Email, communication and more:
How software engineers use and reflect upon email at the workplace

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Abstract

This thesis presents an empirical study into the use of email within a software engineering environment. It aims at filling a gap in the research area of professional email use, looking at specialists within a technology driven industry that is central to the phenomenon of email and electronic communication. An interpretative qualitative methodology allows an investigation into how software engineers use and relate to email in their everyday work. Sixteen software engineers currently engaged in industrial practice constitute the sample for this thesis and provide their subjective views on the topic.

Beyond the communicative function, email helps software engineers with personal information management, such as filtering, archiving and retrieving important information. Moreover, social behaviour when using email, including response expectation and email etiquette, appears to be of significance. Asynchrony, the compression of time and space, and email as a distraction at work, amongst others, were vital considerations for software engineers' perception when using email at work. The findings indicate that the email behaviour of software engineers mostly resembles behaviour found in other professions, with some subtle differences. The study provides a starting point into the use of email within a specific profession and concludes with several further research suggestions such as different methodological approaches into the same profession as well as comparative studies into other professions.

KEYWORDS: Software engineers, email, personal information management, communication, task management, HCI

<u>**Acknowledgements**</u>

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List of Abbreviations

CMC	Computer-mediated Communication
CSCW	Computer-supported Cooperative Work
CST	Critical Social Theory
Email	Electronic mail
HCI	Human-Computer Interaction
IEEE	Institute of Electrical and Electronics Engineers
IRT	Information Richness Theory
MFT	Media Fitness Theory
MRT	Media Richness Theory
PIM	Personal Information Management
SIP	Social Influence Perspective
vmail	Voicemail

1. Introduction

The purpose of this study is to investigate how professional software engineers use and relate to email in their daily work.

"Over the past decade, email has progressed from being a personal information communication technology to one that is centrally managed, archived and critical to daily business operations." (Wasiak et al., 2010, p.45)

This recent quote by Wasiak et al. (2010) alludes to the vast development in the use of email. However, their notion only captures part of the concept of electronic mail, email, which is so central to everyday communication. Academia has long engaged in the field of email research, especially since the 1990s, when electronic mail was already becoming an established communication tool. (Rice et al., 1990) Since then, research into email has been considered from a variety of different disciplines, with numerous different theoretical and methodological approaches.

The varied features, behaviours and contexts around email add to the complexity of email as an academic subject of research. Early studies focus on media choice (Daft and Lengel, 1986), and on explaining how and why email affects communication flows within a company (Sproull and Kiesler, 1986). Across three decades of research, it is apparent that email is more than just a tool simply for communication. In the information age of today, people use email for personal information management and task management, managing contacts and drawing together social networks across great distances. (O'Kane and Hargie, 2007a) Each of these purposes encounters different behaviours and problems, most of which have been considered by the respective literature. Nonetheless, the research field of email as a whole lacks cohesion, despite attempts to draw together this array of disparate literature (for example, Garton and Wellman, 1993; Ducheneaut and Watts, 2005)

Despite the amount and range of academic research into email, there are still gaps in the literature that require further research. Most research has focused on specific aspects of email, rather than focusing on the use of email in the context of a specific profession. This is especially true for the software engineering profession, where research into email use is close to non-existent. This paper aims at filling this academic gap, by focusing on a profession that is exclusively computer literate, hence, experienced in Human-Computer Interaction (HCI) and Computer Mediated Communication (CMC). Current theoretical concepts and frameworks are fundamental to approaching this gap in the research.

So why study email in the context of software engineering and how is studying email relevant to the academic discipline of communication?

Software engineering, as defined in the *IEEE Standard Glossary of Software Engineering Terminology* (IEEE 610, 1990, p.67), is "The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the

application of engineering to software." As email is commonly referred to as "the most successful computer application yet invented" (Whittaker et al. 2005, p. 1), it is logical to research a profession that is, by definition, so central to the concept of email.

Wasiak et al. (2010) highlight that email, in its original sense, was supposedly a pure information communication technology. Therefore, studying email as a means for communication in itself makes this research a valuable contribution to the academic discipline of communication studies. Moreover, since email falls at least into HCI and CMC, which are already established research fields related to communication, the relevance of studying email is apparent. Additionally, studying email within the professions makes this research attractive to the field of organisational and professional communication, which in turn contribute to organisational behaviour and business studies.

Existing literature offers much knowledge about specific facets of email use. Nonetheless, an abductive research approach is considered appropriate to investigate the use of email within software engineering, to develop themes and codes based on participants' perceptions and how the make sense of email at work. Furthermore, operating in an information age with numerous alternatives to email including phone, social media, instant messaging, or simply face to face communication, it is vital to understand the relationship between email and work.

1.1 Research Rationale

The following study is underpinned by additional personal, academic and professional rationales.

To begin with, there is the researchers' own constant use of electronic mail as a means of communicating within private as well as academic life. It requires information organisation, prioritisations, and efficient delivery of content between one another. The challenges and opportunities that arise with the respective software is part of everyday interactivity which makes it all the more vital to grasp and understand the phenomenon in hand.

Moreover, anecdotal evidence shows that engineering professions are on demand within the local labour market. Job fairs and careers days within Gothenburg are primarily concerned with graduates in the fields of civil engineering, mechanical engineering, environmental engineering and software engineering, amongst others. As ongoing communication experts, this thesis is an opportunity to get an insight into a profession that is so vital to potential future communication technology.

1.2 Research aim and question
The overall aim of this thesis is to investigate how software engineers currently use and relate to emails at the workplace. The guiding research question for this thesis is "How do software engineers use and reflect upon email as a tool in the workplace?

Methodological Outline

The study will embrace a qualitative research approach employing semi-structured in-depth interviews with software engineers as a mono-method approach. Subjective participant perceptions and the interpretive nature of this research underpin the exploratory research aim to investigate how software engineers use and relate to email. The method has been identified as the most suitable one for the focus and the scope of the study and will be justified in the methodology chapter.

Thesis Structure

Following this introduction, the literature review provides insight into the areas of email, its use in the workplace and developmental aspects throughout academia and practice. Respective communication theories, features of email and user behaviour play a central role in this section. The subsequent chapter is dedicated to the methodology. It will outline and justify the methodological approach to this thesis. This section will introduce the mono-method approach employed for primary research and justify it in the context of this study.

Chapter four presents research results which are structured into themes and codes developed from primary research. The fifth chapter will discuss findings from the previous chapter by referring back to the existing studies analysed in the literature review. Conclusions and recommendations summarise the research in the final chapter and guide it towards further areas of interest.

2. Literature Review

Email as a research area includes a substantial collection of work encompassing numerous different research fields. As Ducheneaut and Watts (2005) presented in their comprehensive review of email research, email itself is hard to classify, and the large number of different disciplines and theoretical approaches makes it almost impossible to present a unified body of research. Human-Computer Interaction (HCI), Computer-supported Cooperative Work (CSCW), communication studies, organisational studies, user behaviour and social sciences, to name a few, are disciplines that have focused on varied aspects of email over the last thirty five years. Ducheneaut and Watts' (2005) review is perhaps the most comprehensive to date, and necessary reading for any researcher interested in email. As such, this review will address their article in a later section, in an attempt to draw together early theories into a basis for a theoretical framework.

The issue of reviewing email literature is not new, however. In the late 80's and early 90's, critical reviews had already been written to address the large and disconnected bodies of literature. Even then, they had problems unifying and addressing gaps across disciplines. Rudy (1996, p.1), focusing on email from an information management and management studies background, summarised this by stating "despite a great deal of published work though, the field still has an unsatisfactory, piecemeal feel to it." This sentiment was echoed by social scientific researchers investigating email, for example, Garton and Wellman (1995, p. 1-2) who asserted that "it is impossible to keep up with the proliferation of research, especially because they are published in many disciplines, often in poorly circulated reports and conference proceedings."

It is apparent that two important theoretical approaches to email emerged during the 80's. The first theory addressed communication choices people make based on attributes of the medium itself, very much embedded in organisational and management studies. (Daft and Lengel, 1984, 1986) The second, drawing from aspects of social sciences and ethnography, considered social interactions and the human element in trying to understand the medium. (Fulk et al., 1987) It is important to note that despite many of these studies now being over twenty years old, these theoretical frameworks still form the basis of more recent research. (for example, Trevino, 2000; Otondo, 2008) These studies often compared the two theories, or analysed one from a particular context as a way of either strengthening or refuting one of the two. The following sections will detail the early formation of each theory, as a way of understanding later articles dealing with media choice and behaviour as they relate to email.

Media richness Theory

The first important theoretical approach under discussion is the Media Richness Theory (MRT). A significant impact that computer-mediated communication (CMC) had on communication within an organisation is that the variety of communication choices increased. Many theories have been proposed to explain and understand the choice of media for communication and their subsequent effect. It was only natural that these theories would be

applied to email, especially when it started to be embraced by organisations. Daft and Lengel (1984) first proposed their Information Richness Theory (IRT) as a way of understanding how organisations manage and process information. They proposed that an organisation's success is directly linked to their "ability to process information of appropriate richness to reduce uncertainty and clarify ambiguity." (Daft and Lengel, 1984, p. 5) While earlier studies used the term IRT, later studies adopted the term MRT, to include new electronic media as well as more traditional forms of communication, such as face to face, letters and the telephone. Even Daft, Lengel and Trevino (1987) adopted the term in their later research. Much of the relevant literature, especially when considering the context of emails, points to the MRT as being the most cited and used theory. (see, for example, Suh, 1999)

The term 'richness' was coined to describe how much information a message could carry. Thus, if the data or message contained information that could strongly change the message, for example, nonverbal information such as gesture feedback, then the information would be considered rich. Drawing from aspects of both language and organisational research, Daft and Lengel (1984), and in a more refined version (Daft, Lengel and Trevino 1987, p.358), proposed four criteria from which one can derive how rich a medium is:

(1) The capability and availability of feedback
(2) The use of different communication cues (for example, gestures and prosody)
(3) Language variety (the use of different language symbols, i.e. numbers)
(4) Personal focus (whether you can convey emotions and feelings).

Based on these criteria, they came up with a hierarchy from richest to least rich medium of face-to-face, telephone, written (personal, for example letters), written (formal, for example documents), and numeric computer output. This is important, as upon initial consideration, it would appear that email is quite a lean (non-rich) medium, lying somewhere in the last three categories of the continuum. The hierarchy was based on each medium's ability to handle the confusing and complex environment of an organisation, as measured through the two concepts of uncertainty and equivocality. Daft and Lengel (1986) pointed to existing research agreeing on the idea that organisations process information in order to reduce uncertainty. The authors, however, also promoted the less popular idea that organisations wish to reduce equivocality. Uncertainty arises because of a lack of information. In this case, managers can reduce uncertainty by seeking new information. Equivocality, on the other hand, is more closely related to ambiguity. For example, there might be contradicting information or misunderstandings might arise due to people not having the tools to correctly interpret information. MRT proposed that for ambiguous tasks, such as negotiating, richer communication mediums are best, while less ambiguous tasks are more suited to lean communication mediums. Thus, emails have characteristics of telephone and written memos, but would be inappropriate for more rich tasks such as "resolving disagreements, getting to know someone, or negotiating." (Daft and Lengel, 1986, p. 363)

Some research has provided support for MRT in relation to new media, most notably the original proponents of the theory (Daft, Lengel and Trevino, 1987) in their multi

methodological study of a large company. They did, however, acknowledge two more factors that influence media choice, drawing upon earlier theories of symbolic interactionism which proposed that society is made of interactions which help create and understand symbols and meanings. Symbolic cues, the first factor which allows for meaning beyond the explicit message, influence choice; situational determinants, such as time, place, and other contextual factors, also have an impact on media choice. Trevino (1990) extended this further by allowing for individual differences and preference. It is important to note, that Trevino still asserts that for situations with high ambiguity you need a rich medium (not email). It is only for less ambiguous communication where individuals can assert preference. The findings from Trevino's research, as they relate to email, are quite interesting as by 1990 email use had risen in organisations (Trevino, 1990). Face to face communication was chosen over email in close proximity and emails were predominantly used for large amounts of information and to back up data. Email, more than any other medium was driven by situational determinants, and was considered to carry little symbolic meaning.

Even as early as the mid-1980s and early 1990s, MRT had become one of the predominant theories in CMC and media choice research. This trend continued with much later research looking into media choice and communication effectiveness being grounded on MRT. (Otondo et al, 2008, p. 21) While this thesis focuses on actual use and behaviour, as opposed to choice, MRT is valuable as it provides context for later research, as well as one framework for interpreting why people use email in certain situations or environments.

As Kahai and Cooper (2003) pointed out, one interesting aspect of MRT is that while the conceptual framework has been popular among researchers, the results of much of the later empirical research has been contradictory; some research provides support for MRT as a useful tool for explaining media choice, other research refutes it, and there is little consensus. Despite this, researchers still consider MRT worth exploring. This is perhaps due to the fact that later theories often came about as a response to either further clarify MRT or argue against MRT from a different conceptual framework.

Social theory and MRT

This next section will outline theories within social science that arose to explain phenomena which MRT struggled to explain. These deficiencies include the contradictory results of MRT as it relates to new electronic media, and the lack of empirical research into actual use of media, rather than choice. (Kahai and Cooper, 2003) The main focus of this section is on the Social Influence Perspective (SIP), and later theories that derived from this sociological approach.

Fulk et al (1987), identified two prominent theories in the relevant literature focused on communication media choice. The first, MRT is essentially based on objectivity in choice. The second, the social information processing theory (see Salancik and Pfeffer, 1978), asserts that choice is subjective and meaning is constructed socially. The conflict between these two different frameworks is partly based on whether one views choice as being guided by

rationality. Fulk et al (1987), drawing on aspects of the social information processing theory, proposed the Social Influence Perspective (SIP) theory which asserts that media choice and evaluation is both subjective and objective. The individual, the task, experiences, and other social and situational factors affect choice, as do objective factors. Schmitz and Fulk (1991), as part of a larger study, used surveys and follow up interviews to test SIP as it relates to email use in a large organisation. They found that richness is a more fluid, perceived variable and it varies dependent upon individuals, social relationships and experiences. The more rich an individual perceives email, the more often they would use it. For example, a person with more experience in CMC and typing would consider email to be a richer medium. Applying this on a large level, an organisation with email embedded into their workplace communication routines would, on the whole, consider email to be a richer medium than MRT would suggest.

Other researchers also compared these two contrasting theories, for example Rice et al. (1989) and Rice et al. (1990). Both studies pointed towards situations where SIP explained observed phenomena better than MRT, and vice versa. For example, email was found to be affected strongly by proximity (users close to one another used email much less), while email was still used for less ambiguous tasks. Golden (1992) found similar results in that user perceptions affect patterns of use, social networks encourage email use and social pressure affects adoption of email. This supported earlier work (El-Shinnawy and Markus, 1988) that found emails to be preferred over voicemail (vmail) for equivocal situations, not the reverse, as MRT would tend to suggest.

