innovation is of vital importance. Since it requires less change in behavior, and therefore easier for consumer to adopt. Compatibility with previously introduced ideas, raise the question of what the previously introduced ideas are. Is it paper that is the previously introduced idea we have to make our product compatible with, or is it other digital artifacts? Rogers (2003) talk about indigenous systems and technology clusters when he introduces the factor of compatibility with previously introduced ideas. Is it possible to define paper as an indigenous system, a result of the incredible complex way the use of paper has naturally accrued in the work place? Furthermore digital artifacts could be regarded as devices that are already in use, and as devices that are similar since they come from the same technology cluster. The question is whether a hybrid solution for digital alternatives to paper is the right

alternative in the quest for the paperless office. The mere fact that the technological alternatives are compatible with the previously introduced idea of pen and/or paper make it at least a viable choice, but as Rogers (2003) state it is the individuals perception of attributes that counts, not the objectively classified attributes set by experts. So a big question arise: Will consumers view products that mimic the use of pen and paper as innovation in a digital context or in a context of pen and paper? The context users place an innovation in can have a large impact on the perceived compatibility of hybrid products. Terrenghi et al (2007) states that a better design decision could be to look at hybrid or physical-digital user interfaces. But one can question some of the way she has come to this conclusion. Especially the fact that they designed the interactive tabletop that fits into the category of restricting interaction exclusively to digital media. The interactive tabletop was the only digital alternative interfaces the researcher group tested, so the findings are not substantial enough to make conclusions about all systems that restricts interaction exclusively to digital media. Hybrid products are all specialty products, and they are not used in our main stream markets. Another questionable aspect with these hybrid products, is that they try to take on all the affordances of paper.

Since I want to focus on technology that already exist, the first category for digital alternative is most interesting. Restricting interaction exclusively to digital media the existing ecology of digital artifacts can be studied. The ecology of digital artifacts we know today is undergoing a rapid development and growth. Smartphone sales had a growth rate of 74% last year, the e-reader increased a staggering 325%, and tablets have a predicted growth in sales of 300% this year. There is also a shift in that more of the mobile devices sold are running on the big platforms like Android and iOS. These big platforms are supported by big developer communities that have access to rich SDK (Software development kit), with access to most of the smartphones systems. The reason Android and iOS are especially interesting is due to their cross mobile devices support. Android and iOS are already available on tablets, smartphone and minicomputers and have a market share of 39% for smartphones and over 98% for tablet in 2010 (Gartner, 2011a, Gartner, 2011b). This gives great opportunities for cross device communication. There is even a possibility for cross platform communication since all the devices mentioned has internet access, and uses WIFI and Bluetooth standard for wireless communication. These standards and platforms are essential according to chasm theory. To succeed in the main stream market a great generic product is not enough, one need to have the best whole product. So by designing for products that are based on these new

platforms some of the requirements needed for a whole product are present: support for additional software and hardware, and standards.

The results of my case study show that there were a few applications or services that were used across different devices. All of the subjects used mail on more than two of their digital artifacts and calendar application was used by two of my three subjects. Both mail and calendar applications are products that fit well in the whole product model by using standards, great system integration, supports additional software and hardware. The last two application that were used cross platforms where pdf viewer (Kindle) and a task manager app (OmniFocus). These where used by subject three that fits into the category of innovator or early adopter, and according to Moore (2002) these adopters are more willing to piece together the whole product themselves. Both of these applications have some of the qualities of a whole product, they are thought of as standards for the uses described, they do not support additional software. So a whole product approach seems to be crucial for designing for the paperless office.

Jung et al. (2008) stated that designers should try to support users development of personal ecologies. One way of letting users re-invent their employment of existing artifacts is by supporting other software and hardware. Like the example from my findings where subject 3, came by the office of subject 1 and showed him a calendar application that re-invented some of the function of the existing calendar application, by mainly adding a week view. This could not be done if there had been an opportunity for installing other application on the smartphone, and equally important is the fact that this could not have been done without sync standards like Exchange, Google Calendar, Outlook, MobilMe and others. These standards are what make the switch possible, since it is this sync standards most people use for their calendar in the first place. So a switch of calendar application is almost instant. By supporting a whole product model as described by Moore (2002), we would give users some form of controlled possibilities for re-innovation. Opening up for re-innovation leads to sustainability (Rogers, 2003).

According to Moore the only way to be able to do support the whole product model is by segmentation (Moore, 2002). Therefore we should try to move towards the paperless office looking at what existing technologies are able to do, and how people are inclined to use them. What kind of affordances for paper is it possible to replace by restricting interaction exclusively to digital media? Another aspect of looking at segmentation towards the

paperless office is what kind of uses of paper do we see most gains by replacing with digital alternatives.