Adams et al (1993) also focused on vmail versus email, in particular how they affected people's perceptions of communication within an organisation. This study, different to MRT, used the criteria of scope (both breadth and capacity), communication pattern, communication task, and the content of the message. The study asserted that email expands the scope of organisational communication and improves effectiveness and efficiency. This means that email has a strong impact on how communication is perceived by employees within an organisation, thus highlighting the social influence a communication medium can have. Markus (1997) also compared email to vmail in a follow up on El-Shinnawy and Markus (1988). This again questioned aspects of MRT in implying that richness, such as tone of voice, was not always important at the workplace and at times can be irrelevant and confusing. People preferred written to spoken language, especially as writing can be manipulated, and email supports documentation, collection and retrieval of information. They also questioned the original four variables measuring richness. For example, according to MRT, immediate feedback makes a medium richer; email, however, despite often being thought of as asynchronous, has the ability to provide almost immediate feedback, albeit in a different way to face to face communication. Additionally, it is uncertain whether the four MRT categories should be given equal weight. Perhaps immediacy of feedback is the most important factor, along with other factors not considered by MRT, such as being text based. Clearly, there were other factors influencing email use other than inherent objectives qualities in the medium itself.

One of the seminal papers of the 80's and 90's was Markus (1994). She discovered that within

the organisation being studied, managers consistently used email for equivocal communication. MRT did not explain this phenomenon, which Markus attributed to social behaviours that fostered a business environment in which email was no longer asynchronous, but almost as fast as the telephone. Although the message can be sent straight away, response speed is entirely dependent on the receiver, something which earlier MRT research did not consider. Managers were found to check email constantly, and even interrupt face-to-face discussions to read an email, similar to taking a phone call. The users attributed the same speed and richness to emails as they do to phones (a 'richer' communication medium). These behaviours were largely influenced by the social influence of managers. "Yet there is considerable evidence that senior managers ... routinely reinforced the use of email by actively discouraging the work-related telephone calls that threatened to displace email." (Markus, 1994, p. 519) Markus supported the social definition theories, the idea that people form beliefs about the worth of a technology in the process of using and interacting with it. (Markus, 1994) Lee (1994), analysing textual data from an earlier study by Markus (1991), also attributed the emergence of communication richness to social interactions. The sender and receiver are not passive, but engaged in interaction. Managers chose media based not just on the inherent qualities of the media itself, but on other social and situational factors that emerge over time through social interactions. Thus email "is neither rich nor lean" (Lee, 1994, p.156), but richness emerges through social constructions.

Garton and Wellman (1993) identified characteristics of email, adapted from earlier work by Sproull and Kiesler (1986), which have an impact on social interactions. These are asynchrony, the fast nature of sending and receiving messages, the ability to send to one or more people (dyadic or multiple connections), and the ability to store, retrieve and manipulate information. They still, however, argued that email use is determined more so by social factors than technological ones. "The nature of interpersonal relationships, social networks, social influence, and organizational power structures all affect how groups and individuals use e-mail." (Garton and Wellman, 1993, p. 20) Garton and Wellman came to several conclusions about what most of the previous social literature agreed upon:

- Email has less communication cues, thus leading to more status and power equalisation. This encourages a wider network, linking people across space, time and other boundaries.
- Email allows for more informal interactions which increase social interactions, as well as task related group work.
- Email increases access, which leads to more participation and group involvement.
- Email provides greater connectivity, enabling social networks.

Kettinger and Grover (1997) were among the first researchers to investigate communication between organizations as opposed to within a single one. Contrary to those researchers asserting that social determinants were the driving factors in email use and behaviour, they maintained that the primary factors contributing to emails broad usage were its technological characteristics and functionality. Its primary strength, however, was its cost effectiveness. Additional important considerations are the timing of communication, and the ability to transmit and receive information over a wide network of people (broadcast role). Tasks also

brought people together as emails were used to coordinate and communicate for group work. Interestingly, physical proximity was less of a factor in when and why people used email, contrary to the previous findings of Rice et. Al (1989, 1990). They did, however, acknowledge that there are also underlying social factors, intertwined among the task and broadcast roles. Even though some email communication might be task oriented, people still build and maintain social networks in the process. They highlighted the mixture of technological features, task and social influences in saying that "in sum, task use is higher among those who perceive the medium to be one that is useful and economical, facilitates timing, and has a configuration that enables a variety of communication flows." (Kettinger and Grover, 1997, p. 536)

Two studies in 1999 reflected the contradictory findings from MRT and SIP research. Suh (1999) analysed four different mediums, with email being the text medium. The results did not support the hypotheses related to media richness. They suggested that factors other than media richness affected performance and that email could be considered rich enough for negotiating, despite taking more time in some cases. Roh and Struck (1999) considered richness as it relates to cultural values. They compared the adoption of fax, email, vmail and the telephone using a cultural values scale. While discussions of cultural values are not relevant to this thesis, their findings proved interesting as they considered richness through a different lens. They found support for MRT and unequivocally stated that "more ambiguous and interactive objectives promote the use of the telephone which all studies rank higher in richness than vmail, email and fax." (Rowe and Struck, 1999, p. 179) In other words, MRT has value if you expand the concept of richness beyond the original four concepts proposed by Daft and Lengal. Perceived richness is influenced by social and cultural factors that explain the ready adoption of email in organisations. Kahai and Cooper (2003) extended this concept in their article that focused on feedback and communication cues that differentiate rich media from lean. To a certain extent, they found that emails increase the clarity of communication where employees have less knowledge of the task at hand. Richer media, on the other hand, enables more social and emotional communication, being more suited to situations where employees have greater task knowledge.

It is pertinent at this point to consider the conceptual frameworks that guided this early email research. "Almost all of the past empirical studies of IRT have been conducted from the positivist perspective of the natural-science model." (Ngwenyama and Lee, 1997, p. 149) That is, the natural-science model, governed by logic, uses dependent and independent variables to test hypotheses, preferably in situations as close to a laboratory as possible. In this model, CMC is data processed by a computer, and the humans are viewed mainly as users, not affecting how the communication is shaped. Some studies were notable exceptions however, drawing from aspects of interpretivism. Lee (1994), as mentioned previously, used data from Markus (1991) to analyse communication using hermeneutics, an interpretivist tradition of textual analysis. Interpretivism, in the context of communication via email, holds that humans are an essential part of communication. Both the sender and receiver create meaning through shared understanding in a social context. Markus (1994) also differed from much previous research in using both approaches; she used a partly positivistic approach, using hypothesis

testing and surveys, coupled with an interpretivistic approach. Markus conducted interviews, along with textual data in actual emails, to identify social behaviours and meaning creation in email use, and how they were learned and disseminated. Ngwenyama and Lee (1997) claimed to be the first to approach communication richness in CMC from a Critical Social Theory (CST) perspective. They emphasized how humans, actors within social contexts, are the primary processors of information in CMC, as opposed to computers being information processors and humans merely being users. It is interesting that Ngwenyama and Lee (1997) used the same data as Markus (1994) to illustrate how the other perspectives were overlooking important considerations. They provided an example of the richness created when a person questions the validity of another person's message, and as a result changes his or her actions. According to CST, this questioning of validity, and resulting social action, is a rich form of communication, and thus email is richer than MRT proposed.

<u>Combining MRT and social theories</u>

Trevino et al. (2000) pointed to a trend in the research to compare and contrast theories about email attitude and behaviour, rather than amalgamating them or using aspects of each to complement each other, for example, using aspects of both MRT and SIP. They also pointed to a gap in the research as it mainly focused on either attitudes to media, its use, or choice of media, while arguing that all three are important and need to be considered. These were two important criticisms of the opposing theories, and taking aspects from each allowed for a better framework from which analyse choice. Trevino et al.s' (2000) research indicated that media choice is influenced by situational requirements relating to objective and social factors, in particular perceived richness; Attitudes to media are influenced by individual preferences and technology attributes, while media use changes depending on larger social factors and a more broad objective thinking. To clarify, each situation has factors that influence media choice, while broader, more organisational factors influence general patterns of media use. Email use was strongly affected by what employees perceived others to think of email.

Park et al. (2012) used this multiple theory approach to examine MRT, along with two other previously unmentioned theories: The Uses and Gratifications theory, and Network Effects theory. The Gratifications Theory focused on personal, individual differences based on a person's own needs; this is more relevant to interpersonal communication theories. The Theory of Network Effects measures the effect a social network has on technology use. While less relevant to email, the theory is more appropriate for analysing settings like Facebook and social media, where communication is within the context of a network of social relationships. Park et al. (2012) found MRT to not be applicable to email, despite richness being relevant for the other media being researched, Facebook wall postings and mobile phone texting. They maintained that the primary reason for choosing email is that email makes communication possible. That is, we use email because we are forced to if we want to communicate in today's society because email is such an institution in both private and work life, rather than because of any implicit features of email itself. This way of thinking of email as an institution will be explored further in a later section (Email as habitat).

Gu and Higa (2007) also suggested that MRT and SIP can be complementary rather than simply opposite, contrasting theories. They proposed the Media Fitness Theory (MFT), where fitness is assessed via 3 groups: "communication task needs, the communication user and user group, and the supporting environment in which the media [is] being utilized." (Gu and Higa, 2007, p. 47) In developing these criteria, they worked with three IT engineers to come to an agreement about which factors help measure each group item. Email was considered to be the most "fit" media, ahead of video conferencing, instant messaging, face to face, fax, and the telephone. However, the company in which the research was undertaken was in the process of shifting email and telephone use towards instant messaging. Gu et al. (2011) compared the effectiveness of MRT, SIP, and MFT in predicting media choice. MFT proved more accurate, however the study, as suggested by the authors themselves, was limited and needs further research. MRT and SIP considered only single media usage, while MFT can be used for multiple media usage, thus being more appropriate for analysing software like video conferencing that also supports instant messaging. Developing theories to answer the question of why people use emails is even more problematic when one considers the blurring of boundaries between different CMC's. Gu et al. described this trend as "increased usage of multiple-media" (2011, p. 297). Methodologically, this is interesting as they argued that surveys have been overused, and are not suited to researching the unpredicted, or shifting boundaries of media.

Email as power equalizer

Clearly, social factors such as work relationships and status within an organisation can affect the choice of email as a communication medium in the workplace. The question remained, once email is chosen for communication, how does the use of email affect the power hierarchy existing within an organisation? In early email research, Sproul and Kiesler suggested that email "reduced social context cues, [and] provided information that was relatively self-absorbed, [and] undifferentiated by status." (1986, p. 1509) This is echoed by Garton and Wellman (1993), who in reviewing relevant literature suggested the consensus is that emails contain less social cues and help equalise power and status.

Panteli (2002), writing about power and hierarchical differences in email, argued that despite emails often being seen as a lean medium, they have the ability to convey rich social cues that reveal and are shaped by power within an organisation. Only few previous studies had looked at text-based attributes, and the assumption of Panteli (2002) was that text based characteristics can carry much more information. Panteli built upon Lee's (1994) interpretation, as discussed previously, of Markus (1991) where users aren't passive, but working towards creating meaning. While Lee (1994) focused on the recipient, Panteli (2002) argued that one needs to consider the sender as well. She found that while formality and language use changes and varies in email communication, aspects of power and hierarchical difference still persist in email. "Email, therefore, as a communication medium signals and supports rather than alleviates hierarchical differences" (Panteli, 2002, p. 84). Ducheneaut (2002) found a similar trend when exploring the impact of email on organisational power and structure by looking at power games in the context of email. The suggestion is that rather than

breaking down hierarchies, emails and CMC can strengthen existing structures. This is despite the assertion of many researchers "that these technologies should flatten hierarchies and rearrange communication networks." (Duheneaut, 2002, p. 183) Clearly the literature varies regarding the impact email can have on hierarchical structures and social distance. As there is no literature specific to software engineers, this thesis may provide some insight into how emails affect hierarchy within the profession of software engineering.

Another aspect of hierarchy can be seen in the way in which people start and close messages. In a study of two very different, large organisations, organisational structure was found to have the greatest impact on formality in greetings and closings (Waldvogel, 2007). Status and social distance were also factors; when communicating with people of higher status, formal greetings and closings were more often used. Likewise, language and greetings were less formal for 'close' colleagues than for people separated by more social distance.

Trust and MRT, another research area, was considered by Lo and Lie (2008). While the concept of trust is not directly relevant to this thesis, and a large and complex field in itself, this study revealed some interesting findings related to email. Highly equivocal tasks require richer media in long distance communication (thus supporting MRT), while in short distance communication, task equivocality does not affect media choice. They found emails to be considerably leaner than the telephone, Instant Messaging with a webcam, and instant messaging with only text.

Other aspects of email research

As highlighted earlier, there is a large degree of fragmentation and variety of disciplines in email research. MRT, and other theories explained media choice, focusing on the individual, often managers. Emails were viewed as the communication system, in which the communication is primarily processed by computers. Social network and influence theories focused on social interactions and behaviours as ways of explaining why people used email, as opposed to the different ways in which people actually used email. Emails are a medium through which people socially construct meaning and develop relationships. However, researchers also began to focus on other aspects of email. As El-Shinnawy and Markus (1988, p. 250) stated, there is "stronger support for an explanation grounded in different technological features of communication media than the ability to transmit personal and social cues (richness)." A key finding of theirs is that other technological features are important, such as the easy retrieval of information, the ability to work in groups, and accessibility and ease of use. Researchers began to explore these facets of email.

Mackay (1988) was an important study that examined patterns of email use in an organisation. This was one of the first studies, often referenced in later literature, that looked beyond email as a communication system, and considered its time and task management attributes. A key finding was that not only do people use and process email differently, but their whole way of thinking about email was different to what previous research attributed. Mackay described different categories of people based on how they conceptualize the functionality of email.

'Prioritizers' view email as tool to help them manage time; others who use the archiving and database functionality view email as an information management tool. Finally, some use and think of email as a way of managing tasks. Each of these categories branched out to become important research areas in themselves, drawing interest from varied disciplines. For example, Mackay et al.'s (1989) investigation a year later focused on file management and found that people with little experience can create, sort, prioritize and maintain rules in email system.

Towards a conceptual framework

Before continuing, it is worthwhile trying to bring together an understanding of email research as a whole. Perhaps the most important, single collection of email research belongs to a special edition of the publication "Human and Computer Interaction." (2005) A group of scientists, professors and industry professionals collaborated on a series of articles related to email. Acknowledging the vast opportunities of email they claimed that despite prevailing challenges, email has not seen much change or improvement over the past decade. This paradox provided a starting point for a special issue concerned with the possible solutions for email problems and system design.

Ducheneaut and Watts' (2005) review of email research in this special issue is particularly relevant to this thesis, and forms the most comprehensive, broad review of the entire research field to date. The authors tried to get to the very heart of what email research is and whether research can actually have an impact upon system development. They used three metaphors to categorise email. The *file cabinet* metaphor refers to email as a means to individually organise information, store it and retrieve it as necessary. This category is dependent on individual cognitive capabilities and how the individual makes sense of the world around him/her. Email as a *production line* is the second category. It is rooted in groups or teams of people where key considerations include social context, linguistic structure, organisational structure, and communication flow. The third metaphor views email as communication genre in a social and organisational environment. Therefore, email as a communication technology is inevitable for the survival of an organisation. Ducheneaut and Watts' (2005) categorisation proves valuable for primary research and further sections in this paper. Even though it is not the aim of this thesis to advise system design, the concepts of storing, retrieving, as well as information flows and organisational settings play a major role in following chapters.

Two further articles in the special issue of Human-Computer Interaction explored different options on how to solve potential email constraints related to Personal Information Management (PIM), task management, and overload. While again, not central to the research at hand, they are important articles in the greater context of email research as a whole, and deserve mentioning. Schmandt and Marti (2005) looked at software that may help with prioritizing email and with filtering and monitoring issues. Kraut et al. (2005) explored the pricing of electronic mail as a possibility to prevent quantitative email overload (spam).

Personal Information management, Task Management, and overload

Personal information management (PIM) and task management, although separate concepts, often go hand in hand in the literature. People organise their email using certain patterns, and this in turn help them manage and prioritise tasks. Likewise in completing tasks, people create information, often in emails, that then becomes part of their PIM. Overload is a term that essentially refers to problems in using email, either related to the volume of incoming mails, or issues arising from email being used for multiple different functionalities. As can be seen, overload is intertwined within PIM and task management.

Whittaker and Sidner (1996) were among the first to question the multiple roles email played in the workplace, additional to its original function of asynchronous communication. They argued that email was also used for delivering and archiving documents and other information, delegating work and tasks, storing contact information, and other uses. They categorised these into task management and personal archiving (often referred to as PIM in other literature). They also identified numerous factors that lead to problems and coined the term *email overload* to refer to the fact that email is being used for tasks for which it was not originally designed. This could lead to a variety of issues: clutter, lost information due to poor filing, ongoing conversations adding to the difficulty of proper sorting, the difficulty in categorizing some messages, irrelevant emails, multiple user exchanges over long periods of time, and increasing piles of to-dos and to-reads.

Part of dealing with overload is to look at behaviour in order to implement design changes. Whittaker and Sidner (1996) identified certain types of behaviours that could be used to classify how people use email. *No filers* seldom organise their inbox and tend to have large inboxes; *spring cleaners* sporadically organise their files, often in large systems of filing; *frequent filers* often arrange their information, and have small inboxes. They suggest that more folders and more frequent filing will result in less feelings of overload, perhaps as users are actively dealing with managing their inbox. Despite these different approaches, they assert that "user comments and their experience with email filters clearly indicated that 'automatic filing' was not desirable." (Whittaker and Sidner, 1996, p. 283) Identifying these patterns led to the authors suggesting two key design implications that are essential for reducing problems associated with multiple asynchronous conversations over time: the need for context, and the need to be able to track the status of a conversation. Ducheneaut and Belloti (2001) supported the idea that most users do not use filters, or only use simple filtering, while not using automatic filtering (essentially the same as filing; filtering implies that emails are sorted into separate folders upon arriving into an inbox). Neither do users make use of search functionality in the email client; they instead sort emails by one or more of the following criteria: Sender, association or organisation, project name or description, and personal categories. This pattern is supported by more recent research; Koprinska et al. (2007) also found that most users do not manually set up rules, due to the difficulties associated with having to constantly add, change and delete folders.

Threading, as touched upon briefly before, refers to having continued conversations in an email containing previous conversations. This could be chronologically, or it could be an amalgamation of related conversations and messages into a thread with a common theme. The need for such functionality was an ongoing theme (see, for example, Venolia and Neustaeder, 2003), the rationale being that an email user can get both a better local context (to help understand the meaning of a single message), more of a global context (to help understand the broader conversation), and to help reduce work for the user (i.e. deleting/moving one thread instead of deleting/moving multiple messages). Most users of email today, for example gmail users, would be familiar with threading as it is now a fairly common practice.

Ducheneaut and Belloti (2001, 2003) followed the progress of email as a personal management tool. They claimed that "personal information management is … embedded where it is most needed and accessible, that is, in the knowledge workers' new electronic habitat: e-mail" (Ducheneaut and Bellotti, 2001, p. 37). Email had become not just a place to work, store information, delegate tasks and manage workplace activity, but a central site for resources and communication that is always on and accessible. Venolia et al. (2001) argued upon a similar line and proposed 5 conceptual models to understand user activity. (1) *Flow*: similar to Ducheneaut and Bellotti's concept of email as habitat, flow refers to email being open while people work on other tasks, so they are keeping up with the flow of emails. (2) *Triage*: People deal with email sporadically, similar to *spring cleaners*: They let email accumulate, and then deal with them in a longer activity. (3) *Task management*: People use email as a reminder. They send themselves emails with details of upcoming tasks needing to be done. (4) *Archive*: storing of information. (5) *Retrieve*: methods of retrieval.

Users from all three studies tended to store emails mostly in the inbox. Emails had become such an embedded part of users' workplace communication and activity that they would email themselves task related communication. "We even observed the same thing Ducheneaut and Bellotti found: People place non-email related tasks in their inbox by sending themselves mail." (Venolia et. al., 2001, p. 5) Advances in email also added the ability to support attachments and embed links to other information services (Decheneaut and Bellotti, 2003), and workbound communication over email became products themselves, storing valuable information. Documents sent via email would have conversations surrounding and attached to these objects that add contextual meaning. Users were innovatively taking advantage of the different ways email can be used.

More researchers focused on email as a habitat of multiple functionalities in addition to being a communicative medium. O'Kane et al. (2007) described this by attributing a polymorphic role to email. Polymorphic describes how email is intertwined in daily work activities, knowledge creation and sharing, which has the potential for both positive and negative patterns of communications They were interested in analysing day to day interactions with email with the aim of understanding how people communicate and manage their email, rather than focusing on one specific aspect. They identified two themes, developed also in O'Kane et al. (2007), similar to the 3 metaphors of Ducheneaut and Watts (2005). These were email as information management and email as social interaction. It is worthwhile illustrating their key

points, as much of the literature points to one or more of the aspects these authors discussed. Negative points have been set in *italics*

Information management
- This theme encompasses technical and communication medium aspects of email. Email spans geographical boundaries with great speed, allows for easier access to knowledge, and the sharing of knowledge within groups. Information in emails has permanency, that is, it can be stored and retrieved. Emails can increase the accuracy of information through the writing and editing process. Information logs can be used to confirm things or double check. *Information overload, and time wasted on irrelevant or poor email communication can be problematic. Writing can improve, but also degrade the quality of communication (although most literature agrees that writing often leads to greater clarity). Individual communicative skills can hinder or enhance communication. Emails can decrease the potential for discussions. People might restrict their email use due to fear of being held accountable.*
- Contacts allow for contact management, with access to more people, contact lists, and group emails. *There is the potential danger of including the wrong people. Using contacts improperly can lead to awkward situations, time wasting and spam. Group emails also change the communication dynamic as it isn't always obvious who is expected to answer and who is expected not to.*

Social interaction
- Emails can build relationships, especially through larger number of contacts. They claim that emails can help diminish hierarchical boundaries and lead to increased upward communication. *Emails can hinder social relationships, people might show avoidance behaviour by using email, emails can depersonalise communication. Potential for alienation if people not included in certain emails.*
- *The composition of emails can lead to misunderstandings, inappropriate tone and style of message, and impulsive writing (writing quickly and sending before thinking through the message)*

(List of characteristics adapted from O'Kane and Hargie (2007) and O'Kane et al. (2007)

Fisher et. al. (2006), revisiting Whittaker and Sidner's (1996) earlier work, also pointed to significant advances in the ten year gap between the articles. For example, threading, and flagging (keeping track of emails) is now widely available and systems had more sophisticated ways of organising email. They wanted to investigate if email users were still behaving in the same way to deal with email overload. They found that archives had increased tenfold (from 1996), however the average inbox size was around the same, resulting in many more folders. According to Fisher et al. (2006), users were clearly not feeling overload because of large filing systems. The 3 categories of filing (no filers, spring cleaners and frequent filers) were not as polarised as the earlier article suggested, and there was not a noticeable grouping of behaviour. Whittaker (2011) found evidence of similar behaviour in attributing filing as a reaction to too many messages. He also supported the idea that threading reduces foldering and leads to increased success in finding the right information.

Identifying personal information management behaviour remained important in the literature. Tungare and Pérez-Quiñones (2009) summarised the different strategies of approaching PIM and noted that although the literature was using different terms (for example, piler-filer, prioritiser-archiver, cleaner-keeper, filer-no filer), they essentially referred to whether people would keep messages in their inbox or archive them into folders, and how they flag/sort in order to prioritise tasks. Tungare and Pérez-Quiñones still maintained that overload results from the use of email for tasks other than communication, although acknowledging that volume of emails is also a problem. Whittaker (2011) added two more strategies that people use: *preparatory* (pre-defined ways of organising) and *opportunistic* (no pre-work, just sorting and searching). He found that each group of filers and searchers actually find information in about the same amount of time with the same accuracy. Filing was used mostly for task management and a reaction to having too many messages. In creating folders and reducing emails in the inbox, people could see and organise their "to-dos" (tasks) more efficiently.

Continuing on with this approach to PIM, Whittaker (2006) identified a further problem of information becoming fragmented; To clarify, information is not only left in emails, but often spread across a series of emails and hard to access, as opposed to being ported across to programs specifically designed for PIM and task management (for example, calendars). Two approaches were suggested: Centralisation - *Importing* features of Information Management (IM) programs into email (their example is Outlook having a calendar) and *Extraction* – exporting data from emails to a PIM tool in a format that can be understood (the article uses the development of google as an example, which does indeed support this in google mail currently – 2013). The idea of *importing* was also suggested earlier by Bellotti et. al. (2003) when designing their taskmaster system which showed "that it is possible to significantly and positively affect email users' experience by embedding task management resources directly in the inbox." (Bellotti et. al., 2003, pp. 351-352)

Bellotti et. al. (2003) provide a comprehensive summary of problems encountered in task management, much of which remain issues in later literature: (1) Tracking to-dos (both individual to-dos and what people expect of others); (2) Being able to attribute importance or priority to tasks; (3) Activity over time; (4) Deadlines and reminders; (5) Collating task information; (6) Managing multiple programs and windows; (7) Managing overviews of information. Subsequently, as part of the 2005 special issue on emails, Bellotti et al. (2005) take the challenges of task management a step further. They discover that the issue of overload lies not only with the actual quantity of email, but the collaborative nature of email task and project management. Within the organisational context, the element of time recurs over and over again. The authors define a range of issues from managing concurrent actions and extending activity, to prioritising task information and managing reminders and deadlines. Another special edition article, presented by scientists of the IBM Collaborative User Experience, aimed at informing system design. Wattenberg et al. (2005) viewed email as an element of corporate collaboration, taking it beyond a mere communicative function. They focus on information visualisation of emails by means of a Thread Arcs case study. Throughout, emphasis is placed on the idiosyncratic nature of email use and email overload in

the sense of Whittaker and Sidner's (1996) definition of being overwhelmed when email is used for many purposes at the same time.

Tungare and Pérez-Quiñones (2009) also addressed the issue of PIM and task management and suggest the solution is along the lines of collaborative information management; People within a social network should be able to tag and sort in a collaborative way that shares the workload, the emphasis being on the contacts within an email system. Whittaker (2005) also dedicated a special issue article to managing collaborative tasks via email. The focus of the study was not actual team work but rather how the individual participants make sense of group emails, how they identify and access task information and how they use email as a reminder to perform multiple tasks. He introduced two applications, a paper-based task management system, as well as a people-based task management tool. The former helps with structuring and organising task-related information, while the latter reminds participants of outstanding tasks through associations of their social contacts, environment and structures. Even though the current paper does not focus on tools outside of email, they are still relevant to email research as a whole.

While some research focused on overload in terms of the multiple, unintended functionalities of email, others diverged and attributed email overload to individuals perceptions that they did not have control of their own email due to sending and receiving more emails than they can process and deal with effectively. Some research found a correlation between increased work effectiveness and increased work stress and distress. (Mano and Mesch, 2009) However, the same researchers discovered that more emails received and sent could also correlate to improved work performance, indicating that email communication is an important carrier of information that, in turn, helps people carry out tasks (Mano and Mesch, 2009). Dabbish and Kraut (2006), working with this concept of overload, pointed to a connection between how important an individual perceives email communication and the amount of emails, and more feelings of overload. Contrary to Whittaker and Sidner's (1996) assertion that more filing would be linked to a decrease in email overload, they found that maintaining a larger filing system would lead to more email overload. This is supported by Edenius (2006) who found that people have trouble managing large numbers of folders, due to poor memory, an ineffective taxonomy, or a simple mismatch between small and large folders. Elsiler (2012), in three concurrent studies, came to the same conclusion; Filing does not necessarily relate to better PIM and reduced overload as it is often time consuming to remember and locate required information. These findings are particularly important as there is a tendency for engineers to retain a large amount of information (including, but not limited to emails) in personal storage, using large filing systems (Hicks et. al., 2008).

Soucek and Moser (2010) combined the two approaches in categorising three facets of information overload. (1) Too much information, particularly due to multiple group emails and the ease of access to responds quickly and frequently; (2) inefficient workflow (relates to Whittaker's concept of email overload); (3) poor communication quality (messages that are ambiguous, superficial, poorly developed). Training programs proved effective in reducing these three areas related to overload. Szostek (2011) also pointed to the fact that email

overload generally refers to being overwhelmed by too many emails, as opposed to Whittaker's original interpretation. This is, perhaps, indicative that the 'unintended' functionalities of email are becoming more accepted as part of email. Szostek (2011) argued that because emails require action, users are forced into a series of steps: assess the need to answer, check initial information (sender, topic, time, perhaps first paragraph), re-evaluate how to deal with the email, act on further multiple actions the email might require, and make decisions about archiving. He pointed to the fact that modern email clients support some of the previously suggested functionality to implement; Outlook supports flagging, google mail supports group labelling, sorting and threading. The two further needs in relation to design are the ability to show relative importance of emails and relationships between emails, and having an efficient inbox structure.

User behaviour

As email systems develop, patterns of how people access, and even think about email change. Fisher et al. (2006) pointed to evidence that email users were becoming more used to working with and adapting to the medium. This is supported by Dawley (2003) who found a link between those with more experience in email and those feeling less email overload. This emphasis on experience is widely supported across the literature. For example, MRT studies also agreed that experience is fundamental in shaping "communication effectiveness ... [and] also richness perceptions that develop through the learning processes." (Kishi, 2008, p. 283) Interestingly, "although most email users feel adequately trained in how to use email, they often blame their peers' lack of email training as a possible source of this email overload." (Dawley, 2003, p. 192) With people becoming more experienced and more familiar with email as a 'habitat', comes changes in email behaviour. User behaviour in emails can also be negative (Phillips and Reddie, 2007). They found evidence of people procrastinating by spending too much time in email clients, and 'buck passing', which refers to resending emails on to others to avoid taking responsibility.

A significant proportion of literature relating to PIM and task management focused on the practicalities of how people deal with emails (store, delete, sort, whether/how to reply). Dabbish et al. (2005) used behavioural data to analyse the ways in which people make decisions, as opposed to explicit user behaviour. A key part of the study was how perceived importance affects their user behaviour. Up to this point, there had been little research centred on understanding the factors within an email that determine its importance. The following findings are of particular interest. The sender and content of a message influenced perceived importance the most, which in turn has a direct impact on how people respond. Additionally, people do, however, respond to emails that are less important (indicative of other factors playing a role). The most responded (and more quickly) to emails were social messages, indicating that social factors may influence response more than perceived importance. People tended to also respond to direct information requests.