So is it possible to replace some of the affordances of paper with digital alternatives? Liao et al.(2008) stated that restricting the interaction exclusively to digital media gives you the limitation of not having flexible screen size, and the limitation of not being able to view multiple documents simultaneously. The big growth in mobile artifacts and the rise of major platforms supporting them change how you can look at these limitations. We do not yet have technologies in the mainstream market that gives the possibility of folding your big digital screens together and putting it in your pocket and thus overcoming the limitation of flexible screen size. What users do have is different screen sizes on digital artifacts that you can use for different needs. More and more people always carry their smartphones with them, providing a constant portal to everything they may need, similar to the folded paper. The tablet offers a bigger screen size and therefore can be compared to the standard A4 page. Overcoming the problem of viewing multiple documents simultaneously, should be as easy as overcoming the limitation of flexible screen sizes, by understanding that you need to design for multiple devices. So the two limitation mentioned by Liao et al. seem to be the main concern when designing for digital alternatives by restricting interaction exclusively to digital media. From my case study I found that the problem lies with how users deal with context and labeling, and the way consumers seem to use digital artifacts in a sequential manner.

Ecology research show that people seem to look at artifacts in the context of use. This was one of the layers of artifact ecology mentioned earlier in the theory chapter. People seem to label artifacts with for example "work computer, home computer" and these labels affect how people use their artifacts. My finding from the workshops was that they often labeled some machines as test computers. The subjects had one main computer and one test computer. From my observation I could see that the test computer was not used for other things, or if it was used for other things it was for a thing that was close to the concept of test. And most of them had to change position to shift to work on the other computer. One subject even had to change chair to use his test computer. So by labeling it as a test computer, it seriously affected how they used the computer. In diffusion of innovation Rogers talk about how the naming of an innovation effects the perceived compatibility of an innovation. He further argues that the perception of an innovation is colored by the words and symbols used for it, and that words are thought units that communicate and build people's perceptions. And as earlier stated it is

the perception of attributes, and not the attributes that themselves that affects the rate of adoption of new innovation. Rogers et al. (2003) also state that naming of an innovation affects the perceived compatibility and therefore its rate of adoption. So rather than just looking at what an innovation is called by the innovator, one should try to consider the labeling people do and its effects. A good example of this phenomena is the different computers in the office of subject 3, he had one test computer, and one test rig with several computers hooked up to one screen. Even if this was used for the purpose of testing, there are no technical reasons why he couldn't have incorporated these computers with their screens into his workflow. The same example was with the laptop for subject 2 that was used for testing. She rarely used it at all, and never for anything else than testing. The important thing to take from how naming and context of use affect consumers use of their digital artifacts, is that it seems to lead them to use their artifacts in a sequential manner.

From my finding you can see that my subjects used one and one devices and never seemed to use two at the same time, as you often see with people using paper. They used different device in different contexts. Mail seemed to be used on their smartphones when on the move and in other locations. Except subject 3 that used his iPad when in other location, but smartphone on the move. But when in the office they all used their computer for mail. So context seem to be the big definer of use. This seems to fit with Jung et al. findings of contextual affordance and commonality as a connection factor for ecology, and the layer of context of use.

That my subject used most of their devices in a sequential manner, could be affected by little available optimized software for use on multiple screens in their existing ecology. But I thought that there would be some re-invention for use of multiple screens. In a study done by Terrenghi et al. (2007) they found that even when designing a interactive table top for bimanual manipulation, users used it in a sequential manner. They stated that the subjects used in the table top, that was designed for bimanual interaction in much the same way as they used mouse on a computer. This leads me to believe that context of use and naming of innovations can affect the use of digital artifacts more than we have earlier believed. It is worth researching if optimizing for bimanual manipulation is best done with multiple devices, instead of one device as they did when testing for this in Terrenghi et al. (2007).

7 Conclusion

When one look at two of the affordances of paper, how paper support the interweaving of reading and writing and reading across more than one document at time. One understand that this is hard to mimic in a digital environment. This is especially hard when one look at how a single artifact can try to support this. That is why we should look at the ecology of digital artifacts, and we need to understand the users ecology from their point of view. To get a step closer to the paperless office we should look at how digital artifacts are compatible with existing products and existing ways we work with paper.

By designing compatibility with existing standards, using platforms as in the whole product approach we open up for re-invention both by users themselves and through other developers. Opening up for re-innovation by users leads to sustainability.

Peoples' use of their ecology of digital artifacts seems to be affected by the context of use and their own labeling of digital artifacts. This effected people to use their digital artifacts in a sequential manner, and therefore hinders them in taking on some of the affordances of paper. So to better understand how to introduce digital alternatives to paper, we should look more into the naming of innovation by both the developers and the consumers.

Software developer should have this in mind:

Design with the understanding that it is the ecology of all digital artifacts at the office that are important. For by not locking yourself to thinking about one device, you are developing a product by the whole product model.

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