Tyler and Tang (2003) noted that people check emails continuously and have a tendency to respond more quickly to messages within a small group, to and from people with a history of

quick conversations, and messages following up from previous conversations. They coined the word peri-synchronous (almost synchronous) to explain the expectation of senders to receive a quick reply, almost like a flowing conversation. In their research, users had a clear expectation of when to receive a response to an email, based upon previous experiences with individual people. This varied from almost immediately, to a few days, depending upon the nature of the message, and the person they are communicating with. Renaud (2006) also pointed to the difficulty of determining whether emails are synchronous or asynchronous, as is done for traditional media. He coined the term *e-synchronous* to explain this phenomenon. A large majority of the people in his study (84%) kept email on continuously throughout the work day and Renaud noted the widely agreed upon increasing expectation of people to more promptly answer emails. In this context, Gauducheau (2011) documented two groups of people, those continuously online and checking messages immediately, and those who check at pre-determined times. Those who checked continuously perceived email to be synchronous communication. Interestingly, Gauducheau (2011) found that the pattern of email checking is not a determinant of whether a person replies immediately, thus evidencing the fluid nature of emails in that they can be either synchronous or asynchronous. Dabbish and Kraut (2006) related the concept of synchronous emails to overload, maintaining that continuously checking new emails, rather than at pre-determined times, actually reduces email overload. These new patterns "are at odds with the conventional wisdom that urges managers to check their email only at the end of the day" (Dabbish and Kraut, 2006, p. 438)

Jackson et. al. (2001, 2003a, 2003b, 2006) presented a different view to Dabbish and Kraut (2006) in their analysis of the disruptive effects associated with being continuously receptive to emails. In their research, 75% of people checked incoming mail within 6 seconds; 85% reacted to new email within 2 minutes (Jackson et. al., 2001, p. 87). Drawing from earlier research into telephone interruptions, and citing the complete lack of empirical research in relation to emails, they provided evidence that a large majority of people check almost immediately, and take an additional minute of recovery before resuming their ongoing task. (2003b). With the cumulative effect of these interruptions possibly being quite large, they offer a series of recommendations. Users should restrict functionality within emails, such as reply-to-all, and, contrary to the previous research in how to reduce overload, *not* check emails continuously (2003b). Additionally, user practices such as only reading small descriptions, title, sender, and minimizing email notifications can reduce the effect of email interruptions (2003a). Training programs can also reduce wasted time (2003a, 2006).

<u>Software engineering and emails</u>

Thus far, the literature review has focused on email research, not on engineering or a particular profession. Empirical data in the literature was not often focused on researching a particular profession's use of email, but on some aspect of email using data that happened to be from a certain profession. Moreover, the data was most often from a variety of professions, looking at one or more organisations as a whole. In some cases, data happened to be drawn

from engineers, for example, Gu and Higa (2007) collected data from people involved with IT services or programming. However, there was no emphasis on investigating that particular profession.

There is a distinct lack of research specifically focused on email use by software engineers, something that is perhaps surprising given that this profession is involved in coding and designing email software. Additionally, software engineers as a whole group can be assumed to be rather experienced users of both email and technology, due to the nature of their profession. Much research has been focused around the collaborative communication practices of software engineers. Software engineers are technology savvy, and use a wide variety of communication and coordination technologies (Whitehead, 2007). Literature has often focused on organisational theory and co-ordination theory, as well as a focus on collaborative software. (McChesney and Gallagher, 2004) Some early articles related to software engineers focused on whether and how email should be implemented. (Bekert, 1988; Safayeni, et al., 1992) However, little focus has been put on how software engineers (or engineers in general) use email.

Wasiak et al. (2010), is the only article identified that focused on engineers (in this case, aerospace engineers, not software engineers) and their use of email. They eloquently described the dearth of literature as follows:

> It is widely believed that email is increasingly becoming the medium where in collaborative engineering work is done; yet, this assumption has not been properly examined. Thus, the extent of engineering information contained in emails and their potential importance within the context of knowledge management is unknown. (p. 43)

Despite the data being drawn from aerospace engineers and not software engineers, it is still one of the most relevant articles. Unlike other email studies which used interviews to collect data (OKane and Hargie, 2007, Renaud et al., 2006, Ducheneaut and Bellotti, 2001), Wasiak et al.'s primary data was drawn from coding email corpora. Their research agreed with much previous research stating the primary uses of email were to manage and inform, with emails containing much project relevant information (either technical information or task related information). A smaller portion of emails in their study were used for generating ideas through discussion. Their findings are in line with Hicks et al.'s (2008) assertion that engineering deals with large amounts of information, and requires fast and reliable access to accurate and updated information.

3. Methodology

The previous chapter reflects upon existing literature and theoretical frameworks around the general use of email, email within organisational settings and email in the engineering profession. The literature as a whole reflects the complexity of using email effectively in the workplace. The following chapter will outline and justify the methodological approach to this thesis that concerns how software engineers use and relate to email in their daily work.

3.1. Research Philosophy, Approach, and Strategy

The underlying research philosophy of interpretivism requires the researcher to understand individual differences amongst people and to interpret social roles. Lee (1994, p.146) refers to interpretivism as "phenomenon of subjective understanding". According to Saunders et al. (2008) the interpretivist philosophy is rooted in phenomenology and symbolic interactionism which rely upon the human ability to make sense of the social world they live in and to interpret this social world.

This thesis is an investigation of the use of email at work from the context of the software engineering profession. The researchers are interested in individual perspectives describing the use of email as a means of communicating within the software engineering environment. Consequently, the study adopts a qualitative methodology, which reduces the ability to generalise the results to the software engineering population as a whole. Tying in with the research philosophy, "Qualitative research is an approach that enables researchers to explore in detail the social and organizational characteristics and individual behaviors and their meanings." (Schensul in Lapan et al. 2012, p.69) General comments about perceptions within the research sample can potentially hint towards broader patterns in the profession as a whole; this, however, would then require further (quantitative) research.

According to the research philosophy, the analysis of primary research data is inevitably subjective since it relies upon the research targets and as well as the researchers' own view of their social environment.

Several major studies in the field of email use and user perceptions of email have inspired this qualitative research approach to investigate the issue in hand. (O' Kane et al., 2007; O'Kane and Hargie, 2007; Bellotti et al., 2003; Dawley and Anthony, 2003; Whittaker and Sidner, 1996; and Mackay, 1988) They have all used at least qualitative in-depth interviews to obtain respective research outcomes.

The study follows an abductive research approach. Timmermans and Tavory (2012) explain that

> "abduction is the form of reasoning through which we perceive the phenomenon as related to other observations either in the sense that there is a cause and effect hidden from view, in the sense that the phenomenon is seen as similar to other phenomena already experienced and explained in other situations, or in the sense of creating

new general descriptions. Abduction is the most conjectural of the three logics because it seeks a situational fit between observed facts and rules." (p. 171)

This means that this research is based upon participant perceptions of email at work and, at the same time, essentially relates findings within the sample to existing theoretical frameworks and codes drawn upon in the literature section.

The following section will explain the adopted method in detail and justify its value for this thesis.

3.2. Research Method

The study examines how and why software engineers use and perceive email at work. As indicated above, this study employed semi-structured in-depth interviews in a mono-method approach. Emphasis is placed upon individual sentiments, individual user perceptions of emails within the work environment.

Research Sample and Participants

The adopted sampling method is a combination of non-probabilistic self-selection sampling and snowball sampling. (Hennink et al., 2012) The judgemental nature of the former method ties in with the subjective interpretivist philosophy. Self-selected sampling describes a research target that is selected by the researchers themselves. Initially, two pilot interviews were conducted with software engineers known to the researchers, within their circle of family and friends. Even though the responses are not considered in the results and discussion sections, this primary step was vital to ensure the quality of the interviews. It served as an assessment of interview questions to guarantee valuable responses that contribute to the overall research aim. Subsequently, the sample started to snowball with the two trial interviewees identifying several potential research participants. The researchers were hence able to select their participants from within the software engineer population.

Three assumptions were vital for the selection process:

1. Participants are software engineers
2. Participants actively work as software engineers
3. Participants all use email for their daily work

For this study, a total of 16 software engineers from six different companies were selected to take part in the research eventually. All participants hold a higher education degree within the software engineering discipline. All participants are actively working within the broader software engineering domain. Variations in terms of practical experience, time- as well as work-wise are to be mentioned, however, of no relevance for the purpose of this study. Similarly, the fact that participants come from six different companies plays no major role in this study because the research is not concerned with organisational culture. Self-selection and snowball

sampling result in respondents from several companies which increases the chance of various uses of email within the software engineering profession. A single company or case study approach would probably have led to less variation in results. On the other hand, such an approach would most likely lead to a deeper understanding of the complexities of email use, and would be appropriate for further research.

An initial research target of 15-25 participants was considered appropriate. The actual number is justified by the aforementioned data saturation or theoretical saturation point which "is simply the point at which the information you collect begins to repeat itself." (Hennink et al., 2012, p.88) The researchers iteratively collected data and decided on such point after 16 interviews were conducted. Smaller samples are suitable for in depth, longer interviews. Saunders et al. (2009) explains that the data collection most often used within the interpretivist tradition relates to qualitative, usually in-depth investigations using a smaller sample.

Interviews

Due to participant availability, time restrictions, physical access and general logistics the researchers split the interviews 12 to 4 amongst themselves. As such, all the interviews took place with only one interviewer present, in order to minimize potential problems such as having additional stress on the interviewees. The pre-scheduled interviews took place throughout May and June 2013 with interview times of between 30-50 minutes. Of the 16 interviews, 14 were conducted face-to-face, with 12 taking place in quiet facilities at the respective company premises; two took place in the researcher's home. Another two out of these 14 were interviewed in a group interview due to time constraints of the respective persons. The remaining two interviews were conducted via Skype.

With individual written permission, oral permission in the case of Skype, all interviews were audio recorded. Interviewees were guaranteed anonymity throughout the study. In the following sections they will be addressed as Participants P1-P16.

An interview guide was necessary to allow for the semi-structured in-depth nature of the interviews. (Appendix A) Questions and their sequence were inspired by existing studies and the overall research aim which strives to investigate how software engineers use and perceive email in everyday work. Initial questions relate to the individual, their job role and every day activities as software engineers. Subsequent questions relate to the use of email and perceptions of email at the work place. The interview was guided by the question 'What do you think about email at work?' which was adopted from Dawley and Anthony (2003). In order to examine pros and cons of email at work two further questions were adopted from the same study:

(How) Does email help you in your job?
(How) Does email hinder our job performance?   (Dawley and Anthony, 2003)

The mono-method choice is not solely based on time limitation or access restrictions. The qualitative nature of the semi-structured in-depth interviews allowed the researchers to get a deeper insight into the software engineering profession and the use of email within. Opinions and perceptions about the use of email at work were best accumulated by semi-structured interviews. Wasiak (2010, p.45) points out that "interviews are well suited to gather users' opinions […], interviews can potentially be more open ended, capturing more detail (than surveys)." This is accompanied by further methodological advantages. A certain level of trust could be built between the researchers and the interviewees by introducing each other as well as the study to the individuals beforehand. Furthermore, face-to-face interviews, in contrast to methods such as surveys or electronically written interviews, leave space for direct further inquiry. This is a vital part of semi-structured interviews where both, the interviewer and the participant have control over the conversation to a certain degree.

On the one hand, the interview technique should enable the respondents to represent their own viewpoint and allow them to stress what is important for them. At the same time interviews should lead to the desired research aim. (Bryman and Bell, 2007) Even though an interview guide was designed, the semi-structured approach left space for a flexible conversation.

The above methodology was believed to best represent the research in hand, thus leading to most valuable research outcomes within the scope of the study. It follows a straight forward approach that is logical and comprehensible for the reader. The following paragraph will give a brief overview of the analytical cycle that will then lead into the results section.

3.3. Data Analysis Approach

The analytical cycle began with data preparation. Verbatim transcripts of the interviews were produced and to support anonymity of engineers the order of interviews was randomised. Focus was placed on informational content, not the mechanics of speech. (Hennink et al., 2012) Early on in the interview phase, several re-occurring themes were discovered throughout the interviews. A saturation point was determined through regular interview follow-ups and continuous discussion between the two researchers. After transcribing, interviews were coded independently in order to develop a set of preliminary codes. 'Inter-coder agreement' guaranteed a high degree of "consistency between researchers in coding data". (Hennink et al., 2012, p. 229) Discussions and analyses generated ideas, categories and groupings of themes which ultimately determined the set of codes used in the result and discussion chapters. Coding and codes will be discussed in the next chapter.

In line with the research philosophy, data interpretation and analysis succumb to the researchers' subjectivity. In other words, they are influenced by the researchers' experiences and views of their social environment. The following biases and limitations were considered throughout the research.

3.4. Bias, Limitations and Ethical, Considerations

Throughout the entire study, the researchers must respect the anonymity of all participants and the organisations they may represent. Written and verbal agreements eliminate any kind of breach in this respect.

General logistic limitations may include the time frame to accomplish the study, especially with regards to primary research. Participants were busy during work hours and researchers were dependent on individual work schedules.

This lead to a 12 to 4 split in how the researchers conducted the interviews, which could generate a potential lack in consistency of data collection. Even though the interviewers approach the study with a similar mind set and a common research aim, interviews were nonetheless exposed to subjectivity. The same potential bias or limitation relates to data analysis and discussion. As outlined previously, they are justified to a certain degree by the interpretivist philosophy that underpins this study.

One limitation that became evident during the group interview was the presence of a verbally stronger participant. P14 showed a tendency to mirror the responses of the more dominant participant, P13, not adding much new information at certain points. The responsible interviewer tried to narrow down this potential limitation by actively engaging the participant in question.

With regards to the Skype interviews, the main but not severe constraint was the physical distance between researchers and interviewees. Nonetheless, the Skype application proved a rich alternative to on-site face-to-face interviews.

Worth mentioning, but not of severe relevance is the observation of one researcher, that in comparison, the interviews conducted at home enjoyed a more relaxed atmosphere. Participants did not feel any time pressure like the ones in the office who often felt the constraint of going back to work.

Summary of the methodology

The qualitative mono-method approach of semi-structured in-depth interviews is believed to be the most suitable way to approach the overall research aim. It is based upon previous research and on the interests of the study in hand which demand insights into individual perceptions and viewpoints towards email within the software engineering environment.
The abductive research approach will hopefully lead to novel findings that can still be related back to existing literature. Before reaching the discussion section of the study, the subsequent chapter is dedicated to the results and findings of the primary research.

4. Results and Findings

While the previous section outlines methodology and data analysis measures, the following section is dedicated to results of primary research data. The chapter will discuss the generation of themes and codes in more detail before presenting them in line with concrete examples and statements from participant responses.

Identified themes are indicated by **BOLD CAPITAL TYPOGRAPHY** and refer to more general categorisations of patterns. They may have **sub-themes**, marked in **bold**. Themes can then be broken down into a number of <u>codes</u>, denoted by being <u>underlined</u> in headings and *italicised* in text. Developing codes, as explained in the foregoing chapter, was an ongoing process throughout both the ethnographic as well as analytic cycle. Codes shape the reoccurring ideas, opinions and addressed topics by the partaking software engineers. They are evident patterns within interview data. (Hennink et al., 2012)

The coding follows a logical sequence underpinned by the sequence in the interview guide (Appendix A), examples of existing literature, and the identified patterns concerning participant actions and behaviours related to email. Codes are of abductive nature, and therefore solely based upon participants as social actors and their perceptions of the email phenomenon within their daily work environment. (Ong, 2012)

The above is feasible within the realm of the interpretivist nature of the research where the interview guide and participant responses are necessarily based on the respective party's subjective view of the world.

The following section will begin with a more general paragraph on the concept of email, how software engineers think and talk about email, followed by more general information that derived from the interviews. Subsequently, themes and codes are identified according to participant response patterns and the outlined methodology. Due to the indicated complexity of email, identified themes and codes may overlap at times.

The Concept of Email

Initial questions related to job roles and daily activities at work were necessary to break the ice and get the engineers' attention for the interviews. The explicit question 'What is email to you?' aimed at shifting participants' mind set towards email and leading them to defining email in their own way. It is noteworthy that some of the answers related to this question overlap with some of the codes that will be discussed later on in this section.

"Email is email!", says P6. This statement indicates that for P6 it is obvious what email means. However, partaking software engineers have a quite diverse way of thinking and talking about email. An interesting discovery is that some thought of email as an actual communication tool, whereas others define email in terms of technical functionalities and

enablement. Five of the 16 participants place emphasis on communication. Notable remarks define email as…

"…a way of communicating with people inside and outside the company" (P2)
"…well thought through communication where you have time to think first" (P4)
"…an instrument in a big company to communicate...directly…like phone but less personal" (P8)

For P2, email plays an important role in the communication within and beyond organisational boundaries. This closely relates to his daily duties of communicating with customers and clients via email. P4 obviously emphasises the time aspect of email with regards to email composition. P4values the optional time management email can offer her as individual user. In terms of email quantity, both incoming and outgoing mail, P4 turned out to be one of the heavier email users in the sample.

P8 draws a connection between email and phone as similar ways to communicate. Two interesting aspects of his statement are the less personal nature of email and that communication via email is as direct as phone calls. These attributes will tie in with specific codes elsewhere in this chapter.

Three participants, P5, P6 and P7, all referred to email as an (electronic) letter. When differentiating email from instant messaging, P5 concurs with P13 on the asynchronous nature of email. "Email is just really this kind of asynchronous information" (P13) In this context, P13 and P6 distinguish email from face to face communication and conversations, respectively. This phenomenon was particularly interesting since it indicates that respondents define email in comparison to alternative communication channels.

Recipient-centred responses from P2 and P3 were concerned with email use to unfamiliar and multiple receivers. P12 insists that email is "Lots of information that needs to be composed in a way that the reader can digest it…"

As mentioned before, functionalities play a major role for some interviewees when defining email. Across the sample, email is a tool for organising, logging, storing, documenting and retrieving information. Moreover, it seems to serve as a reminder of outstanding tasks as well as a tracking system for specific tasks.

P16's definition encompasses aspects of all the above:
"It's a system which allows me to send written communication to one or more people almost instantaneously, and to very importantly keep a record of all communication that can then be referred to in the future […] important things go through email."

This question as to what email means for the individual was necessary to break the ice, to get respondents talking freely about email and to gather spontaneous impressions and perceptions of the concept of email.

General Information

Before moving on to coding and analysis, there is some contextual information worth mentioning that can provide a superficial overview of the participants' daily email activities. For example, while seven of the respondents receive less than 10 emails per day, six receive up to 50 emails per day and only three of the engineers deal with up to 100 incoming emails per day. These include spam, newsletters and error reports.

These fluctuations in email numbers are due to different job roles and responsibilities within the realm of software engineering. Moreover, quantitative trends of incoming and outgoing emails seem to stand in connection to organisational structure. Statements from some engineers betray that the use of email changes within the hierarchical structure of the company. The more email traffic an engineer experiences, the higher his/her position. P7 for example explicitly states that "I'm sort of a low position in the hierarchy; I don't get that many emails."

A further trend was perceived after asking participants what email client they work with. Most of the sampled software engineers who work within a large company explained that they use Outlook for work-related email. It would be interesting to follow up the reasoning behind this phenomenon, which is not the focus of this study.

In terms of 'how' and 'why' participating software engineers use email at work, several themes and codes appear throughout the research sample. These will now be presented, explained and supported by engineer quotes where appropriate.

4.1 Themes and Codes

Connectivity (Online Presence)
The concept of *online presence* simply refers to the availability of internet during work. Since email requires users to access the internet, *online presence* is obviously prerequisite for email use. However, it refers more to connectivity and whether the participants have the ability to check emails at any time during work.

All participants are connected to the internet and hence have access to their email accounts at all time during work hours. The research found that most participants have their work-related email account running constantly during work, even if the email client is running passively in the background. This implies that they all have the ability to quickly access their email client or account at any time during work. For example, P1 describes his computer working environment. "I tend to always have email … I have three screens on my desktop so I always have one screen for the email client and I always sort of have an eye on the email client." This particular engineer takes this further in insisting on his 24/7 online presence, meaning inside as well as outside of working hours.

Connectivity (Multi-device access)

An emergent code is the *multi-device access* to email. All interviewees explained that they access email at least via computer in their working booth. Additionally, at least half of the respondents explained that they connect their work-email to their phone, tablets or other (mobile) devices. Busy as the targeted software engineers are, it was not uncommon for some of the participants to check their mobile phone for incoming work-emails even during the interviews. Interviews were mainly conducted during working hours and obviously it was vital for respondents to be able to look at incoming email directly. P11 demonstrates that he addresses emails via mobile phone during meetings, in lunch breaks, and during other tasks.

ACCESSING EMAIL AND DECISION MAKING WITHIN THE USE OF EMAIL

Email is complex. Respondents must decide when to actively use email and judge upon the most appropriate action to take. Whenever a new email arrives in the inbox, the software engineers must decide what to do with it. Engineers make judgements in whether they need to read, to respond, or to take other action upon emails, as well as decisions such as archiving and deleting.

Planned time for email activity

Planned time for email activity as a code developed from respondents explaining a normal day at work. It deals with how email is incorporated time-wise in everyday work procedures.

Despite most respondents not setting aside specific times for dealing with email, a few had patterns of checking emails at specific times. P2 and P12 consent with P4 who states that "Well, my day actually starts with email." Checking email upon arriving at work seemed to be a pattern, as even those that check continuously during day would also naturally check in the morning to see if emails had arrived overnight.

P8 had a different approach to managing email activity. "I look [at email] when I wait for other stuff...whenever I have spare time…I usually look at my emails. Basically using time that I would waste otherwise!" This notion was not shared by others.

Initial reaction (assessing)

Most of the engineers would notice email via pop-ups, alerts and notifications as soon as it arrives in their inbox. The majority of respondents would then immediately assess the email to decide what further action to take. *Initial reaction (assessing)* is the respective code for this trend. P10 describes the process that is common for the majority; "I usually read email when I receive them, but I don't act on them immediately". He glimpses quickly at emails as soon as they arrive, but often disregards them if working on another task.

Others do not read the email straight away, but still immediately go through the process of assessing what step to take next. P3 displays this behaviour when he "quickly browse[s] all the mails to determine 'is this relevant?'" P1 describes this procedure in more detail. "If I get an email that requires immediate response, then I sort of do that then…If it's something I can

handle later, then I usually postpone it to the end of the day or the next morning."

The trend is clear; the participants immediately address email upon receiving them, even if it is just to disregard it or delay dealing with it until later.

Prioritising email
The previous code encompasses choices of when respondents deal with email. *Prioritising email* as a code is a way of analysing how they decide upon different actions, in particular, whether they read an email or not.

The subject heading, sometimes called topic, as well as the sender are critical in determining how to act upon an email. P3 states "I always read the topic, just to figure out if I can discard it immediately or not. Well, the topic and the sender." Likewise, the ambiguous topics can make it harder for people to assess and prioritise emails. "If it's a really long and fuzzy subject you can't really tell if it's important or not, if it's relevant or not to my work" (P4)

To whom the email is addressed also influences prioritisation. Respondents place more importance on emails which had their name in the "To" field, as opposed to in the "Cc" field. P10 asserts that "Cc" is only for information and does not require further action. For P15 it is a good idea to read "Cc'ed" emails, but no further action is needed: "Cc is good if you read it, but you don't need to respond…If it's actually addressed to me, with my name, I would pay even more attention to it."

Interviewees also use the tactic of quickly skimming to figure out the general message of the email and then decide what to do with it. "I always read every one [email] … You read it fast and see if there is any new points or something that you are interested in, otherwise you just delete it." (P9)

Decision to write email
Closely linked to *prioritising email*, engineers must make a *decision to write an email*. This code relates to both initiating and responding to email. A transparent pattern throughout engineer responses is that many of them would respond to direct requests for information or help.

Among the research sample, the sender or initiator of an email has much impact upon the initial reaction or the prioritising process. Several engineers allude to responding differently, e.g. quicker, to a manager or superior than to close colleagues. P16 stresses the hierarchical structure of the company he works in by explaining that for him "It really depends more on who it's from than how it's written."

Whether, and when to respond to an email obviously depends upon a number of factors pointed out above. Sender, receiver, topic and structure of email are the most common prioritising factors and decisional aspects for the respondents. The previous codes describe initial ways in which the participants assess the importance of an email, and hence this has an

impact as to whether they respond or not.

Decision to receive email

A rather unexpected code is the *decision to receive email*. It refers to a range of ways that the participants choose to get emails from another party. The most common response in the context of email as a hindrance to job performance is that software engineers tend to receive quite a number of company newsletters for company updates and developments. P8 explains that "we have lots of newsletters about this and that […] which you also have to read to know what's going on in the company, that is taking you away in the context that you have…" Despite the negative connotation in this case, by becoming an employee of a certain company, participants choose to be updated on the respective organisation, hence this kind of email is among the emails chosen to be received.

A second way which is often mentioned throughout the research sample is newsletters, invitations and updates from different services and websites which respondents may have signed up for. P11 eagerly explains that "Of course I'm getting a lot of emails but then it's my problem if I'm in all those distributions lists. And then I need to take action on doing something about it." Signing up for mailing lists is clearly a *decision to receive an email*.

The third way to decide upon receiving an email is displayed through explicit email requests. P1 explains that "it is not uncommon that you might talk to somebody and they say 'Oh, can you fix this?' and your answer is 'Yes, send me an email'…" Self-inflicted email is then to be dealt with appropriately.

PERSONAL INFORMATION MANAGEMENT (PIM)

Personal Information Management (PIM) alludes to the organisation of information across one's email account. This can be any kind of information and is not limited to incoming email. It may also refer to how software engineers use the different functionalities of email. "You have to organise your emails in sub folders and things like that, in order to make it easier. But still, it's really difficult. That responsibility is put on you, as a user." (P4) P11 agrees and insists that "The problem is not that people are sending me email. They want to do that. And then I need to find a way how to deal with it." Respondents' different ways of organising emails lead to sub-themes and codes as follows.

Mailbox management

Mailbox management refers to individual approaches of interviewees to sort through their email load and make sense of information. Mailbox management is treated as a sub-theme of PIM and comes with several codes within.

Filtering incoming email

Filtering incoming email refers to certain technical features that allow participants to filter email via certain criteria such as key words or sender name. Even though only a small number

of respondents use filters for incoming email, filtering seems an important part of their daily mailbox management.

P2 stresses his personal value attributed to filtering activities: "I have started using different filters also now. So before there were a lot of [mails], everything was coming in the same folder. But now I have at least a couple of filters. So I can sort them out directly by putting them into different folders. It's pretty useful because some systems send me emails whenever something happens and then you get all those emails in the same folders with your important emails. It can be a bit confusing."

Archiving and/or filing
Archiving and/or filing corresponds to the activity of separating emails from the inbox and sorting them into folders created in the email account. This process can also be automatically enabled by filtering as emphasised by P2 above.

Even though not all engineers place emphasis on the actual activity of *archiving and/or filing* information, they do stress the reasoning behind it.

Documentation of decisions is particularly relevant for P9 who explains that "I use email to document some decision we make on our side and also what they respond on that email … and store it to have it as a backup." Similarly, P16 states that "I want to have a record in place where it's easy to retrieve."

"The good thing about email is that you have it written … For many people if you don't have it in email, then you don't have it. So I don't get the blame if something isn't done. I have written that someone else was going to do it" (P10). P2 agrees and states that archived email is helpful as proof in the case of false accusations related to tasks.
Going hand in hand with these reasons for archiving and/or filing, P12 associates filed email with task management since "email helps me to track several things at the same time."

Other methods of documentation
From responses throughout the interviews, it becomes evident that not all participating engineers sort their email into separate folders. Technical email functionality allows engineers to flag emails or change status of emails as relevant in order to give respective emails personalised significance.

 "I use email like a task force. Mails…in the inbox I read it and I sort it directly because I know I shouldn't do anything about that. But if I should do anything I don't unlock [or] unread them." (P9) Similarly, P1 agrees with P9 by explaining that "I usually keep everything in my inbox and search through my inbox if I need to find it again." His individual way of remembering tasks is to either flag email or leave them in the unread status, highlighting that he needs to take action within the context of those emails. Both quotes reveal thinking about how to organise emails as well as email as task management.

As a more general comment on the individual organisation of email, P1 adds that "I tend to think that it's sort of a natural way to do it but it's just a habit."

Searching and/or retrieving email
This code is a logical follow-up of the previous codes. Here respondents talk about different methods of how to search for existing information and retrieve it for further reference. Software engineers express different ways of retrieving information, however, all stress the importance of being able to locate and retrieve relevant information. Whether or not participants arrange information through filing and/or archiving into folders, they still rely on search methods to find information.

Some respondents use the subject line as a way of searching for information. Subjects can be very specific and therefore vital to retrieving information or specific emails. For P13, the subject is usually not important, however, when searching for emails and information, "suddenly the subject is super important." P11 agrees by emphasising that the subject allows him "to search for other relevant email[s] in that topic", hence facilitating grouping of email. Software engineer P12 declares: "It's easier to track in the case of trouble reports, for instance, every report has a serial number…then it's easier to find it in the inbox."

Flagging helps in retrieval, particularly in recent emails that appear on the first page of the inbox. Picking up on the previous quote of P1, he continues: "I usually just keep everything in my inbox and search through my inbox if I need to find it again. And things that I need to remember to follow up on, I either flag them as something that I need to follow up on or I flag them as unread so I know that I have something to do."

Since most interviewees rely upon Microsoft Outlook as their email client, P15 specifies that it is good to have a "hard copy of something that you can always go back to. The way Outlook works is quite easy to search through and look at the archive you have of email if you're looking for something old." The quote potentially indicates a justification for companies to work with this particular email client.

Summing up the previous three codes P16 clearly defines his position: "I want to have a record in a place where it's easy to retrieve!"

Deleting redundant email
This code refers to engineers' practice of erasing any emails that are not or no longer required. Even though deleting email is not a major subject matter throughout the interviews, several participants mention that they only delete irrelevant emails that they do not read in the first place. This phenomenon can be explained by means of previous coding and the different needs to retrieve information or email related to completed tasks or projects.

Contact Management
Contact management as a code in itself refers to the organisation of names and email addresses in and around email. Software engineers within this study placed great importance

on contact management and it can be coded as a vital aspect within personal information management.

Almost half of the engineers indicate that email is organised internally in a way that everybody has a contact or mailing list of at least immediate colleagues or team members. It is hence an important resource for daily communication flows within the respective organisation, especially with regards to multiple recipient emails.

A rather unique but interesting thought concerning email as the main contact information is what P15 has to say about the matter. The engineer specifies, that she would sign an email rather with her name and email address than including her phone number. " I guess it's also got to do with the preference of getting email rather than phone calls for the interruption thing…they are less likely to call me." Although a slightly different way of thinking, this is certainly part of contact management.

For email communication within as well as across organisation boundaries, P1 highlights that "The email address is sort of the o n e way of communicating with people."

SOCIAL BEHAVIOUR IN THE USE OF EMAIL

Social behaviour in the use of email is a broad theme which reappears in different contexts throughout the primary research. It relates to user conduct when communicating via email. Social behaviour within software engineering and the use of email is particularly interesting considering the stereotypical perception of these professionals as satirically depicted by P6: "I'm a software engineer, I don't like talking to people."

The theme can be broken down into several codes introduced below.

Response expectations
This code essentially defines expectations as to when, why and how software engineers reply to email and what their anticipations are for other persons to reply to their email.
P1 for himself is convinced that

> "You're not forced to respond to email immediately. So you can sort of fire and forget. So if you are the initiator of an email you do not expect a response immediately and if you are the recipient of the email you also know that you don't have to respond immediately."

Indifferent to this perception P12 argues that "If we do have something very important that needs to be fixed, I often expect an answer within the hour. If it's more general than maybe one or two days."

The flexibility in response expectations is something that participating engineers seem to value very much. Nonetheless, the pattern of receiving an email response approximately

within a day seems evidently desirable throughout primary research data. P11 labels this phenomenon as "more of a social convention."

P1, more than any other respondent stands firm in his belief that "[in] the software development world, quick iteration, quick turn-around, is so key many times and you can't afford to have several days response time on certain questions."

In the case where quicker response is sought-after, interviewees would often use face-to-face communication to ask colleagues to address an email, thus increasing the importance of responding sooner rather than later. "The most effective way is to go and actually talk to the person. Can you read that email? Can you answer it?" (P12)

In this context, another common behaviour amongst the research sample was to make others aware of the importance of a response by sending follow-up emails, reminders, or simply send the same email again if there was no response within a day. Again, this is subject to individual email use.

It is noteworthy, that regular meetings and a high degree of group collaboration amongst participants and their respective teams seems to lead respondents to some kind of common consensus as to which email needs addressing immediately and which email can be postponed.

Within this context, mismatch of communication expectations can happen. "Sometimes I feel like I sit here and wait for an answer, but it is maybe because I feel it is a more urgent issue than they interpret it is. So in that case email may not be the best way. But if it is really urgent I tend to use the phone. So email is questions that could be a day, the day after." (P10)

Reciprocal behaviour in email writing
Reciprocal behaviour in email writing relates to mirroring communicative behaviour within the use of email.

P1 and P5 agree that on a (semi-) sub-conscious level they do respond differently to people depending on how the email was written to them. P1 elaborates "If somebody comes into contact with me in a very relaxed way I might feel inclined to continue the relaxed tone. And if somebody writes an email to me in a very very formal way I will most likely keep that up." P5 is more inclined to sound neutral in his emails.

P13 hold a firm stand that "If I get something that is not well formatted, I don't think they value my time, and I don't feel as obligates to actually give them a proper answer or an answer directly." In a more colloquial and straight forward sense, P3 admits that, concerning the greeting and sign-off of an email, "if it's a bit rude I'll tend to be rude myself."

Furthermore, similar to the title being important for the respondents to prioritise and organise incoming mail, participants are also aware that other people may place the same importance on their own titles that they write. P3 insists: "The title is quite important when it comes to having other people determine whether to go on reading your mail or discard it."

In contrast to the above, an interesting stance by P10 reveals that "It's the information IN the email that I should respond to. I keep the same way of writing email regardless…" A handful of engineers implicitly agree by arguing that they would stick to the same way of responding, regardless of how email is written to them. This trend seems to build up amongst those interviewees who experience lower email traffic at work.

Mirroring behaviour, that is *reciprocal behaviour in email writing*, whether consciously or sub-consciously done, is a really important issue that concerns most software engineers in this study. They might refer to different parts of an email or to an email as a whole, nonetheless, this pattern is an essential code for the findings in hand.

Appropriate email etiquette
Appropriate email etiquette refers to formality issues and careful writing within email communication. Naturally, email etiquette varies from respondent to respondent and it is interesting to analyse in what sense it differs.

> "There is a lot of ambiguity in emails, so you can pick up tones and undertones that are really not there [...] If I write an email, that takes some time because I'm quite picky. I really have to put thought into it if it's someone who doesn't know me, to get the emphasis right, and the period, and the correct place…"(P5)

P5 obviously takes the time to draft emails in order to find the right tone and level of formality. As pointed out before, this particular software engineer is inclined to keep a neutral tone when responding to email. P4 mirrors this notion to some extent by explaining that "When I disagree with someone and I want to get my point across in a good way I try to be very careful about not being, sounding, angry…but rather, sound productive in an email." With regards to email etiquette, the process of drafting also plays an important role amongst other software engineers.

Others still have their own way of writing, unaffected by others. As indicated in previous sections, these participants tend not to receive or write as many emails in their day to day work, and the ones they did were often related to a specific project or task.

In terms of formality, P6 feels discomfort when he receives an email from higher up the organisational hierarchy that addresses him in a too formal way. He would find a way to de-formalise this in future correspondence.

Despite various notions of appropriate email etiquette, P13 is quite convinced: "I think email has got to a point where there are a lot less formal emails and the custom in email is a little lost where people are expected not to be offended!"

Presentation of information in an email
Closely related to email etiquette is the *presentation of information in an email*. It focuses on

content structure with particular attention to typography and style. These issues are important considerations for at least half of the engineer sample throughout the responses.

P4 explains the efficiency of in-line response, while P12 prefers bullet points. P14, P15 and P16 all stress the necessity for sections and paragraphs of email contents. P14 insists that email requires space, "especially a longer email, it's important to make sure it's readable." P16 observes that the important information to communicate should be within the first few paragraphs due to receivers skipping information in too long emails.

P15 takes this notion of paragraphing a little further and explains:

> "I try to make it structured so if there are different topics touched by the email either bullet lists, having headings and bold letters, sections, headings, not just one big block of text cause I want it to be scannable – this also has to do with what I do for work: being a designer and making stuff easy to use I apply that also to emails so that they are easily consumable."

Going hand in hand with this statement, P11 accentuates different typographic options to support the information that is being communicated.

The importance of typography and content structure within the *presentation of information in an email* for participating software engineers leads right into the following code.

Need for understanding, clarity and certainty

Need for understanding, clarity and certainty is a code that refers to improving message accuracy by minimising or even eliminating the potential for misunderstanding and uncertainty, hence, miscommunication.

P2 opens the discussion by explaining that "There is a tendency of misunderstanding when using emails." P4 elaborates that "of course [email] leads to misunderstandings; that's why it takes time to compose [email] to begin with." General misunderstandings or the perceptions of unclear information are a concern throughout most of the interviews.

One reasoning for this potential barrier to effective email communication is the existence of cultural cues. P4 very clearly differentiates:

> "We work in different cultures, really, I mean even between Sweden and the States it's different. And we don't really need to have miscommunications or misunderstandings. (…) Like for instance communicating with China in an email, it's really important to not leave any open-ended questions for instance (…)"

P15 picks up on miscommunication via email associated with the complexity of organisational structure. It goes hand in hand with P4's statement since P15 is also referring to intra-organisational communication to international branches.

The following codes are not dependent on a specific theme within email. They are codes related to email itself and can therefore be dealt with individually.

Email as an agent for change

Email as an agent for change refers to email as a tool for transmitting information that may then have an impact in any kind of sense. This could be communication of actual change that already happened and is being transmitted via email, or change that derives from action upon email, hence is being initiated by email. This code corresponds with question 11 in the Interview Guide that relates to impact of email. (Appendix A)

P5 explains that an impact of an email "is pretty much the only one purpose that I have identified."
A common sentiment amongst at least half of the engineers is that email always has some impact upon somebody or something, "otherwise I wouldn't be writing [email]." (P8)

The impact of email on change appears to different extents. For example P8 simply facilitates change by sending a task-related response that might help the receiver to accomplish the task. P2 and P4 both generally hope that their email triggers action. "People usually read what I send them and act on it, hopefully." (P2) P4 emphasises her target for change: "I'd rather hand-pick those specific people that I know will be interested and listen to what I have to say and then act on it."

P13 and P14 in the group interview agree that email impacts upon the receiver but that it is rather difficult to communicate greater change via email. They agree that change is better communicated via face-to-face conversations.

Email as local convention

Email as local convention explains why the individual participating engineers use email within their work environment. The pattern emerged throughout several interviews and responses.

Email as a standard place of communicating as part of their daily work is clearly addressed by P1 who states that "email is sort of the de facto standard how to communicate with people." P3 agrees by referring to email as "the default way of communicating" but explains that at work he only uses email because everybody else is using email. This is an interesting pattern that seems to be popular among responding engineers who use emails to a lesser extent.

Another two intertwining reasons for participants to use email at work is the organisational setting and that there might not be any alternatives due to the former. This will be further explored in the following codes.

The compression of time and space

The compression of time and space obviously refers to the opportunity of email bridging geographical distances and time zones that software engineers operate in. In particular it

comes up in the context of collaborative work and team communication.

In terms of times zones P5 addresses the convenient nature of email as a communication tool at work. "There's a time difference which makes email the most convenient form of communication."

P8 explains that "we have different time zones, we have to use [email], there is no other way to reach people in the company…" He continues talking about offices in Shanghai and San Francisco which would mean "crazy times for at least two [branches]" when considering alternatives such as online meetings or conference calls.

P15 agrees with P5 and P8, again, due geographical distance and times zones associated with organisational structure. Team communication across organisational branches seems key for engineers who mentioned and elaborated on *the compression of time and space*.

(A)Synchrony within email communication
(A)Synchrony of email communication has a dual meaning in context. On the one hand it refers to synchronously sending an email which the respondent can receive instantaneously without any further action. On the other hand it refers to immediate back and forth communication via email more in the sense of a conversation. Asynchrony refers to the use of email as communication where sender and receiver of email communication are timely independent from each other.

Respondents acknowledge email potential for asynchronous communication as well as synchronous communication. However, it solely depends on the function of an email or the situation engineers use email in. P1 and P8 refer to quick email responses if it is a small issue or simple questions. P1 assesses that "Email has sort of merged into a single medium of doing both, the long latency questions and the quick upholding also."
Nonetheless, participants show a trend of using email as a more asynchronous tool. P5 continues his notion on different time zones stating that with email "people can answer in their own time." P13 and P14, as introduced in the email concept, think of email as mainly asynchronous communication.

In the context of synchrony and asynchrony related to email, many interviewees refer to a range of instant messaging software that is broadly associated with synchronous communication. They are evaluated as more informal, quicker and shorter than email. P15 thinks of different instant messaging or chat programs as "really good, more like sitting in the same room, you can just send a message and get a reply rather quickly" in contrast to email. Similarly, P6 explains that while email is more time consuming, applications such as Microsoft Lync and Skype are more convenient for instant conversations.

Blurring of technological boundaries
This code refers to the phenomenon of alternative communication technologies. Users do no longer have limited communication technologies to choose from for a specific purpose but a

whole range of different applications that are intertwined and connected.

An interesting feature of Microsoft Lync, an instant messaging application, is revealed by P7: "The conversations are saved in Outlook as well. They are linked. You use the same usernames and everything. It's all one system." He explains that if he is currently offline on Lync, messages within Lync are being sent to his email address. This is due to the fact that the company he works for uses Microsoft applications for both, email and instant messaging. The same accounts for P9 who additionally uses Microsoft SharePoint to communicate with his suppliers. Everything is linked to his email account with notifications ensuring he does not miss any important information.

P15, the only respondent who happens to use Gmail, talks about similar benefits due to the linkage of Gmail and the respective chat program. Due to this *blurring of technological boundaries* P15 also has to manage private and professional emails, and instant messaging, all within the one program.

The *blurring of technological boundaries* shows that the nature and connection of email is changing. Connections to other forms and channels of communication change synchrony and asynchrony in the context of email.

Email as a distraction at work

As the code implies, *email as a distraction at work* relates to the different ways in which email can divert attention from daily work processes. Despite a generally positive notion of email as an indispensable tool for work throughout primary research data, email does not always help.

Quantitative email overload was mentioned by P15 who fears that "things do get lost" in the email account. Closely related to the codes *decision to receive email* and *blurring of technological boundaries*, participants complain of constant company updates and newsletters, amongst others via email. In accordance with P2 and P8, P15 also continues to describe the distracting nature of email pop-ups and notifications that disrupt her line of thought. P8 say that due to these email notifications "you start thinking about other things, not about the problem you are working on."

P11 holds his firm standpoint that it is the individual who has to cope with a lot of incoming email. P16 points out that "If I wanted to be lazy I could quite easily spend my working day sending and receiving emails." Likewise, P1 stresses a certain degree of discipline needed when dealing with email: "will get your immediate attention [and] distract your attention from what you are actually doing at that moment."

Email training

Email training is a code that comes from the direct question whether participants require training specifically for the use of email as a communication tool at work.

Responses showed a split in sentiments about training. The majority of the software engineers

said that they certainly do not require training. The notion of 'I don't but others do' reappears throughout the sample. P10 insists that "It is assumed that everyone knows how to write email, [and] use email today"

P5, P9 and P6 think along the lines of 'learning by doing'. "It just comes with using email. You get more comfortable with it." (P5) P9 agrees and believes that "you improve yourself every day!"

P6 further relies upon support from colleagues who can teach him professional manner within the use of email.

P8, P12, P13 and P14 do state that they potentially require email training in the context of stakeholder communication. Structure, typology and formality are amongst the main concerns.

P16 expresses his curiosity and his willingness to learn more: "Training is always important. You can always get better. The way I use email is something which I develop myself over the time I have been using [email] but maybe there is a better way which I don't know about."

4.2 Summary of the Results and Findings

The above section reflects upon results in a logical and comprehensible manner. The perceived conceptualisation of email sets the tone for themes and codes developed from participants' responses. Codes range from the very basic concept of *online presence*, to a broad *PIM* and *social behaviour*, before looking at individual codes such as *email as an agent for change, the compression of time and space,* and *email as a distraction at work*. Each theme and code is appropriately reinforced by interviewee statements.

The subsequent section discusses the above results and findings in alignment with the reviewed literature. Theoretical concepts and frameworks will be supported and challenged accordingly.

5. Discussion

This section relates the subjective perceptions of participants to the reviewed literature. As this study explores different features and aspects of email from the context of one profession, the discussion is broken down into several sections, following the logical sequence of the previous results section.

The results section begins with some general, contextual information. Due to the fact that this study is qualitative in nature, and that the sample size is relatively small compared to other studies, this information cannot be compared with other literature. However, a general pattern was observed. The variation in the amount of emails received and written per day seems to be connected with the responsibilities and hierarchical position of the participant; Participants higher up in the hierarchy tend to work with emails more. Although the focus of this thesis is not on hierarchy or organisational structure, it is worthwhile noting that the same tendency has been observed previously. (Markus, 1994; Ducheneaut, 2002)

What is email?

In the same way that research has focused on emails from different academic perspectives, participating software engineers think about email in many different ways. Not only do their perspectives match various parts of the literature on email, they also provide an insight into what each engineer thinks is the predominant use of email; the way in which they define email might suggest what they view email's functionality to be. To clarify, those defining email primarily as a communication tool, probably use email mostly for the purpose of communicating. On the other hand, engineers who stress the ability to store and retrieve information most likely spend more time organising emails for personal information management (PIM).

Respondents' perspectives of email align with two of the three metaphors of Ducheneaut and Watts (2005); these are 'email as communication genre' and 'email as filing cabinet'. Some of the participants think of email as a communication genre or tool, a means to collaborate and communicate with people both within and outside of their context (working group, company, country, time zone). Email is important for direct communication, and is described by one participant (P8) as similar to a phone, but more impersonal. Participants that think of email as communication tool, naturally think of and describe email in reference to other communication technologies. Answers also centre on the features of the technology, sometimes implicit to the technology, sometimes compared to other technologies. The interviewed software engineers refer to features such as being asynchronous, the ability to reach multiple parties across different boundaries, and the ability to take time and present more accurate information. Some compare email to letters, thus attributing features of letters (asynchronous, written) to emails, while others compare emails to telephones, suggesting a quicker, and more conversation like method of communicating.

Other perspectives reveal how engineers think of emails as a personal information

management (PIM) tool. Rather than describing emails in terms of communication features, or in comparison to other communication technologies, they stress the importance of storing information (like in the filing cabinet metaphor) and managing the work tasks of oneself and others. Given that knowledge management is integral to an engineer's work (Wasiak et al., 2010), it is unsurprising that they view and define email in a way that fits in with this metaphor.

Online presence

The concepts of online presence and connectivity are crucial towards understanding how engineers use email. Despite the fact that emails have not changed considerably in the last twenty years (Whittaker et al., 2005), technology has moved forward at a fast pace. The participants constantly have access to the internet, and many stress the fact that they can access email whenever they want, regardless of their pattern in dealing with incoming mails. Put simply, whether receiving a new email, or wanting to retrieve older information, they are always connected.

This connectivity occurs in different ways. Most of the engineers interviewed are constantly connected to their email client, either by having it on a separate desktop, or having the email client running in the background. Those that do not have email constantly connected, do so by choice, not by lack of access. Additionally, engineers use and are constantly connected to a range of other technology and software. They are able to link other software to email, through notifications and account linking. While this relates to a later code, the *blurring of technological boundaries*, it also describes how connectivity is not exclusive to emails, but is relevant to software engineers' working environment as a whole. They were even able to stay connected to emails during interviews through their mobile devices (phones, tablets). This phenomenon is not new, however. Markus (1994) documents managers interrupting conversations to deal with new emails. This is attributed to the social influence of the managers, and the acceptance of this social behaviour in the organisation. Expanding on this today, it seems that being connected all the time is socially acceptable. Checking ones phone, or quickly answering an email on a laptop, are both examples of behaviour fitting into the norm, or at least the norm in the interviewed sample, in a profession centred on technology and information.

Personal information management

The participating software engineers are mostly aware of how to manage emails on a day to day basis. As mentioned previously, most of them are aware of new emails immediately upon arrival. But how do they deal with them? While most deal with the email in one way or another immediately, there are some time periods in which certain engineers set aside planned time for working with emails. These generally occur in logical time periods, for example, immediately upon coming to work to check for emails received overnight. The other common period is immediately after a logical break, for example after the daily AGILE meetings that a majority of the participants had with their team, at least once a day, most often in the morning.

This behaviour very much matches the literature which supports the observation that most people continuously check emails at the workplace. (Jackson, 2001, Tyler and Tang, 2003, Renaud, 2006, Gauducheau (2011)

Whether or not the participants are continuously aware of new emails, the majority would immediately assess new emails through a number of steps. Their first decision is whether there is a need to answer the email straight away, or if it can be answered later or not at all; this is often related to importance. This behaviour is very close to that predicted by Szostek (2011). The participants describe a process of assessing the need to answer based upon information they can access quickly (Sender, topic, opening paragraph, receivers, when it was sent). They emphasise the importance of the topic (also called subject heading). The majority prioritise people up in the hierarchy or important clients from outside their company or working group. Additionally, they are more likely to reply if the email was addressed specifically to them, rather simply being one of many names in the CC list. Dabbish et al. (2005) support the idea that perceived importance and the sender have a direct impact on whether to respond to emails. Dabbish et al. (2005) also claim, however, that the most responded to emails are social messages. This was not true for the participants of this study, with some engineers unequivocally stating they would respond quicker to people up in the hierarchy than they would to close colleagues. This seems to indicate that emails reinforce the existing organisational hierarchy, in line with what Ducheneaut (2002) predicts, rather than flatten hierarchical structure. (see, for example, O'Kane and Hargie, 2007a, Garton and Wellman, 1993)

Once the participants have assessed an email, and written, or not written a reply, as the case may be, they need to take some kind of action, such as filing into a folder, flagging, deleting, or simply doing nothing. In the sample, there did not seem to be a trend in how software engineers use folder. There are no clear trends in terms of no-filer, spring cleaner and frequent filer, according to the divisions observed by Whittaker and Sidner (1996). Instead, there is less of a pattern, similar to what Fisher et al. observed when they re-visited Whittaker and Sidner's study. (Fisher et al., 2006)   All the engineers, however, seem to take on the responsibility of managing their own information in a way that suits their personal preferences. They are aware that the onus is on them, not the software, and they have developed individual ways of dealing with this. This has important implications for the concept of overload, which will be discussed further on. It is particularly interesting, as much of the literature is centred on system design and developing new ways to handle filing systems (Schmandt and Marti, 2005; Kraut et al., 2005). The participants put that responsibility on themselves and not on outside developers. Not only does this reflect their competency in working with and managing technology, it also suggests that they might be a key profession for future researchers to collaborate with regarding email design and development.

Only some of the participants use filtering. Contrary to what Ducheneaut and Bellotti (2001), and Koprinska et al. (2007) predict, the engineers that used filtering set up their own rules. This is perhaps due to the fact they are often aware of regular emails they receive. They commonly filter emails with information that could be useful at some point, but does not

require immediate attention, for example, weekly newsletters, daily updates and reports, and auto generated notifications. This kind of behaviour matches Whittaker's (2011) strategy of preparatory organising. According to Whittaker (2011), this kind of behaviour is a direct response to reducing emails in their inbox, in order to better manage emails they need to either read or deal with. This explanation seems highly plausible in the context of this research, as most of the people that used filtering tended to receive more emails.

Regardless of how the engineers manage their inbox, the fact that emails can be stored (archived) for later purposes is very important to all of them. This feature of email is well documented by literature (Markus, 1997; Kettinger and Grover, 1997; Ducheneaut and Watts, 2005). As O'Kane and Hargie (2007a) summarised, email is permanent in nature, and this has ramifications. Most of the participants in this study stress the need to have an information source that can be easily accessed, through folders or search systems. Additional to this is the need to document for proof. Some participants point towards the fact that one can have a record of discussions and decisions made in order to manage one's own (and others') responsibilities. This could be seen to be another kind of task management (Tungare and Pérez-Quiñones, 2009), in that it is a collaborative way for a team to access task information, and also a reminder as to task roles within a group.

The other predominant reason why participants use archives relates to individual task management, where a person has several simultaneous tasks to track, and emails can help in the process. This has been documented thoroughly in the literature, even as early as Mackay's (1988) early description of email as a task management tool. The fact that participants tend not to delete emails may at first seem to be an oddity, however this has been documented in most studies focused on inbox behaviour (Venolia et al. 2001, Whittaker 2011). What is interesting, however, is the fact that the software engineers did not seem to find saving most emails to be a problem, thus suggesting a level of efficiency in their filing and retrieval methods.

There are two common methods for participants to retrieve information: searching using the email client's inbuilt functionality and flagging to remind oneself which emails to retrieve later. Most participants worked with the email client Outlook, and find its search capability easy to work with. As most of the engineers use Outlook's search functionality at one point or another, they are all aware of the importance of having a consistent and logical naming system for the topic. This is perhaps one reason why software engineers seem comfortable in using search functionality, contrary to Ducheneaut and Bellotti's (2001) observation that most people do not use inbuilt search functionality. Another reason might be that Outlook's functionality has evolved in the twelve years since Ducheneaut and Bellotti's finding.

The second behaviour identified is flagging, something that research (Ducheneaut and Watts, 2005; Tungare and Pérez-Quiñones, 2009) has identified as being central to task management. This involves leaving a visual reminder in the inbox, either by flagging an email with a different status, or marking it as unread, thus making it evident that further action still needs to be taken.

Contact management has long been an integral part of email, and something to which the literature often refers. Garton and Wellman (1993) summarised what most social research at the time agreed upon: Email allows for greater connectivity, encourages social networks, and links people across boundaries, both physical and social. This still remains pertinent today. (O'Kane and Hargie, 2007a) The participating engineers describe email contacts as a resource for important information, and maintain that efficient structuring of contacts leads to a more efficient way of working. Not only that, but other important information, such as technical information, or for example, documents and ideas, becomes associated with specific email addresses and people. Thus contact management is connected to information management as links are made between information and people within social networks. Related to the previous discussion of using search functionality, finding specific information can also be done through searching contacts associated with that information. This relates to Ducheneaut and Bellotti's (2003) concept of email as habitat. In this sense, contact information is vital and becomes connected to the habitat

Throughout the sample, some consensus on the organisation of email can be found. Patterns arise in terms of how engineers use the respective technical facilities of email and also with individual users and their priorities. Despite the various approaches to managing email, the participating engineers clearly understand that it is their own responsibility to develop a personal system of managing emails and information. As mentioned previously, they are very much aware of the need for organising their work email. Due to these rather individual approaches, the results present personal information management behaviours, rather than a cohesive, overlying behaviour for all software engineers. The impact on individual differences on PIM behaviour was also found in Dabbish et al. (2005).

Social behaviour

It is apparent that within the sample there are different ways of forming and managing social behaviours related to email use. This has been much documented in the literature which first focused on explaining social factors that influenced the choice of emails in organisations (Fulk et al., 1987; Rice et al., 1989, 1990). Other studies looked at the social influence of managers (Markus, 1994) and how social interactions lead to richness and understanding (Lee, 1994). Later studies looked at email as a social, collaborative medium (Ducheneaut and Watts, 2005) used in daily work activities that leads to knowledge creation and has an impact on communication (O'Kane and Hargie, 2007a).

The possibility for almost synchronous conversation (Tyler and Tang, 2003; Renaud, 2006) means that it is important for engineers to manage response expectations. Most engineers point to the flexible nature of email, in that more important emails can be responded to more quickly. The general consensus though, is that the use of email to communicate a message also communicates the expectation that a response is needed within a certain period of time, usually within a day. Engineers are aware that they work in a profession where quick responses to problems are often needed. In this case, they manage expectations by explicitly

communicating these expectations, for example, using face to face communication to verbally communicate the change from the normal response expectation. This is very similar to what Tyler and Tang (2003) found: email users manage contextual and social cues to form response expectations, response behaviour is often mirrored, and response expectations are sometimes communicated through media other than email. Interestingly, another common behaviour for software engineers in this research was to use email itself to manage response expectations. They did this by sending follow up emails to stress the importance of addressing the previous email quickly, or simply by sending the same email again.

Some participants describe situations where there is a mismatch between what the sender expects and what the receiver thinks they expect. However, in these cases the participants point to the fact that they can just use another communication medium, and that email is better suited to messages not needing a really quick response time.

Similar to reciprocal behaviour in matching response expectations, participants also tend to mirror communicative behaviour in their actual writing. This can be seen in their patterns of matching the formality in their own writing to the message they are responding to, as well as placing importance on aspects of the message which they know others deem important (title, well-structured information). Lee (1994) asserts that both sender and receiver are active participants in communication and social interactions have an effect on communication. This is clearly evident in software engineers who match their communication style to others.

As Waldvogel (2007) pointed out, people were more likely to be formal when communicating with people higher in the hierarchy, or outside of their colleagues to people separated by greater social distance. This was quite evident in the research at hand. In addition, there appears to be a general awareness and willingness to talk about issues of written communication in emails. Put simply, engineers spend time on thinking and formulating their emails as they are aware of the complexities in communicating the right message. Engineers often match the formality of a received email in their own response. Likewise, if initiating an email, they would more often be more formal, which would then decrease in further communication as they develop a social relationship with the person they are communicating with. Nevertheless, there is a sense that emails are not as rigid or formal as some other communication mediums. The tendency is to reduce formality over time, and emails are also used for quick, social messages without the need for formal greetings or sign offs. Interestingly, the software engineers did not seem to respond more often or more quickly to informal social messages. The formality or tone of the message did not seem to be related to response patterns. This is contrary to what Dabbish et al. (2005) propose in that social messages are the most quickly responded to messages. Perhaps this can be attributed to the fact that software engineers use a variety of other CMC tools, such as Skype messaging, or other instant messaging tools, for this more social kind of conversation.

Software engineers in this study display a logical and well considered approach to writing emails. Fundamental to their profession is their management of information and knowledge. (Hicks et al., 2008) This is evident in the way in which they present information in emails.

Rather than focusing on writing longer narratives or perhaps more formal paragraphs, they focus on presenting the information in that is clear and concise. Also important is that the information can be easily grasped and is readable; visually, the layout of information needs to make sense. Questions are often answered not in separate text, but attached to the original question so that the reader can instantly remember the question and context. Other respondents use different structural writing techniques, such as the reverse pyramid where the most important information is summarised first, so they can be easily and quickly read, and then more detailed explanations follow should the reader desire more information. While there is much research into how engineers write, (see, for example, Hållsten, 2008), there is little that focuses specifically on software engineers and their writing in emails.

Wasiak (2010) notes that engineers write emails mostly to manage and to inform. Taking this assumption that much of their email communication has the goal of either presenting information in the best manner, or managing tasks with as little misunderstanding as possible, it is then logical that software engineers are very particular about the way they write. Issues such as readability, visual layout and space, and being concise become important. P11 even uses different colours and templates to better present and highlight key information. O'Kane et al. (2007) point to the potential of email to either improve accuracy and understanding, or reduce communication quality as a result of individual communicative and writing skills. Engineers are uniquely aware of this, working in what is essentially a knowledge management profession (Whitehead, 2007), and it is reflected in their writing. Engineers actively emphasise how emails can be misinterpreted and lead to misunderstandings. Factors that exacerbate this are communication across cultural boundaries, and communication across organisational boundaries. One study focused on how culture and cultural values affects email use (Roh and Struck, 1999). Interestingly, the study found that email was unsuited to more ambiguous tasks because it was easy to be misinterpreted. The participating engineers seem to be aware that there is more room for misunderstanding in communication across cultural boundaries. While culture is not pertinent to this study, it is interesting that some software engineers were actively talking and thinking about these issues, thus strengthening the idea that the way in which they communicate and present information is important.

Assessing a communication medium is a difficult task. Early MRT studies pointed towards email as being a lean medium not suited for tasks such as negotiating or discussing and making decisions. (Daft and Lengel, 1986; Rowe and Struck, 1999) Richness, in their sense, is defined by a set of criteria related to how much information the message is capable of carrying in terms of feedback, cues, variety and emotions. This research takes a different approach in asking participants if they could make an impact through emails. To clarify, if people feel that a medium can be a catalyst for change, or have an impact with new ideas or discussion, then perhaps that medium is rich, or at least richer than early MRT studies allowed for. Several of the engineers in this study feel strongly that email is a medium through which they could have an impact in one way or another. They write emails which have direct consequences on how others act, and could prompt discussion and change. It is also a way for them to bring specific people together via email, in order to discuss possible change, before taking further action.

'Richness' is perhaps better viewed through Schmitz and Fulk's (1991) interpretation where richness is variable and depends on social factors such as relationships and experiences. In this sense, email could be considered rich, as the participants are clearly used to discussing, negotiating and even creating change through this medium. El-Shinnawy and Markus (1988) question the weighting of the original four MRT variables, saying perhaps not all are important in equivocal situations. They suggest that perhaps the fact that emails are a written medium adds richness. Certainly in the case of the research at hand, written communication is a familiar and comfortable way for engineers to express ideas, discuss, negotiate and prompt change. As P8 simply states, "otherwise I wouldn't be writing [email]." The small sample indicates that if email were actually as lean as some studies suggest, it would not be as widely used.

The code *email as a local convention* alludes to the idea that email is a standard part of their daily work activity. This concept has been well covered in the literature. One of Venolia et al.'s (2001) conceptual models 'flow', where users keep email constantly open and work in and around emails. Ducheneaut and Bellotti (2001) expand this idea to claim that email was a central place for workplace activity, essentially an electronic 'habitat'. This seems to be very much the case for the present software engineers, one of whom summarises this sentiment in referring to email as the 'de-facto standard'. Park et al. (2012) reflect this idea in calling email an institution, that is, so integral to work life that we use email because we are forced to if we want to communicate, rather than because of specific features of email.

There are, however, some specific features of email reasons that prompt engineers to use email at work, other than the fact that it is the standard. Participants point out email's ability to bridge geographical and time boundaries, especially when working in large, spread out, collaborative groups. In addition, an organisation's hierarchy might make email communication more suitable than other forms. These features of email have long been considered to be aspects that both influence media choice, and change email behaviour. There is perhaps, a strong argument that technical features offer more of an explanation about email use than the criteria of richness does (El-Shinnawy and Markus, 1988). Adams et al. (1993) point towards email as expanding organisational boundaries and O'Kane and Hargie (2007a) list a number of relevant features that are important, the ease and access of emails being among the most important.

Whether emails are synchronous or not has been in debate through much of the literature. While originally being considered as an asynchronous medium (Daft and Lengel, 1987; Adams et al., 1993), it is feasible to allow for the idea that synchronous communication is possible through email. This has been referred to in different ways throughout the literature. Tyler and Tang (2003) called email peri-synchronous to refer to the almost synchronous nature of flowing conversation that is possible in email. Renaud (2006) used the term e-synchronous instead of peri-synchronous to describe the difficulty of assessing how synchronous emails are, especially given the nature of technology and connectivity today.

Perhaps due to the fact that we did not ask participants to classify emails as either synchronous or asynchronous, there was no consensus either way. They do, however, talk about different communication situations, describing both synchronous, chat-like communication, as well as asynchronous communication, more in line with a medium like letters. One trend that can be identified is that the software engineers were open to both interpretations of synchrony, and could see how email is useful for both. Having said that, the majority of participants use email mainly for asynchronous communication. In situations of close proximity, face-to-face communication was preferable, and even in situations where this was not possible, there is a variety of options. Skype, email, and instant messaging software all provide the capability for nearly synchronous, chat-like communication. However, participants tend to use instant messaging on programs like Skype or Microsoft Lync, citing the fact that they can see a person is online, and hence know they are receptive to a conversation or a quick response.

Related to the discussion of synchrony is the apparent blurring of technological boundaries, as seen in email, Skype, instant messaging, and other CMC tools being able to replace one another and complete the same task. Even as early as 1988, researchers were aware that features of different technologies would converge and change the way in which people communicate. (El-Shinnawy and Markus, 1988) Relating this to software engineers, much research has focused on how they use different collaborative software to communicate in a variety of different ways. (McChesney and Gallagher, 2004) It is apparent through discussions that there often seems to be multiple ways of approaching a communication situation. Participants often talk about the ways in instant messaging software, video conferencing software with built in text, and emails would overlap. For instance, they might instant message someone to ask them to look at an email, or vice versa, write someone an email to see if they have time to chat over Skype. Likewise, a similar blurring of boundaries occurs between email and other task management tools. A person would often set up scheduling software, for example, to notify themselves via email about an upcoming event, otherwise they would forget. Another example is where participants would send an email with an error report in it, and specific questions or instructions relating to the error report. This error report would be available through error tracking software, however would often be dealt with through email. One possible explanation for this behaviour might be that the participants are so used to working in their email environment and do not have the same sense of familiarity with the alternative software. Whittaker (2006) describes the problem of information becoming fragmented because of the overlapping functionality of different software. He offers two approaches to the problem: *centralising* information by having email import data from other software, and *extracting* information from emails to a different software. Given this framework, it seems that participants use aspects of centralisation by taking information from outside sources, and managing this within an email client.

Overload

While interviews did not specifically focus on overload, discussions of inbox management, email functionality, email behaviour and the potential problems or distractions of email all

relate to the important concept of overload in the literature. Overload has two different meanings in the literature. Whittaker and Sidner's (1996) original interpretation of email overload, from which the term was coined, referred to the fact that email was being used in unintended ways, for example, PIM and task management, which then causes stress and overload. This is not evident at all in the current research. Participants talk about the different ways of using email as if they were intended and obvious uses of email. They seem to have adapted email as a central working environment, including all the functionality, in the sense that O'Kane and Hargie (2007b) suggested, that email has 'polymorphic roles' and is intertwined in daily work activities. If anything, the 'unintended' functionality is what helps participants deal with emails, as opposed to creating overload.

The other interpretation of overload in the literature is the feeling of being overwhelmed by the volume of messages, to the point where one feels out of control. (Dabbish and Kraut, 2006; Szostek, 2011) While indeed, some engineers do point to the volume of messages being a small problem, there is little sense that they feel out of control or that it is a major issue. This definition of overload, in the sense of overload due to the quantity of emails, was also not evident in discussions with the software engineers. As one participant states "Of course I'm getting a lot of emails, but then it's my problem." (P11) This particular person receives the most emails out of the group, but is well aware of his own responsibility in creating the issue, and has developed tactics to reduce the effects of overload. Others also discuss similar behaviour, and do not express feelings of overload or distress. For example, P11 receives much information from his organisation in the form of regular informative emails. He controls this through managing subscriptions and notifications, through automatic filtering, and through managing other software that generates email. Instead of describing problems or stress, he in fact expresses the opposite. Being constantly informed and having access to this broader information helps him better carry out his job. Mano and Mesch (2009) also note the connection between receiving more emails and improved work performance. However, the associated rise in stress they predicted was not evident in this study.

So the question remains, why do the participants not express strong feelings of being out of control or unable to manage their email? Part of the explanation lies in the previously stated fact that they are aware of the potential problem, and highly aware of the need to manage their own information. Additionally, email being the central habitat for most of the participating engineers at work, implies that they are used to working and dealing with multiple, simultaneous tasks and information management routines. Gauducheau (2011) and Dabbish and Kraut (2006) suggest that continuously checking email (as most of the participants do, while working in their 'habitat') is a way of actually reducing overload. Also, the fact that the engineers did not use extensive and complex filing systems might be further reason for why they did not express feelings of overload (Edenius, 2006; Elsiler, 2012)

There are also social behaviours and norms which help them deal with overload. Many participants refer to the fact that when they are CC'ed into an email, rather than in the TO field, they do not have the pressure of others expecting a response. In this way, software engineers can signal to others that this information is possibly relevant or interesting, however

does not require action. Additionally, other social norms such as attempting to present information in as concise and accurate a form as possible, go towards addressing possible overload.

While overload does not seem to be a problem, the software engineers do refer to potential distractions that emails can cause. They admit to pop ups and notifications being distracting, and sometimes leading to a loss of concentration and work flow. Others note the fact that emails have the potential to take up a significant amount of work time. Jackson (2001) provides evidence that people tend to check emails continuously and that it takes about a minute to recover after each new mail comes in. The software engineers are certainly aware of the potential distraction, however did not highlight it as a big problem, just something to deal with in normal working life. Interestingly, Jackson (2003b) suggests users should not continuously check email, something which the software engineers mostly do.

As a closing part of the interviews, the concept of email training was addressed. Most felt they do not require training. There is also a tendency for participants to express the idea that they had good email practices, and hence did not require training, but that other people might benefit from training. There are some, however, that express interest in further training, and the fact that they might not have the best email practice currently. Additional to this, some participants describe the learning process, where you learn by using and watching others, as something they themselves went through. Some research does suggest that training is effective at improving email behaviour. (Jackson, 2003a, 2006) It seems to be an underdeveloped research area, however, and a significant number of participants in this study are quite sceptical about the need for further training.

Thus far the discussion has centred on numerous aspects and behaviours related to email use by software engineers. The literature often offers multiple different findings about specific aspects of email. As such, it is mostly possible to match behaviours found in this study, to at least one other study, even though others might contradict others. Likewise, it is possible to partially support some claims in one specific study, while disagreeing with others in that same study. The result is an overview of behaviour specific to a single profession, which needs further research in order to further validate the patterns identified. This need for further research, and a brief summary of findings, will be addressed in the concluding chapter.

6. Conclusion

Research into emails is problematic. The literature review shows that email research encompasses a large, disconnected body of literature and different research fields. This in turn leads to numerous, often contradicting ways of explaining various different phenomena of email. Research has focused on media choice, specific behaviour, the file and task management attributes of email, and the associated email overload and potential problems, to repeat a few. While much research focused on one or more specific aspects of email, there is limited research focusing on a single profession and email use within. The aim of this thesis is to fill this research gap through investigating how software engineers use and relate to email at work. This was done through appropriate coding and subsequent comparing of participant responses to the extensive body of existing literature concerning email. The abductive nature of the research allowed for codes and themes to be developed solely on the basis of participants' responses and their views of the email phenomenon.

Data indicates that the small sample within the software engineer population relates to email on the one hand as a means for communication, on the other in tool for alternate purposes. Software engineers in this research clearly use email in a variety of different ways. Decision-making processes, Personal Information Management including archiving and retrieving email, as well as contact management, social behaviour patterns such as response expectation, email etiquette and the need for clarity in emails, amongst others, represent vital technical functionalities and user habitat of email within the target. The compression of time and space, the concepts of synchrony and asynchrony, and email as a distraction from work, amongst other codes, are closely associated with the use of email. Email has become such a crucial part of their working life that it can be considered integral to their communication and daily work activities. Participants store, manipulate and access information and coordinate tasks using email. Moreover, email is a part of their daily social interactions, where they manage expectations and navigate organisations. The way that responding software engineers talk about email reflects software engineering as a profession that centres on technology and knowledge management.

All in all, the research shows that findings can be related back to literature and confirm existing concepts, patterns and ideas to different extents. The methodological decision to focus on one profession that by definition is at the heart of email, rather than one specific aspect of email has ramifications. Since this study explores the overall use of email within software engineering, further research into the same profession could focus on individual aspects of email. The issue of synchrony for example, is an interesting aspect to explore further. Where is the boundary between synchrony and asynchrony in emails, and what effects does this have on written communication? Are emails really capable of synchronous communication or does the very nature of the medium inhibit emails from having the characteristics of synchronous communication?

There is clearly a blurring of technology capabilities, and participating engineers often use different types of CMC in their work. Previous studies which compared emails to other media

only focused on media choice, and considered the media to be all separate. Interesting further research could look at software engineers and how they use email in concurrence with other communication software, for example instant messaging. This could potentially provide a more complete picture of written communication at the work place, rather than only focusing on one medium.

In addition, it is hard to compare software engineers' use of email with other professions due to the lack of research. It would be beneficial to do a follow up study using a quantitative approach, on a broader scale. Quantitative measures could potentially support or challenge current findings and enable a possible generalisation of findings within the population of software engineers. Further email studies centred on different specific professions would also provide more context for this study. Are software engineers unique in the way they use and think about email? Is email such an institution that other professions also have their work embedded in and around email?

Even though email only represents a rather small area in the discipline of communication, this research successfully investigates the necessity of email in the everyday work of the software engineering sample. Both reviewed literature and primary research data agree with the initial statement by Wasiak et al. (2010) that email goes beyond the mere function as a communication technology. Evaluations of primary data indicate that email persists amongst the research sample and that the participating users refrain from using alternative communication media due to a range of opportunities and strengths of email as a multifunctional tool incorporated in everyday software engineering practice. Dedicating email research to individual professions such as software engineering can eventually inform system design and tailor email to the respective needs of the professional user. Additionally, software engineers have the skills and knowledge to both inform and be a part of email development.

Considering the situational use of email and behaviour patterns of users, the study confirms several concepts and frameworks developed throughout the past three decades of email research and essentially supports Whittaker et al.'s (2005) notion of email potentially being "the most successful computer application yet invented."

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Appendix

Appendix A: Interview guide: semi-structured in-depth interviews

Introductory questions

1) How would you describe your position and role at work?

2) Briefly describe a normal day at work, with some possible activities.

3) What is email for you??
Just as some clarification about the term 'email', before we continue on further, we would like you to describe what you mean by email (i.e. what makes an email an "email"). This could be listing things that make something an email, or comparing it to other things and talking about differences.

Emails and Numbers

4) What do you think about email at work? (from Dawley and Anthony, 2003, as a guiding question)

5) a) What email client do you use at work? (How is email organized at your company?)
   b) Do you use any other communication software (written communication) that is similar to email?

6) a) How much time would you estimate you spend on your email account each day? (Just an approximate guess, on an average day) (You can clarify if it depends on projects/activities)
   b) Do you set aside planned time for writing email?
   c) How much of that time do you think would be spent on reading, writing/responding, organising emails?
   d) Do you normally draft emails? That is, finish an email, re-read it and improve the writing. (I.e. do you write quickly, slowly - take care when writing, etc. etc. - touches on formality of the writing)

7) Approximately how many emails would you
 a) Receive in a normal working day?
 b) Read out of those received?
 c) Write (both emails that you initiate and emails you respond to)?

Email Function

8) a) What do you use email for?
   b) What situations do you use email in? / Does your use of email change depending on the situation? (Positions, internal/external, initial/follow-up)

c) What makes you choose emails e.g. over other methods of communicating (in those situations described?)

9) a) How does email help you in your job?? (Adapted from Dawley and Anthony, 2003)
   b) How does email hinder our job performance? (Adapted from Dawley and Anthony, 2003)

11) Do the emails you write have an impact? (That is, do you think you can have an impact through the medium of email, for example, in promoting change, etc.)

Email specifics

12) Lets consider the following parts of an email:
   a) the topic title
   b) the greeting
   c) the body (the way in which you organize the information in the main text)
   d) the goodbye (sign off)
   e) the name of the sender(s)
How do you use them? Are they important, or do they help you in any way? What do you think about them (if you think about them at all)?

13 a) Do you respond differently to emails depending upon how they're written (maybe even depending upon specific aspects, like the title, or first few lines)?
   b) (If appropriate) Have you thought about this when writing your own emails?

14 a) Do you use automated replies or any automated functionality?
   b) How do you feel about them?

15) Are there any templates or guidelines that you have to follow?

Closing Questions

16 a) Just briefly, can you remember and describe any training specific to written communication that you did in your studies? Was this discipline specific to your studies (for example, maths, engineering subjects) or was it a language and/or communication subject?

   b) Was there anything specific in your education that focused on email writing? Could you apply the knowledge and skills from that education to the writing of emails?

17 a) Have you received support or training in relation to email communication?
   b) Do you feel you need email related training?